Economic Impact Assessment

Prepared by Oxera Consulting Ltd and PA Consulting Group for Gatwick Airport Limited

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Contents

Executive summary

The Airports Commission (the ‘Commission’) is required to report by summer 2015 on:[1]

- its assessment of the options for meeting the UK’s international connectivity needs, including their economic, social and environmental impact;
- its recommendation(s) for the optimum approach to meeting any needs.

In its interim report, the Commission shortlisted three options for meeting the UK’s international connectivity needs:[2]

- a **second runway at Gatwick**: 3,400 metres in length and positioned sufficiently far south of the existing runway to permit fully independent operation (the ‘Second Runway Development’, or R2);
- a **third runway at Heathrow**: 3,500 metres in length and positioned to the north-west of the airport, sufficiently far from the existing airport to enable fully independent operation (‘Heathrow NW’);
- an **extension of the existing northern runway at Heathrow** to the west to a minimum of 6,000 metres in length, thereby allowing it to be operated as two separate runways.

The Commission has undertaken to provide a business case and sustainability assessment for each of these options,[3] following the guidance set out by HM Treasury for the production of business cases in government.[4]

Gatwick Airport Limited (GAL) commissioned Oxera Consulting Ltd (Oxera) and PA Consulting Group (PA) to collate information on the Gatwick option, undertake independent economic analysis, and provide an assessment of the options for capacity expansion. In conducting our analysis, we have used inputs from other consultants working for GAL. Our estimates are therefore the result of using such assumptions.

The purpose of this document is to provide an independent economic impact assessment which reflects this information. This should assist the Commission in its task and provide clarity in the assessment of the Gatwick option. It sits alongside other documents produced for GAL, including a sustainability assessment, which is in keeping with the requirements of HM Treasury’s Green Book.

Both the Commission’s and our business case consist of five cases, as follows.

- **Strategic Case**: sets out the strategic context around the need for additional capacity and the reasons why government intervention is required. While this case is broadly independent of any proposed option, it sets out the wider policies and frameworks that should be taken into account when determining a preferred option and the rationale for the approach to evaluate and assess the potential options.

[1] Airports Commission Terms of Reference, available from: https://www.gov.uk/government/organisations/airports-commission/about/terms-of-reference
[2] Airports Commission (2013), ‘Interim report’, December, p. 14. The Commission has also commissioned further work into the possibility of a new hub airport located in the Thames Estuary, with a view to ascertaining whether this option is viable.
[3] Airports Commission (2014), ‘Appraisal framework: consultation’, January.
[4] HM Treasury (2013), ‘Public sector business cases using the five case model: Green Book supplementary guidance on delivering public value for spending proposals’.

- **Economic Case**: this case sets out the evaluation and appraisal of the options against the evaluation framework, providing a clear rationale for which option is preferred and why. It contains an economic analysis, showing the incremental costs and benefits of each option against a 'do-minimum' baseline.
- **Commercial Case**: this case sets out the commercial approach to procuring the capability required to deliver the preferred option. The case also outlines the main commercial considerations around the acquisition of the necessary land for an additional runway.
- **Financial Case**: this case sets out the costs of delivering the preferred option, how these costs will be financed, and what the expected revenues will be.
- **Management Case**: this case shows that the preferred option is deliverable and will provide the benefits to the UK as set out in the Economic Case.

This document provides an economic appraisal of two of the Commission's three options—Gatwick R2 and a third runway at Heathrow—against a common baseline (known as the '**Do Minimum**'). The third option identified by the Commission (of extending one of the two runways at Heathrow) is not considered in detail owing to a lack of detail about this proposed scheme at the time of writing.

Both the Commission and the Department for Transport (DfT) have frameworks for appraising the economic, social and environmental impacts of additional airport capacity.[5] These frameworks are broadly consistent (indeed, the Commission's framework builds on the DfT's framework), in that they aim to assess the impact of additional airport capacity on societal welfare, which covers a wider range of considerations than just economic benefits (for example measured by GVA) or environmental costs. For example, welfare includes the benefits that consumers receive from purchasing a product or service, which are greater than (or equal to) the price they paid for that product or service.

Both of these frameworks overlap with the requirements of a Sustainability Assessment. However, the economic impact assessment focuses on different aspects, such as placing greater weight on the impacts on users and providers of the aviation sector than does the Sustainability Assessment. As such, these two approaches complement each other in providing a more rounded assessment of the impacts of additional runway capacity.

Where possible, this economic appraisal covers the requirements of both the Commission and the DfT's appraisal frameworks, and extends them in areas that have important consequences for welfare that are not covered by the appraisal frameworks—one of which is the impact of competition on the aviation market. Keeping within these frameworks means that both options are compared against a common Do Minimum, rather than directly against each other. This facilitates comparison of the two options by avoiding having to reconcile the impacts of detailed assumptions and is standard practice when conducting economic appraisals.

While there are considerable similarities between the Commission's and the DfT's appraisal frameworks, there are also areas of difference. The DfT's

[5] Airports Commission (2014), 'Appraisal framework', April. The DfT's appraisal framework consists of a number of units, all available from: https://www.gov.uk/transport-analysis-guidance-webtag, accessed 16 March 2014.

framework has been used to provide the structure of this appraisal, with the additional requirements of the Commission's framework accounted for where necessary. We have adopted this approach because the DfT's framework lends itself more naturally to assessing the economic aspects of the business case. Moreover, before any government policy is adopted, a DfT-compliant appraisal will need to be conducted. However, it is important that the relationships between the two frameworks are clear. The table below provides a mapping between the two systems.

Mapping from Commission to DfT appraisal frameworks

		Contained in:				
Commission appraisal modules	**TAG Unit**	**Strategic Case**	**Economic Case**	**Financial Case**	**Commercial Case**	**Management Case**
Strategic fit	n/a	✓				
Economy impacts	A1.3, A2.1	✓	✓			
Local economy impacts	A2.2, A2.3, A4.2	✓	✓			
Surface access	A2.3		✓			✓
Noise	A3		✓			✓
Air quality	A3		✓			✓
Biodiversity	A3		✓			✓
Carbon	A3		✓			✓
Water and flood risk	A3		✓			✓
Place	A4.1		✓			✓
Quality of life	A4.1		✓			✓
Community	A4.1		✓			✓
Cost and commercial viability	A1.2		✓	✓		
Operational efficiency		✓			✓	✓
Operational risk		✓	✓			✓
Delivery				✓	✓	✓

Source: Oxera.

While the appraisal aims to put a monetary value on as many of the economic, environmental and social impacts of additional airport capacity as possible, there are areas where the appraisal is mostly qualitative, including the social and distributional impacts of that capacity expansion. Furthermore, although the objective of the appraisal is to compare the impacts of R2 and Heathrow NW on the London system of airports, this is not always possible owing to data constraints. Therefore, reasonable assumptions have been made to allow R2 and Heathrow NW to be assessed on a consistent basis.

In all aspects of the economic appraisal, the relevant consideration is the overall impact of R2 or Heathrow NW on the London system of airports and the rest of the UK, rather than the impact at individual airports. Therefore, wherever we refer to R2 or Heathrow NW, we are referring to the option for expanding capacity through building a second runway at Gatwick or a third runway at Heathrow to the North West of the current airport. This makes the economic appraisal different to some other parts of the business case that are concerned with the financing of infrastructure at particular locations.

Oxera and PA have used inputs from other consultants working for GAL and from public domain reports. We have conducted a high-level scrutiny of these inputs, but have not undertaken a detailed quality assurance process.

The key conclusions arising from this economic appraisal are that R2:

- would deliver **significant benefits to users and providers of the aviation sector (including through greater competition)**, with benefits of £51bn,[6] rather than £29bn from Heathrow NW.[7] This effect arises from lower fares, a greater volume of demand, lower costs, lower levels of delay (including from changes to the surface access network), increased levels of competition and reduced travel times compared with expansion at Heathrow;

- would enable greater competition between both airports and airlines than Heathrow NW. The benefits of this greater competition could be as large as £10bn–£14bn.[8] These benefits are expected to arise through a number of mechanisms, which vary depending on whether the competition is between airlines of the same type, and whether those airlines are competing from the same or different airports. The benefits from increased competition are likely to disperse throughout the London airport system, benefiting all passengers, even on routes where there is no direct competition. This indirect effect could be as much as the direct competition effect;

- would provide **significant economic benefits** to the UK economy. The wider economic benefits of R2 (i.e. those that are additional to the benefits to users and providers of aviation services) are predicted to be £28bn compared with £21bn for Heathrow NW. This value is considerably lower than some other benefits other studies have attributed to the expansion of airport capacity,[9] principally because we have sought to avoid double-counting any of the costs or benefits of additional airport capacity. The wider economic benefits outlined in this document (increase in output arising from the reduction in transport costs in imperfectly competitive markets, agglomeration, move to more productive jobs and increased trade) are additional to the benefits experienced by the users and providers of aviation. This is not the case for some of the other estimates of the economic impact of additional airport capacity; as such, care must be exercised when comparing numbers in this area;

- would be expected to be **revenue-generative** for the Exchequer, providing a present value of £15bn of additional revenue to the Exchequer through increased receipts of Air Passenger Duty (APD) (£4bn), fuel duty and VAT receipts (£8bn) and contribution to rail franchises (£3bn). This compares with £11bn for Heathrow NW, where APD receipts would increase by £3bn and rail franchise revenue by £1bn. As similar data is not available for the Heathrow NW scheme on the additional fuel duty and VAT this category is assumed to be the same as for the R2 option;

[6] All monetary values are in net present value (NPV) over a 60-year appraisal period from 2021 to 2080, discounted to 2014 prices at the social discount rate of 3.5% for the first 30 years and 3.0% afterwards. All monetary values are 2010 prices.
[7] These values include both a transfer of wealth from producers to consumers and a reduction in overall welfare loss.
[8] Oxera's approach has been to calculate the impact of competition in such a way that the competition benefits presented here are additional to the benefits to users and providers, and hence are included in the overall benefits summarised in the first bullet.
[9] See, for example, Frontier Economics (2012), 'One hub or none: the case for a single UK hub airport', November.

- would have **lower monetised environmental impacts (excluding greenhouse gas emissions)** than Heathrow NW. The monetised environmental impacts of R2 are £0.2bn covering the impact of noise and local air quality, compared with £1bn for Heathrow NW. However, expansion at Heathrow would result in approximately 190,000 people being affected by noise (an increase of approximately 50,000 from the Do Minimum),[10] while expansion at Gatwick would affect approximately 14,100 (an increase of approximately 11,000 from the Do Minimum). Other environmental costs (such as the impact on landscape and biodiversity) have not been monetised as part of this appraisal, but the qualitative assessment is that, on balance, these environmental costs are less at Gatwick than Heathrow;

- would have **higher greenhouse gas emissions**, with monetised costs of greenhouse gas emissions of £13bn for R2 compared with £9bn for Heathrow NW. Greenhouse gas emissions are driven mostly by the number of flights and are therefore greater for R2 than for Heathrow NW, reflecting the greater traffic forecast by SH&E for R2 compared to Heathrow NW.

- would be **lower cost** and **more flexible** than Heathrow NW. R2 is expected to cost £11bn (including OPEX),[11] compared with £19bn (including OPEX) for Heathrow NW. Oxera understands that R2 could be financed by private capital, while Heathrow would require a significant public sector subsidy for surface access work.[12] In addition, there is expected to be a significant value associated with the greater flexibility from expansion at Gatwick compared to that at Heathrow, with the facilities at Gatwick being easier to adapt to reflect the level and type of demand than those at Heathrow. Therefore, expansion at Gatwick is likely to be better able to meet passenger demand for air travel than expansion at Heathrow, in a wider range of plausible outcomes. For example, if increased demand in the future is driven by the emergence of lower-cost, long-haul carriers offering point-to-point services then Gatwick is better placed to service those carriers than Heathrow. This is because Gatwick is likely to be able to offer lower airport charges and faster turnaround times, which would make those carriers' business models more profitable, in a way that Heathrow, with higher airport charges and longer turnaround times, cannot;

- would have **lower delivery, planning and cost risk** than Heathrow NW. There are significant risks associated with the infrastructure work at Heathrow, which is not the case at Gatwick. For example, the work required on road access is much greater at Heathrow (due to the modifications required to the M25) than at Gatwick (where the only major road scheme is the re-routing of the A23). In addition, significant delays are expected to other users of surface access (with a total cost of approximately £1bn for construction at Heathrow);

- would have significant economic benefits to the local economy and the wider London and South East area, providing the **potential to regenerate local areas of deprivation**, and enabling the delivery of the London Plan[13] and ambitions of the Coast to Capital Local Enterprise Partnership.[14] Expansion at

[10] Based on ERCD data for comparative purposes.
[11] Including all surface access costs. Split between capital costs of approximately £7.3bn, and £3.3bn on operating costs. Hence, the total base cost of the project is estimated to be approximately £10.6bn.
[12] http://mediacentre.heathrowairport.com/press-releases/heathrow-north-west-third-runway-option-short-listed-by-airports-commission-779.aspx, accessed 9 May 2014.
[13] Mayor of London (2011), 'The London Plan: spatial development strategy for Greater London', July.
[14] Coast to Capital Local Enterprise Partnership (2012), 'Our strategy for Growth', July.

Gatwick is expected to generate significant numbers of jobs (approximately 22,000 as a direct consequence of the expansion), as well as those arising from catalytic effects. While the areas immediately around Gatwick are relatively affluent, many areas from which Gatwick could draw employees are relatively deprived. It is expected that many of the employment opportunities created by an expansion at Gatwick could be filled by people from these more deprived areas, thus facilitating considerable regeneration of areas such as Croydon, South London and South East London. However, the success or otherwise of such a strategy will be dependent on GAL having a robust employment strategy to recruit employees from areas of deprivation. The planning strategies of the relevant local authorities will also be important in facilitating the regeneration of these areas;

- would provide **greater strategic resilience** to the London airports system by increasing the potential for Heathrow and Gatwick to accept traffic from the other to reduce delays thus increasing the attractiveness of London (and the UK) as a destination. This is likely to raise the levels of traffic to London as a whole compared with alternative options;
- could be **constructed faster** than a new runway at Heathrow, with R2 operational by 2025. The benefits of this are included in the greater benefits of R2 compared with Heathrow NW outlined above, as these benefits would begin to accrue earlier.

In summary, the present value of benefits arising from R2 is £52bn excluding wider economic impacts, and £79bn including wider economic impacts,[15] providing a total benefit–cost ratio (BCR) of 4.9.[16] The present value of benefits arising from Heathrow NW is £30bn excluding wider economic impacts, and £51bn including wider economic impacts,[17] providing a BCR of 1.5. All these values exclude indirect competition benefits of between £10bn and £14bn from the construction of R2 rather than Heathrow NW.

This analysis therefore shows that R2 is the preferred option for providing the additional runway capacity required to meet the UK’s need for additional aviation connectivity, by providing a solution that would have lower costs, superior economic benefits, greater levels of competition, and environmental costs similar to the alternative of Heathrow NW.

[15] Total benefits (£51.7bn) consist of user and provider impacts (£50.5bn) plus the impact on public accounts (£14.8bn) less environmental costs and the costs of greenhouse gas emissions (£13.6bn). The addition of £27.7bn of wider economic impacts gives the total of £79.4bn.
[16] Using resource costs as the measure of costs and excluding wider economic impacts and indirect competition from the benefits.
[17] Total benefits (£29.5bn) consist of user and provider impacts (£28.6bn) plus the impact on public accounts (£11.3bn) less environmental costs and the costs of greenhouse gas emissions (£10.4bn). The addition of £21.4bn of wider economic impacts gives the total of £50.8bn (there may be a slight discrepancy due to rounding).

1 Introduction

The Airports Commission ('the Commission') is required to provide:[18]

- its assessment of the options for meeting the UK's international connectivity needs, including their economic, social and environmental impact;
- its recommendation(s) for the optimum approach to meeting any needs.

In its interim report, the Commission shortlisted three options for meeting the UK's international connectivity needs:[19]

- a **second runway at Gatwick**: of more than 3,000 metres in length and positioned sufficiently far south of the existing runway to permit fully independent operation (the 'Second Runway Development', or R2);
- a **third runway at Heathrow**: 3,500 metres in length and positioned to the north-west of the airport, sufficiently far from the existing airport to enable fully independent operation ('Heathrow NW');
- an **extension of the existing northern runway at Heathrow** to the west to 6,000 metres in length minimum, thereby allowing it to be operated as two separate runways.

These options will be subject to further analysis.

The Commission has also commissioned further work into the possibility of a new hub airport located in the Thames Estuary, with a view to ascertaining whether this option is viable. The Commission has undertaken to provide a business case for each option,[20] following the guidance set out by HM Treasury for the production of business cases in government.[21] This approach requires the production of five separate cases, as follows.

- **Strategic Case**: this case sets out the strategic context around the need for additional capacity and the reasons why government intervention is required. While this case is broadly independent of any proposed option, it sets out the wider policies and frameworks that should be taken account in determining a preferred approach and the rationale for the approach to evaluate and assess potential options. In this case, we also set out the key strategic strengths of R2.
- **Economic Case**: this case sets out the evaluation and appraisal of the shortlisted options against the evaluation framework, providing a clear rationale for which option is the preferred approach and why. It contains an economic analysis of the options, showing the incremental costs and benefits of each option against a 'do-minimum' baseline.
- **Commercial Case**: this case sets out the commercial approach to procuring the capability required to deliver the preferred option. The case will demonstrate that the main commercial considerations are around the acquisition of the necessary land for an additional runway.

[18] Airports Commission Terms of Reference, available from: https://www.gov.uk/government/organisations/airports-commission/about/terms-of-reference
[19] Airports Commission (2013), 'Interim report', December, p. 14.
[20] Airports Commission (2014), 'Appraisal framework: consultation', January.
[21] HM Treasury (2013), 'Public sector business cases using the five case model: Green Book supplementary guidance on delivering public value for spending proposals'.

- **Financial Case**: this case sets out the costs of delivering the preferred option and how these costs will be financed.
- **Management Case**: this case shows the preferred approach is deliverable and will provide the benefits to the UK as set out in the Economic Case.

Gatwick Airport Limited (GAL) therefore commissioned Oxera Consulting Ltd (Oxera) and PA Consulting Group (PA) to provide an independent business case for R2. This business case is also consistent with the five-case approach set out by HM Treasury. This economic appraisal provides independent analysis for that business case, and in particular the Economic Case.

The two options considered in this document are the creation of a second runway at Gatwick and a third runway at Heathrow. The third option identified by the Commission (of extending one of the two runways at Heathrow) is not considered in detail owing to a lack of detail about this proposed scheme at the time of writing.

Box 1.1 Summary of the strategic case within the business case

Within a five case business case, the strategic case is broadly independent of any particular option for expanding capacity (this makes it rather different to the strategic case for Gatwick, which is made elsewhere in Gatwick's submission to the Commission). Rather, it focuses on why expansion of airport capacity is needed, the policy context in which a decision will be taken, and the important issues that need to be addressed.

The UK has an increasing dependence on air travel, with international connectivity supporting the export and import of goods and services, facilitating inbound and outbound tourism, and enabling increasing numbers of people to travel to visit friends and relatives in different countries. Economic growth in the UK has seen the number of passengers travelling through UK airports increase more than fourfold over the last 40 years, as foreign trade—in particular in the UK's service-based economy—has increased, people have become accustomed to holidays abroad, and the UK has increased levels of inbound tourism. Demand for air travel to and from the UK is forecast to continue rising over the next 40 years.

Owing to the historical locations of UK airports, and the distribution of the UK population, much of the demand for air travel is concentrated in the South East of England, primarily across the major London airports of Heathrow and Gatwick. These airports are now reaching maximum capacity, placing a constraint on the international connectivity of the UK to support further economic growth.

The time taken to deliver new airport capacity is considerable due to the evaluation of options, obtaining planning permission and construction. There is therefore a strategic need to consider the options now and initiate a preferred approach in order to deliver additional airport capacity within the next 10–15 years.

This strategic case sets out the strategic context around the need for additional capacity and the reasons why government intervention is required. While this case is independent of any proposed option, it sets out the wider policies and frameworks that should be taken into account when determining a preferred approach.

We explore the strategic imperative for a government-determined approach to provide additional airport capacity in the South East of England, setting out:

- **the need for investment in additional airport capacity in the South East of England**: we show the need for additional airport capacity and that future demand is unlikely to be met with current infrastructure—potentially limiting future growth in the UK economy;
- **the need for government intervention to deliver the optimal solution**: we show that while capacity will be delivered (although not necessarily entirely funded) by the private sector, airport providers require clear government support before starting any planning application for additional capacity. Furthermore, additional capacity should support wider government policies for economic development and the environment;
- **the future requirements for additional capacity**: we examine the likely future requirements for any proposed solution and the uncertainties within these requirements;
- **the proposed options to meet the strategic need**: we set out the strategic options and provide an initial assessment of how these options meet the strategic requirements.

Source: Oxera and PA.

As with other documents comprising the business case, Oxera and PA have drawn extensively on input from GAL and other consultants working for GAL. In drawing comparisons with Heathrow, Oxera and PA have used publicly available information and reasonable assumptions (i.e. supported by as much evidence as available), which are detailed where necessary.

This economic appraisal is broadly consistent with both the appraisal framework set out by the Commission and that set out by the Department for Transport (DfT)—known as WebTAG.[22] The appraisal is carried out for the London system in each case—i.e. to compare the costs and the benefits of a London system with three runways at Heathrow and one at Gatwick (known as '3+1') with the costs and benefits of a London system with two runways at both Heathrow and Gatwick (known as '2+2'). Precise details of where the costs fall are important for the financial and commercial cases, but are less relevant to the economic case, the focus of which is the impact of the schemes on social welfare.

As with any study of this type, there is considerable uncertainty about a wide range of factors, including (but not limited to) the demand for aviation travel; how airline business models evolve; government environmental policy; the international macroeconomic environment; and the role of aviation in facilitating trade. It is therefore important to acknowledge the range of uncertainty around the precise numerical results reported in this study. However, many of the arguments presented are expected to be robust and relevant in a wide range of future states of the world.

[22] Airports Commission (2014), 'Appraisal framework consultation', January; WebTAG consists of a number of 'units', which are available here: https://www.gov.uk/transport-analysis-guidance-webtag

The document is structured as follows:

- section 2 outlines the appraisal frameworks of the Airports Commission and the DfT, summarises their key differences, and explains how any differences have been reconciled;
- section 3 describes the Do Minimum, which provides the baseline against which both the Heathrow and Gatwick schemes are compared;
- section 4 describes the Do Something options, covering both a second runway at Gatwick and a third runway at Heathrow, and providing a comparison of the options;
- section 5 then presents an appraisal of the two options, providing the results in a series of tables drawn from WebTAG, and concluding on the relative costs and benefits of a 3+1 system compared with a 2+2 system;
- section 6 concludes;
- Appendix 1 provides a detailed mapping from the Commission's objectives to the Commission's appraisal modules and WebTAG;
- Appendices 2–11 contain detailed descriptions of the analysis that has been undertaken, including discussions of the relevant conceptual frameworks and data analysis;
- a glossary of the abbreviations used in this document is provided in Appendix 12.

2 Appraisal framework

Both the Commission and the DfT have appraisal frameworks that can be used to assess the economic, environmental and social costs and benefits of increased capacity at Heathrow or Gatwick.

The overarching guide to how appraisal should be conducted for decisions that involve spending public (i.e. government) money is the Green Book, produced by HM Treasury.[23] This sets out principles for justifying spending public money through the production of a five-case business case, as outlined above. Both the Commission and the DfT's appraisal frameworks draw on this framework and are outlined below. Appendices 2–11 provide more detail of the approach and the analysis.

2.1 Department for Transport appraisal framework (WebTAG)

The DfT has extensive guidance on how transport schemes should be appraised—this guidance is collectively called Transport Analysis Guidance (WebTAG).[24] The appraisal process is designed to 'enable analysts to build evidence to support business case development, to inform investment funding decisions'.[25] However, WebTAG has been developed predominantly to appraise domestic road and rail schemes, and therefore certain of its aspects need to be adjusted to capture fully the impacts of expanding airport capacity in the South East of England.

WebTAG is separated into a number of units, each of which provides detailed guidance on how to appraise a scheme's:

- costs;
- impacts on users and providers;
- wider economic impacts;
- regeneration impacts;
- impacts of any surface access schemes;
- distributional impacts;
- environmental impacts (covering noise, air quality, greenhouse gases, landscape, townscape, historic environment, biodiversity and water);
- social impacts (covering accidents, physical activity, security, severance, journey quality, option and non-use values, accessibility and personal affordability).

There is also an aviation appraisal unit, which outlines how the other WebTAG units should be used in assessing the impacts of an aviation scheme.[26]

2.2 Airports Commission appraisal framework

The appraisal framework published by the Commission outlines 16 'appraisal modules' that will be combined to produce a five-case business plan for the options for additional runway capacity. These appraisal modules are:[27]

[23] HM Treasury (2011), 'The Green Book: appraisal and evaluation in central government'.
[24] Available from https://www.gov.uk/transport-analysis-guidance-webtag
[25] Department for Transport (2014), 'Transport analysis guidance: an overview of transport appraisal', January, p. 1.
[26] Department for Transport (2014), 'TAG Unit A5.2: aviation appraisal', January.
[27] Airports Commission (2014), 'Appraisal framework consultation', January, p. 3.

- strategic fit;
- economic impacts;
- local economy impacts;
- surface access;
- noise;
- air quality;
- biodiversity;
- carbon;
- water and flood risk;
- place;
- quality of life;
- community;
- cost and commercial viability;
- operational efficiency;
- operational risk;
- delivery.

These appraisal modules will be used to test the options for expanding airport capacity in the South East of England against the Commission's objectives.[28]

The Commission will assess the options against a common Do Minimum. However, as this important aspect of the appraisal has not been set out in detail in the appraisal framework, Oxera has made assumptions about this Do Minimum, set out in detail in section 3. In addition, it is unclear how the different appraisal modules will fit together to produce an overall business case.

2.3 Reconciling the two approaches

Both of the appraisal frameworks outlined above are designed to support the production of a five-case business case. Given the considerable overlap between the Commission's appraisal framework and WebTAG, the appraisal reported here draws extensively on WebTAG as well as the Commission's appraisal framework.

To facilitate comparisons, Table 2.1 provides a mapping between the Commission's appraisal modules, WebTAG units, the different cases in the business case, and the relevant sections of this economic appraisal.

Table 2.1 Mapping from Commission to DfT appraisal frameworks

	Evidence on module contained in:						
Commission appraisal modules	**Strategic case**	**Economic case**	**Financial case**	**Commercial case**	**Management case**	**TAG Unit**	**Economic appraisal appendix**
Strategic fit	✓					n/a	n/a
Economy impacts	✓	✓				A1.3, A2.1	2, 8
Local economy impacts	✓	✓				A2.2, A2.3, A4.2	8
Surface access		✓			✓	A2.3	3
Noise		✓			✓	A3	4
Air quality		✓			✓	A3	4
Biodiversity		✓			✓	A3	4
Carbon		✓			✓	A3	4
Water and flood risk		✓			✓	A3	4
Place		✓			✓	A4.1	6

[28] Airports Commission (2014), 'Appraisal framework consultation', January, pp. 11–12.

	Evidence on module contained in:						
Commission appraisal modules	**Strategic case**	**Economic case**	**Financial case**	**Commercial case**	**Management case**	**TAG Unit**	**Economic appraisal appendix**
Quality of life		✓			✓	A4.1	6
Community		✓			✓	A4.1	6
Cost and commercial viability		✓	✓			A1.2	1
Operational efficiency	✓			✓	✓		n/a
Operational risk	✓	✓			✓		6
Delivery			✓	✓	✓		n/a

Source: Oxera.

The two key areas where Oxera and PA have deviated from the Commission's appraisal framework are:

- the wider economic impacts of expanding airport capacity;
- the impact of competition on welfare.

2.3.1 Wider economic impacts

The Commission's approach to assessing the wider economic impacts of expanding airport capacity is to consider the effects on trade, investment and tourism (referred to in this document as top-down impacts). However, as the Commission itself comments,[29] these wider economic benefits should not be considered to be additional to the welfare effects on users and providers of airports.

In conducting an economic appraisal, it is of considerable importance to avoid double-counting the benefits (or costs) of the scheme in order to avoid presenting a distorted picture of the business case for the scheme. Therefore, the approach to quantifying the wider economic impacts, as set out in WebTAG, is appealing, in that it provides a way of capturing only those economic benefits not captured elsewhere in the appraisal in the wider economic impacts assessment. (The wider benefits captured by a WebTAG appraisal can be characterised as being derived using 'bottom-up' approaches. They cover agglomeration, labour market impacts, and an increase in output in imperfectly competitive markets.)

[29] Airports Commission (2013), 'Interim report: appendix 3: technical appendix', December, p. 9.

Box 2.1 The relationship between top-down and bottom-up wider economic impacts

There is a complex relationship between 'top-down' wider economic impacts (such as the impact on trade, investment, etc.), bottom-up wider economic impacts (such as agglomeration, labour market effects, etc.), and user and provider impacts. For example, consider the impacts of expanding an airport on:

- the gains from trade (a top-down impact);
- the move to more productive jobs (a bottom-up impact);
- the users and providers of that airport.

Starting from the standard position that at the core of a transport appraisal are the impacts of the capacity expansion on users of the airport and providers of the airport services (as these are likely to be both the largest and most direct effects), it is then important to ensure that any benefits added to these user and provider impacts are genuinely additional to those impacts; otherwise, the benefit is double-counted.

The top-down impact of gains from trade will arise from an increase in international connectivity which will result in increased trade. This, in turn, is expected to result in increased economic activity, thus providing a benefit to the UK. However, it is important to understand *how* these gains from trade arise in order to prevent double-counting, as noted above. Double-counting may arise because the way in which these gains from trade arise is via individuals moving to jobs because of a reduction in (generalised) transport costs. This reduction in transport costs may arise as a result of the increase in airport capacity, which provides greater opportunities to trade, enabling greater specialisation of labour and therefore it is now profitable for that individual to move jobs when it was not before. Individuals would be expected to move jobs to the point at which the benefit to them (through higher pay, greater job satisfaction, etc.—measured through the willingness to pay for transport) is equal to the cost to them (i.e. the cost and time of travel). However, the benefit to that individual from moving jobs will be captured in the user and provider impacts, as these cover the difference between users' willingness to pay for travel and the cost of that travel.

Therefore, it would not be appropriate to count either the entirety of the additional productivity from the move of jobs or the gains from trade as additional benefits from the expansion of airport capacity. However, there is an additional impact on the UK arising from the move to a more productive job, which is not captured in the user and provider impacts: the additional tax paid by the more productive employee (as greater productivity would be expected to result in a higher wage for the employee and/or greater profit for the firm).

Similar issues are present in considering other top-down effects, such as changes in the level of tourism, and changes in investment.

Source: Oxera.

However, as noted in section 3.1, WebTAG has been developed for domestic road and rail schemes, and therefore also needs to be amended to reflect the likely effects of these schemes, given their international dimension. The approach adopted for this appraisal is set out in more detail in section 2.4.8.

2.3.2 Competition

The impact of changes in the intensity of competition on economic welfare is an important consideration in assessing the structure of a market.[30]

Box 2.2 The Competition Commission's market investigation

In 2009, the CC reported on its investigation into the market power of BAA. The aim was to establish if there was currently competition between BAA airports and other airports, if there was scope for increased competition, and if the break-up of BAA would facilitate this competition.

The CC concluded that common ownership by BAA of the three London Airports (Heathrow, Gatwick and Stansted), and Heathrow's status as a hub airport, is a feature 'which prevents competition between them'.[31] Common ownership of Glasgow and Edinburgh airports was also deemed to have a negative impact on competition. It was consequently decided that divestiture by BAA of two of the three London airports was necessary. The benefits which would accrue from this decision, and the subsequent increase in competition, were expected to be substantive. 'The way in which the London airports deliver capacity in terms of its timeliness, design and cost effectiveness as well as its allocation to users',[32] were all expected to improve. It was recognised that capacity constraints currently limited extensive price competition, but as these constraints were in part a result of BAA's common ownership, consumers were expected to benefit from lower prices a few years down the line.

Source: Oxera, based on Competition Commission (2009), 'BAA airports market investigation. A report on the supply of airport services by BAA in the UK'.

While the impact of competition is not explicitly addressed in WebTAG, there is a competition objective in the Commission's appraisal framework, and the Commission has stated that competition will be assessed as part of the 'economy impacts' appraisal module. The way in which competition in the aviation sector functions is complex and is not straightforward to include within the standard approach to economic appraisal. In addition, the demand forecasts produced by the Airports Commission and the DfT do not allow for the modelling of the effect of the different capacity options on competition, while those produced for GAL by SH&E do. Therefore the welfare impacts of competition are considered separately to the other aspects of the appraisal, as explained in Appendix 6.

[30] For example, it was considered in detail in the Competition Commission's investigation into BAA, which resulted in the break-up of BAA. See Competition Commission (2009), 'BAA airports market investigation: A report on the supply of airport services by BAA in the UK', 19 March. The final report is available here: http://www.competition-commission.org.uk/our-work/directory-of-all-inquiries/baa-airports/final-report-and-appendices-glossary

[31] Competition Commission (2009), 'BAA airports market investigation. A report on the supply of airport services by BAA in the UK', para. 1(a).

[32] Competition Commission, 'BAA airports market investigation', March 2009, p15

2.4 Summary of appraisal framework used in this document

The approach to appraisal adopted in this document is summarised in this sub-section. Table 2.2 sets out the key appraisal parameters.

Table 2.2 Key appraisal parameters

Parameter	Value	Comments
Appraisal start date	2021	Expected start of major construction works
Appraisal end date	2080	60 years after start of construction, as per Commission appraisal framework
Runway opening date (Gatwick)	2025	Provided by SH&E traffic forecasts
Runway opening date (Heathrow)	2030	Provided by SH&E traffic forecasts
Discount rate	3.5% for first 30 years, 3.0% otherwise	HMT Green Book, p. 99
Price base	2010	Deflated to 2010 using GDP deflator
Scenarios considered		Do Minimum, Heathrow NW, Gatwick R2—option 3/no End-Around Taxiways (EATs)
Phasing of construction	Yes	
Base year	2014	Consistent with WebTAG

Source: Oxera.

The following sub-sections provide an introduction to the appraisal approach adopted in each area. More details of the approach are available in the relevant appendices.

2.4.1 Costs

The estimation of the costs for R2 is a crucial component of the appraisal process. These costs need to be evaluated in a robust and realistic manner to ensure that the assessment of affordability and value for money is not adversely affected.

Oxera's approach to estimating costs is based on the framework described in WebTAG.[33] As with other aspects of this economic impact assessment, Oxera has relied on data supplied by GAL and has not verified separately the reliability or accuracy of those estimates. However, we understand that GAL has undertaken extensive work to verify the cost estimates, some of which is outlined in Appendix 2, while the remainder is detailed in the relevant technical reports.[34] Data for expansion at Heathrow is taken from public sources.

The costs have been grouped under three main components, as required by the TAG guidelines:

- base costs;
- adjustment for risk;
- adjustment for optimism bias.

[33] Department for Transport (2014),'TAG Unit A1.2 Scheme Costs', January, available at https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/275128/webtag-tag-unit-a1-2-scheme-costs.pdf; accessed on March 26th, 2014.
[34] Turner & Townsend (2014), 'London Gatwick Airport expansion Airports Commission submission: Module 16 construction programme and risk profile'.

Base costs are the standard costs relevant to R2, and comprise capital expenditure (CAPEX), operating expenditure (OPEX) and maintenance costs in a given price base. These incorporate costs relevant not only to the new runway itself, but also to all other associated projects, such as surface access, terminals, taxiways, aprons, and car parks. Also incorporated are costs associated with project design and project management. In the case of R2, the assumption is that prices would rise in line with inflation over the course of the construction project. The base costs capture the cost to all parties (including central government and the Highways Agency), regardless who pays them.[35]

The **adjustment for risk** is based on a detailed risk analysis, as described by the Quantitative Risk Assessment (QRA) framework of the TAG guidelines. Gatwick has undertaken three forms of QRA:

- Quantitative Cost Risk Analysis;
- estimating uncertainty;
- Quantitative Scheduled Risk Analysis.

The first step of the QRA identified risks that are likely to affect the delivery and operation of R2. These risks were then evaluated and scored. The impact of risks that will be transferred to other parties (e.g. through insurance or hedging) is not considered (as, if those risks arise, the costs will fall on other parties), and only the costs/premiums for the risk transfer are included. Using a comprehensive risk register, the impact of risk on the costs of the project, likelihood of occurrence, and probability distribution, was then evaluated. Running simulations through risk modelling software provided estimates at various confidence levels.

Additionally, mitigation plans have been developed for the top 20 risks. The proactive mitigation plans which are in place increase the likelihood that GAL would deliver the scheme on budget.

The adjustment for optimism bias has not been used for the Master Plan – Operational Efficiency base estimate as a result of the project's mature risk management framework and processes.

2.4.2 User and provider impacts

As airlines and customers of air travel services (passengers and freight users) are the main users and consumers respectively of runway space, the economic impact assessment of R2 and Heathrow NW needs to include analysis of the impact on these two groups. For this analysis, Oxera has followed the methodology outlined in WebTAG,[36] on which the Commission's approach is also built.[37]

The quantification is based primarily on forecast traffic data from SH&E. Where the analysis required additional forecast variables, which were not available from SH&E, other data sources have been used. Further details of the methodology and data used are given in Appendix 3.

[35] GAL and its consultants have conducted detailed bottom-up cost estimation analysis, including extensive risk-modelling. The result is significantly different to that adopted by the Commission in its interim report, which was also based on the DfT's TAG guidelines. Much of the difference may be explained by the difference in quantifying optimism bias. As explained in Appendix 2, GAL's estimates are based on a mature risk management framework and therefore optimism bias has not been applied to most aspects of its cost estimate.
[36] Department for Transport (2014), 'TAG Unit A5.2 Aviation Appraisal', January.
[37] Airports Commission (2014), 'Appraisal framework consultation', January.

2.4.3 Surface access impacts

Changes in surface access (roads and rail links) to airports have a number of impacts, by:

- allowing the airport expansion to proceed in the first place—maintaining an adequate service to other road users is not only a key aspect of the Commission's surface access appraisal module, but also likely to be an important aspect in gaining planning permission; and
- providing benefits to other users of that surface access network who gain from the improvements.

Therefore, it is important to capture these benefits in the economic appraisal, Oxera has followed the approach set out in WebTAG,[38] which essentially is to:

- assess the user benefits—changes in 'generalised cost' (i.e. the time and monetary cost of travel) for those people travelling on the surface access networks regardless of airport expansion;
- capture the benefits of the airport development (i.e. changes in land values, amenity values of land, and external costs of transport).

2.4.4 Environmental impacts

To monetise the environmental impacts of additional runway capacity, Oxera has followed the approach set out in the Commission's appraisal framework. However, it is important to recognise the inherent uncertainties in monetising the impacts of changes to the environment, and, while the values contained in this section are consistent with best practice, in some cases there remains considerable uncertainty surrounding the appropriate values to use.

Noise

The Commission recommends the following for the monetisation of noise effects: for sleep disturbance and annoyance, the use of the WHO disability-adjusted life years (DALY) approach;[39] for health effects, including acute myocardial infarction (AMI) and hypertension, the use of the ERCD report 1209.[40] Both of these methods involve calculating the percentage of people within a noise contour 'affected', and then applying a disability weighting to estimate the health cost to the 'affected' people in terms of years of life lost (YLL). Oxera has followed these recommendations, and applied a DALY value of £60,000 (in 2009 prices) as recommended by the Interdepartmental Group on Costs and Benefits (IGCB). Forecasts of populations in L_{Aeq}, and L_{DEN} contour bands were provided by GAL to facilitate the monetisation.

It is important to remember that the appropriate values to use in monetising the health and annoyance impacts of noise remain an active area of research, and there is considerable uncertainty about the magnitude of these values. In light of this uncertainty, we have also had regard to the number of people exposed to noise from the airports, which is measurable with more certainty and is a

[38] Department for Transport (2014), 'TAG Unit A5.2 Aviation Appraisal', January.
[39] World Health Organisation (2011), 'Burden of Disease from environmental noise', http://www.euro.who.int/__data/assets/pdf_file/0008/136466/e94888.pdf.
[40] CAA/ERCD (2013), 'Proposed methodology for estimating the cost of sleep disturbance from aircraft noise', January, ERCD report 1209.

relevant (non-monetised) consideration in drawing conclusions about whether R2 or Heathrow NW is the preferred option.

Carbon

Emissions of greenhouse gases (GHGs) can arise from both aircraft use and non-aircraft use. Given the global impact of GHG emissions, it is important that all sources of emissions are captured. All GHG emissions are converted into tonnes of CO_2 equivalent (tCO2e) prior to monetisation.

The monetisation of carbon emissions is relatively straightforward:

- the change in carbon emissions relative to the Do Minimum is calculated, drawing on data from the DfT and GAL;
- the cost of these emissions is calculated using values provided by the DfT and the Department for Energy and Climate Change (DECC).

Where GHG emissions are included in the EU's Emissions Trading Scheme, the cost of the emissions is valued using DECC's traded carbon prices.

Air quality

The main components of air quality are nitrous oxide (NOx) emissions and particulate matter (PM) emissions. The greater these emissions, the more health issues are expected. For both types of emissions, the Green Book guidance, as published by the Department for Environment and Rural Affairs (Defra), in line with the Commission guidance, is used to monetise the effects.

This guidance recommends using a 'Damage Costs Approach', whereby the increase in costs does not exceed £50m.The IGCB provides estimates of cost per tonne of NOx emissions, and a 'PM Transport Average' cost per tonne of PM emissions. These are combined with estimates of emissions from GAL to provide a monetary cost.

Other environmental aspects

Other aspects of the environment are discussed qualitatively, and, as described in WebTAG and the Commission's appraisal framework, include landscape, townscape, historic environment, biodiversity and water.

2.4.5 Competition

Constructing an additional runway at either Heathrow or Gatwick would provide extra capacity to meet the demand for air transport. However, the two schemes could lead to different impacts on the dynamics of competition for air transport demand. It is therefore important to set out the mechanisms by which these differences in competition effects come about, and through which more capacity at one airport could lead to greater competition, and therefore greater benefits, than the same amount of additional capacity at another location.[41]

This impact is not captured in WebTAG, but the Airports Commission has included a competition objective in the Strategic Fit module in its appraisal framework. Oxera has set out how competition functions in this market and quantified the potential changes in the intensity of competition that could arise

[41] Oxera has analysed the competition impacts of the expansion scenarios and has considered the benefits separately (and therefore additionally) to those which would result from a reduction in the shadow cost (which is included in the user and producer impacts).

from each scheme, by combining the traffic forecasts from SH&E for Gatwick with the results from the literature.

2.4.6 Social impacts

An appraisal of the social aspects of aviation capacity expansion is predominantly qualitative and covers physical activity, security, severance, journey quality, option and non-use values, and accessibility.

The value of increased accidents when using surface access modes is monetised using the approach set out in WebTAG. While a significant expansion of aviation activity would increase the risk of an aviation accident, given the good safety record of aviation in the UK, the value of this increase in risk is not monetised.

Oxera has also developed an approach to assessing the value of increased strategic resilience from a London system with 2+2 runways, compared with 3+1. This approach is based on the ability to continue to service more passengers in the event of the closure of one airport.

2.4.7 Distributional impacts

As with the social impacts discussed in section 2.4.6, the Commission is to include in the Community module of its appraisal framework an assessment of the distributional impacts of the options for increasing airport capacity. Key to that module is the construction of a local community profile. The Commission will then undertake a high-level qualitative review of households whose situation may change in terms of isolation, severance, diminished access and equality. Also relevant are the distributional aspects of other impacts, such as accidents, noise, air quality and user benefits. Personal affordability is also highly relevant to the overall equalities assessment to be undertaken.

2.4.8 Wider economic impacts

In the context of a transport appraisal, wider economic impacts are the impacts of a change in the transport network that accrue to people and businesses beyond the users and providers of the transport network. For example, greater connectivity of a city due to an improvement in the road network is likely to increase productivity for firms located in that city as they can access a larger labour force and as the size of the market accessible from that city grows. These wider economic impacts can make a significant difference to the business case for investment in transport networks.

The DfT's appraisal framework sets out a methodology for appraising the wider economic impacts of changes to the transport network, but is mainly focused on domestic road and rail schemes.[42] The mechanisms in WebTAG explain how, at a firm level, changes in transport costs affect output—known as 'bottom-up' effects. The Airports Commission has considered the economic impact of additional runway capacity in some detail, considering high-level economic impacts from trade, increased foreign direct investment (FDI) and tourism. These are aggregate outcomes, and can be considered 'top-down' effects of changes in the transport network.

Oxera's approach has been to examine the various mechanisms by which expansion in airport capacity can be expected to affect the economy, and then to

[42] Department for Transport (2014), 'TAG Unit A2.1: Wider Impacts', January.

identify the bottom-up impacts on the economy, where possible, and calculate top-down impacts elsewhere. A key consideration here is to make sure that the wider economic impacts do not double-count effects identified elsewhere in the appraisal framework.

2.4.9 Local and regeneration impacts

The local economy module of the Commission appraisal framework states that the Commission will analyse the impact of airport expansion schemes on their local area and surrounding region in terms of business and employment, regeneration, pressure on local services, housing and land use, and their contribution to wider economic development strategies. A study has been conducted by RPS and Optimal Economics for the proposed expansion of Gatwick. They focus on an area covering 14 Local Authorities going beyond the ‘Gatwick Diamond’ (see Appendix 9), to include local councils along the south coast and north to Croydon.[43]

Oxera’s analysis starts from estimates of the gross number of airport-related jobs created by the airport expansion, including direct on- and off-site jobs, jobs in the supply chain and those supported by extra employee spending. These will depend on the productivity of airport and related employees in handling the extra passengers and air traffic movements (ATMs) involved. The estimates for the number of gross new jobs are then translated into estimates of net job creation, to allow for the displacement of other jobs by the jobs created by expansion at Gatwick. Estimates of the net increase in household numbers can then be obtained, given standard assumptions about household size and composition, and estimates of changes in patterns of commuting and migration into or out of the area. These in turn enable any net increase in house building or land-take to be estimated.

The impact of airport expansion on local employment will be driven largely by the extra passengers generated, but also by the rate of growth in airport productivity. Furthermore, Gatwick would attract new businesses, which would in turn create additional jobs across London and the South East.

A similar analysis is performed for the effects of expanding Heathrow.

2.4.10 Government impacts

Airport expansion can have impacts on both local and central government costs and revenues.

In the case of Gatwick, the only costs imposed on government are expected to be through part-funding of surface access schemes, which are accounted for directly.

In particular, an intervention in the aviation industry can have both direct and indirect effects on government tax revenues. The former can come from changing revenues from taxes directly imposed on aviation service providers; the latter from passing taxes on to aviation service users as changes to air fares. In line with the methodology described in WebTAG, Oxera analysis focuses on the second type of change only.

In the case of airport expansion, revenues related to APD, fuel duty and value added tax (VAT) would be influenced by changes in the number of passengers.

[43] RPS and Optimal Economics Ltd (2014), ‘Gatwick R2 - Local Economy Impacts’, May.

This is because APD is paid by air passengers as part of their airfare; fuel duty is paid by air passengers travelling to/from an airport by car; VAT, apart from being paid on car fuel, is included in the price of goods and services offered in terminal buildings. All these user costs are major contributors to growth in indirect tax revenues. Section A11.2 provides further explanation of the approach used by Oxera to assess the impacts on indirect tax revenue, and presents the results of the assessment.

3 Do Minimum

The Do Minimum is the baseline against which both the R2 and the Heathrow NW options are assessed. By comparing both options with the same Do Minimum, a like-for-like comparison is possible without having to untangle potentially complex assumptions. In essence, the Do Minimum adopted in this document is characterised by a gradual increase in passenger volumes, but the absence of additional runway capacity in the South East of England. At the time of writing, the Commission has not detailed its Do Minimum and hence it is not possible to assess whether the assumptions in this report are consistent with those that the Commission will make in its assessment of the Do Minimum. Any changes to the Do Minimum will result in substantial alterations to the magnitudes of the analysis detailed in this report.

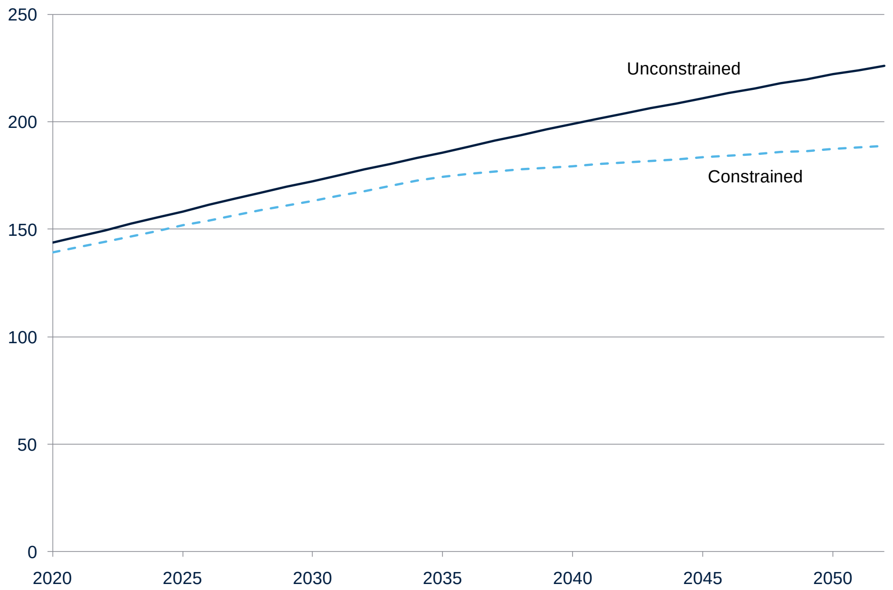
This section outlines the key assumptions for the Do Minimum, covering:

- traffic forecasts (and implications for fares);
- environmental issues;
- surface access schemes (i.e. those schemes that are expected to be required in the absence of any airport expansion);
- changes in technology and regulation.

3.1 Traffic forecasts

In the Do Minimum, unconstrained demand is forecast to continue increasing due to increasing incomes, etc., but demand will be constrained by a lack of available runway capacity, as illustrated in Figure 3.1.[44]

Figure 3.1 Constrained and unconstrained passenger demand for origin and destination traffic the London system in the Do Minimum (mppa)

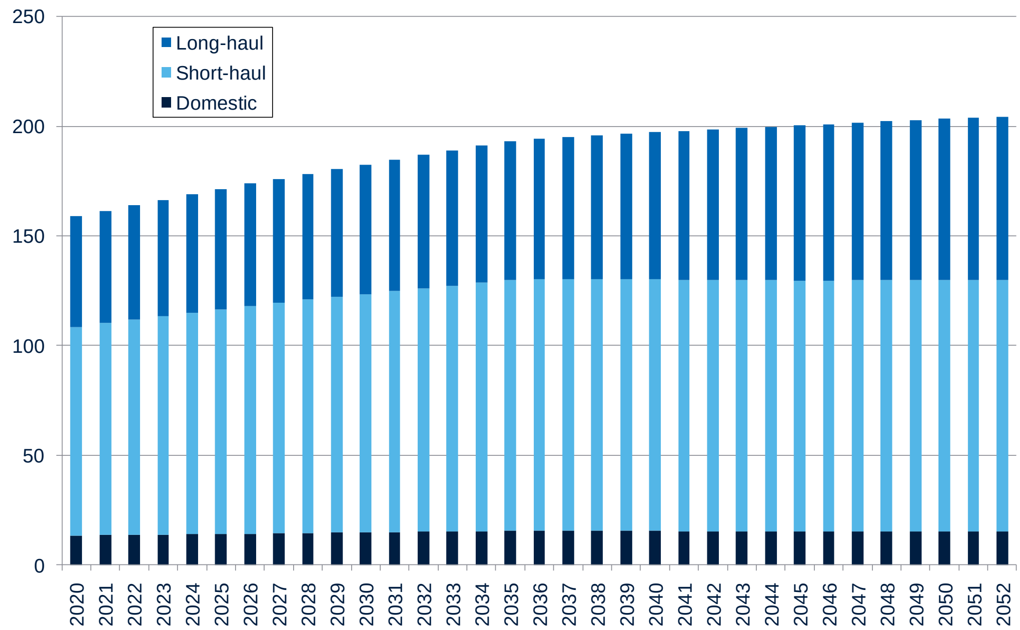


Source: SH&E.

[44] All traffic forecasts in this report are sourced from ICF SH&E, as detailed in ICF SH&E (2014), 'London traffic report: market trends, forecasts and implications for airport capacity', 10 May.

This figure shows that while, in 2020, the capacity constraint is forecast by SH&E to result in the loss of approximately 3% of demand with its origin or destination in London, by 2052 this is forecast to be approximately 17%. However, even with the capacity constraints, overall passenger volumes are forecast to increase from 159m in 2020 to 204m in 2052, as illustrated in Figure 3.2.

Figure 3.2 Passenger volumes in the London system in the Do Minimum (mppa)



Source: SH&E.

As can be seen from Figure 3.2, both short- and long-haul traffic is forecast to grow in the Do Minimum, although short-haul traffic is forecast to remain approximately flat after around 2035. This suggests that, over time, there is an increasing loss of welfare from a lack of runway capacity because people want to fly but cannot. This is expected to be reflected in an increase in the fares charged to passengers (or a reduction in the frequency of flights), above (below) the levels that they would otherwise be—known as 'scarcity rent' and, given the regulatory constraints on airport pricing in the UK (discussed below), is expected to accrue to incumbent airlines (i.e. airlines which operate from the London system and have slot rights) in the form of either higher profits or higher slot values.[45] This is broadly consistent with the forecasts produced by the Airports Commission, which suggest that constrained demand would be approximately 17% lower in 2030 than would be the case if demand were unconstrained.[46]

3.2 Environmental issues

Airport operations incur considerable environmental costs, the most notable being noise, GHG emissions, and the adverse effects on air quality from both airport operations and surface access. There is a wide range of other potential environmental impacts from airport operations that affect the local area, such as adverse effects on local waterways and biodiversity.

[45] New entrants who have to pay for the slots receive neither.
[46] Airports Commission (2014) 'Airport level passenger forecasts 2011 to 2050', January.

3.2.1 Noise

In the Do Minimum, for Gatwick Airport, the number of households experiencing average noise levels above 57dB will decrease by 25% between 2012 and 2040, mainly caused by reduced noise emissions from aircraft. For Heathrow Airport, the number of households experiencing average noise levels above 57dB will decrease by 45% between 2015 and 2030.[47] This is potentially caused by the different current fleet mix at the two airports. However, the number of households adversely affected by noise from Heathrow is approximately 80 times more than that from Gatwick. Consequently, the absolute cost of noise emissions in the Do Minimum for Heathrow is £3,091m versus £67m for Gatwick, taking the annoyance and heart attack (AMI) figures measured in cost for years of life in perfect health lost (DALY).[48]

3.2.2 Carbon

Carbon emissions from aircraft departing from Gatwick will increase from 2010 onwards in the Do Minimum due to changes in the flight mix: the number of long-haul flights is forecast to increase and the average distance per short-haul flight is also expected to increase. After 2046, carbon emissions are forecast to decrease, mainly due to more efficient aircraft. However, total annual carbon emissions will still be higher than in 2010. This is consistent with DfT forecasts.[49]

Non-aircraft carbon emissions at Gatwick, such as electricity, are forecast to follow a slightly decreasing path from 2020 onwards.

Carbon emissions from aircraft departing from Heathrow are expected to increase slightly from 2010 to 2030 in the Do Minimum, due to an increase in the ratio of long-haul to short-haul flights. Beyond this point, although long-haul flights will continue to grow, emissions are expected to begin to fall due to improvements in aircraft efficiency.

3.2.3 Air quality

Annual emissions of NOx (from both aircraft and non-aircraft sources at Gatwick) are forecast to fall from 1,840 tonnes per year to 1,750 tonnes in 2040.

Annual PM emissions at Gatwick and the surrounding area are forecast to fall from 77 tonnes in 2020 to 72 tonnes in 2080. However, if the significant increase in emissions from non-airport-related traffic on the road network around Gatwick is excluded, there is forecast to be a reduction in PM emissions of 20 tonnes between 2020 and 2080. This reflects technological improvements in aircraft engine design.

3.3 Surface access

The surface access schemes covered by the Do Minimum include schemes required for access to both Heathrow and Gatwick, as detailed in Table 3.1. Given the information available to Oxera, the assessment of these schemes is considerably more developed for Gatwick than for Heathrow.

[47] Due to the use of different data sources, it is not possible to compare Gatwick and Heathrow in the same years.
[48] World Health Organisation (2011), 'Burden of Disease from environmental noise', http://www.euro.who.int/__data/assets/pdf_file/0008/136466/e94888.pdf
[49] Department for Transport (2013), 'UK Aviation Forecast', January, p. 90.

Table 3.1 Surface access schemes in Do Minimum

Road	Rail
M25 junctions 5–7 smart motorways	Gatwick Airport Station enhancements including platform 7
M25 Jn 8–10 controlled motorways	London Victoria Underground and National Rail station improvements
M25 Dartford Crossing free-flow tolling	Redhill Station additional platform
A23 Handcross to Warninglid safety scheme	Thameslink Programme Key Output 2 and new trains
M25 junctions 23–27 smart motorways	London Bridge Station and East Croydon improvements
M23 smart motorway and Gatwick junctions	Brighton Main Line re-signalling
HA pipeline projects throughout the South East	Assorted junction improvements
A23 (London) junction improvement scheme	East Croydon Station additional platform
Local junction improvements	Gatwick Express new rolling stock
	North Downs Line speed improvements, electrification and new services
	Milton Keynes Central–East Croydon service extension to Gatwick
	Crossrail
	Western rail access to Heathrow
	Piccadilly Line upgrade

Source: Arup.

In essence, the surface access schemes contained within the Do Minimum are:

- committed rail schemes (Thameslink upgrade and Western Rail Access to Heathrow);
- Crossrail;
- Piccadilly Line upgrade;
- road schemes with Highways Agency funding already committed, including the remodelling of the M25/M23 junction and capacity upgrades on the M25.

These are schemes that are required to provide a reasonable service to users of the transport network in the absence of additional runway capacity, although they may be part-funded by Heathrow Airport Limited (HAL) or GAL to enable the increase in passenger volumes contained in the Do Minimum.

3.4 Competition and regulatory changes in the airports markets

In the Do Minimum, it is assumed that the UK airports will continue to be regulated in much the same way as at present, with Heathrow being subject to RPI - X regulation set by the Civil Aviation Authority (CAA), and Gatwick being allowed greater commercial freedom than Heathrow, but subject to regulation based on contracts with, and commitments to, the airlines significantly limiting Gatwick's pricing power. Therefore, the regulatory policies which will be set by the CAA will have significant implications for the evolution of the airports market.

The level of competition in the London system of airports would be expected to increase over time in the Do Minimum as more available capacity is used, thus increasing the number of destinations served by more than one carrier and/or from more than one airport.

4 Do Something

The Do Something options are:

- a second runway at Gatwick: of 3,400 metres in length and positioned sufficiently far south of the existing runway to permit fully independent operation;
- a third runway at Heathrow: 3,500 metres in length and positioned to the north-west of the airport, sufficiently far from the existing airport to enable fully independent operation.

However, it is important to recognise that this appraisal is concerned with the effects of the economic, environmental and social impacts arising from the change to the London system of airports—i.e. in comparing 3+1 with 2+2. This is achieved by assessing both options against a common Do Minimum, as set out in section 3.

The traffic, cost, environmental, surface access and other attributes of the options are considered below.

4.1 Comparison of options

There are a number of key differences between expanding Gatwick and expanding Heathrow. Although not strictly relevant for the purpose of this appraisal, Table 4.1 presents a brief comparison of the two options, before these options are described in more detail in the following sub-sections.

Table 4.1 Comparison of options

Aspect	2+2	3+1
Passenger volumes	Passenger volumes forecast to increase by almost 20% above Do Minimum in 2050, with growth driven by all market segments. Capacity available (and benefits start accruing) from 2025.	Passenger volumes forecast to increase by almost 15% above Do Minimum in 2050, with growth driven by long-haul journeys Capacity available (and benefits start accruing) from 2030.
Destinations served	New destinations served from both Heathrow and Gatwick, enabling improved connectivity from the London system. Increased level of overlap between airports	New long-haul destinations served from Heathrow. No or limited new destinations served from Gatwick
Costs	Estimated capital cost of £7bn	Estimated capital cost of £17bn
Environmental issues	Limited additional noise and air quality impacts; some increase in carbon emissions	Significant noise, air quality and carbon impacts
Surface access	A23 remodelling	M25 tunnelling, A4 and A3044 realignment
Changes in competition and regulation	Significant increases in competition; impact on regulation hard to predict	Reduction in levels of competition; Heathrow Airport likely to continue to be regulated by the CAA

Source: Oxera.

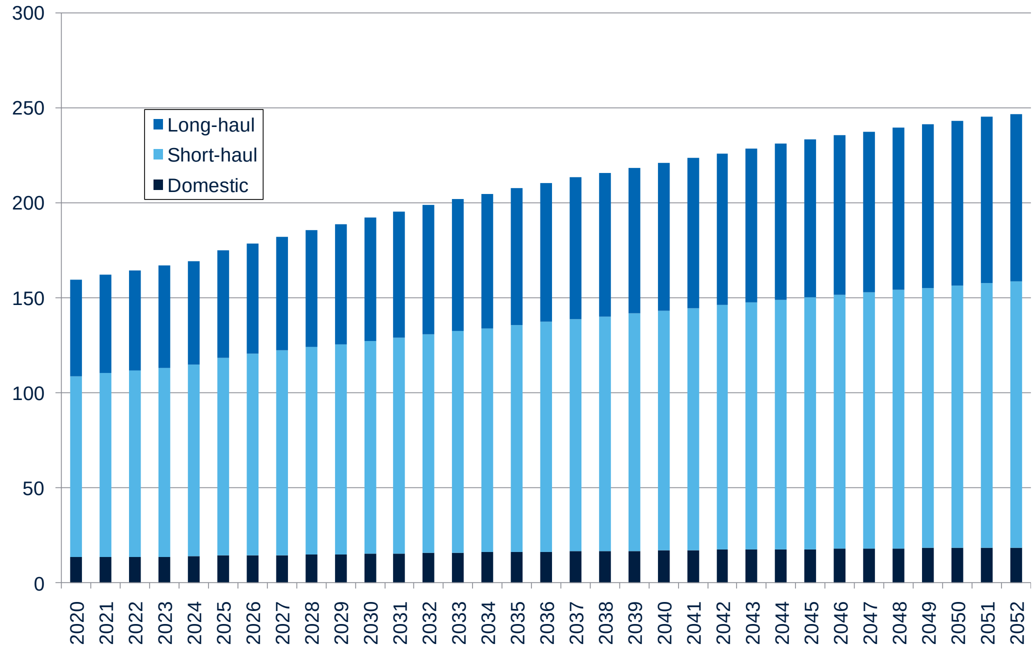
4.2 An additional runway at Gatwick (2+2)

The option considered is an additional runway at Gatwick, positioned to the south of the existing runway, built using a phased approach, with the initial opening in 2025 and construction completed by 2039.

4.2.1 Traffic forecasts

Figure 4.1 illustrates the expected increase in passenger volumes in the London system from an additional runway at Gatwick.

Figure 4.1 Passenger numbers in the London system under 2+2 (million passengers)



Source: SH&E.

In the central case, a second runway at Gatwick is expected to result in an additional 40m passengers in 2050 compared with the Do Minimum, an increase of almost 20%. As can be seen from Figure 4.1, growth is expected in all market segments.[50] We have considered a range of scenarios, the outcomes of which are detailed in Appendix 3.

In addition to this increase in passenger volumes, expansion at Gatwick is expected to facilitate an increase in the number of destinations served by the London system and the number of destinations that can be reached from both Heathrow and Gatwick—see Table 4.2.

[50] ICF SH&E (2014), 'London traffic report: market trends, forecasts and implications for airport capacity', 10 May.

Table 4.2 Destinations by type under 2+2

		2013	2024	2035	2050
Heathrow	New non-competed	n.a.	5	10	16
	Existing competed	94	77	91	92
	Existing non-competed	79	64	38	38
Gatwick	New non-competed	n.a.	12	24	31
	Existing competed	153	167	195	198
	Existing non-competed	62	70	77	74

Note: A competed destination is defined as a destination served from both Heathrow and Gatwick. No new competed routes are forecast.

Source: SH&E data and Oxera calculations.

4.2.2 Costs

The total present value of the incremental capital costs of the project (assuming a phased construction up to 2039) is approximately £7.3bn, with an additional spend of £3.3bn on operating costs.[51] Hence, the total base cost of the project is estimated to be approximately £10.6bn.

4.2.3 Environmental issues

While there are many environmental impacts from additional runway capacity, those monetised in this document are noise, carbon and air quality. The effects of additional capacity at Gatwick on these aspects of the environmental impacts are described below.

- **Noise**: the number of households experiencing average noise levels above 57dB would increase to 14,100.
- **Carbon**: carbon emissions from aircraft departing from Gatwick would increase from 6.2m tonnes in 2050 without a new runway to 12.0m tonnes with a new runway. Alongside this, carbon emissions from aircraft departing from other London airports (i.e. London Luton, Stansted, London City and Southend) would fall from 3m tonnes in 2050 to 2.7m tonnes, as a result of a reduction in ATMs due to expansion at Gatwick. Gatwick expansion is forecast to have little or no effect on Heathrow carbon emissions. Non-aircraft carbon emissions at Gatwick, such as electricity, are forecast to follow a slightly increasing path from 2020 onwards, with efficiency gains being offset by higher ATMs.
- **Air quality**: annual emissions of NOx (from both aircraft and non-aircraft sources at Gatwick) are forecast to increase from approximately 2,000 tonnes to approximately 2,350 tonnes in 2025. PM10 emissions are forecast to increase from 80 tonnes to 105 tonnes in 2040. However, no breaches of legal limits are expected.

4.2.4 Surface access

As there is no expansion at Heathrow, there are not expected to be incremental surface access schemes for Heathrow Airport. However, there will need to be a number of such schemes around Gatwick Airport to accommodate the additional passenger and employee travel generated by a second runway—see Table 4.3.

[51] At 2010 prices, discounted to 2014. Operating costs have been considered up until 2080 (the relevant lifetime of the new assets being built).

Table 4.3 Surface access schemes in 2+2

Road	Rail
M23 Junction 9/9a capacity improvement and free-flow slips	New transit system (Automated People Mover) connection from railway station to new terminal
A23 diversion and improvements	New interchange with other modes—Gatwick Gateway
Improvements to local surface access roads	Gatwick passenger hosting at rail interchange stations

Source: Arup.

These schemes are forecast to be sufficient to enable the surface access network to continue to provide a reasonable service to all users of the affected transport networks.

4.2.5 Competition and regulatory changes in the airports markets

Given the significant change in the relative size of Heathrow and Gatwick, it is plausible that there may be changes in how these airports are regulated. However, any change in regulation would be expected to result from an assessment of the market power of the airports.[52] The outcome of such an assessment and any subsequent changes in regulation are difficult to pre-empt, and could range from a finding that both airports have significant market power and should be regulated by the CAA, to a finding that competition (with the attendant benefits of lower costs, increased innovation and lower charges) between the airports has developed to such an extent that economic regulation is no longer necessary. Therefore, the assumption used in this study is that Heathrow and Gatwick continue to be regulated as they would be under the Do Minimum.

However, there is expected to be a considerable increase in the level and intensity of competition under 2+2, which would manifest itself in a range of consumer benefits, including lower fares and increased cost efficiency than in the Do Minimum. Airports would be expected to compete more intensely for airlines, and airlines to compete more intensely for passengers. The former is expected to be especially significant in the 2+2 case, as LGW would be able to compete on a more or less level playing field with LHR. There would be an increase in both the number of airlines competing at Gatwick, and also in the number of destinations served by both Gatwick and Heathrow, and/or Gatwick and other London airports. This is primarily likely to benefit consumers through fare reductions on these competed routes, as has been quantified in this report. However, competition theory, and indeed past evidence from the airports market in situations where competition has increased, would suggest a range of broader benefits, including increased innovation, greater diversity and quality of products, and better planning and capacity development. These points are elaborated on in Appendix 6.

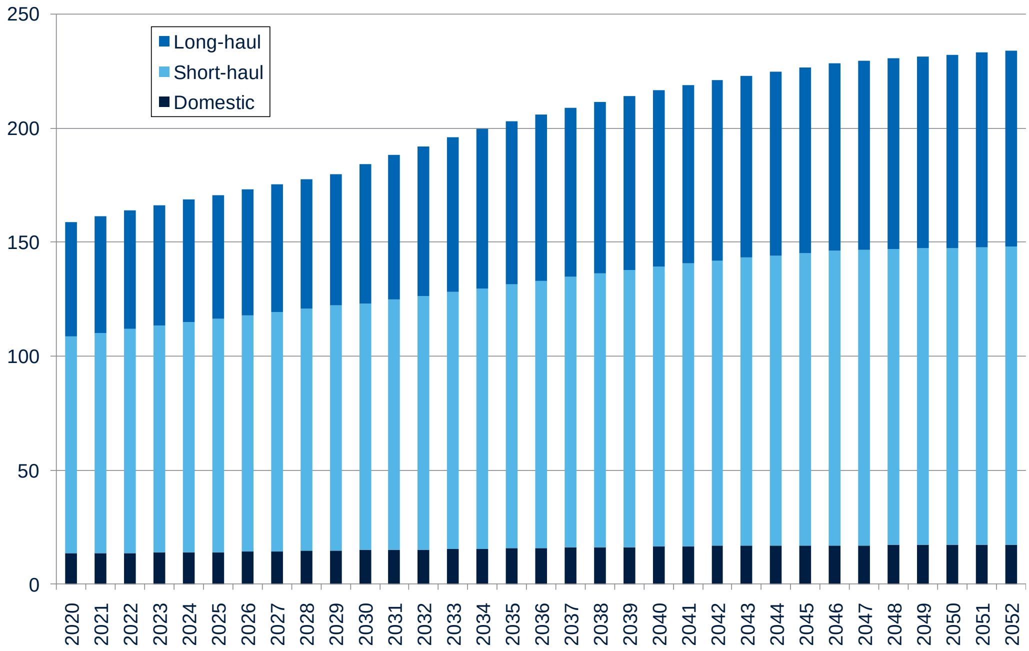
[52] Similar to that recently undertaken by the CAA, see: https://www.caa.co.uk/default.aspx?catid=78&pagetype=90&pageid=12275

4.3 An additional runway at Heathrow (3+1)

4.3.1 Traffic forecasts

Figure 4.2 illustrates the expected increase in passenger volumes in the London system from an additional runway at Heathrow.

Figure 4.2 Passenger numbers in the London system under 3+1 (million passengers)



Source: SH&E.

A third runway at Heathrow is forecast by SH&E to result in an additional 30m passengers in 2050 compared with the Do Minimum, an increase of almost 15%.[53] As can be seen from Figure 4.2, growth is expected to come predominantly from the long-haul market segment. This occurs because much of the growth in demand from short-haul traffic (served by low-cost carriers, LCCs) cannot operate from Heathrow due to the level of landing charges and anticipated taxi times being too long to enable the rapid turnaround of aircraft on which these carriers rely.

Expansion at Heathrow is expected to increase the number of destinations served by the London system, but to reduce the number of destinations which can be reached from both Heathrow and Gatwick—see Table 4.4.

[53] Although is forecast to be less than under 2+2.

Table 4.4 Destinations by type under 3+1

		2013	2024	2035	2050
Heathrow	New non-competed	n.a.	7	35	43
	Existing competed	94	76	78	69
	Existing non-competed	79	69	76	86
Gatwick	New non-competed	n.a.	10	0	3
	Existing competed	153	158	163	109
	Existing non-competed	62	70	54	35

Note: A competed destination is defined as a destination served from both Heathrow and Gatwick. No new competed routes are forecast.

Source: SH&E data and Oxera calculations.

4.3.2 Costs

The total present value of the incremental capital costs of the project (assuming a phased construction up to 2039) is approximately £16.9bn. In addition, incremental operating costs are estimated to be approximately £2.4bn.[54]

4.3.3 Environmental issues

The environmental cost of expansion at Heathrow in terms of noise, carbon and air quality is described below. Where accurate forecasts were not possible due to lack of data, a qualitative summary of expected costs is presented.

Noise: the number of people experiencing average noise levels above 57dB would increase by approximately 50,000 to 190,000.[55]

Carbon: carbon emissions from aircraft departing from Heathrow would increase from 14.4m tonnes in 2050 without a new runway to 20m tonnes with a new runway. As a result of a decrease in ATMs at other London airports that are forecast to occur alongside Heathrow expansion, carbon emissions from flights departing these airports would decrease from 2.95m tonnes in 2050 to 2.9m tonnes. Emissions at Gatwick would also fall, from 6.2m to 4.7m tonnes in 2050, as a consequence of fewer long-haul flights. Owing to a lack of data, non-aircraft carbon emissions have not been assessed.

Air quality: accurate figures on future PM and NOx emissions at Heathrow which would result from expansion are not available. That said, given that Heathrow is situated in a densely populated area, where NOx and PM concentrations are already high, increased emissions as a result of expansion are likely to have a greater health cost. In particular, NOx concentrations may breach EU limits, as they did at two sites around Heathrow in 2013.[56]

[54] The CAA's report on airport OPEX suggests that operating costs per passenger at Heathrow are approximately 1.5 times those at Gatwick. The higher rate of operating cost per passenger at Heathrow is captured by the fact that similar levels of additional terminal and pier area are assumed at both airports, even though SH&E's forecasts assume approximately 45m additional passengers at Gatwick compared with 25m additional passengers at Heathrow by 2050. See CAA (2013), 'CAA Airport Operating Expenditure Benchmarking Report 2012', June.
[55] Based on ERCD data for comparative purposes.
[56] 'Heathrow Air Quality Report, Q4 2013' p. 2, available at http://www.heathrowairwatch.org.uk/documents/AQ_briefing_2013_Q4.pdf.

4.3.4 Surface access

While there is an absence of detailed information about the surface access schemes provided by Heathrow (for example, how the increase in passengers could be delivered without an increase in airport-related traffic on the road),[57] information on major schemes is available.[58] The schemes required are:

- tunnelling of the M25;
- remodelling of the A4 and A3044.

Cost information and who is expected to meet these costs is unclear, but the Commission estimates the cost of airport access to be £2bn–£3bn.[59]

4.3.5 Competition and regulatory changes in the airports markets

The relative decline in competition between airports is likely to act as a barrier to innovation. In addition, the change in market structure—from adding a third runway at Heathrow—is likely to mean that Heathrow will continue to be regulated by the CAA on the basis that it has significant market power.[60] The position of Gatwick in this scenario is unclear, but it is plausible that the CAA may find that Gatwick does not possess significant market power and de-regulates it.

However, the decrease in the level and intensity of competition under 3+1 would be expected to be such that benefits from competition would be greater in the Do Minimum than in 3+1, a conclusion which is consistent with the CC's conclusions that Heathrow's position as the sole hub is a feature of the UK aviation market which restricts competition.

[57] HAL (2014), 'A new approach: Heathrow's options for connecting the UK to growth', January, p. 36.
[58] Airports Commission (2013), 'Heathrow Airport – Northwest Runway Sift 3'.
[59] Airports Commission (2013), 'Heathrow Airport – Northwest Runway Sift 3'.
[60] An assessment reached by the CAA in its market power assessment in 2013. Civil Aviation Authority (2013), 'Heathrow Airport Limited operator determination'.

5 Appraisal

This section presents information in the form expected by WebTAG, except in cases where the appraisal framework does not reflect impacts of the airport scheme in question. The section ends with a comparison of the R2 (2+2) and Heathrow NW (3+1) schemes.

5.1 Transport Economic Efficiency Table

The first table that WebTAG suggests for the presentation of appraisal outputs shows the impact of a scheme on 'Transport Economic Efficiency' (TEE).

Table 5.1 below presents user benefits, split between leisure and business users. (The split presented in this table is a change from the WebTAG TEE table, albeit one that is more relevant for an aviation scheme.)

The second element of Table 5.1 concerns impacts on private sector providers. This includes both airlines and airports, although, as noted in WebTAG Unit A1.1 (paragraph 3.2.4), the costs incurred do not have to be separated between infrastructure providers and service operators. As is clear from paragraph 3.2.7 of the same Unit, any offsetting grants or subsidies from government are to be clearly represented in the associated table.

As noted in paragraph 3.3.4, impacts are to be shown separately between passenger and freight, and by source mode. (In the context of this document, we have split the aviation and surface access impacts in the table).

Table 5.1 Transport Economic Efficiency (£bn)

Aviation	**Gatwick R2**	**Heathrow NW**
User benefits		
Leisure users	39.2	28.0
Business users	43.4	31.2
Total user benefits	**82.6**	**59.2**
Provider surplus	**–39.8**	**–28.2**
Cost to providers		
Capital investment costs	–7.3	–16.9
Operating costs	–3.3	–2.4
Grant/subsidy	0.0	6.0
Total cost to providers	**–10.6**	**–13.3**
Present value of TEE benefits	**32.2**	**17.7**[1]

Note: Benefits are shown as positive numbers, while costs are shown as negative numbers. All entries are discounted present values, in 2010 prices and discounted to 2014.Freight user benefits have not been quantified. [1] This includes the cost to the government of the £6bn subsidy for Heathrow. All figures rounded to one decimal point, other tables in this report are rounded to nearest billion pounds to avoid spurious accuracy.

GAL is expecting to invest £7bn solely in the airport infrastructure for R2. The total incremental operating costs for the airport once R2 is opened would be £3bn, giving total costs of the scheme to GAL of £11bn.

Oxera's analysis of the Heathrow NW scheme, again based on SH&E traffic forecasts, identifies leisure and business user benefits of £59bn. Combining this assessment with provider impacts gives total user and provider benefits of

£18bn. The lower figures for Heathrow compared with R2 are driven by lower fares and higher demand in the R2 scenario (explained in detail in Appendix 3), and thus a greater increase in overall welfare. In addition, the greater benefits with the R2 option are driven by the new runway being scheduled to open in 2025, whereas a third runway at Heathrow would become operational later, in 2030.

The total capital cost of Heathrow NW is expected to be £17bn. Total incremental operating costs for the airport once the third runway is open would be £2bn. HAL has stated that it expects £6bn of grant or similar funding from government to build the NW scheme,[61] suggesting total costs to HAL of £13bn.

5.2 Public Accounts Table

The second category of output table from WebTAG is intended to demonstrate the impact on the public sector purse of a scheme. The table captures costs and revenues from the perspective of the public sector; investment by the private sector has already been depicted in the TEE table.

Oxera has approached the completion of the public accounts table as follows:

- while there is no requirement for central government funding for R2, we have assumed a form of funding (investment costs) for the Heathrow NW scheme;
- indirect tax impacts (taken from Appendix 11) comprise changes in APD, fuel tax and VAT.

Table 5.2 Public Accounts (£bn)

	Gatwick R2	Heathrow NW
Grant/subsidy	0.0	6.0
Change in revenue from APD	–3.9	–2.9
Change in revenue from fuel duty and VAT	–7.9	–7.9
Change in rail franchise revenue	–3.1	–0.6
Total change in government costs	–14.8	–5.3

Note: this table follows the approach set out in WebTAG, where expenditure by government is positive and income is negative. Numbers may not sum due to rounding. All figures rounded to one decimal point, other tables in this report are rounded to nearest billion pounds to avoid spurious accuracy.

Source: Oxera.

Table 5.2 reflects the increase in government revenues under both schemes, although the increase arising from R2 is considerably greater. Revenues from APD, fuel duty and VAT are expected to be £12bn higher if R2 is built, and there are limited government investment costs. In contrast, under the Heathrow scheme, a lower APD increase, driven by fewer outbound passengers in the SH&E forecasts, is offset by the government investment cost. The significantly higher levels of government subsidy required for the Heathrow NW scheme (reflecting the larger government contribution to the surface access schemes) is also a significant factor in the impact on public accounts.

[61] http://mediacentre.heathrowairport.com/press-releases/heathrow-north-west-third-runway-option-short-listed-by-airports-commission-779.aspx, accessed 9 May 2014.

5.3 Assessment of Monetised Costs and Benefits Table

WebTAG's next table 'summarises all of the monetised impacts of a scheme that are considered sufficiently robust for inclusion in the scheme or option's Net Present Value'.[62] As can be seen from Table 5.3 and Table 5.4 below, the Assessment of Monetised Costs and Benefits table combines information from the TEE and Public Accounts tables, together with evidence on other impacts (such as GHGs and accidents). Oxera's approach to populating this table for the R2 and Heathrow NW schemes is as follows:

- include user and provider impacts from the TEE table;
- include competition benefits (which are not usually calculated in a WebTAG framework);
- include indirect tax revenues from the Public Accounts table, but with the sign reversed (WebTAG Unit A1.1, para. 3.4.3) and excluding any government subsidy, as this is captured as a cost in the AMCB table;
- include monetised estimates of the noise, air quality and GHG impacts from Appendix 5, and monetised estimates of the impact of the schemes on accidents from Appendix 7;
- reflect the costs of the schemes from *both* the public sector perspective (using information from the Public Accounts table) *and* the total resource cost to the economy (from section 2.4.1).

[62] WebTAG Unit A1.1, paragraph 3.4.1.

Table 5.3 Assessment of Monetised Costs and Benefits (£bn)

	Gatwick R2	Heathrow NW
Noise (A)	–0.2	–1.3
Local air quality (B)	0.0	0.0
Environment (excl. greenhouse gases)	**–0.2**	**–1.3**
Greenhouse gases (C)	**–13.4**	**–9.1**
User benefits (business) (D)	43.4	31.2
User benefits (leisure) (E)	39.2	28.0
Competition benefits: users (F)	7.7	–2.5
Impact on providers (airlines) (G)	–50.5	–47.5
Impact on providers (airports) (H)	10.6	19.3
Economic efficiency (total)	**50.5**	**28.6**
Public Accounts (I)*	14.8	11.3
Present value of benefits (excluding WEIs) (K=sum (A:I))	**51.7**	**29.5**
Wider economic impacts (WEIs) (J)	27.7	21.4
Present value of benefits (including WEIs) (L=sum (A:J))	**79.4**	**50.8**
Present value of costs (M)	10.6	19.3
Overall impacts		
Net present value (excluding WEIs) (N=K-M)	**41.1**	**10.1**
Social benefit–cost ratio (excluding WEIs) (O=K/M)	**4.9**	**1.5**

Note: * Including government subsidy where appropriate. Numbers may not sum due to rounding. All figures rounded to one decimal point; other tables in this report are rounded to nearest billion pounds to avoid spurious accuracy. Local economic benefits are not included in this table as they are not additional to the other impacts presented here.Some environmental impacts have not been included in this table, as Oxera quantified only some effects in the R2 option. The competition impact is the direct impact only and does not include the indirect impact of up to £10bn–£14bn.

Source: Oxera analysis.

The table demonstrates that there is a large, positive present value of benefits from R2. While environmental costs offset the economic benefits somewhat, they are considerably outweighed by user benefits. In addition, indirect tax revenues rise, and the cost to the public sector is limited. Even when the full resource cost of the scheme is taken into account, the scheme NPV is strongly positive, and the BCR is 4.9.

When compared with the Heathrow NW scheme, it can be seen that R2 would offer more benefits at less cost, both to government (see Table 5.3) and overall. The Heathrow scheme would deliver lower user and provider benefits, which would be considerably (although not entirely) offset by the cost of its environmental impacts. From a government perspective, the capital cost contribution is outweighed by increases in projected APD revenue, VAT, fuel duty and additional rail franchise revenue.

5.4 Appraisal Summary Table

The final output in the WebTAG suite is the overall Appraisal Summary Table, which collates the outputs of the economic impact assessment. Oxera has approached this table as follows:

- the first column presents estimates of impacts (quantitative and qualitative);
- the second column provides a reference to the relevant appendix to find more detail.

Table 5.4 Appraisal Summary: Gatwick R2 (£bn)

Impacts	Quantitative	Relevant appendix
Noise	–0.2	5
Air quality	0.0	5
Environment (excl. greenhouse gases)	**–0.2**	**5**
Greenhouse gases	–13.4	5
User benefits (business)	43.4	3
User benefits (leisure)	39.2	3
of which, journey time impact	3.0	3
User benefits	**85.6**	**3**
Providers (airlines)	–50.5	3
Providers (airports)	10.6	3
Provider impact	**–39.8**	**3**
Competition	**7.7**	**6**
Public accounts	**14.8**	**11**
Wider economic impacts (WEIs)	**27.7**	**9**
Accidents	–0.3	7
Social	**–0.3 and a small value from resilience**	**7**
Social (other)	Not quantified	7
Local economic (including regeneration)	Significant local and regeneration opportunities	10
Flexibility	Not quantified	12

Note: Numbers may not sum due to rounding. The competition impact is the direct impact only and does not include the indirect impact. Freight user benefits have not been quantified. All figures rounded to one decimal point; other tables in this report are rounded to nearest billion pounds to avoid spurious accuracy. The competition impact is the direct impact only and does not include the indirect impact of up to £10bn–£14bn.

Source: Oxera.

Table 5.4 demonstrates considerable user benefits and wider impacts from R2. Reductions in delays and road accidents, and competition impacts would further increase benefits. Regeneration of disadvantaged districts is evaluated positively and, more generally, the local economy would be expected to benefit from increased employment. These benefits would be offset to some extent by increases in noise, local pollution[63] and carbon.

Social impacts, other than the impact on road accidents, are expected to be generally positive.

[63] It is important to note that there is likely to be an adverse effect on local air quality from R2. However, the monetised value of this change is less than £100m and is therefore shown in Table 5.4 as zero. The impact of R2 is expected to be less than Heathrow NW.

The benefits of flexibility (essentially, user time savings from R2) and resilience are also expected to be substantial.

Finally, R2 has limited impact on the public sector budget, although the overall scheme would be expected to cost £11bn to users. Indirect tax revenues would be expected to increase considerably.

In summary, the present value of benefits of R2 would be £52bn excluding WEIs, and £79bn including WEIs, while its total resource cost would be £11bn. The public accounts impact is expected to be positive. Expressing the impact as a BCR, where total resource costs are used, implies an impact of 4.9, excluding WEIs.

Table 5.5 Appraisal Summary: Heathrow NW (£bn)

Impacts	Quantitative	Relevant appendix
Noise	–1.3	5
Air quality	0.0	5
Environment (excl. greenhouse gases)	**–1.3**	**5**
Greenhouse gases	–9.1	5
User benefits (business)	31.2	3
User benefits (leisure)	28.0	3
Journey time impact	0.0	3
User benefits	**59.2**	**3**
Providers (airlines)	–47.5	3
Providers (airports)	19.3	3
Provider impact	**–28.2**	**3**
Competition	**–2.5**	**6**
Public accounts[1]	**5.3**	**11**
Wider economic impacts (WEIs)	**21.4**	**9**
Accidents	Not quantified	7
Social (other)	Not quantified	7
Social	**Limited value from resilience**	**7**
Local economic (including regeneration)	Not quantified	10
Flexibility	Not quantified	12

Note: Numbers may not sum due to rounding. The competition impact is the direct impact only and does not include the indirect impact. All figures rounded to one decimal point; other tables in this report are rounded to nearest billion pounds to avoid spurious accuracy. The competition impact is the direct impact only and does not include any indirect impacts. [1] Net of subsidy.

Source: Oxera.

The Heathrow NW scheme is also expected to deliver substantial user and provider benefits (albeit less so than R2), and WEIs of a similar magnitude to R2. The scheme is expected to have a detrimental impact on competition and the environment, and to deliver less flexibility and resilience than R2.

The Heathrow scheme would impose costs on users and providers, and there is expected to be £6bn of funding from the taxpayer, which would be offset by indirect tax revenues of £11bn.

In summary, the present value of benefits of the Heathrow NW scheme would be £30bn excluding WEIs, and £51bn including WEIs, while its total resource cost would be £20bn. The public accounts impact is expected to be positive. Expressing the impact as a BCR, where total resource costs are used, implies an impact of 1.5, excluding WEIs.

6 Conclusions

This Economic Impact Assessment provides an assessment of the incremental costs and benefits associated with R2 and the Heathrow NW schemes.

Based on a set of reasonable assumptions, and data and analysis provided to Oxera and PA by GAL and its other consultants, we conclude that there would be considerable benefits associated with both schemes.

However, it is clear from our analysis that R2 would provide considerably greater benefits through higher passenger numbers and greater competition, at lower cost, than Heathrow NW. Moreover, R2 would be essentially privately financed. Indeed, on every appraisal criterion, R2 would outperform the Heathrow alternative.

In aggregate terms, R2 would be expected to deliver a present value of benefits of **£52bn** (see Table 5.3), compared with **£29bn** (see Table 5.3) for the Heathrow NW scheme (both figures excluding WEIs and £10bn–£14bn of indirect competition benefits for the R2 scheme). The equivalent figure including WEIs is **£79bn** for R2 and **£51bn** for Heathrow NW. Meanwhile, the expected costs of the two schemes are different, with the Gatwick scheme costing **£11bn** (£7.3bn CAPEX and £3.3bn OPEX; see Table 5.1) and the Heathrow scheme **£19bn** (£16.9bn CAPEX and £2.4bn OPEX; see Table 5.1), of which **£6bn** (see Table 5.2) is currently expected to be provided by taxpayers.

Oxera has also analysed a number of alternative scenarios, covering a range of passenger forecasts produced by SH&E for the London airport system. These show that, across a range of scenarios, expansion at Gatwick offers greater benefits than expansion at Heathrow.

A1 Detailed mapping from Airports Commission appraisal to WebTAG

There is considerable overlap between the two appraisal frameworks, as illustrated in Table A1.1.

Table A1.1 Mapping from Commission to DfT appraisal frameworks

	Evidence on module contained in:						
Commission appraisal modules	**Strategic case**	**Economic case**	**Financial case**	**Commercial case**	**Management case**	**TAG Unit**	**Economic appraisal appendix**
Strategic fit	✓					n/a	n/a
Economy impacts	✓	✓				A1.3, A2.1	2, 8
Local economy impacts	✓	✓				A2.2, A2.3, A4.2	8
Surface access		✓			✓	A2.3	3
Noise		✓			✓	A3	4
Air quality		✓			✓	A3	4
Biodiversity		✓			✓	A3	4
Carbon		✓			✓	A3	4
Water and flood risk		✓			✓	A3	4
Place		✓			✓	A4.1	6
Quality of life		✓			✓	A4.1	6
Community		✓			✓	A4.1	6
Cost and commercial viability		✓	✓			A1.2	1
Operational efficiency	✓			✓	✓		n/a
Operational risk	✓	✓			✓		6
Delivery			✓	✓	✓		n/a

Source: Oxera.

This sits within a wider framework of evidence requested by the Airports Commission, covered in the other supporting information being provided to the Commission by Gatwick in the following documents:

- Strategic argument;
- Airport Master Plan;
- Engineering Plans;
- Mitigation Strategies;
- Development Strategies;
- Surface Access Strategies;
- Sustainability Assessment.

A2 Costs

The cost analysis conducted by Oxera relies on inputs from a number of sources (e.g. Turner & Townsend, Arup, SH&E and GAL).

A2.1 Cost estimates for R2

A2.1.1 Data

The cost data received by Oxera comprises the following:

- CAPEX relating to R2 and airport expansion (with End-Around Taxiways, EATs) based on analysis conducted by Turner and Townsend.[64] This includes costs relating to project management, design, land acquisition, surface access, utilities, enabling works, terminals and piers, airside equipment, insurance and compensation;
- CAPEX relating to highways (including Gatwick and non-Gatwick spend) as estimated by Arup.[65] This includes costs relating to dual carriageways, ramps, bridges, access roads and roundabouts;
- operating costs associated with R2 and with the expansion of the terminal areas to accommodate the additional passenger traffic. These have been inferred from GAL's financial model, which assumes a phased construction plan, which is consistent with the assessment of CAPEX.[66] This includes incremental costs relating to staff (including security personnel), rent, utilities, maintenance and cleaning, and air traffic control;
- traffic forecasts from SH&E; and
- risk management reports from Turner and Townsend.[67]

In order to ascertain the cost of the scheme, it is important to include the non-Gatwick spend within the costs framework. The non-Gatwick spend included in Arup's estimates has been added to the surface access costs listed in the Turner and Townsend analysis.[68]

A2.1.2 Modifying the data

The data received by Oxera was not strictly compliant with the methodology set out in the TAG guidelines. Oxera has undertaken the following modifications to ensure compatibility of the final cost output with the TAG framework:

- the CAPEX data has been adjusted to account for real cost increases, assuming general inflation to be 2%[69] and construction price inflation to be 4%;[70]

[64] These figures are based on the cost assessment provided by Turner and Townsend, version 3.3B, dated 14 March 2014.
[65] Based on data supplied by GAL, dated 8 January 2014.
[66] Operating costs are based on an assessment provided by GAL, version 4, dated 7 May 2014.
[67] Oxera has not received the underlying models for the risk assessment.
[68] This analysis may not be comprehensive since it does not include costs for some local highway schemes, car parking, and other committed or planned schemes that are not funded by Gatwick. It also excludes any additional costs borne that might be borne by National Air Traffic Services (NATS) for providing additional air traffic control.
[69] Bank of England policy target rate. HM Treasury (2014), 'Remit for the Monetary Policy Committee', 19 March, available from: http://www.bankofengland.co.uk/monetarypolicy/Documents/pdf/chancellorletter140319.pdf.
[70] EC Harris (2013/14), 'Construction Growth Accelerates as Confidence Grows'.

- Turner & Townsend has conducted detailed QRA, and a blanket 25% increase in risk for costs has been attributed to all CAPEX categories.[71] Oxera has not undertaken any further modification for QRA;
- Arup's analysis of non-Gatwick contribution for highway costs also does not include any uplifts for QRA—it is not clear whether QRA will be conducted for these cost items;
- the Gatwick spend of the investment costs has not been subject to any optimism bias, whereas the non-Gatwick spend on surface access projects relating to highways incorporates a 44% uplift for optimism bias (as per the TAG guidelines);[72]
- the data has been rebased from 2013 Q4 prices to 2010 prices;
- an indirect tax correction factor of 1.19 (based on TAG guidelines) has been applied to convert factor costs into market prices; and
- all the cost data has been discounted at the social discount rate of 3.5% (as per the TAG guidelines).

Gatwick's construction programme has been devised to match the forecast demand (leading to a phased build programme). This approach minimises the project risk by de-coupling the redesign of airspace and runway commissioning from new terminal capacity. The new runway will be brought into use by maximising existing terminal capacity, and the subsequent phased construction of terminals and piers will allow for a controlled runway opening phase for full utilisation of R2. The risk modelling for the project has been developed in accordance with ISO31000 and the OGC Management of Risk guidelines. The analysis shows that R2 will be functional by 2025, followed by the terminal infrastructure in 2030. The probabilistic model identifies a P80 level of confidence in achieving this.

A2.1.3 Conclusion

The total present value of the incremental cost of the project is approximately £10.6bn, assuming a phased construction up to 2039 and an average asset life of 60 years for the new runway and terminal expansion. This includes £7.3bn of capital costs and approximately £3.3bn of operating costs. Operating costs are assumed to incur until 2080—i.e. over the entire asset life.

A2.2 Discount rate

As Oxera is conducting an economic impact assessment of the social welfare arising from the R2 scheme, it is appropriate to discount all cash flows at the social discount rate. Importantly, the analysis incorporates non-Gatwick-related costs and benefits. This makes Oxera's analysis different to the assessment presented in the financial case, which considers the perspective of Gatwick's investors—in this case, all the Gatwick-related cash flows would need to be discounted at the project-specific cost of capital.

[71] It is assumed that the Arup analysis regarding Gatwick's contribution for highway costs is included in the Turner and Townsend cost estimates for surface access.
[72] Optimism bias has not been taken into account in the R2 Master Plan base estimate because of the project's mature risk management framework and processes.TAG guidelines do not require operating costs to be uprated for optimism bias.

A2.3 Cost estimates for Heathrow R3

It is not clear whether the capital cost estimates for Heathrow's R3 option are consistent with the TAG guidelines in terms of the various adjustments.[73] For indicative purposes, Table A2.1 presents estimates for Heathrow's project costs as presented by HAL and the Commission. These costs also exclude OPEX.

Table A2.1 Heathrow R3 cost estimates

Project	Commission cost estimate (£bn)	HAL cost estimate (£bn)	Comments
North	13–18	14.3	Includes airport infrastructure, surface access, environmental impact, community impact
North-West	13–18	16.9	As above
South-West	16–22	17.6	As above

Note: Airport infrastructure includes runway, taxiway, apron, aircraft stand, terminal capacity and pier, tracked transit, baggage system, access road, car park, and control tower costs. Surface access includes road, highway, motorway, and rail costs. Environmental impact considers re-provision of wildlife habitat, flood mitigation and reprovision of reservoir costs. Community impact includes residential property, commercial property, and general land compulsory purchase, community facilities re-provision, community infrastructure levy, and air noise compensation costs. The Commission estimates include risk adjustments and optimism bias. The North and South-West runway options have not been shortlisted and are presented for indicative purposes only.

Source: Heathrow Airport Ltd (2014), 'A New Approach', January; Airports Commission's sift 3 templates regarding long-term options available at https://www.gov.uk/government/publications/airports-commission-interim-report, accessed on 28 March 2014.

Oxera has undertaken a high-level assessment of Heathrow's projected operating costs applying the same methodology and unit cost assumptions as used in GAL's financial model.[74] The costs are driven primarily by SH&E's traffic forecasts for Heathrow in the event of the North-West runway being built at Heathrow.[75]

HAL has estimated the north-west third runway to cost about £17bn, which includes: £11bn of airport infrastructure costs; £2.1bn of surface access costs; and £3.8bn of environmental/community costs. Of these costs, HAL has stated that up to £6bn might be funded using public finances.[76] However, it is not clear to Oxera which cost items from the list above would be funded by the £6bn subsidy.

In its January 2014 document, Heathrow pointed out that the North-West runway option would be served by a new Terminal 6 and extensions to Terminal 2.[77] Based on the existing capacity, forecast increase in passengers, and required terminal area at Gatwick and Heathrow, it is not unreasonable to assume a similar increase in terminal area requirement for both the Gatwick and Heathrow

[73] For example, the values contained in Heathrow Airport Limited (2014), 'A new approach: Heathrow's options for connecting the UK to growth', January.
[74] The one off adjustments to staff numbers have been re-profiled to match the profile of R3 passengers at Heathrow over time. Sensitivities have been conducted to these adjustments and the overall results for total costs do not vary by more than +/-£100m.
[75] SH&E's forecasts for passenger traffic are presented up until 2050 (after which it is assumed that traffic would not grow any further).
[76] Available from: http://mediacentre.heathrowairport.com/press-releases/heathrow-north-west-third-runway-option-short-listed-by-airports-commission-779.aspx, accessed 12 May 2014.
[77] Heathrow Airport Ltd (2014), 'A New Approach: Heathrow's options for connecting UK to growth', January.

projects. However, GAL assumes a 17% allocation of space to retail activities.[78] This appears to be higher than the current allocation of retail space across the four operating terminals at Heathrow (which is approximately 8%).[79] Hence, for the purposes of this assessment, the retail area at the new proposed Terminal 6 is assumed to be 10%. The operations at the new Terminal 6 are assumed to increase in a phased manner according to the projected increase in passenger traffic.

All operating costs are assumed to start in 2030 and to continue to be incurred until 2085 (based on an average asset life for the runway and terminal buildings). The estimation of staff costs (including security and policing) draws on the analysis conducted by GAL. However, subsequent increments in staff requirements have been re-profiled to match the increase in passenger numbers based on SH&E's forecasts for Heathrow. Unit costs relating to maintenance, utilities, rent, etc. are assumed to be at levels similar to those presented in GAL's analysis.[80]

The analysis estimates operating costs at Heathrow to be approximately £2.4bn (in 2010 prices) over the life of the new assets that need to be constructed.[81] This implies that the overall cost of the North-West runway option (i.e. the shortlisted option) is likely to be £15bn–£20bn.

Based on the numbers in Table A2.1 and the estimated operating costs, R2 is a lower-cost option than Heathrow expansion for increasing runway capacity in the South East of England.

[78] Based on an assessment provided by GAL, version 4, dated 7May 2014.
[79] Based on data from BAA (2011), '2011 Heathrow investor visits: Review of Heathrow's retail activities' available at http://www.heathrowairport.com/static/HeathrowAboutUs/Downloads/PDF/Heathrow-Retail-Presentation-2011-final.pdf; last accessed on 8 April 2014 and http://www.heathrowairport.com/about-us/company-news-and-information/company-information/facts-and-figures; last accessed on 8 April 2014.
[80] The CAA's report on airport OPEX suggests that operating costs per passenger at Heathrow are approximately 1.5 times those at Gatwick. The higher rate of operating cost per passenger at Heathrow is captured by the fact that similar levels of additional terminal and pier area are assumed at both airports, even though SH&E's forecasts assume approximately 45m additional passengers at Gatwick compared with 25m additional passengers at Heathrow by 2050. See CAA (2013), 'CAA Airport Operating Expenditure Benchmarking Report 2012', June.
[81] Although the CAA benchmarking study concludes that Gatwick is more efficient than Heathrow, the lower estimate for total operating costs at Heathrow is largely driven by the lower forecast for passengers resulting from a third runway at Heathrow compared with R2. However, operating costs per passenger remain higher at Heathrow. For example, in the year 2050, per-passenger operating costs at Heathrow are forecast to be £6.70 as compared with £4.30 at Gatwick. The proportionate difference in these costs is similar to the numbers presented in the CAA's benchmarking study. See CAA (2013), 'CAA Airport Operating Expenditure Benchmarking Report 2012', June.

A3 User and provider impacts

Box A3.1 Airports Commission 'economy impacts' module

The quantification of user and provider impacts relates to the 'economy impacts' section in the Commission's appraisal framework. The module states that assessments of the impacts on user and providers should include the following:

- how passengers' and airports'/airlines' 'surplus' might alter or be transferred;
- how delays in the UK airport system might change;
- how the aviation market and corresponding competition between airlines and airports is likely to change;
- what the impact on the air freight industry could be.

Oxera's analysis covers all these impacts (the impact on competition is presented in Appendix 6).

Source: Oxera; Airports Commission (2014), 'Appraisal framework consultation', January.

As the main users of runways, passengers and airlines determine the demand for this capacity, which is why the economic assessment of the R2 and Heathrow NW schemes needs to quantify the welfare effects on airports, airlines and passengers resulting from the two Do Something scenarios. The analysis presented in this appendix measures the welfare impact on these three groups.

The DfT's guidance on aviation appraisal sets out the methodology that the DfT follows when evaluating the impact of government interventions in the aviation industry.[82] As WebTAG offers a clear framework for the analysis of user and provider impacts and the Commission is using the DfT's aviation modelling suite that implements this framework, Oxera also follows this methodology to ensure consistency with the Commission's analysis.

Sections A3.1–A3.5 of this appendix focus on the economic surplus that accrues to users and providers; section A3.6 quantifies the impact of changes in delay; and section A3.7 quantifies the impact on freighters. The impact from changes in competition is covered in Appendix 6.

A3.1 Methodology based on Aviation Appraisal TAG unit

Oxera uses the framework set out in the Aviation Appraisal unit of WebTAG. As with any model, this framework has limitations arising from the underlying assumptions—for example, assumptions made about the demand curve, the shape of which reflects how consumer demand responds to changes in fares. This means that assuming a different functional form might lead to a smaller or larger effect on consumers and producers because of fares changes following a capacity increase. Another issue is that, in reality, airlines do not have a uniform pricing strategy, but set different fares for different customer types—known as 'price discrimination'. This suggests that the effect of a capacity extension is likely to differ across consumer types. For example, airlines may increase fares

[82] Department for Transport (2014), 'TAG Unit A5.2 Aviation Appraisal', January.

by more on flights with a higher proportion of business passengers who are less responsive to changes in fares as their employers are paying these costs.

It is important to keep in mind these limitations and their potential effect on the results. However, this methodology provides a transparent approach, which is comparable to that adopted by the Commission. Therefore, while the approach has some limitations arising from the simplifying assumptions, these limitations are unlikely to affect the ordering of options.

Consumer and producer surplus

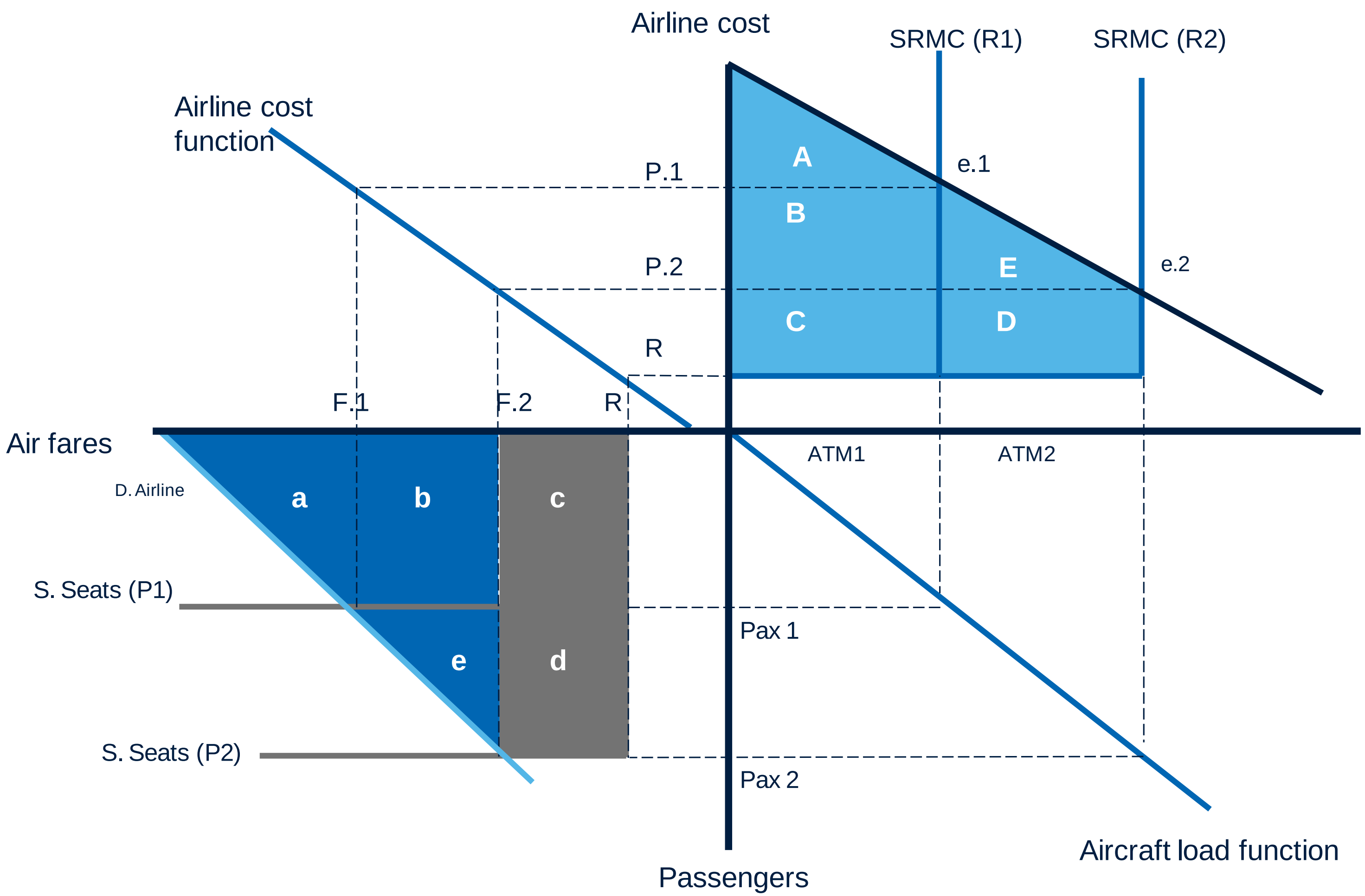
The main parameters of interest in the user and provider impact analysis are changes in consumer (i.e. passenger, freight users) surplus and producer (i.e. airline and airport) surplus:

- consumer surplus represents the value of the service to customers beyond the price they pay for it. In economics terms, consumer surplus is given by the maximum amount consumers are willing to pay less the actual price of the services;
- producer surplus represents the value to the airlines from providing air travel services, given by the price airlines charge beyond the associated (economic) costs they incur.

TAG aviation model

The TAG unit on aviation appraisal is based on an economic model which looks at the supply and demand in two separate but interrelated markets: the market for runway space (i.e. the airport–airline market) and the market for airplane seats (i.e. the airline–passenger market). The key link between the two is established by a direct translation of the runway capacity constraint into a constraint on airplane seats, and hence on passenger numbers. Figure A3.1 below illustrates these two interrelated markets.

Figure A3.1 DfT's conceptual framework



Note: Oxera's analysis quantfies the bottom left-hand quadrant and changes to the airport's revenue/costs only. This is because the areas in the two quadrants mirror each other; if all the components were quantified and added together, this would lead to a double-counting of some of the welfare effects. The shadow cost that airlines receive is defined as the monetary difference between F1 and R in the airline–passenger market, multiplied by the volume of passengers.

Source: WebTAG Unit A5.2, p. 12.

The figure portrays the airport–airline market in the top right-hand quadrant, and the airline–passenger market in the bottom left-hand quadrant. These quadrants are linked by relationships between airline costs and air fares (top left-hand quadrant), and relationships between ATMs and passengers in the bottom right-hand quadrant.

Airport–airline market

The market for runway space is characterised by demand on the part of airlines and supply from airports. In the London system, supply is limited by constraints on runways and airspace, which allows the possibility for either airports and/or airlines to generate economic rent from their customers by charging a price higher than marginal cost. This is shown in Figure A3.1 in the top right-hand quadrant by the supply curve SMRC (R_1) being fixed at the same level of capacity (ATM_1). If it was not regulated, the airport could charge P1 to airlines and earn areas b and c, which is the difference between the price charged and the marginal cost. This is referred to as the 'shadow cost' (or 'scarcity rent'). In practice, the CAA sets airport charges and the model assumes that the charge is set equal to marginal cost. This limits the ability of the airport to extract the economic rent, and effectively passes it to the airlines.

When additional capacity is created in the form of more runway space, this shifts the supply curve to the right, which is shown by the movement of the supply curve from SMRC (R_1) to SMRC (R_2) in the top right-hand quadrant. This leads to more flights being provided and the average price falling to fill this extra demand, which results in the shadow cost falling.

Airline–passenger market

Airlines represent the supply side of the passenger seats market, which is constrained owing to the airport capacity constraint. On the demand side of this market are business and leisure passengers whose responsiveness to changes in air fares can be summarised in their price elasticity of demand,[83] which is one of the key variables in the analysis.

Due to the capacity constraint in this market and the regulated price in the market for runway space, airlines are able to charge fares that are higher than their marginal cost and thereby extract economic rent, which is reflected in higher airline profitability or higher slot values (for incumbent airlines). This is shown in the bottom left-hand quadrant of Figure A3.1 by the supply curve S-Seats (P_1) being fixed at the same level of capacity (Pax_1). Airlines charge air fares at a price higher than the margin cost (equal to R in Figure A3.1), which results in them earning scarcity rent equal to areas b and c. Expanding airport capacity for the take-off and landing of planes weakens the constraint on ATMs. This would be expected to reduce airlines' ability to extract economic rent and reduces passenger fares. This is shown in the bottom left-hand quadrant of Figure A3.1 by a reduction in fares from F_1 to F_2 and the demand for seats increases as passenger numbers increase from Pax_1 to Pax_2.

[83] A price elasticity is defined as the percentage change in demand following a 1% change in price.

Box A3.2 Critique of Frontier Economics' report

HAL has commissioned a report from Frontier Economics, which analyses the economic impacts of an additional runway at Heathrow.[84] The report considers the impact of additional airport capacity on ticket prices and connectivity, considered in turn below.

Impact of capacity on ticket prices

Broadly following the approach adopted in this Economic Impact Assessment, Frontier Economics finds that expansion at Heathrow would result in a reduction in air fares and a larger reduction from the Heathrow NW scheme than the Gatwick R2 scheme. However, it is important to note that Frontier Economics does not appear to account for the change in flight frequency, which is an important aspect of this Economic Impact Assessment. This would be expected to increase the level of fares in the Do Minimum beyond that which would occur in reality. Specifically, Frontier Economics predict that the reduction in fares at Heathrow would be £95 per return ticket (or 15%) today, compared with £14 (7%) at Gatwick. Because of increasing costs of capacity constraints, by 2030 the reduction in fares at Heathrow would be £320 (38% of the average fare), but only £40 at Gatwick (18% of the average fare).

The analysis behind these numbers assumes, crucially, that demand currently choked off (or paying a high price) at Heathrow would not move airports if capacity were built at Gatwick. The analysis takes today's capacity constraints at each airport, projects them forward, and implicitly assumes that the capacity added caters *only* for the excess demand at each airport. In other words, the analysis assumes little or no substitution between Gatwick and Heathrow.

However, this view is not consistent with a range of decisions from competition and regulatory authorities, which have found that passengers can substitute between the London airports. In particular:

- the CAA's scarce capacity allocation decision on the London to Moscow route, which included Gatwick and Heathrow in the same market;
- the decision of the CC on the Ryanair/Aer Lingus minority shareholding divestiture, which found passenger air services from London to be in the same market; and
- the European Commission's decision on the Ryanair/Aer Lingus proposed merger, which also found passenger air services from London to be in the same market.

The CAA has recently defined Gatwick and Heathrow to be in separate markets and these to be in a separate market from Stansted. However, this conclusion was not conducted in the context of assessing the impact on competition from a second runway, nor is it consistent with the CAA's previous decision in 2007 to advise the DfT to de-designate Stansted, where the DfT also concluded that there was a single South East of England market. In addition, the analysis of the Office of Fair Trading and CC in the BAA market investigation found there to be a broad South East airports market and that there would be scope for substantial competition between the London airports with the provision of new capacity. This analysis is contrary to the analysis undertaken by Frontier Economics, which appears to assume that passenger demand is not substitutable between airports in the South East of England.

Frontier Economics also appears to assume that there is significant excess demand in the London system (for example, with over 50% of unconstrained demand in London being unmet in 2030, compared with approximately 17% from the Airports Commission's analysis or 6% from SH&E). Frontier Economics also appears to assume that (despite the other aspect of the paper (see below), there is no demand

[84] Frontier Economics (2014), 'Impact of airport expansion options on competition and choice: a report prepared for Heathrow Airport', April.

impact from increasing connectivity or frequency to existing destinations. When consistent demand forecasts and the adjustment for frequency described in this appendix are adopted, the analysis presented in this appendix and the analysis conducted by Frontier Economics provide results that are of the same order of magnitude.

This analysis demonstrates the possibility that, following capacity expansion at Heathrow, airlines could reduce fares relative to the Do Minimum. However, without the additional competition which would arise under 2+2, the response by both airports and airlines in the 3+1 scenario would be likely to result in lesser fare reductions and fewer benefits to passengers.

To validate the analytical approach taken by Frontier, further analysis of the past behaviour of airports and airlines following capacity expansion at airports would be important.

Impact of capacity on connectivity

Frontier Economics presents evidence that the 'number of new direct connections facilitated by a Heathrow expansion is likely to be almost six times higher than the number of new connections in any likely Gatwick scenario'. Forty new direct connections are created at Heathrow, relative to eight at Gatwick, of which 15 (one at Gatwick) become 'frequent' connections. Direct connections are defined as at least one service per week (long-haul, two per week short-haul), while a 'frequent' connection is three per week (long-haul, six per week short-haul).

Frontier Economics' approach of deriving unconstrained demand and assessing whether there is sufficient demand to support direct services appears broadly reasonable. However, there are issues with both the conceptual approach and the practical implementation that raise doubts about the accuracy of the results.

Frontier Economics appears to suggest that an additional direct connection from one London airport to a destination has no value if there is already a connection from another London airport. However, as shown in Appendix 6, there is a significant benefit to consumers from this connection, which should be accounted for in any economic assessment of the impacts of expanding capacity.

Specifically, the assessment of the level of unconstrained demand appears to assume that technological progress is 1% a year. This value is based on the average increase in plane size. The use of average plane size to proxy increases in unconstrained demand requires a detailed explanation of the underpinning logic, which is not provided. In addition, Frontier Economics does not appear to have taken account of the fact that airlines can (and do) vary aircraft sizes to maximise the profitability of routes. Therefore, the application of an arbitrary threshold equivalent to three flights per week on a Boeing 786/767 with a 75% load factor may not be sufficient to derive robust results and conclusions.

Overall, therefore, there appear to be significant issues with the implementation of the analysis of both the impact of additional capacity on ticket prices and the impact of additional capacity on connectivity.

A3.2 Quantification approach

This sub-section describes the process by which Oxera has translated SH&E's traffic forecasts into the 'user and provider benefits' element of the economic impact assessment.

Oxera's analysis focuses on the London aviation system as a whole, and distinguishes three separate flight market segments: domestic, short-haul and long-haul. The analysis is designed to estimate the welfare benefits for passengers of capacity expansion, distinguishing between business and leisure, and airlines. To do this, it is necessary to estimate the fares charged and services offered for the three scenarios under examination: Do Minimum, Gatwick R2 (2+2) and Heathrow R3 (1+3). This estimation takes as given the demand forecasts generated by SH&E.

For simplicity, the analysis and results are presented in aggregate terms, starting with airline costs, translating these into fares in the Do Minimum and Do Something scenarios, and then describing how these estimates are used to produce the numbers required for the Commission. Figure A3.2 shows the model structure used to derive the user and provider impacts.

Figure A3.2 User and provider impact model structure

Source: Oxera.

Each of these steps is considered in turn below.

Costs

The starting point is analysis of the costs that airlines face, including 'normal' profits—i.e. profits that airlines would earn in competitive market conditions in which sufficient capacity was made available to meet underlying demand. Fuel and environmental costs, APD, landing charges and other operating costs have been profiled and projected into the future.[85] Airlines' normal profits are assumed to remain at 3% of turnover in line with recent behaviour, and Heathrow and Gatwick are assumed to price in line with existing regulation. Landing charges are assumed to be flat in the Do Minimum case, but to be higher for a 20-year period in the expansion scenarios as airports pass on capital costs to their airline customers. The other cost components are assumed to increase over time so that, in the Do Minimum scenario, total unit costs (per passenger) are higher than at present in 2050 and beyond.[86]

Table A3.1 Unit costs and charges in the Do Minimum scenario

	2020	2040	2050
Fuel (£)	95	84	77
Environmental charges (£)	3	36	48
Landing charges (£)	17	17	17
APD (£)	15	16	18
Average of other costs (£)	52	55	58
Normal profit (£)	6	7	7
Total costs (£)	**188**	**214**	**225**

Note: All values are in 2010 real terms. Landing charges are the weighted average of the charges provided by SH&E for Gatwick and Heathrow, weighted by the number of passengers at each airport. Values are for the whole of the London system and may not sum due to rounding.

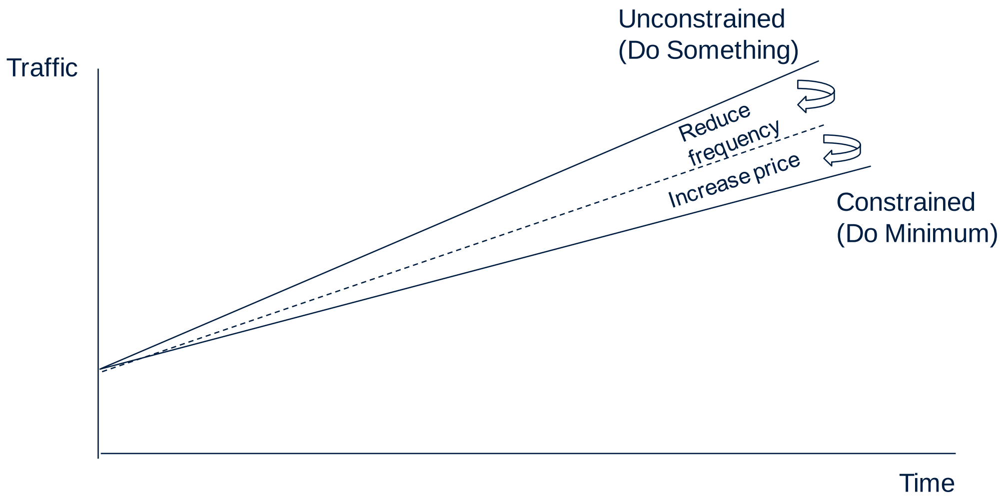
Source: Oxera.

[85] Fuel, environmental costs and APD were taken from DfT (2013), 'Aviation forecasts', January, Annex C.4. GAL provided data on landing charges, adjusted to ensure that the effect on the airport's revenue of the additional runway is NPV-zero.
[86] A different underlying path of costs would change the assumed fares trend over time, but not substantially the difference between scenarios.

Fares in the Do Minimum

The next stage of the analysis involves translating the costs from Table A3.1 into air fares. In the Do Minimum scenario, the London system becomes increasingly constrained by shortage of capacity. To ensure that demand is limited to the available capacity, airlines would either restrict the services available (frequencies or destinations available) or raise fares to choke off ‘excess’ demand, as explained in section A3.1. Both involve welfare losses to passengers: they would have been willing to travel at the fare and level of service provided in an unconstrained world, but either do not travel or have to accept lower service levels and higher fares in the Do Minimum. However, higher fares also generate scarcity rent for airlines, effectively shadow costs of the constraints in the system which are passed on to passengers.

Figure A3.3 Reconciling the Do Minimum and Do Something forecasts



Source: Oxera.

SH&E forecasts of demand in the Do Minimum are used to estimate the shadow costs (higher air fares) and service reductions (relative to an unconstrained situation) required to bring demand down into line with capacity.

Oxera has produced estimates of the extent to which air fares are higher under the Do Minimum than in the Do Something scenarios using two steps:

- comparing projections from SH&E of flight frequencies in the Do Minimum case with those expected in the two airport expansion scenarios.[87] We have translated these differences into an implied effect on demand using an elasticity of 0.6, in line with the academic literature.[88] We find that approximately half of the difference in traffic between the Do Minimum and Do Something scenarios is due to loss of frequency in the Do Minimum. Not accounting for this change in frequency will result in artificially large increases in fares in the Do Minimum as all of the reduction in traffic will be attributed to increases in fares;

- assuming that the remaining demand that needs to be choked off to match demand to supply in the Do Minimum will be reduced by fares rising above

[87] The data used to model the increases in flight frequencies also includes new routes, so the effect on demand of new destinations is implicitly captured within the frequency effect.
[88] A 1% increase in flight frequency leads to a 0.6% increase in demand.

airline costs in the Do Minimum. We use price elasticities supplied by SH&E to translate the demand to be choked off into fare increases.

The formula for a change in demand when only the price effect is assumed is given below:

$$\%\ change\ in\ demand = price\ elasticity * \%\ change\ in\ price$$

This can be rearranged to give the change in price:

$$\frac{\%\ change\ in\ demand}{price\ elasticity} = \%\ change\ in\ price$$

It is possible to derive fares using this relationship for future periods and for the different scenarios. A worked example of how fares are calculated in the Do Minimum is shown below in Table A3.2.

Table A3.2 Worked example of price elasticity calculation

Parameter	Value
Excess demand (A)	15%
Elasticity (B)	–1.2
Price rise needed to 'choke off' excess demand (C=–A/B)	12.5%
Price with no capacity constraint (D)	£200
Price with capacity constraint (E=D*(1+C))	£225

Note: The values in this example are for illustrative purposes only. No frequency effect is assumed in this calculation.

Source: Oxera.

Table A3.3 displays excess demand and the values of average fares and shadow costs, both of which increase over time due to the mechanisms explained above.

The average fares are for the London system and represent single journeys. They are derived by weighting the domestic, short-haul and long-haul fares by the number of passengers within each category. They include APD and all other taxes/charges.

Table A3.3 London system excess demand and fares in the Do Minimum scenario

	2020	2040	2050
Excess demand	3%	11%	19%
Average fare (£)	193	226	241
Shadow cost (£)	5	12	16

Note: All values in 2010 real terms.

Source: Oxera.

Fares in the Do Something

The two expansion scenarios increase capacity and allow extra demand to be generated, as forecast by SH&E. Reversing the calculations used to derive fares in the Do Minimum enables the fare reductions (relative to the Do Minimum) to be calculated. The fares reductions calculated in the Do Something ensure that, given the projected service frequency increases, the extra demand is realised.

Table A3.4 Effects on London system demand, fares, frequency and shadow costs in the expansion scenarios

	Gatwick R2			Heathrow R3		
Changes relative to Do Minimum	**2020**	**2040**	**2050**	**2020**	**2040**	**2050**
Increase in demand (%)	0	11	19	0	8	13
Reduction in average fare (£)	0	10	22	0	6	14
Increase in frequency (%)	0	19	19	0	15	15
Fall in shadow cost (£)	1	13	15	0	16	14

Note: The shadow cost fall in 2040 in the Heathrow R3 scenario is also affected by the higher landing charges, which squeeze the premium that accrues to airlines. All values in 2010 real terms. Fares fall by more than the shadow cost in the R2 scenario due to changes in flight mix, which lowers other costs, and therefore fares.

Source: Oxera.

Although fares in the expansion scenarios are substantially lower than in the Do Minimum case, they would still rise over time, given the underlying cost assumptions used here (see Table A3.1).

User and provider surplus

The demand and fares projections are then translated into effects on user and producer surplus in the two expansion scenarios, using standard DfT WebTAG methodology consistent with the Commission's intended approach.

Based on the TAG aviation model, the producer surplus is defined by the difference in the number of passengers multiplied by the shadow cost between the case in which one of the proposals is implemented and the Do Minimum. This can be interpreted as the difference in an airline's super profit between a scenario with a new runway (the proposal) and the Do Minimum (base case).

Producer surplus

$$= \{(passenger\ numbers_{proposal} * Shadow\ cost_{proposal}) - (passenger\ numbers_{base\ case} * Shadow\ cost_{base\ case})\}(1+t)$$

The consumer surplus is based on the sum of the number of passengers and the difference in the air fare under the Do Minimum and one of the two proposed runway options. It captures the benefit that passengers gain from paying lower air fares. The consumer surplus for leisure and business passengers is measured separately owing to the treatment of indirect taxes. As businesses are not charged indirect taxes (i.e. they are allowed to claim back the indirect taxes they have paid), the consumer surplus calculations need to be adjusted for business passengers. The adjustment for indirect tax is also applicable to the producer surplus calculation.

Since Oxera's methodology also considers the effect on demand from an increase in frequency, the welfare effect on consumers is calculated in two steps. The proportion of benefits accruing from lower fares is calculated using the two formulae below for business and leisure passengers, consistent with those outlined in WebTAG.[89]

[89] Department for Transport (2014), 'TAG Unit A5.2 Aviation Appraisal', January.

Business consumer surplus

$$= \frac{1}{2}\left(passenger\ numbers_{proposal} + passenger\ numbers_{base\ case}\right) * \left(air\ fare_{base\ case} - air\ fare_{proposal}\right)(1+t)$$

Leisure consumer surplus

$$= \frac{1}{2}\left(passenger\ numbers_{proposal} + passenger\ numbers_{base\ case}\right) * \left(air\ fare_{base\ case} - air\ fare_{proposal}\right)$$

To calculate the welfare impact on consumers from increases in flight frequency, the above formula is slightly adjusted. This accounts for the difference in the shape of the consumer surplus triangle when there is only a frequency effect and no price effect. The formulae are given below, which are applied to the proportion of benefits that accrue from the frequency effect.[90]

Business consumer surplus

$$= \frac{1}{2}\left(passenger\ numbers_{base\ case}\right) * \left(air\ fare_{base\ case} - air\ fare_{proposal}\right)(1+t)$$

Leisure consumer surplus

$$= \frac{1}{2}\left(passenger\ numbers_{base\ case}\right) * \left(air\ fare_{base\ case} - air\ fare_{proposal}\right)$$

To derive the impact on the airport, the aeronautical revenue received by the airport is calculated as the landing charge per passenger multiplied by the number of passengers. The change in airport revenue is calculated by comparing landing charges and passenger numbers between scenarios, plus the additional non-aeronautical revenue that the airport receives. The cost to the airport for building and maintaining the new runway is then subtracted from the change in airport revenue to give the net impact on the airport resulting from the expansion.

A3.3 Data

To quantify the impacts set out above, Oxera has used forecast traffic data from SH&E. These forecasts provide passenger numbers for domestic, short-haul and long-haul flights and ATMs for the period 2020–52 for Gatwick, Heathrow and the London system under the three scenarios: Do Minimum, Gatwick R2 and Heathrow NW options. In addition, the forecasts include landing charges for Gatwick and Heathrow before and after the respective projects are implemented.[91]

SH&E also provided passenger fares for the base year (2020) and price elasticities for domestic, short- and long-haul flights for Gatwick and Heathrow in the base case. While the passenger and ATM forecasts were provided by SH&E at different levels of aggregation, Oxera has computed the impact at the London system level. The impacts will differ across the London airports, but for

[90] Consumer surplus will be increased relative to the Do Minimum case, not only because fares are lower but also because of the increases in services available (proxied here by increased frequency). The services effect is somewhat smaller for any given increase in demand than the effect of lower fares, but is still substantial.
[91] Oxera has adjusted the landing charges so that the airport can recover the cost of building a new runway over a 20-year period.

presentational (and analytical) simplicity, the modelling and description focuses on the London system as a whole. This enables the overall impact to be captured.

Box A3.3 Aggregation bias

The quantification is undertaken at the London system level of aggregation for each of the domestic, short-haul and long-haul markets. Alternatively, it could be carried out at a lower level of aggregation—e.g. at the individual airport level. However, it was not possible to do this without making a number of assumptions about the level of fares at other airports. In addition, the changes in fares at each airport would have to be modelled in a way that accounts for substitution between the airports, and is consistent with the traffic forecasts at each airport. Modelling at the London system level allows such impacts to be captured implicitly within the analysis.

However, modelling at a higher level of aggregation might introduce a bias to the results. The potential bias is examined in a stylised example shown in the table below. The table shows that the net change in consumer and producer surplus is larger when modelled at a disaggregated level. This suggests that the modelling at a London system level—which Oxera has done—is likely to provide conservative estimates in terms of the impact on users and providers.

	Heathrow	Gatwick	Aggregated
Inputs			
Fare (base)	102.0	77.0	89.3
Pax (base)	28.5	29.2	57.7
Pax (3+1)	30.0	34.0	64.0
Outputs			
Implied fare (3+1)	97.5	75.9	81.9
Change in CS	130.9	264.7	456.2
Change in PS	–478.9	63.4	–786.0
Change in CS+PS	–348.1	328.1	–329.8
Aggregated minus disaggregated	**–309.8**		

Note: The elasticities used are those presented in Table A3.2. The price response at the airport which does not expand (i.e. Gatwick) is calculated by assuming an inward shift in demand. All monetary values are in real 2010 terms. The analysis is based on the short-haul market in 2040. The values have not been discounted.

Source: Oxera.

To derive costs, forecast data on cost drivers for airlines comprising the total average passenger fares was used. Since this data is not available from the SH&E data source, DfT forecasts were used to derive the proportion that APD, fuel and carbon costs make up of airline fares.[92] Other costs (e.g. operating costs, capital costs and normal profit) were derived by subtracting landing charges, shadow costs and the DfT costs from air fares in the Do Minimum.

[92] DfT (2013), 'Aviation forecasts', January, Annex C.4.

Assumptions and inputs for the model

Table A3.5 displays the assumptions on which the model is based.

Table A3.5 Modelling assumptions for user and provider impact model

Parameter	Value	Comments
Appraisal start date	2021	Start of construction
Appraisal end date	2080	60 years after start of construction, as per Airports Commission appraisal framework
Discount rate	3.5% for first 30 years, 3.0% otherwise	HMT Green Book, p. 99
Price base	2010	Deflated to 2010 using GDP deflator
Base year	2014	WebTAG requires 2010 base year, but that was not viewed to be appropriate in this case
Indirect tax	1.19	Applicable for business passengers' consumer surplus and the producer surplus calculations
Business/leisure passenger splits	Various	Based on data from SH&E and DfT aviation forecasts
Business fares	60% higher than average fares	Based on DfT data
Leisure fares	30% lower than average fares	Based on DfT data
Extrapolation of forecasts	Flatlined	SH&E data on passenger numbers covers the period until 2052. Figures beyond this year have been forecast by assuming that the values remain unchanged in future years

Source: Oxera; DfT (2014), 'TAG Data Book', January; DfT (2013), 'Aviation forecasts', January; and DfT (2009), 'Update on fares and short-haul and long-haul passengers, FOI response 5469', April.

In addition, the landing charges assumed are shown in Table A3.6 below.

Table A3.6 Landing charges (£, 2010 real)

	No runway	Runway
Gatwick	9	14
Heathrow	21	28

Note: The 'no runway' landing charges apply before construction and once the cost of the runway has been recovered. The 'runway' charges are applied for a 20-year period during and after construction. The value of the 'runway' charges is equal to a value which ensures that the effect on the airport of the additional runway is NPV-zero. The additional revenue generated by the incremental passengers is netted off the costs of operation in calculating the landing charges, in keeping with current economic regulation.

Source: Oxera and GAL.

The London system-wide elasticity used has been estimated by taking an average of the Gatwick and Heathrow elasticities weighted by the proportion of passengers in the two airports.

Table A3.7 Price elasticities

	Domestic	Short-haul	Long-haul
Gatwick	–1.15	–1.41	–0.95
Heathrow	–1.02	–1.18	–0.85

Note: The weighted elasticity will change over time to reflect the relative changes in traffic between Gatwick and Heathrow. The elasticities are based on a study by InterVistas and are market elasticites. The difference between the elasticites for the two airports is due to differences in the mix of business and lesiure passengers. Since Heathrow has a higher proportion of business passengers—who are less responsive to price changes—its elasticities are lower in absolute terms.

Source: SH&E; Intervistas (2007), 'Estimating Air Travel Demand Elasticities', December.

The frequency elasticities used were based on those estimated in the literature.

Table A3.8 Frequency elasticities

Region	Frequency elasticity
London market (Oxera approximation)	0.6
Europe	0.77
Africa	0.59

Source: Schipper, Y. Rietveld, P. and Nijkamp, P. (2002), 'European Airline Reform: An empirical welfare analysis', *Journal of Transport Economics and Policy*, May; Abate, M.A. (2013), 'Economic Effects of Air Transport Liberalization in Africa', Swedish National Road and Transport Research Institute; and Oxera.

Oxera's approximation is based on the lower frequency elasticity of the two from the literature in Table A3.8 because, owing to the high amount of flight frequencies to destinations already served by the London air market, the impact of providing more frequency is likely to be less significant.

A3.4 Results

Table A3.9 shows the value of key parameters in the Do Minimum for 2020 and 2050. Passenger numbers rise by 34% over the 30-year period due to an increase in factors such as income. The level of excess demand increases as unconstrained demand grows while capacity is constrained. Airlines therefore raise fares to choke off the excess demand.

Table A3.9 Spot-year summary (Do Minimum)

	2020	2040	2050	Change (2020–50)
Passengers (mppa)	142	182	190	34%
Average fare (£, real 2010)	193	226	241	25%
Average shadow cost (£, real 2010)	5	12	16	207%

Note: All the numbers are at the London system level. International transfer passengers have been excluded from the passenger numbers (i.e. passenger numbers are all domestic passengers and London-originating passengers).

Source: Oxera.

Table A3.10 displays the value of key parameters in R2 for 2020 and 2050. The provision of extra capacity leads to fares falling when compared with Do Minimum—£22 lower in the Gatwick R2 scenario. This, and the increase in frequency, induces extra demand to fill up the increased capacity, which is highlighted by an increase in passenger numbers of 58% over the 30-year period. The increase in capacity is also characterised by an increase in competition between airlines (see Appendix 6). The mix of flights also changes as the proportion of long-haul flights rises while that of short-haul flights falls. The reduction in fares, higher frequency and increase in passenger numbers leads to welfare benefits to consumers of about £2bn. The airlines' producer surplus declines as the drop in scarcity reduces the shadow cost.

Table A3.10 Spot-year summary (R2)

	2020	2040	2050	Change (2020–50)
Passengers (mppa)	142	202	225	58%
Average fare (£, real 2010)	193	216	219	13%
Average shadow cost (£, real 2010)	5	–1	1	–80%
Discounted change in consumer surplus (£m, real 2010)	134	1,856	2,006	-
Discounted change in producer surplus (£m, real 2010)	–89	–1,271	–1,090	-

Note: The discount factors are 0.81 in 2020, 0.41 in 2040 and 0.3 in 2050. International transfer passengers have been excluded from the passenger numbers (i.e. passenger numbers are all domestic passengers and London-originating passengers) and the consumer suplus calculations. The consumer surplus figure is adjusted to account for the frequency benefit, which is in addition to the benefit from reduced fares (relative to the Do Minimum).

Source: Oxera.

Table A3.11 shows the value of key parameters in the Heathrow R3 scenario for 2020 and 2050. Again, the provision of extra capacity leads to air fares falling (compared with the Do Minimum). This, and the increase in frequency, induces extra demand. Passenger numbers rise by 51% between 2020 and 2050 within the 3+1 scenario. System-wide fares are about £14 cheaper in 2050 when compared with fares in the Do Minimum in Table A3.9.

Table A3.11 Spot-year summary (Heathrow NW)

	2020	2040	2050	Change (2020–50)
Passengers (mppa)	142	197	214	51%
Average fare (£, real 2010)	193	220	227	18%
Average shadow cost (£, real 2010)	6	–3	2	–59%
Discounted change in consumer surplus (£m, real 2010)	–33	1,682	1,530	–
Discounted change in producer surplus (£m, real 2010)	48	–1,556	–982	–

Note: The discount factors are 0.81 in 2020, 0.41 in 2040 and 0.3 in 2050. International transfer passengers have been excluded from the passenger numbers (i.e. passenger numbers are all domestic passengers and London-originating passengers) and the consumer suplus calculations. The consumer surplus figure is adjusted to account for the frequency benefit, which is in addition to the benefit from reduced fares (relative to the Do Minimum). Source: Oxera.

Comparing the two scenarios, fares are lower in R2 in 2050, which induces more demand than the Heathrow R3 option. The R2 option allows more scope for increases in service provision by LCC-type airlines, which are generally able to charge lower fares.

In both scenarios, lower fares and higher passenger numbers (compared with the Do Minimum) lead to increases in consumer surplus in 2050. This is partly offset by lower producer surplus, as lower fares reduce the amount of scarcity rent that airlines receive. Overall, there is an increase in welfare in 2050, with R2 delivering more benefits due to lower fares and higher demand than the Heathrow NW option.

The NPV of the impact of the two separate runway options is calculated by summing the discounted streams of the consumer surplus and producer surplus over the appraisal period. These values are given in Table A3.12. In addition, the impact on the provider (i.e. the airport) is shown in the table, which includes the change in aeronautical and non-aeronautical airport revenue and the cost of building/operating the new runway. In conclusion, one of the main impacts of the extra runway (regardless of location) is to prevent scarcity rents accruing to airlines due to a capacity constraint.

Table A3.12 Present value of user and provider impacts (£bn, real 2010)

	Gatwick R2	Heathrow R3
Leisure passengers consumer surplus	39	28
Business passenger consumer surplus	43	31
Airline producer surplus	–50	–48
Net impact on passengers/airlines	**32**	**12**
Airport revenue	11	19
CAPEX	7	17
OPEX	3	2
Net impact on airport	**0**	**0**
NPV	**32**	**12**

Note: All values in 2010 real prices. See Appendix 2 for more details on the costs. The numbers may not sum due to rounding. International transfer passengers have been excluded from the passenger numbers and the consumer suplus calculations.

Source: Oxera.

Table A3.12 shows how the net impact on passengers/airlines is significantly higher with R2. The differences between the effects of the two expansion scenarios, detailed in the tables above, are driven largely by differences in the growth of demand they generate, as projected by SH&E. The difference in user benefits is larger in the 2+2 scenario as the extra capacity becomes operational earlier, which means that the benefits from a reduction in fares and increase in frequency accrue earlier. The impact on producer surplus is similar between scenarios due to two offsetting factors:

- larger fare reductions in 2+2, which decrease the shadow cost that accrues to airlines;

- higher landing charges in 3+1, which squeeze airlines' shadow costs.[93]

One important final remark is that the model assumes that all values plateau after 2052, which has implications in particular for the 3+1 scenario. Passenger forecasts show that the London system is not full in the 3+1 scenario by 2052, which suggests that demand may continue to grow beyond this period. Oxera has not assumed that demand will grow in 3+1 after 2052, as this would necessitate modelling constrained and unconstrained demand in the Do Minimum in order to keep the calculations consistent across scenarios. However, approximate calculations indicate that if Heathrow continued to fill up in 3+1 after 2052, this would lead to an increase in net benefits to passengers/airlines of about £3bn–£4bn. This would increase the 3+1 NPV to £15bn–16bn.

Magnitude of estimates

The results in Table A3.12 can be compared with the Airports Commission's economic analysis, which quantifies the cost to users and providers of not relieving the capacity constraint. The results are presented in Table A3.13, to show the benefits to users of capacity expansion and the cost to providers.

Table A3.13 Airports Commission's preliminary quantification of the costs of capacity constraints

Present values (£bn, 2012)	Carbon-capped	Carbon-traded
User (passengers)	58.4	72.4
Provider (airports and airlines)	–51.2	–58.7
Public finances (government)	7.9	3.8
Net benefit	15.1	17.6

Note: All the results are quoted with a 2012 present-value year and price base for a 2021–80 appraisal period.

Source: Airports Commission (2013), 'Interim report: appendix 3: technical appendix, December, p. 11.

It can be seen that benefits to users from the capacity constraint are smaller than the benefits to passengers calculated by Oxera in the 2+2 scenario, similar to those calculated in the 3+1 option.

The Commission's quantification on the loss of surplus to providers in the carbon-traded scenario from the capacity expansion is higher than Oxera's calculations of the reduction in producer surplus in both the 2+2 and 3+1 scenarios.

The net effect calculated by the Commission is smaller than Oxera's calculation for the 3+1 scenario and higher than the 2+2 scenario.

Impact on providers

Table A3.12 shows that there is a substantial negative impact on airlines in terms of loss of producer surplus. The producer surplus calculation is based on changes in the shadow cost and passengers between scenarios, calculated on

[93] The model assumes that landing charges are not passed on to consumers, and thus squeeze airlines' profits. In reality, this increase in landing charges may be passed on to passengers through higher fares—which is not explicitly modelled. However, the method used to derive fares does implicitly account for this as the traffic forecasts are based on pass-through that may occur.

an annual basis. However, it can be shown from the cost breakdowns that airlines would still benefit from expansion when compared with their position in 2020. Table A3.14 below shows a breakdown of airlines' financial positions in the three scenarios for 2020 and 2050.

Table A3.14 London system airline profits in the expansion scenarios

	Gatwick R2			Heathrow NW		
	2020	2040	2050	2020	2040	2050
Demand (mppa)	142	202	225	142	197	214
Average fare (£)	193	216	219	193	220	227
Unit cost excl. normal profit (£)	183	211	212	182	217	218
Normal profit per passenger (£)	6	6	7	6	7	7
Shadow cost per passenger (£)	5	–1*	1	6	–3*	2
Total profit (£m)	1,495	1,151	1,695	1,609	613	1,942

Note: * The negative shadow cost is driven by the increase in landing charges; in reality, this would be reflected in higher fares or lower normal profits. A 3% normal profit margin is assumed. All values are in 2010 real terms. Numbers may not sum due to rounding. The average of other cost changes differs due to changes in the mix of flights between domestic, short-haul and long-haul. Passenger volumes do not include international transfers.

Source: Oxera.

Table A3.14 demonstrates that airlines still benefit over time in both the Do Something scenarios, owing to higher passenger volumes and marginally higher normal profit per passenger.

A3.5 Sensitivity analysis

Oxera has conducted sensitivity analysis to assess how the user and provider impacts change under alternative passenger forecasts. The alternative scenarios are given in Table A3.15.

Table A3.15 Additional scenarios

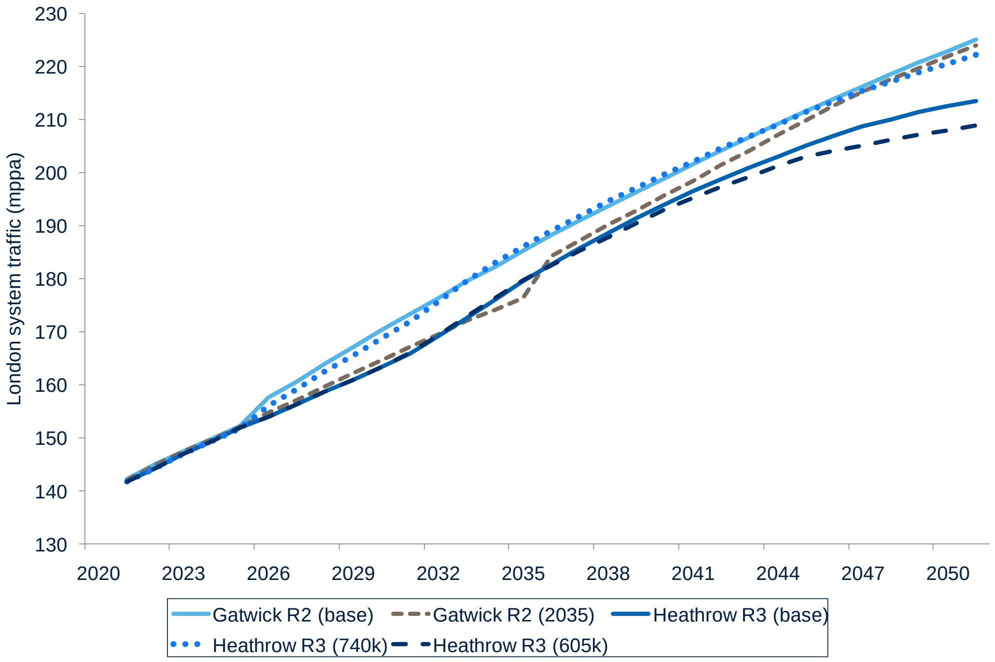
Scenario	Comment	2040 pax	2050 pax
R2	Base scenario	202	225
R2 (2035)	Assumes R2 does not open until 2035	199	224
Heathrow R3	Base scenario	197	214
Heathrow R3 (740k)	Third runway opens in 2025 and can accommodate 740k ATMs per annum compared with 670k in the base scenario	202	222
Heathrow R3 (605k)	Heathrow expansion can accommodate 605k ATMs per annum compared with 670k in the base scenario	195	209

Note: Passenger numbers exclude international transfer passengers.

Source: SH&E.

Figure A3.4 displays the profile of the five scenarios.

Figure A3.4 Do Something scenarios



Note: International transfer passengers are not included.

Source: Oxera and SH&E.

Figure A3.4 shows that Heathrow R3 (740k) sensitivity leads to more passengers in the London system, with a profile over time that is similar to the 2+2 option. The Gatwick (2035) scenario has fewer passengers than the base R2 option, but has a higher growth rate from 2035 onwards, which leads to a similar level of passengers by 2050.

The results from using the alternative forecasts above are displayed in Table A3.16, which shows the difference in the NPV of the impact on airlines and passengers.

Table A3.16 Net present value of user and provider impacts, including sensitivities (£bn, real 2010)

	Gatwick R2	Gatwick R2 (2035)	Heathrow R3	Heathrow R3 (740k)	Heathrow R3 (605k)
Consumer surplus	83	65	59	75	50
Producer surplus	–50	–40	–48	–53	–42
Net impact on passengers/ airlines	**32**	**25**	**12**	**21**	**8**

Note: All values in 2010 real prices. The numbers may not sum due to rounding. International transfer passengers have been excluded from the consumer suplus calculations. For simplicity, the effect on airports is not included in the table as it is assumed that this is NPV-neutral in the alternative scenarios and will not alter the net impact.

Source: Oxera.

Table A3.16 shows that, if R2 were to open in 2035, this would reduce the benefits experienced by airlines/passengers by £7bn relative to the Gatwick R2 scheme—i.e. the cost of delaying a decision by ten years is approximately £7bn. In the alternative 3+1 scenario where the assumed capacity at Heathrow is 740k ATMs per annum and the new runway opens in 2025, this would lead to an increase in benefits of £9bn. However, the net impact in the Heathrow R3 (740k) alternative scenario is still smaller than the central R2 option due to two main factors: the loss of producer surplus being greater in Heathrow R3 (740k)—driven by higher landing charges; and demand being higher in the R2 scenario in the last 30 years of the appraisal period, which implies lower fares in the system and greater benefits for passengers. The more conservative Heathrow R3 (650k) scenario leads to the net benefits decreasing by £4bn, driven by fewer passengers experiencing higher fares compared with the central 3+1 scenario, although this effect is partly offset by airlines not losing as much scarcity rent.

A3.6 Delay and time savings

Providing additional airport capacity is expected to have implications for the overall travel time experienced by passengers in a number of ways—the time it takes:

- to travel through the terminal (for passengers starting or ending their journey at the airport);
- to make connecting connections (for connecting passengers);
- the plane to taxi from the terminal to the runway (all passengers);

and, thus, the delay experienced in the journey.

Drawing on analytical input from Arup on the differences between Heathrow and Gatwick with a new runway, values of time from the DfT and passenger volume forecasts from SH&E, Oxera has monetised these categories, as outlined below. Owing to a lack of data about what would happen in the Do Minimum, this comparison provides only a relative cost between the 3+1 and 2+2 options, rather than a difference against the base case.

A3.6.1 Travel time through the terminal

Gatwick plans a straightforward design to the new terminal facility, combined with a series of technological innovations such as ‘walk-through’ security, enabling quick and easy transit for both arriving and departing passengers. While Heathrow could also adopt technological innovations, the layout of Heathrow, with satellite piers located further from the terminal building than is the case at Gatwick, is likely to mean that it will take a passenger on average approximately 10 minutes longer to travel through the terminal at Heathrow than Gatwick.

This difference applies to all passengers starting or ending their journey at the airport. Applying the appropriate values of time to this time difference and combining with the passenger forecasts from SH&E (for the additional passenger who would travel from/to Heathrow) results in a value of this time of £1.4bn.

A3.6.2 Connection time

For those passengers connecting between flights, the time taken is an important consideration. Given the relatively simple, compact nature of Gatwick’s terminals, Gatwick expects intra-terminal connection times of 30 minutes, with inter-terminal connection times of 45 minutes. Due to the more dispersed nature of the terminal facilities at Heathrow, connection times are longer for inter-terminal transfer. However, intra-terminal connection times are currently in the region of 60 minutes.

For the purpose of this appraisal, however, the benefits accruing to international transfer passengers are excluded as there is no benefit accruing to the UK (unless those transfer passengers are UK residents).

A3.6.3 Taxi time

As with the design of the terminal facilities, Gatwick plans a straightforward design for the airfield operation, which will minimise taxi times and distances by locating the new terminal facilities between the two runways. This means that the average taxi time at Gatwick is expected to be 7 minutes. At Heathrow, because of the more complex layout of the terminal facilities and greater potential for congestion, average taxi time is predicted by Arup/GAL to be 16 minutes.

This difference applies to all passengers using the airport. Applying the appropriate value of time to this time difference and combining with the passenger forecasts from SH&E results in a value of this time of £1.2bn.

A3.6.4 Delay

The impact of delay is also an important consideration as it has some significant implications, including passenger inconvenience and increased cost to airlines. While the redesign of the London airspace is expected to significantly reduce the levels of delay in the air,[94] congestion on the ground could still introduce some delay into the system. At Gatwick, with the relatively simple layout and two mixed-mode runways, such delays are expected to be minimal. However, at Heathrow, with the more complex layout of taxiways, more dispersed terminals and using two runways in segregated mode, there is likely to be less resilience and hence more delay. GAL’s analysis suggests that this delay may average three minutes per passenger.

Oxera has calculated that the total cost of delay under 3+1 compared with 2+2 would be £0.4bn.

A3.7 Freight impacts

Any expansion of airport capacity would be expected to have significant knock-on benefits to the freight industry because of the use of bellyhold capacity to transport long-haul freight. As the demand for freight (shipped by all modes) is likely to be determined by the wider economy, of which the price of air freight is only one component, the impact on the freight industry of additional capacity is likely to be similar, regardless of where that additional capacity is provided. The key issue is whether the additional capacity is likely to provide the connectivity demanded by the freight industry.

Given the potential for increasing profitability from shipping freight, it seems likely that additional capacity at either Heathrow or Gatwick would provide broadly equivalent levels of service to the freight industry. Given the slightly larger passenger volumes and greater number of destinations, it is possible that a 2+2 system may offer a more beneficial solution than a 3+1 system, but this is likely to be marginal.

[94] For more information, see http://www.londonairspaceconsultation.co.uk/

A4 Surface access impacts

One of the key aspects of any expansion of airport capacity is the change in surface access that will be required to enable that the expansion. Both the Commission and the DfT appraisal frameworks contain detail on how the impact on surface access should be considered.[95]

The Commission's appraisal framework sets out three sub-objectives relating to surface access:[96]

- to maximise the number of travellers arriving at the airport on public transport, or promote environmentally sustainable modes of transport;
- to accommodate the needs of other users of transport networks, such as commuters, intercity travellers and freight;
- to enable access to the airport from a wide catchment area.

The DfT's appraisal framework does not consider surface access schemes to airports directly, but rather the appraisal of 'dependent developments'—i.e. developments that are dependent on a transport scheme. In this context, the transport schemes are the surface access schemes required to deliver the airport expansion.

The DfT's appraisal framework sets out four key steps: [97]

- determine whether the additional airport capacity is likely to be dependent on additional surface access;
- identify the surface access schemes required to provide all users of the transport network with a reasonable level of service;
- assess the transport user benefits of the surface access scheme in isolation (i.e. in the absence of the airport capacity expansion);
- assess the benefits of the airport capacity expansion, assuming that the surface access scheme is provided.

In this case, therefore, the two appraisal systems are quite different, with the DfT's appraisal system concentrating on accurately measuring the user and provider impacts of changes in surface access, and the Commission's approach focusing more on ensuring that surface access facilitates its chosen policy outcomes.

There are significant overlaps between the appraisal systems, with the DfT's approach providing a way of quantifying the requirements set out by the Commission—see Table A4.1.

[95] Airports Commission (2014), 'Appraisal framework consultation', January, pp. 43–7; and Department for Transport (2014), 'Transport appraisal in the context of dependent development: TAG Unit A2.3', January.
[96] Airports Commission (2014), op. cit., p. 43.
[97] Department for Transport (2014), 'Aviation appraisal: TAG Unit A5.2', January, p. 6.

Table A4.1 Mapping the DfT and Commission appraisal frameworks (surface access)

Commission objective	Link to DfT appraisal
Maximise the number of travellers arriving at the airport on public transport, or promote environmentally sustainable modes of transport	Not directly linked. The DfT appraisal framework values the benefits to all users of surface access rather than maximising the number of travellers using public transport, reflecting the fact that some passengers may prefer to travel by non-public modes
Accommodate the needs of other users of transport networks, such as commuters, intercity travellers and freight	The DfT's appraisal framework requires an assessment of the surface access schemes required to provide all users of the transport network with a reasonable level of service. Therefore, the two frameworks are aligned in seeking to ensure that other users of the transport networks are not unduly affected by the expansion at the airport
Enable access to the airport from a wide catchment area	Not directly related

Source: Oxera.

As has been demonstrated, there is a significant overlap between the Commission's surface access appraisal framework and the DfT's appraisal. GAL's surface access strategy demonstrates how R2 performs against the Commission's objectives. However, an important part of the economic appraisal is to consider the welfare changes associated with changes in the surface access scheme, as detailed below.

A4.1 Analytical approach

A4.1.1 Steps 1 and 2: identify the surface access schemes required

There are a considerable number of surface access schemes that are expected to take place around Gatwick, with or without R2. Understanding which of these are required for delivery of R2 has been an important part of the surface access team's work, which has resulted in the identification of several schemes that are already committed to (or highly likely to happen) without R2 and others that are incremental to R2 (as detailed in Table 3.1).

In summary, there are no incremental rail schemes associated with R2. This is because the Thameslink upgrade programme, combined with the upgrade of the station at Gatwick, is expected to deliver sufficient capacity to enable the rail network to provide a reasonable level of service to other users of the rail network in the presence of R2. Similarly, there are some extensive upgrades planned to the road network, including the remodelling of the M25/M23 junction and hard-shoulder running on the M25. However, these improvements are also required as part of a general programme of upgrades to the road network, and are not required for the surface access network to deal with the expansion of passenger traffic associated with R2. Nevertheless, there are some upgrades required to the road surface access network, expected to cost approximately £0.3bn, the most significant of which is the re-routing of the A23.

Significant surface access projects are also planned at Heathrow, including Crossrail, an upgrade to the Piccadilly Line; Western Rail Access to Reading; and capacity improvements to parts of the M4 and M25.[98] These schemes are

[98] Airports Commission (2013), 'Northwest runway sift 3', p. 2.

already committed to, and therefore not driven by any capacity expansion. However, the construction of Heathrow NW would require a section of the M25 being placed into a tunnel (among other surface access schemes). The Commission estimates that surface access costs would be £2bn–£3bn (excluding optimism bias).

Engineering consultants have done extensive work to identify the surface access schemes required to accommodate the needs of all users of the surface access infrastructure.

A4.1.2 Transport user benefits without airport expansion

This is a standard assessment of the transport user benefits for those who use the surface access infrastructure with or without the expansion of the airport, but who receive a benefit from the incremental surface access schemes. Such an assessment can be carried out by comparing the generalised cost (i.e. including monetary costs and time) between the two scenarios:

- a scenario without the incremental surface access improvements and without the expansion of the airport;
- a scenario with the incremental surface access improvements and without the expansion of the airport.

By comparing these scenarios, important aspects of the overall appraisal can be calculated:

- the value of time savings for existing users of the infrastructure (split by business/leisure/commuting passengers);
- the value of cost savings for existing users of the infrastructure (split by business/leisure/commuting passengers);
- any additional costs incurred by public transport operators and local authorities.

These costs and benefits have not been quantified due to lack of data.

A4.1.3 Benefits of the airport expansion, with the surface access schemes provided

As set out in WebTAG Unit A2.3, the change in society's welfare from a development comes from two main components:

- private benefits associated with a change in land value arising from a change in land use;
- a net external impact arising from the loss of amenity value of land compared with its existing use and transport-related external costs.

The private benefits associated with a change in land value can be derived from other analysis carried out by GAL for the business case. This includes work by Deloitte, which finds that the cost of acquiring the land for the second runway would be £804m.[99] Given this, one method of assessing the private benefit due to a change in land value can assumed to be between zero and the cost of acquiring the land (£804m).

[99] Deloitte (2014), 'Land acquisition and other compensation costs', January.

The net external impact from the loss of amenity value can be examined through understanding the amount of land acquired and its current use. However, Oxera has not quantified this impact as we expect the value to be relatively small, although further work may be carried out at a later date if deemed appropriate.

The transport-related external costs can be assessed using the results of the transport modelling.

A4.2 Results

For this section, Oxera has only quantified the transport-related external costs. To do this, the additional distance that would be generated on highways from the new runway at Gatwick was estimated using data provided by Arup. Values of marginal external costs in the WebTAG data book were then used to provide a range for the transport-related external costs.[100] A summary of the data is given below in Table A4.2.

Table A4.2 Data for transport-related external costs quantification

	Value
Additional kilometres in 2040 (m)	882
Marginal external costs from congestion (2035)	
Motorways (£, real 2010)	0.03
A roads (£, real 2010)	2.18
Other roads (£, real 2010)	1.07

Note: 2035 is the last year that marginal external costs are provided for in the TAG data book.

Source: Arup, Oxera, DfT.

A4.3 Results

Combining the data in Table A4.2 gives an indication of the range of the transport-related external costs from congestion. The NPV is provided in the table below.

Table A4.3 Data for transport-related external costs quantification

	Lower bound	Upper bound
NPV of transport-related external cost (£bn, real 2010)	0.5	16.9

Note: To derive the lower bound, it was assumed all additional traffic was on motorways. The upper bound assumed it was equally distributed on the three different types of road: motorways; A roads; and other roads.

Source: Oxera

The results show a large range and it is expected that the transport-related external costs would lie somewhere between the lower and upper bound. In addition, it should be note that this quantification has only been done for Gatwick R2 and the corresponding calculation for the 3+1 scenario has not been done—due to a lack of data. However, it is expected that the value would be at least as big in the 3+1 scenario because there is already considerable congestion around Heathrow and passengers travelling to Heathrow may be more likely to use A and other roads than would passengers accessing Gatwick. As motorway travel

[100] DfT (2014), 'TAG Data Book', January.

has, on average, lower marginal external costs, this would result in larger costs from a the additional traffic travelling from Heathrow than Gatwick.

In addition to the costs from greater levels of congestion, if Heathrow NW is built, it would require significant construction works, including putting a section of the M25 in a tunnel beneath the new runway and re-routing the A4 and A3044. Oxera has conducted indicative analysis to quantify the impact that this construction work may have on road users due longer journey times. The analysis indicates that the cost to road users would be in excess of £1bn. The quantification approach and assumptions used to derive this result are given in more detail in Box A4.1.

Box A4.1 Impact of disruption to the M25, A4 and A3044

The quantification approach is outlined below.

Data and assumptions: there were three main groups of inputs: values of time; extent of delay; and traffic volumes. These are described below.
Values of time: taken from the DfT's transport appraisal guidance data book.[101] The values vary by vehicle type, driver purpose and the calculation year (as values of time are expected to increase over time due to increasing real incomes).
Extent of delay: based on assumptions about: average speed on the affected roads; the length of road section disrupted; by how much the speed was reduced; and the duration of the roadworks. The table below shows these input assumptions and the resulting difference in journey times.

	M25	A3044	A4
Duration of roadworks (years)	3	3	3
Average speed on road (miles per hour)	60	38	38
Length of section disrupted (miles)	15	10	10
Speed reduction due to roadworks	60%	60%	60%
Travel time through affected section:			
without roadworks (minutes)	15	16	16
with roadworks (minutes)	37	40	40
Difference (minutes)	22	24	24

Source: Oxera.

From the table it can be seen the disruption leads to between 22 and 24 minutes of additional journey time on average.

Traffic volumes: these were calculated using daily traffic count data for the relevant sections of the three different roads.[102]

[101] DfT (2014), 'TAG Data Book', January.
[102] The data was taken from DfT traffic count data. For more information, see http://www.dft.gov.uk/traffic-counts/index.php

A5 Environmental impacts

There are a significant number of potential environmental costs of expanding airport capacity. As such, both the Commission's framework (the noise, air quality, biodiversity, carbon, water and flood risk, and place appraisal modules)[103] and WebTAG contain detailed approaches to appraising the environmental costs.[104]

Of the many environmental costs associated with the expansion of airport capacity, this appraisal focuses on the three that are expected to have the most material impact on the business case when monetised: noise, carbon and air quality. A qualitative assessment is included of other environmental effects such as changes in biodiversity.

A5.1 Noise

An increase in noise emissions is considered to have a number of effects on human health. These are categorised as 'annoyance', 'sleep disturbance', 'acute myocardial infarction' (AMI) and 'hypertension' (increased risk of stroke and dementia). While there is considerable uncertainty in the welfare effects of noise, the Commission recommends the use of the WHO DALY approach for monetisation of annoyance and sleep disturbance, and the methodology followed in the ERCD 1209 report for monetisation of AMI and hypertension. Oxera has followed these recommendations to produce estimates of the difference in noise-related costs between the Do Minimum and R2 options, as follows.

- GAL provided Oxera with data on the number of households and population in 3dB noise bands above 57db for the Do Minimum and for the R2 scenario for the year 2040. From a report by the CAA's Environmental Research and Consultancy Department, the number of affected population was derived for 2012.[105] The data on the affected population for Heathrow was derived from an ERCD report that projected noise effects when a third runway would be in place.[106]
- As aircraft are expected to continue to become quieter, it has been assumed that, after 2040, the number of population affected by noise declines (linearly) by 10% by 2080. This compares with an expected reduction of 18% between 2012 and 2040 (distributed linearly). This is known as the 'efficiency factor'.
- The SH&E forecast of ATMs was used to calculate an annual growth factor for both the Do Minimum scenario and the second runway scenario.
- For the Do Minimum, the data was interpolated between 2012 and 2040 by taking the 2012 number of households for every band and applying first the efficiency factor and then the ATM growth rate before multiplying the number of population affected by noise by the growth in ATMs. After 2040, the household numbers for each band was extrapolated using the 2040 Do

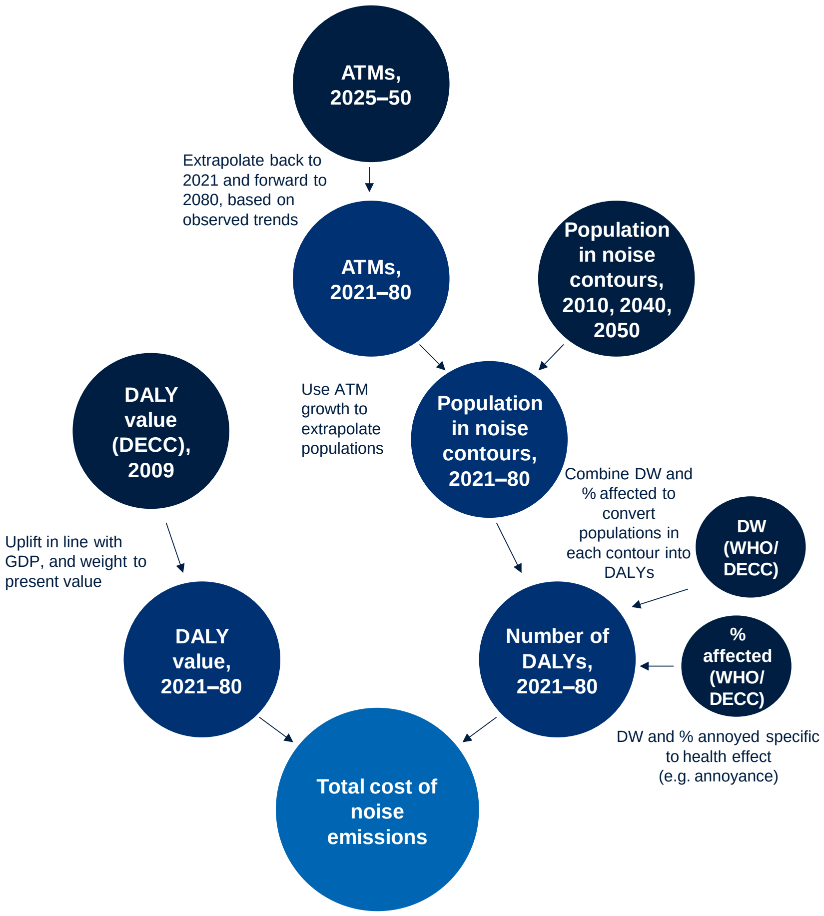
[103] Airports Commission (2014), 'Appraisal framework consultation', January.
[104] Department for Transport (2014), 'TAG Unit A3: environmental impact appraisal', January.
[105] Environmental Research and Consultancy Department (2013), 'Noise Exposure Contours for Gatwick 2012', ERCD Report 1302, September.
[106] Environmental Research and Consultancy Department (2007), 'Revised future aircraft noise exposure estimates for Heathrow airport', ERCD Report 0705, November. The expansion option at Heathrow considered in this report is for a runway to the north of the airport, which is shorter and further east than the current Heathrow NW proposal. However, this is the best information on the noise impact of an expansion at Heathrow that is currently available.

Minimum values as the starting point. The efficiency factor was then applied before multiplying the result with the growth in ATMs to calculate the number of population affected by various levels of noise.

- For the Do Something scenario, the data was extrapolated using population in each band from the 2040 R2 scenario (provided by GAL) and applying the same efficiency factors as in the Do Minimum, before multiplying population with the R2 scenario ATM growth from data provided by SH&E. From 2020 to 2025, the same values were used as in the Do Minimum.
- After calculating the population in each noise band above 57dB in both the Do Minimum and Do Something scenarios between 2021 and 2080, the difference in population in each band for each year was calculated.
- The Gatwick opening year is assumed to be 2025; the Heathrow opening year is assumed to be 2029.

This approach has been reflected in Figure A5.1.

Figure A5.1 Noise approach



Source: Oxera.

Results

Table A5.1 shows the population in each band for each of the scenarios.

Table A5.1 Population affected by noise ('000)

dB	57–59.9	60–62.9	63–65.9	66–68.9	69–71.9	72–74.9	Total
Gatwick							
Do Minimum ERCD (2012)	1.9	0.9	0.2	0.15	0.05	0	3.2
Do Minimum (2040)	2.1	0.7	0.2	0.1	0	0	3.1
R2 (2040)	8.2	4.7	1.1	0.05	0.05	0	14.1
Heathrow							
Do Minimum 480,000 ATM (2015)	156.7	54.8	35.3	11.6	2.6	0.9	261.9
Do Minimum 480,000 ATM (2030)	75.9	41.9	17.7	5.1	1.6	0.0	142.2
Third runway 720,000(2030)	123.5	39.4	17.2	7.3	2.6	1.2	191.2

Source: Oxera analysis of ERCD and Gatwick data.

The outcome of these calculations shows an increase in noise cost for Gatwick to approximately £223m (present value) in the period 2020–80, while for Heathrow the noise cost of a third runway are calculated at £1,282m. These estimates cover the effects shown in Table A5.2.

Table A5.2 Costs of different noise components for the extra runways (£m)

	R2	Heathrow NW
Annoyance	85.9	455.3
AMI	116.3	826.7
Strokes	12.6	n/a
Dementia	8.4	n/a

Note: n/a signifies not quantified due to a lack of data.

Source: Oxera analysis of ERCD and Gatwick data.

Detailed methodology

Noise annoyance

The methodology suggested by the Commission comprises the method described in the 2001 WHO paper, in which annoyance is expressed by the number of DALY lost by experience of noise levels by the affected population.

The DALY is calculated by:

- taking the population experiencing noise per noise band;
- calculating the percentage of people who experience annoyance in the noise bands, using the following formula:

  %HA = -9.199*10^ - 5(Lden - 42)^3 + 3.932*10^ - 2(Lden - 42)^2+0.2939(Lden - 42)

  where Lden is the middle of the noise band;
- calculate the absolute number of people who experience annoyance by noise in each band;

- multiply this by a disability weight (DW). The DW has a low (0.01), central (0.02) and high (0.12) scenario. Oxera used the central scenario for its calculations.

As indicated in section 2.4.4., Oxera has taken the DALY value of £60,000 (2009 prices) to calculate the total costs for noise annoyance. The NPV was calculated using standard DfT GDP growth and interest data.

Oxera has used the LAeq16h data to populate the formula, since this data was the most detailed for both Gatwick and Heathrow, from 57db to 72db in the Do Minimum and Do Something scenario.

Sleep disturbance

The methodology suggested by the Commission comprises the method described in the 2011 WHO paper. As with annoyance, the sleep disturbance caused by noise is expressed by the number of DALY lost by experience of noise levels by the affected population.

The DALY lost is calculated by:

- taking the population experiencing noise per noise band;
- calculating the percentage of sleep-disturbed people in the noise bands, using the following formula:

  %HA = 18.147 - 0.956(Lnight) + 0.01482(Lnight)^2

  where Lnight is the noise level in the middle of the band;
- calculating the absolute number of people whose sleep is disturbed by noise in each band;
- multiplying it by a DW. The DW has a low (0.01), central (0.02) and high (0.12) scenario. Oxera used the central scenario for its calculations.

As indicated in section 2.4.4, Oxera has taken the DALY value of £60,000 (2009 prices) to calculate the total costs for sleep disturbance. The NPV was calculated using standard DfT GDP growth and interest data.

This data could not be calculated due to limited data issues (no base year for Gatwick and only base year for Heathrow).

Heart attack (AMI)

Exposure to persistent high noise levels has been shown to increase the risk of suffering a heart attack. ERCD report 1209, as recommended for use by the Commission, estimates the increase in likelihood of AMI using the dBL_{Aeq} noise contours. Estimates of the population in these noise contours was estimated for both Heathrow and Gatwick using the same method as described above for noise annoyance.

The ERCD then provides an estimate of the odds-ratio for AMI, which measures the increased risk of AMI as a result of being exposed to a particular noise contour.[107] This is multiplied by the average risk of AMI to someone in England, and the population in each contour, to give the number of additional AMI as a

[107] Oxera took 57.5dB as the average value of the 55–60 LDen noise contour, and 65dB as the average value of the >60 Lden contour.

result of the increased noise levels. This number must then be converted into DALY. An AMI can cause disability or death. In line with the ERCD recommendations, a different DW is applied to calculate YLL and YLD. These DWs, as quoted by the ERCD, are provided by Defra, and take into account the average YLL as a result of suffering an AMI, and the likelihood of surviving an AMI. The resulting DW for YLL is 7.94, and that for YLD 0.11.

The number of additional AMI is then combined with the DW to give total DALY as a result of increased noise. This is then monetised on an annual basis using the DALY value of £60,000, as explained above.

Hypertension (high blood pressure)

Although the causal pathway is unclear from a medical perspective, high noise levels have also been shown to increase the risk of hypertension, which in turn raises the likelihood of dementia and strokes.

High noise levels are expected to increase the risk of hypertension during both day- and night-time hours. The ERCD consequently recommend using Lden[108] noise contours when monetising the effects. GAL provided estimates of population exposed to noise in the ranges 55–60dB and above 65dB for 2011, and for the base case and R2 options in 2040 and 2050. These figures were used in conjunction with ATM predictions, and the assumption of a 10% improvement in aircraft noise efficiency between 2050 and 2080, to provide estimates of population exposed to each of these Lden contour intervals in each year between 2021 and 2080.

Research by Harding et al. in 2011,[109] as quoted in ERCD 1209, has led to an estimate of YLD as a result of increased risk of hypertensive strokes and hypertensive dementia. This was multiplied directly by our estimates of population in each noise contour to produce total DALY as a result of the increased noise levels.

The number of increased DALY was then monetised using the DALY value of £60,000, as with the other health effects.

[108] Lden noise contours are a weighted average of noise levels during the day, evening and night.
[109] Harding et al (2011), 'Quantifying the links between Environmental Noise related hypertension and health effects', Report MSU/2011/07, Health and Safety Laboratory.

Box A5.1 Examples of noise monitisation in other countries

The Swiss example

In 2002 the Swiss Agency for the Environment, Forests and Landscape published guidance on the valuation of noise impacts by government.[110] The use of the WHO DALY approach was recommended, with the aim of the publication being to put a value on a DALY which could be applied to any project.

Both ‘hedonic pricing’ (comparing rental prices of properties in low- and high-noise areas) and ‘contingent valuation’ (asking consumers their ‘willingness to pay’ for noise increases) were used, as well as statistical estimations of the value of a single human life. As no particular method was deemed obviously superior to the others, a range was presented. Hedonic pricing returned the lowest of the estimates, at a cost of sleep disturbance of around 2,500CHF (in 2000 prices) per person per year, and a cost of communications disruption of around 1,500CHF. Statistical estimations of the value of a life returned the highest estimates, with a comparable value of sleep disturbance of 15,000CHF, and that of communications disruption, 9,000CHF. A single year’s sleep disturbance is estimated to be the equivalent of 0.055 DALY, and a year of noise disturbance equivalent to 0.033 DALY. This gives a range of the value of one DALY of between 43,000CHF and 271,000CHF in 2000 prices. Converting these values into GBP at 2010 prices (using purchasing power parity) gives a range of £22,000 to £139,000. The UK estimate of £60,000 in 2009 prices sits towards the middle of this range.

The US example

The Federal Aviation Administration in the USA has recently developed the Aviation environmental Portfolio Management Tool, for evaluation of aircraft operations. This includes a framework, based on research at MIT, for monetisation of noise output.

This framework draws on analysis of 60 hedonic pricing studies of airports from around the world. It assesses these studies to find the average relationship between people’s willingness to pay to reduce airport noise and their income. In light of this study, it is possible to evaluate the cost of noise emissions around airports if noise contours and average income are available. An analysis of the costs of noise resulting from expansion at Gatwick or Heathrow using this method is beyond the scope of this study. However, as hedonic pricing studies tend to return estimates of costs that are lower than those in other studies, it is expected that the result would be lower than that in Oxera’s analysis.

A5.2 Air quality

The main components of air quality are NOx and PM emissions. The higher these emissions are, the more health issues are expected. For both types of emissions, the Green Book guidance as published by Defra, in line with the Commission guidance, is used to monetise the effects.

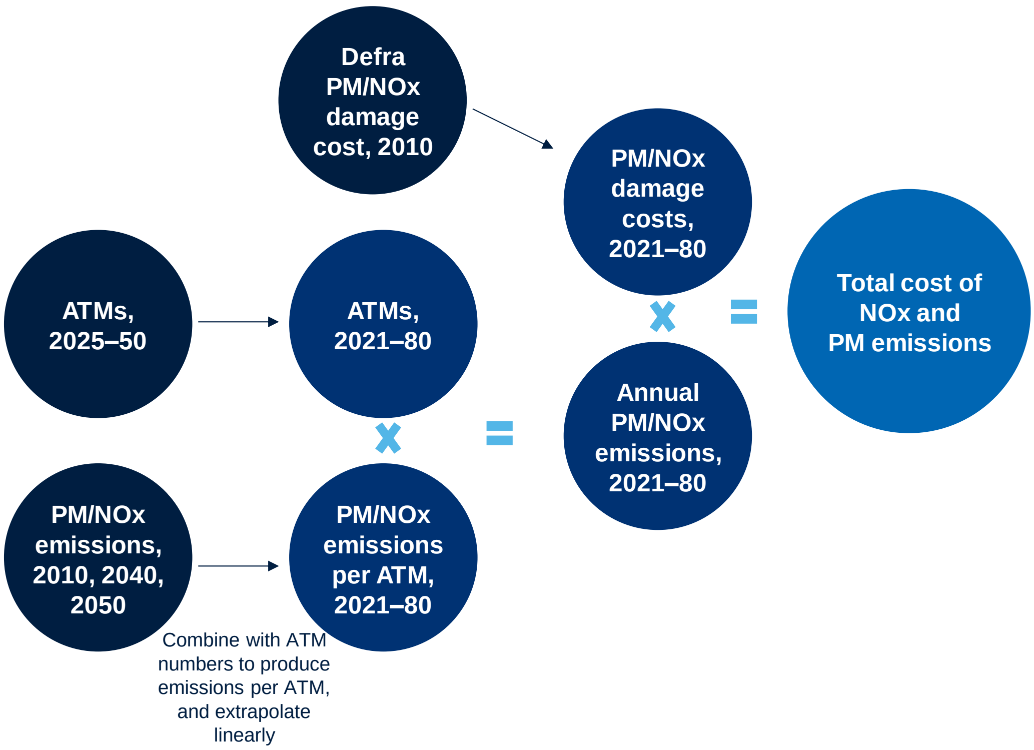
[110] Swiss Agency for the Environment, Forests and Landscape (2002), ‘Monetisation of the health impact due to traffic noise’, Environmental Documentation No. 166.

A5.2.1 NOx emissions

The cost of the fall in air quality in the Gatwick Airport area as a result of R2 in the period 2021–80 is estimated by:

- using estimates of the NOx emissions (in tonnes/year) from GAL, for 2010, and for both the Do Minimum and R2 options in the years 2040 and 2050. These emissions rates were broken down into aircraft, ground service equipment (GSE), stationary source, and road network/car park emissions;
- when combined with ATM forecasts from SH&E, estimating an emissions rate for each year from 2021 to 2080, in both the Do Minimum and R2 options;
- combining these emissions rates with the IGCB estimate of cost per tonne of NOx emissions;
- adjusting these costs in line with GDP growth to reflect a greater willingness to pay to reduce emissions as people grow wealthier. Forecasts of growth in GDP per capita from the DfT 'Air Quality Evaluation Workbook' were used;
- multiplying the adjusted annual cost per tonne by the annual emissions increase;
- adjusting the figures to present value using the DfT's recommended discount rate of 3.5%;
- combining these emission rates with the IGCB's estimate of the damage costs per tonne of NOx emissions, uplifted in line with GDP per-capita growth, and weighted to present value.

Figure A5.2 Air quality approach



Source: Oxera.

Results

Table A5.3 provides a sample of the increase in emissions across the different areas as a result of R2 operating. The total present-value cost of these increased emissions, summed across years, is £33.6m.

Table A5.3 Increase in NOx emissions due to R2 relative to Do Minimum

	Aircraft	GSE	Stationary source	Road and car parks	Present-value cost (£m)
2025	280	20	10	10	
2030	540	20	10	50	
2040	950	10	20	40	
2050	1,170	20	20	50	
2060	1,100	20	20	40	
2070	1,030	20	20	30	
2080	960	20	20	10	
					33.6

Source: GAL, DfT and Oxera analysis.

Aircraft emissions

As the focus is on the effects on local air quality, aircraft emissions are defined as emissions produced while aircraft are on the ground, and during flight around the airport below 1,000m.

GAL provided estimates of aircraft emissions in 2010, and in the Do Minimum and R2 scenarios for 2040 and 2050. These estimates were used in conjunction with SH&E's ATM predictions to calculate emissions per ATM in each of the three years. As a result of the improving fuel efficiency of planes, emissions per ATM fall over time. The rate of this fall was estimated from the GAL 2010, 2040 and 2050 numbers, and then extrapolated to provide emissions per ATM in each year from 2021 to 2080. These figures were then combined with ATM estimates to provide annual NOx emissions.

Non-aircraft emissions

Non-aircraft emissions are broken down into GSE, stationary source, and road network and car park emissions. The emissions figures for each category were estimated as follows.

- **GSE emissions** include all machinery and plants that generate exhaust emissions airside. GAL provided estimates of emissions from GSE in 2010, and for the Do Minimum and R2 options for 2040 and 2050. When analysed alongside ATM predictions, it was observed that GSE emissions per ATM were forecast to fall significantly up until 2040, and then remain level between 2040 and 2050. This is a consequence of more efficient vehicles entering the fleet. Annual emissions per ATM were calculated based on this trend, with the rate assumed to plateau beyond 2040. This was then combined with ATM predictions to calculate annual emissions.

- **Stationary source emissions** include emissions from heating plants and from the fire training ground. As with GSE emissions, estimates were provided by GAL for emissions in 2010, and for the Do Minimum and R2 options in 2040 and 2050. These numbers were used to calculate emissions per ATM in each of the three years. Emissions per ATM are forecast to fall slightly over time. This trend was extrapolated to find emissions per ATM in each year between 2021 and 2080, and then combined with ATM figures to give overall emissions rates.

- **Road network and car park**: road network emissions include all emissions from both airport and non-airport traffic in the 10km × 10km road network around Gatwick. Car park emissions include the emissions from vehicles searching for a parking spot and exiting the airport. As with GSE and stationary source emissions, GAL provided estimates of emissions in 2010, and for both the Do Minimum and R2 scenarios in 2040 and 2050. As emissions from these sources are directly related to the number of passengers using the airport, emissions per passenger were calculated for these three years. This figure fell substantially between 2010 and 2040 due to assumed increases in vehicle fuel efficiency. A downward trend was therefore incorporated in estimating annual emissions per ATM, based on the difference in the 2010, 2040 and 2050 figures. Emissions per ATM were then combined with ATM forecasts to produce annual emissions.

IGCB estimate of cost per tonne of NOx emissions

The above emissions rates were monetised using the IGCB estimate of the cost of 1 tonne of NOx emissions, as recommended by the Commission. The figure is £955 per tonne in 2010 prices.[111] It is the IGCB's estimate of the total cost of emissions, including local and national health and non-health effects. In line with Defra guidance, this cost figure was uplifted in line with growth in GDP per capita for each year to 2080, reflecting people's assumed increase in willingness to pay for a reduction in emissions as they grow wealthier. Costs were then calculated at present value.

A5.2.2 PM emissions

For PM emissions, Defra recommends of the use of a 'Damage Costs' approach when assessing projects with a cost of below £50m. A value of the cost of increased emissions is estimated by:

- predicting the change in PM emissions as a result of the capacity expansion for each year of the appraisal period. This was achieved by extrapolating annual values from GAL's provision of PM emissions in 2010, and in 2040 and 2050 under the Do Minimum and R2 scenarios;
- choosing the most appropriate estimate from the IGCB of damage costs per tonne of emissions, as based on source and location. 'PM Emissions transport average' was used in this case. The final cost figure is heavily dependent on this choice, and estimates of costs under alternative choices are explored below;
- adjusting these costs in line with GDP growth to reflect a greater willingness to pay to reduce emissions as people grow wealthier. Forecasts of growth in GDP per capita were taken from the DfT 'Air Quality Evaluation Workbook';
- multiplying the adjusted annual cost per tonne by the annual emissions increase;
- adjusting the figures to present value using the DfT recommended discount rate of 3.5%.

[111] Defra, 'Air Quality: Economic Analysis' guidance: https://www.gov.uk/air-quality-economic-analysis.

The approach followed to estimate the impact of PM emissions is similar to that followed for NOx emissions, as outlined below. More detail of the methodology for each of the sections is given below.

Results

The cost of PM_{10} emissions is calculated to be £46.0m. Table A5.4 illustrates the increase in emissions from various sources as a result of R2, across a sample of years.

Table A5.4 PM emissions summary: change in PM emissions between Do Minimum and R2 (tonnes)

	Aircraft	Airport road network	Non-airport road network	GSE	Stationary sources	Total
2025	3.8	5.0	-0.7	1.4	0.3	9.9
2030	6.9	7.9	-0.7	2.2	0.3	16.7
2040	11.8	10.8	-0.7	2.5	0.3	24.7
2050	15.0	13.6	-0.7	3.2	0.3	31.5
2060	14.8	14.3	-0.7	3.2	0.3	32.0
2070	14.6	15.1	-0.7	3.2	0.3	32.6
2080	14.4	15.9	-0.7	3.2	0.3	33.1

Source: Defra and Oxera analysis.

Table A5.5 PM emissions summary: change in environmental costs between Do Minimum and R2 (£'000)

Year	Cost
2025	410,
2030	650
2040	830
2050	960
2060	890
2070	830
2080	770

Source: Defra and Oxera analysis.

Detailed methodology

Aircraft emissions

As the focus is on the effects on local air quality, aircraft emissions are defined as emissions produced while aircraft are on the ground, and during flight around the airport below 1,000m.

To provide an accurate estimate of PM emissions from aircraft in each year between 2020 and 2080, emissions per ATM were calculated for the years for which GAL provided data: 2010, 2040 and 2050. These were observed to be almost identical in both the Do Minimum and R2 options, and were seen to decrease gradually over time. This reflects an assumed improvement in aircraft engine technology. This rate of reduction was extrapolated linearly to provide estimates of PM emissions per ATM for each year. These figures could then be multiplied by GAL's predictions of ATMs to arrive at an annual emissions rate.

GSE emissions

GSE emissions include all machinery and plants that generate exhaust emissions airside.

In the figures GAL provided for GSE emissions in 2010, 2040 and 2050, GSE emissions per ATM were observed to fall significantly to 2040. This reflects a gradual switch to electric vehicles within the GSE fleet. By 2040, this fall appears to have plateaued, as all vehicles are assumed to be electric by this stage. As a result, an emissions rate per ATM for the years 2020–40 was estimated based on a gradual improvement in emission standards, and, beyond this point, emissions per ATM were taken to stay at a constant level. These rates were then combined with GAL's predictions of ATMs to provide an annual PM emissions rate from GSE.

Stationary source emissions

Stationary source emissions include emissions from heating plants and from the fire training ground.

GAL provided estimates of PM emissions from stationary sources in 2010, 2040 and 2050. These figures are independent of the number of ATMs, and are consequently constant across time for the Do Minimum and R2 scenarios. Annual emissions rates could therefore easily be calculated for the period 2020–80.

Airport road network emissions

Airport-road network emissions include the emissions from airport-related traffic in a 10km × 10km road network around Gatwick.

Figures were provided by GAL for emissions in 2010, 2040 and 2050. It was assumed that these emissions rates would vary in line with passenger numbers. An emissions rate per passenger was calculated, and observed to fall gradually over time, reflecting improved emissions technology in vehicles. This trend could be extrapolated to provide an annual emissions rate per passenger. This was then combined with GAL's predictions of passenger numbers in the Do Minimum and R2 options, to provide an annual emissions rate of PM.

Non-airport road network emissions

Non-airport road network emissions include the emissions from non-airport related traffic in a 10km × 10km road network around Gatwick.

Although emissions are unrelated to airport activity, GAL's figures show an increase in emissions from this source in the R2 scenario relative to the Do Minimum. It has been assumed that this difference is due to a change in infrastructure owing to R2, and will remain constant over time. Annual figures for the difference in emissions could be extrapolated based on this logic.

Car park emissions

Car park emissions include the emissions from vehicles searching for a parking place and exiting the airport.

Car park emissions are likely to vary in line with passenger numbers. Using GAL's estimates of emissions in 2010, 2040 and 2050, an emissions rate per passenger was calculated. This was observed to fall over time, reflecting improved vehicle emissions technology. This trend was extrapolated to provide an emissions rate per passenger for each year. These figures could then be combined with GAL's predictions of passenger numbers to provide an estimate of annual emissions.

Choice of IGCB damage cost per tonne of emissions

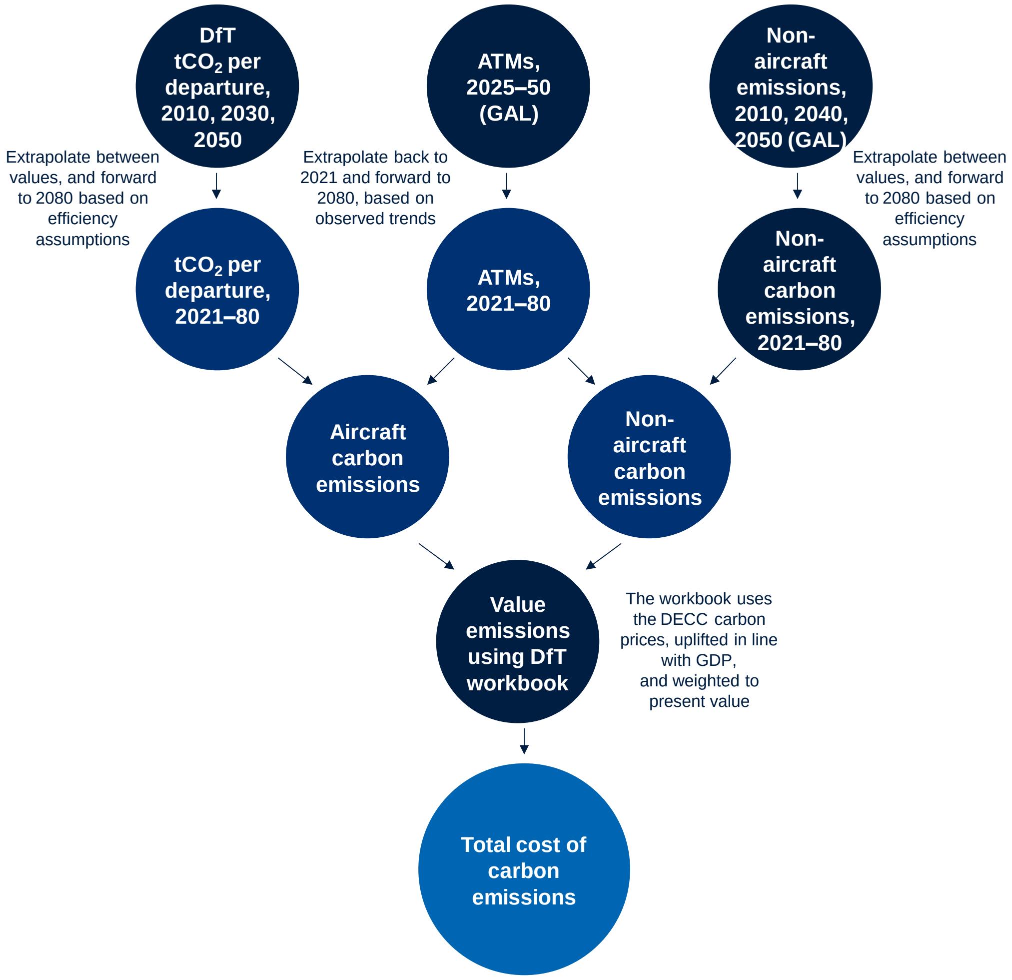
The choice of this variable is significant in determining the final cost figure from a 'damage costs' approach. The IGCB provides estimates (in 2010 prices) for the cost per tonne of emissions from transport for a variety of regions. For example, there are separate figures for 'PM Emissions Transport Inner London', 'PM Emissions Transport Outer Conurbation', 'PM Emissions Transport Rural' and so on. The rate of 'PM Emissions Transport Average' was chosen for this appraisal as we consider that this best reflects the area around Gatwick.

Alternative choices are possible. If 'PM Emissions Transport Outer London' were selected, the cost figure would rise from £46m to £141m. If 'PM Emissions Transport Rural' were selected, the figure would fall to £14m. However, the range of values is unlikely to have a material impact on the conclusions of the analysis.

A5.3 Carbon

The Commission requires the monetisation of both non-aircraft and aircraft carbon emissions. All of these emissions are converted into tonnes of CO_2 equivalent (tCO2e), and monetised using forecasts of carbon prices from DECC. (Where necessary, tradable emissions, such as electricity, are treated as such.)

Figure A5.3 Carbon approach



Source: Oxera.

A5.3.1 Non-aircraft carbon emissions

Non aircraft carbon emissions were estimated as follows:

- using estimates of the carbon emissions in scope 1, 2 and 3 (in tonnesCO_2/ATM) from GAL, for both the Do Minimum and R2 options in the years 2040 and R2 for 2050;
- carbon emissions per ATM or per passenger were observed to fall over time, as a result of more fuel-efficient technology. This trend was extrapolated linearly until 2080, to provide emissions per ATM/passenger in each year;
- when combined with ATM and passenger forecasts from SH&E, these enabled an estimate of an emissions rate from 2025 onwards, in both the Do Minimum and R2 options. For the years 2020–25, the ATMs were extrapolated backwards, using the growth rate in the base scenario (from 2025 to 52);
- these emissions rates were then used in the DfT 'Greenhouse-Gases Valuation Workbook'.[112] This workbook evaluates a present-value cost of carbon emissions, divided into traded and non-traded emissions, based on the DfT's estimates of the cost of 1 tonne of carbon emissions. The values used by the DfT are derived from DECC carbon prices forecast.

Results

As can be seen in Table A5.6, scope 1 emissions are forecast to fall in the R2 scenario, relative to the Do Minimum, despite higher ATMs. This is a result of emissions forecasts provided by GAL, and is expected to be due to expansion allowing improvements in energy efficiency. This effect is, however, offset by increased scope 2 and 3 emissions, giving a total cost of expansion in terms of non-aircraft carbon of £489m.

Table A5.6 Non-aircraft carbon emissions summary: change in emissions between Do Minimum and R2 (tCO_2)

	Scope 1	Scope 2	Scope 3 (excluding aircraft)	Total	Present-value cost (£m)
2025	–7,900	3,000	27,800	22,900	
2030	–6,800	5,700	73,100	72,000	
2040	–5,000	2,400	142,500	139,900	
2050	–3,100	2,000	194,600	193,500	
2060	–3,100	2,000	195,100	194,000	
2070	–3,100	2,000	195,100	194,000	
2080	–3,100	2,000	195,100	194,000	
					489

Source: GAL and Oxera analysis.

[112] Available from: https://www.gov.uk/government/publications/webtag-environmental-impacts-worksheets, accessed 28 March 2013.

Detailed methodology

Scope 1

GAL provided estimates of scope 1 for the Do Minimum and second runway scenarios in 2010, 2040 and 2050. These figures were used in conjunction with SH&E's ATM forecasts to calculate emissions per ATM in each of the three years. It was observed that these were relatively constant over time in both scenarios, but significantly lower in the R2 scenario. A constant level of emissions per ATM was therefore taken across the period 2021–80, with a lower rate for the R2 scenario. These figures were then combined with the ATM forecasts to provide emissions in each year of the appraisal period. These were then valued using the DECC-predicted non-traded cost of carbon.

Scope 2

As with scope 1, GAL provided estimates of emissions in 2010, 2040 and 2050. These were combined with ATM figures to find emissions per ATM in these three years. Emissions per ATM were observed to fall over time in both scenarios, and these trends were extrapolated to provide emissions per ATM in each year between 2021 and 2080. These could be combined with ATM forecasts to find annual emissions. As scope 2 emissions are currently traded, they were valued using traded carbon prices, as published by DECC.

Scope 3 (excluding aircraft)

As with scopes 1 and 2, scope 3 emissions per ATM were calculated in 2010, 2040 and 2050, for the Do Minimum and R2 scenarios. There was observed to be a downward trend in this rate due to improvements in energy efficiency over time. This trend was extrapolated linearly to provide emissions per ATM in each year between 2021 and 2080, for both scenarios. These numbers could then be combined with ATM forecasts to provide annual emissions, which were monetised using the DECC carbon values.

Monetisation

Once estimates of CO_2 emissions in all years between 2021 and 2080 were obtained, the DfT's 'Greenhouse Gases Workbook' was used to estimate the monetary cost of these emissions.

This workbook uses the DfT's estimates of the cost of 1 tonne of emissions for each year between 2021 and 2080, alongside present-value calculations, to estimate an overall cost of emissions from airport capacity expansion. The estimates of cost per tonne of emissions used by the workbook are those provided by DECC.

We also differentiate between traded and non-traded emissions. DECC provides a lower cost per tonne of CO_2 emissions in the traded sector, to reflect the fact that the producer is forced to pay a part of the cost to society, through buying a permit. As electricity generation at airports is currently covered by the EU's Emissions Trading Scheme, scope 2 emissions were entered as 'traded' emissions.

Table A5.7 Sample of years from aircraft carbon emissions calculations: Gatwick emissions for R2[1]

	Gatwick								London airports system[2]	
	Do Minimum	Do Minimum	R2	R2			Do Minimum	R2	Do Minimum	R2
	Short-haul + domestic departures ('000s)	Long-haul departures ('000s)	Short-haul + domestic departures ('000s)	Long-haul departures ('000s)	Short-haul tCO_2 per departure predictions	Long-haul tCO_2 per departure predictions	Total emissions ($MtCO_2$)[3]	Total emissions ($MtCO_2$)	Total emissions ($MtCO_2$)	Total emissions ($MtCO_2$)
2025	120	24	146	29	15	171	6.0	7.3	26.7	27.6
2030	118	28	161	42	15	168	6.4	9.5	27.7	30.2
2040	114	33	187	61	16	144	6.6	11.7	26.3	30.8
2050	112	38	206	73	16	119	6.2	12.0	23.7	29.2
2060	109	41	202	78	15	99	5.8	10.8	21.4	26.5
2070	105	45	197	83	15	83	5.3	9.7	19.3	23.7

Note: [1] This table and Table A5.8 below provide a sample of only six years from the period considered. In calculating total emissions across the 60-year appraisal period, predictions of emissions in each individual year were used. [2] The effect on the London system of a second runway at Gatwick is a fall in departures from other London airports (Stansted, Luton, London City and Southend), which results in a fall in emissions. Separate per departure tCO_2 emissions predictions are used to calculate these values, which are not included in this table. [3] The total emissions columns are calculated by multiplying short-haul departure by short-haul emissions per departure, and adding this to long-haul departures multiplied by long-haul emissions per departure. Where the totals do not sum, this is due to rounding of the departure and tCO_2 per departure figures for presentation purposes, and the total emissions figures should be taken as correct.

Source: DfT, GAL and Oxera analysis.

Table A5.8 Sample of years from aircraft carbon emissions calculations: Heathrow emissions for Heathrow

	Effect on Heathrow								Effect on London airports system[1]	
	Do Minimum	Do Minimum	Heathrow NW	Heathrow NW			Do Minimum	Heathrow NW	Do Minimum	Heathrow NW
	Short-haul + domestic departures ('000s)	Long-haul departures ('000s)	Short-haul + domestic departures ('000s)	Long-haul departures ('000s)	Short-haul tCO_2 per departure predictions	Long-haul tCO_2 per departure predictions	Total emissions ($MtCO_2$)	Total emissions ($MtCO_2$)	Total emissions ($MtCO_2$)	Total emissions ($MtCO_2$)
2025	146	91	146	91	15	171	17.9	17.9	26.7	26.4
2030	144	94	144	105	15	168	18.0	19.8	27.7	28.5
2040	139	99	168	136	16	144	16.4	22.1	26.3	30.1
2050	135	104	173	146	16	119	14.5	20.1	23.7	27.6
2060	130	109	167	152	15	99	12.8	17.7	21.4	24.8
2070	125	114	161	159	15	83	11.3	15.5	19.3	22.2

Note: [1] The effect on the total London system of Heathrow NW includes the carbon effect at Heathrow (the previous two columns), and also the emissions effect at other London airports (Stansted, Luton, London City and Southend) and Gatwick, which results from a fall in departures from these airports due to Heathrow expansion. Separate per departure tCO_2 emissions predictions are used to calculate these values, which are not included in this table.

Source: DfT, GAL and Oxera analysis.

A5.3.2 Aircraft carbon emissions

In line with the Commission guidelines, aircraft carbon emissions have been calculated as the total emissions an aircraft produces over the entire course of its flight, and during ground manoeuvres at an airport. The emissions allocated to an airport are all emissions produced on this basis for all departures.

Aircraft carbon emissions were estimated as follows.

- The per-departure emissions forecasts from the DfT's 'Aviation Forecast 2013' were used.[113] The DfT provided total emissions for short- and long-haul flights (in $mtCO_2$/year) for the years 2010, 2030 and 2050, together with the number of ATMs and thus departures (ATM/2). Oxera used these figures to calculate emissions per departure (in tCO_2) for long- and short-haul flights, and extrapolated these emissions rates between the years 2021 and 2080.
- Combining these results with ATM estimates from SH&E for short- and long-haul flights in the base case and with the additional runway cases for Gatwick and Heathrow, we calculated the total carbon emissions per year for short- and long-haul flights. This included the forecast effect on other airports' ATMs of expansion at Gatwick or Heathrow. For example, expansion at Heathrow is expected to reduce departures from Gatwick, and the positive effect of this change in carbon emissions is also calculated when analysing Heathrow expansion.
- The corresponding carbon emissions per year were monetised using the DfT's Greenhouse Gases Valuation Workbook'.[114] This workbook evaluates a present-value cost of carbon emissions, divided in traded and non-traded emissions, based on the DfT's estimates of the cost of 1 tonne of carbon emissions. The values used by the DfT are derived from DECC's carbon prices forecast.

Results

Table A5.7 and

Table A5.8 provide a summary of the emissions estimates for Heathrow and Gatwick expansion, and the tCO_2 per-departure predictions as sourced from the DfT. The cost of higher ATMs at Gatwick due to expansion is estimated at £14bn, whereas that of expansion at Heathrow is estimated at £13.5bn. However, expansion at Heathrow is also forecast to affect the number of ATMs at Gatwick and other London airports. This yields a carbon benefit of just over £4.25bn. Expansion at Gatwick would have no effect on Heathrow, but would reduce the number of ATMs at other London airports, yielding a carbon benefit of around £850m.

The net carbon cost from aircraft emissions as a result of expansion at Gatwick is consequently forecast to be £13.4bn, with the equivalent figure of expansion at Heathrow being £9.1bn. This is summarised in Table A5.9 below. The higher impact of Gatwick expansion compared with Heathrow expansion is in large part a result of carbon benefits for Heathrow due to decreased traffic at other airports.

[113] DfT (2013), 'UK Aviation Forecasts', January, https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/223839/aviation-forecasts.pdf.
[114] Available from https://www.gov.uk/government/publications/webtag-environmental-impacts-worksheets, accessed 28 March 2014.

In addition, R2 would become operational five years earlier than a new runway at Heathrow.

Table A5.9 Summary of carbon costs from aircraft emissions (£bn)

Heathrow NW	Impact on:	
	Heathrow	13.6
	Gatwick	–4.2
	London other	–0.3
	Total	**9.1**
Gatwick R2	**Impact on:**	
	Gatwick	14.2
	Heathrow	0.0
	London other	–0.8
	Total	**13.4**

Source: Oxera analysis.

Detailed methodology

In order to provide an overall assessment of the cost of CO_2 emissions in the years 2020–80 as a result of R2, or a third runway at Heathrow, it was necessary to estimate emissions in each individual year. This was done using a combination of estimated short- and long-haul departures, provided by GAL, and estimates of per-departure tCO_2 emissions, sourced from the DfT's 'Aviation Forecast 2013'.[115]

Per-departure $tC0_2$ emissions

The latter provided airport-specific estimates of short- and long-haul CO_2 emissions per departure, for the years 2010, 2030 and 2050 in the Do Minimum. These rates are primarily based on assumptions of average short- and long-haul journey length, and average fleet fuel efficiency. In the absence of additional data, these emissions rates are also used in evaluating the impacts of the Do Something. This assumption is likely to be conservative as it implies that:

- average fleet fuel efficiency would not change as a result of an extra runway being built. This appears sensible given that the progress of aircraft technology is unlikely to be influenced by a single new runway;
- average short- and long-haul journey length from Gatwick or Heathrow remains constant if a new runway is added. Although this is unlikely to be the case, the average distance is likely to increase (as airline range increases, for example). This in turn would be expected to raise carbon emissions, and therefore the estimates presented here are likely to be conservative.

In line with the Commission's assumption that extra capacity at either Gatwick or Heathrow will result in similar additional flights, it was assumed that the tCO_2 per short- and long-haul departure from Gatwick and Heathrow would be equal. This is not the case in the DfT's Aviation Forecasts, where emissions per Gatwick long-haul flight are considerably lower than emissions per Heathrow long-haul flight, reflecting the fact that flights from Heathrow are on average longer than

[115] DfT (2013), 'UK Aviation Forecasts', January, https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/223839/aviation-forecasts.pdf.

those from Gatwick. The assumption of equal emissions per flight is consequently likely to overplay, rather than underplay, the level of emissions from Gatwick.

In order to provide estimates of emissions to 2080, it was necessary to extrapolate the DfT's short- and long-haul emissions per departure from 2050 onwards. This was done using the assumption that average fleet fuel efficiency will continue to improve at the same rate as the DfT predicts for the period 2040 to 2050.

ATM predictions

It was also necessary to extrapolate short- and long-haul departures beyond the year 2050 when the figures provided by GAL end. In the Gatwick case, ATM capacity has been reached in both scenarios by 2050, and it was assumed that the runway continues to operate at capacity beyond this point. However, with the airport at capacity, a steady increase of the long-haul to short-haul ratio is observed, reflecting the airport switching gradually out of the less profitable short-haul market. This trend was assumed to continue in a linear fashion. In the Heathrow case, the GAL figures predict that, if a NW runway is built, Heathrow will gradually increases ATM figures from the years 2030 to 2050, but will not reach capacity by this stage. Consequently, Oxera assumed that Heathrow will continue to expand its long- and short-haul ATMs at the same rate as in the years 2045–50 up until 2080, at which point it will be operating just below capacity. As with Gatwick, we assume that the long-term trend of an increase in the long-haul to short-haul ratio will also continue.

Monetisation

Once both ATM predictions and tCO_2 emissions per departure were obtained for each year between 2021 and 2080, emissions per year could be calculated. The cost of these emissions was then monetised using the DfT Greenhouse Gases Valuation Workbook, as described in the carbon non-aircraft section. All emissions were treated as non-traded.

A5.4 Conclusions

This analysis has monetised the costs of the increased carbon emissions, noise and air pollution from Gatwick R2 and Heathrow NW. The approach adopted here is generally consistent with that set out by the Commission, but adapted where necessary to provide comparability between the options using the available data (although even with these adjustments, it has not been possible to quantify all aspects of the options).

Table A5.10 provides a summary of the monetised values.

Table A5.10 Summary of environmental effects (£bn)

Category	2+2	3+1
Noise	0.2	1.3
NOx	0.0	Not quantified
PM	0.0	Not quantified
Carbon		
Aircraft	13	9
Non-aircraft	0.5	Not quantified

Note: All values are present value covering an appraisal period from 2021 to 2080, in real 2010 prices, discounted to a 2014 base year using the social discount rate. PM and non-aircraft carbon emissions are not quantified for Heathrow under 3+1 owing to insufficient data.

Source: Oxera analysis.

A6 Competition

One of the key differences between R2 and Heathrow NW is the degree of competition each is likely to generate in the airport and airline markets—more specifically, in relation to how airports and airlines compete with each other.

Constructing an additional runway at either Heathrow or Gatwick would lead to an increase in the frequency of flights and number of destinations served from one or more of the London airports to meet passenger demand. However, the two schemes would also lead to different impacts on the dynamics of competition for air transport demand. These differences may lead to benefits/costs to passengers depending on which airport is expanded. In particular, there are differences in the suitability of Heathrow and Gatwick to provide services to various airline types, and differences in the concentration of airlines at each airport. Therefore, there are benefits/costs that are likely to arise as a result of differences in the competitive dynamics between airlines and airports under the two expansion options.

Increases in the intensity of competition can deliver a wide range of beneficial outcomes to consumers who use airports. Air fare and freight transit costs decline (over and above those anticipated in Appendix A3 as a result of capacity expansion and the elimination of shadow costs), while service quality rises as airports and airlines seek to make their product more attractive to customers. Importantly, innovation in the service offering—be it by means of efficiencies to keep costs low; offering new types of products; or generating a new customer-led way of doing business—is a necessary accompaniment to improvements in the competitive landscape.

Oxera's analysis indicates that an additional runway at Gatwick (relative to any other scheme shortlisted by the Airports Commission) is likely to lead airports to compete more vigorously for airlines, and airports and airlines to compete more vigorously for passengers and freight traffic.[116] It would therefore be associated with lower costs for airlines, and lower fares for passengers. The scheme would also be likely to deliver wider market participation than additional capacity at HAL[117]—i.e. a 2+2 solution provides for a wider range of airline business models to be satisfied than 3+1, and thus both greater passenger numbers and a wider distribution of the benefits of the increased capacity. Furthermore, a 2+2 outcome is likely to lead to more innovation and more flexible points of entry into the system for airlines, as the SH&E traffic forecasts expect the Gatwick scheme to deliver more passengers.

This appendix presents an analysis of the two schemes consistent with the competition objective included in the Strategic Fit module in the Airport Commission's appraisal framework. The Commission notes that where the analysis suggests that changes in competition could materially affect the economic benefits derived from any option (either positively or negatively), this will be considered as part of the assessment of the Economy Impacts module.[118]

To avoid double-counting with the impacts considered in other parts of Oxera's assessment, we consider here only the impact on the intensity of competition (either between airlines or between airports). The effect on competition is not

[116] Although benefits are expected to arise due to increased competition in the freight market, the analysis in this section is limited to the passenger market, as forecasts of future freight operations are not available.
[117] There are two shortlisted options at HAL: an additional runway and lengthening of one of the existing runways.
[118] Airports Commission (2014), 'Appraisal Framework', para. 1.22.

captured in the traffic forecasts used in other parts of the assessment, so it is important to capture this additional impact in the analysis. This ensures that all relevant economic impacts are included and that the benefits are additional to those set out in the other sections (including the user and producer impacts).[119]

This appendix considers:

- how competition works in this sector and the mechanisms through which competition is expected to lead to additional benefits, in particular as a result of the construction of a new runway at Gatwick (relative to Heathrow);
- how those benefits could be included and quantified in a transport appraisal.

Oxera has provided some indicative estimates based on the available evidence. While the empirical evidence available does not allow precise estimates, the effects we have estimated suggest that the competition benefits of the capacity expansion could be substantial, with a clear advantage for Gatwick. This appendix is therefore designed to provide an input into the Commission's assessment of the incremental competition benefits of the different schemes.

Oxera has estimated:

- a direct competition benefit from expanding Gatwick relative to Heathrow of between £10bn and £14bn in NPV terms as a result of the reductions in fares resulting from greater intensity of competition between airlines;
- an indirect competition effect, as a result of the greater intensity of competition from Gatwick versus Heathrow expansion, which could be as much as the direct effect.

This appendix is structured as follows:

- section A6.1 describes the mechanisms through which benefits are likely to arise from competition between airports and competition between airlines;
- section A6.2 explains the methodology for quantifying the benefits of competition.
- section A6.3 presents the results of the quantification.

A6.1 Assessing the benefits of increased competition

In 2009 the CC decided to break up BAA's ownership of Heathrow, Gatwick and Stansted, suggesting that 'common ownership of the three BAA London airports is a feature of the market which prevents competition between them' [120] and that Heathrow's position as a hub prevented, restricted or distorted competition.[121] It found considerable scope for non-price competition between all three airports, while acknowledging that the 'intensity of price competition may initially be limited by current capacity constraints.'[122]

[119] This is in contrast to Frontier Economics' study for HAL, which does not consider the competition benefits to be incremental to the user and provider benefits.
[120] Competition Commission (2009), 'BAA airports market investigation: A report on the supply of airport services by BAA in the UK', 19 March, para. 28 (a).
[121] Competition Commission (2009), 'BAA airports market investigation. A report on the supply of airport services by BAA in the UK', 2009, para 1(a).
[122] Competition Commission (2009), 'BAA airports market investigation: A report on the supply of airport services by BAA in the UK', 19 March, para. 28 (a).

While this investigation was still ongoing, BAA was already in negotiations to sell GAL, and this sale occurred in October 2009 with the transfer of operations completed in December 2009. In its 2011 review of Heathrow's claim of a material change in circumstances, the CC was able to make an initial assessment of the impact that this sale had on competition. Although GAL had been under separate ownership for only just over a year, the CC identified a number of positive competitive developments. In terms of non-price competition, it concluded:

> there are tangible signs already of non-price competition for airlines and their customers by Gatwick, for example in terms of improving the customer security experience, development of baggage facilities and its capital expenditure process.[123]

The CC also recognised that there was potential for price competition between HAL and GAL. In particular, it noted GAL's 'long-haul incentive program', which led the CC to suggest that there was:

> a willingness to innovate on pricing structures in an attempt to attract business, and [GAL] has started to achieve some success in terms of winning business from other airports.[124]

The CC identified the significant benefits of the change in the competitive dynamic for passengers and airlines and the prospects that future competition would lead to further benefits. Some of these further benefits are having real policy consequences, with the recent de-designation of Stansted, and the move to regulating Gatwick on a 'contracts and commitments' basis. These moves further reinforce the message that a new competition dynamic is emerging in the London system, which the Airports Commission will need to ensure its next runway decision does not inhibit.

The general benefits of increased (or more vigorous) competition are well-known and extensively discussed in the academic and empirical literature. These benefits have been observed in the airline business, particularly as a result of the liberalisation of the air transport sector in both the USA and the EU.

Indeed, the Airports Commission has noted:[125]

> Increasing competition within the aviation sector – including between airlines and airports, both in the UK and overseas – has delivered significant benefits for users of aviation (business and leisure passengers, and the freight sector) and the broader economy through making air travel more affordable and accessible.

The key benefits that are expected to emerge from strong competition between airports and airlines, and the way in which these benefits are likely to arise, are detailed below. These sections focus on the drivers and mechanisms which lead to enhanced competition and how competition manifests itself in end-user benefits and costs.

A6.1.1 Competition between airports

Competition between airports will occur only if at least some airlines and passengers view the airports as reasonably close substitutes. As a result, the location of this additional capacity will matter (in terms of competition between

[123] Competition Commission (2011), 'BAA Market Investigation', March, para. 61.
[124] Competition Commission (2011), 'BAA Market Investigation', March, para. 65.
[125] Airports Commission (2014), 'Appraisal Framework', para. 1.3.

airports) if its location has an impact on whether customers see the airports as being more, or potentially less, equivalent as a result.

Building R2 would lead to two airports in the London system which can compete on a more or less level playing field (e.g. in terms of total capacity). This is likely to increase competition between Gatwick and Heathrow as airlines and passengers will perceive the airports as increasingly substitutable.[126] In fact, if airports are competing against an 'equal player', they will know that marginal changes in their prices or quality could affect customer decisions about which airport to use.[127] The CC recognises this effect:[128]

> The extent of competition between airports depends on the extent of demand substitutability between them, in terms of both passenger demand and airline demand.

R2 would result in a greater increase than Heathrow NW in terms of demand substitutability and consequently competition between Heathrow and Gatwick, and, in particular, for specific demand segments. For instance, many airlines that currently rely on a significant amount of interlining traffic do not consider Gatwick to be a realistic substitute to Heathrow as the interlining possibilities at Gatwick are fewer than those available at Heathrow. In the short term, adding capacity at Heathrow allows more airlines to access these interlining possibilities, but creates an outcome in which Gatwick's relative attractiveness remains low and (relatively) may get worse. Therefore, with an additional runway at Heathrow, competition between airports may not occur for this group.

The expansion of Gatwick does not immediately help Gatwick become more substitutable to Heathrow from the perspective of carriers that rely on a significant amount of interlining traffic. However, as the total demand at Gatwick increases (i.e. the additional capacity becomes used), the equivalence of the airports increases, and the competition between the airports for this type of demand increases. Over time, these airlines have more effective choice of airports, which will provide the airports with a significant incentive to compete vigorously for that traffic.

In other words, the location of the runway will have a direct impact on the position of airlines relative to the airports—i.e. in terms of airlines' bargaining power. The airport where capacity is increased will need to expand its business with existing airlines and attract new airlines. At the same time, other airports will have to negotiate to retain existing airlines and attract new ones due to a credible competitor at the airport where capacity is increased. There will therefore be enhanced competition by airports for airlines.

This situation will hold until the new capacity becomes fully utilised. Full utilisation may occur at different times for different airlines or passenger types (e.g. connecting or business passengers). Competitive pressure resulting from an increase in capacity will therefore tend to fade out gradually as traffic increases.

[126] See, for example, European Commission (2000), 'Commission Decision of 14.03.2000 declaring a concentration to be incompatible with the common market and the functioning of the EEA Agreement (Case No COMP/M. 1672 Volvo/Scania)', March.
[127] It is of note that Frontier Economics' paper for HAL assumes little or no substitution between Gatwick and Heathrow. In Box A3.2 Oxera has set out how this view is inconsistent with a range of decisions from competition and regulatory authorities, which have found that passengers can substitute between the London airports.
[128] Competition Commission (2009), 'BAA airports market investigation: A report on the supply of airport services by BAA in the UK', 19 March, para. para. 3.23 (a).

The competition benefit arises more from expansion at Gatwick rather than Heathrow as the attractiveness of the airports will be more comparable to airlines in a 2+2 versus 3+1 situation, and therefore airlines have more choice about where they operate from. In other words, the additional runway at Gatwick will lead to greater airline buyer power than if the runway is built at Heathrow. Airlines will be able to put Gatwick and Heathrow in competition for a wider range of services.

Effective competition does not require all airlines to be able to switch or threaten to switch all routes. However, switching a limited number of services at the margin could have a significant effect on an airport's profitability (due to fixed costs and loss of aeronautical and non-aeronautical revenue) and therefore it can act as a constraint.[129]

An additional runway at Gatwick would also give passengers a more credible possibility to move between airports and airlines, leading to greater benefits as airports seek to offer better products to customers than their rivals. As competition between airports becomes more effective, airports should be more motivated to provide the services that their direct (airline) and indirect (passengers) customers want, and to become more efficient. This change in the output of airports will feed into a change in the inputs to airlines, which will in turn enhance airlines' ability to meet the demands of their customers. A number of specific benefits may arise as a result of enhanced competition between airports, as set out below.

Lower prices to passengers (direct and indirect effect)

Increased competition between airports is likely to lead to a reduction in price for passengers in the long run. The price decrease could be a direct effect of an increase in competition between airports, which may lead to lower prices for non-aeronautical services, or an indirect effect of increased competition between airports (e.g. through lower rents for commercial sites). Since competition between airports would be stronger should the runway be built at Gatwick than if it were built at Heathrow, prices to passengers are likely to be lower in the former scenario.

Greater diversity and quality of products

Increasing competition between airports would lead to improved and more diversified services to airlines, passengers and other users of airport facilities that generate income for the airports. In order to attract and retain airlines, passengers and other users, airports will need not only to provide attractive tariffs but also offer good value for money to all stakeholders. Indeed, the 'scope for separate ownership to stimulate improvements in the overall quality of service offered'[130] was a key driver of the CC's 2009 decision to separate the ownership of BAA's airports.

Improved service can materialise through upgraded facilities, shorter waiting times or customised offers that suit the specific needs of an airline as opposed to standard contracts and terms across all airlines. In order to retain and expand their business, airports operating in a competitive environment would need to adapt quickly to the changing needs and requirement of users.

[129] ACI Europe (2014), 'Competition in the European Airport Sector'.
[130] Competition Commission (2009), 'BAA airports market investigation: A report on the supply of airport services by BAA in the UK', 19 March, appendix 5.1, para. 4.

There is evidence of these effects arising as a result of competition between airports. The CC found evidence that within a year of Gatwick becoming independently owned, competition resulted in improvements to the customer security experience and the baggage handling system, among other areas.[131] Indeed, recent evidence shows that the competitive dynamics forecast by the CC in 2009 are now visible, in particular that the airports would compete to influence government policy with respect to the decision on the location of a new runway—for example in their engagement with the Commission.

An example where more competition led to improved service and greater diversity in the types of offers in the market is the UK telecommunications sector. In this competitive market, operators seek to differentiate themselves by offering different schemes to customers or different quality of service. The increase in competition has also led to a fall in prices and considerable growth in subscriber numbers.

Indeed, proactive competition policy is becoming a greater focus across UK regulated sectors. For example, one of the five strategic goals of the new Competition and Markets Authority (CMA) in the UK is to extend competition frontiers and use the markets regime to improve the way competition works in regulated sectors.

Increased innovation

An additional effect of increased competition, related to the incentives to improve quality of service and diversify offerings, is the greater necessity for airports to innovate in order to differentiate themselves and attract and retain more airlines, passengers and other types of user.

This effect was recognised by the CC as part of its decision to break up BAA. In noted that if Gatwick and Heathrow became rival airports: ‘competition to invest and innovate, even in the short-term, could be intense.’[132] Since then, the CC has recognised that the development of Gatwick’s ‘long-haul incentive program’ suggests a ‘willingness to innovate on pricing structures in an attempt to attract business’.[133]

Indeed, since the de-merger from BAA, there is evidence of GAL innovating by adopting different commercial strategies and taking different approaches to infrastructure delivery. For instance, it has cancelled some projects that it did not consider would deliver customer benefits, and introduced new projects, such as the South Terminal security project. GAL has also innovated for airlines and passengers at an efficient cost, through its capital investment programme including investments for passengers with reduced mobility, family lanes at security and an A380 pier served stand.[134]

Outside of airports, the impact of competition on innovation is well-known in the economic literature and again can be illustrated by the developments in the telecommunications sector. Introducing competition in telecommunications has generated a stream of substantial innovations by operators in order for them to stay at the forefront of market developments. This includes, for example,

[131] Competition Commission (2009), ‘BAA airports market investigation: A report on the supply of airport services by BAA in the UK’, 19 March, appendix 5.1, para. 4.
[132] Competition Commission (2009), ‘BAA airports market investigation: A report on the supply of airport services by BAA in the UK’, 19 March, appendix 5.1, para. 4.
[133] Competition Commission (2011), ‘BAA Market Investigation’, March, para. 65.
[134] Gatwick (2014), ‘Comments on the CAA’s consideration of Gatwick’s performance and behaviour’, September, Q5-050-LGW29.

increasing Internet connection speed, faster mobile connections, and improved content as well as improvements in design. Telecommunications companies unable to invest and innovate early enough eventually exit the market or get taken over by more dynamic competitors.

With Gatwick and Heathrow having two runways each, the need for innovation would be much stronger than if a third runway were built at Heathrow. This is a result of increased symmetry between the firms: if structural changes (such as a new runway) make two firms closer competitors, they will put considerable effort into innovation in order to differentiate themselves again, as a means to gain some market power over their customers. This is in line with the literature. For example:

> we derive the interesting result that innovation activities are highest for firms in symmetric market positions. This holds as long as research costs are low and potential gains from innovation and cost-reduction are high.[135]

Better planning and capacity development

As the CC has argued,[136] more competition should lead to more investment by airports, in order to enable them to compete more effectively with one another. Fierce competition disciplines firms in the critical decisions they make, since poor decisions may lead to significantly reduced profits. At the same time, a cautious approach (e.g. to increasing capacity) is likely to lead to a loss in market position in the future as rival firms make the necessary (risky) investment themselves. There is therefore a trade-off between making the right investment, while recognising that the riskier the investment, the higher the reward or loss.

Since building an additional runway at Gatwick would introduce stronger competition than if it were built at Heathrow, the incentives for airports to plan more effectively and undertake capacity development would be higher if the runway were built at Gatwick. Again, the increased symmetry between Gatwick and Heathrow will provide them with incentives to differentiate themselves through better products, innovation and better planning of future capacity developments.

A6.1.2 Competition between airlines

The location of the additional capacity will also affect the extent of competition between airlines. There are a number of mechanisms through which competition between airlines may lead to benefits, as follows.

Airline competition at the route level: same airline types

As the total capacity of the system is expanded, there is greater capacity on particular routes to support multiple airlines to meet that demand. As more routes have multiple airlines operating them, both for theoretical reasons and based on empirical observations (discussed in section A1.2 below), competition intensity will increase and fares will fall. The amount by which fares will fall depends on the magnitude of the change in the number of airlines operating the route and the number of existing airlines already on the route.

[135] Neff, C. (2003), ‘Corporate Finance, Innovation, and Strategic Competition’, 522 Lecture notes in economics and mathematical systems, p. 204.

[136] See, for example, para. 19 of the Summary of the 2009 report: ‘A principal effect of rivalry between the airports under separate ownership would be to compete with each other through innovation and capacity development, a process which will of itself bring benefits as well as erode the current constraints on competition.’ Competition Commission (2009), ‘BAA airports market investigation: A report on the supply of airport services by BAA in the UK’, 19 March.

The amount by which fares will fall also depends on whether the airlines are serving the route from the same or multiple airports. In the case of expansion at Gatwick, more routes are served by multiple airlines, which between them use different airports in the London system. Theoretical arguments indicate that competition between airlines will be more intense when airlines compete using different airports, since this case is more likely to be associated with airlines deploying more than one business model on a route. In addition, there is some empirical evidence that indicates more intense competition where airlines use different airports.

Airline competition at the route level: different airline types

Growth in the last decade has mainly come from LCCs and inbound non-European-based airlines rather than European network carriers. Indeed, the Airports Commission has noted that 'the airline market is inherently dynamic and changes can occur rapidly. These are very difficult to predict; in the last decade there has been significant growth in the low-cost sector and consolidation of network carriers into three main alliances.'[137]

Even if past trends do not continue, it is expected that airports will increasingly rely on point-to-point services for future growth as new aircraft technology and faster growth in emerging markets make direct long-haul routes more viable and reduce the reliance on transfer traffic. These new business models will compete with those currently operating in the market and offer a different type of business model that is associated with greater consumer benefits (e.g. lower fares).

To the extent that the Heathrow and Gatwick options lead to expansion of capacity that is suited to different airline business models (or a different mix of models), the extent of competition between airlines is likely to be more intense.

Indeed, an additional runway at these two airports would meet different airline and passenger needs. One of the differences between expansion at Gatwick and expansion at Heathrow is the former's ability to increase the level of competition between airlines that rely on a fast-turnaround business model (i.e. LCCs). This type of airline competition would be expected to deliver lower fares and ultimately benefits to passengers. In addition, it may be the case that expansion at Gatwick would facilitate growth in long-haul LCC operations (such as the services offered by Norwegian from Gatwick to New York) in competition with full-service long-haul provision that would be retained at Heathrow. This relatively new business model has the potential to provide a new set of choices for passengers, with the attendant benefits outlined above—lower prices, increased service quality and a greater range of destinations and flight frequencies.

A growth in the number of LCCs, and their potential entry into the long-haul market, would also be expected to lead to Full Service Carriers (FSCs) developing their business models to yield considerable benefits to consumers. The CAA noted in 2006 that 'most full service carriers cut costs significantly'[138] in response to the entry of LCCs into the short-haul market, whilst also increasing their load factors, and developing their fare structures and marketing campaigns. The entry of LCCs into the long-haul market would be likely to stimulate a similar set of responses from FSCs operating on long-haul routes, bringing considerable benefit to consumers in the process.

[137] Airports Commission (2014), 'Appraisal Framework', para. 1.19.
[138] CAA (2006), 'No Frills Carriers: Revolution or Evolution', Chapter 3, p. 3.

Airline competition at the system level

The implicit assumption in relation to the dynamics of airline competition described above is that competition takes place at a route level only. However, in general airlines do not operate on a single-route basis, and, in many cases, passengers may have a class of destination in mind (e.g. 'winter sun') rather than a specific destination (e.g. Tenerife). Such passengers are not tied to a particular destination and may therefore have a realistic choice of a route that is competitively supplied and one that is still a monopoly (or, more generally, routes with different intensities of route-level competition). As a result, there is a spillover effect to the less competitive routes from those that are more competitive.

In addition, individual airlines will tend to supply services on routes with varying levels of competitive intensity, but may need to respond in ways where they cannot discriminate perfectly between routes based on competitive intensity.

Furthermore, increased competitive pressures in the market may lead to greater innovation by airlines, ultimately lowering prices across the market. Indeed, the emergence of the LCCs has contributed to overall growth in the market and changes in the full-service carrier (FSC) business model. LCCs compete with both LCCs and FSCs, leading to significant benefits.[139]

Through these mechanisms there is likely to be an impact on the less competitive routes from the more competitive routes, and, in a dynamic system, as overall competition at a route intensifies, there will be an increasing impact on the routes that remain monopoly-supplied (or remain at the same level of competitive intensity).

As a result, any difference in the competitive intensity arising from the mechanisms described above will have a knock-on impact on the remaining less competitive routes in the system through an indirect competition effect.

A6.2 Quantification of the benefits of competition

The section above identified the benefits arising from competition between both airports and airlines. The next step is to set out how these can be quantified in order to determine the benefits that arise from additional capacity at Heathrow compared with additional capacity at Gatwick.

As discussed above, the benefits of increased competition between airlines and/or airports are likely to include lower prices to passengers, greater innovation and investment by airlines and airports, and better planning and capacity development. To quantify these benefits, Oxera has considered the available empirical evidence, which focuses on the extent of competition between airlines and the associated effect on passenger fares. Section A1.2.1 describes the available literature and section A1.2.2 shows how this literature has been used to quantify the effects of increased competition.

A6.2.1 Literature on the effect of competition on passenger fares

There is an established literature on the effects of competition in the aviation sector, which provides insights into the magnitude and effect of competition on passenger fares. As discussed above, in addition to a reduction in consumer fares, competition may have other benefits to consumers, such as increased

[139] CAA (2006), 'No Frills Carriers: Revolution or Evolution', November.

quality of service and innovation. However, these benefits are less frequently examined due to their less tangible nature.

InterVISTAS

GAL commissioned InterVISTAS to estimate the impact of market structure on passenger fares. [140] Using data on the top 1,000 routes in the USA and Europe from 2006, the results are cross-checked with the results from a panel of data from 2006 to 2012.

InterVISTAS finds that, for the European data, the presence of an LCC on a specific airport-to-airport route reduces the average fare on the route by around 36%. If the competing LCC is on a V-route[141] or a parallel route[142] (as an airline operating from Gatwick competes with one at Heathrow), the estimate of the effect on consumer fares could be a fall in the average fare paid of around 50–60% compared with the same route served only by FSCs operating between the same two airports.

It is important to note that the results are reported such that, in the presence of an LCC carrier on a route, it is not possible to distinguish between the effect on the average fare of a higher proportion of passengers being carried by the LCC and the effect on the fares of the LCC or FSC carrier as a result of competition.

However, the InterVISTAS study also examines the impact of competition among FSCs on direct routes and V-routes, and estimates that, for European routes, the presence of an FSC competitor on the same direct route (i.e. airline competition within a single airport) reduces fares by around 11%. If the competing FSC is on a V-route, InterVISTAS estimates that fares decrease by around 30%.[143]

These results are broadly similar to those found when InterVISTAS examined the US data, and indicate that competition between airports (or between airlines operating from different airports has an incremental effect on passenger fares over and above the impact of competition between airlines operating from the same airport (even after accounting for the impact of different business models).

Alderighi et al.

Alderighi et al. focus on the response of FSCs to the entry of LCCs, using data on published fares (for various classes) from Lufthansa, British Airways, Alitalia and KLM for the top 12 city pairs from Italy to the rest of Europe.[144]

The authors find that the entry of an LCC affects the price levels of both the business and the leisure segments of the FSC, even when the LCC does not offer a full business service. The authors suggest this may be because when FSCs reduce their leisure fares in response to entry from a LCC, they also reduce business fares to maintain the optimal difference in fares of different classes of ticket. The authors conclude that when the market is transformed from an FSC monopoly to an asymmetric duopoly with an LCC, fares on the FSC

[140] InterVISTAS (2014), 'The importance of Airport Competition on Air Fares Paid by Consumers', 19 March.
[141] A V-route is defined as one where a competitor operates from a different but nearby airport to the origin of the FSC but flies to the same destination airport.
[142] A parallel route is defined as one where a competitor operates from a different but nearby airport to another different but nearby airport to that of the FSC.
[143] InterVISTAS (2014), 'The importance of Airport Competition on Air Fares Paid by Consumers', 19 March. paras 4.2.7 and 4.2.9.
[144] Aldreighi, M., Cento, A., Nijkamp, P., and Rietveld, P. (2004), ‘The Entry of Low-Cost Airlines: Price Competition in the European Airline Market’, Tinbergen Institute Discussion Paper (TI 2004-074 / 3).

decrease by 11%; the corresponding figure when the market is transformed to an asymmetric oligopoly is 16%.

European Commission's analysis of the Ryanair/Aer Lingus merger

The question of the impact of competition on fares is also informed by the econometric analysis conducted by the European Commission in reaching its 2007 decision on the acquisition of Aer Lingus by Ryanair.[145] In its analysis of whether Ryanair and Aer Lingus compete with each other before the merger, the European Commission assessed the impact of Ryanair's presence on a route on Aer Lingus' fares, while controlling for other route-specific characteristics. Based on cross-sectional and panel fixed effects modelling, the European Commission's study included analysis based on airport pairs (which focuses on competition between airlines within an airport pair), as well as city pairs (which takes into account the impact of competition between airports).

The results of the panel data regressions show that the impact of Ryanair's presence on Aer Lingus was higher when the city pairs were considered—i.e. in the presence of airport-level competition. In particular, the European Commission found that, when based on airport pairs, Ryanair's presence reduced Aer Lingus's fares by around 5%. When the same analysis was conducted on city pairs, the impact was 8%.[146] While the European Commission found that the cross-sectional regressions were technically unreliable, the results from these qualitatively supported the above result.

Gerardi & Shapiro

While this study does not directly estimate the effect of competition on the level of fares,[147] it estimates the effect of increased competition on the dispersion (or spread) in fares. In particular, it explores how competition constrains airlines in their pricing to price-insensitive (i.e. business) passengers relative to price-sensitive ones (i.e. leisure passengers). The results indicate that increased competition in mixed business and leisure routes lowers fares at the top of the distribution to a greater extent than it lowers fares at the bottom of the distribution.

Summary of insights from the literature

Overall the literature supports the argument that there will be an impact on fares from the types of competition effect that will arise from increasing the capacity at either Heathrow or Gatwick, and that there may be a significant differential impact because of the differences in the competition effect of the two possible expansion scenarios. In particular, the literature suggests that there may be greater price effects when airline competition occurs between airports (i.e. two airlines operate the same route, one from each of Gatwick and Heathrow) than if airlines compete within a single airport (i.e. two airlines operating from Heathrow). Primarily this result is driven by two airlines at two different airports serving the same destination typically utilising different business models, enabling innovation in provision on behalf of customers. The literature also provides some, but limited, estimates of the size of these direct competition impacts on a route-by-route basis. Oxera has not been able to identify literature that estimates the effect that competitive routes may have on non-competed

[145] European Commission (2007), *Ryanair/Aer Lingus*, Case No COMP/M. 4439, June.
[146] European Commission (2007), *Ryanair/Aer Lingus*, Case No COMP/M. 4439, June, Tables 9 and 12.
[147] Gerardi, K. and Shapiro, A. (2007), 'The effects of competition on price dispersion in the airline Industry: a panel analysis', FRB of Boston Working Paper No. 07-7.

routes (i.e. the indirect competition effect noted at the end of the previous section).

A6.2.2 Oxera's methodology for quantifying the benefits

Oxera has quantified the competition benefits by considering the mechanisms set out above for the dynamics of competition at a route level and spillover effects at a system level. This focuses on competition between airlines (rather than airports) due to the empirical evidence that exists. This section sets out orders of magnitude in terms of how these drivers of competition may manifest themselves in end-user benefits and costs.

The competition benefits that have been quantified are as follows:

- the **direct effect** of increased competition between airlines through the introduction of competition or an increase in competition on routes;
- the **indirect competition effect** due to the greater intensity of competition that results from Gatwick compared with Heathrow expansion.

Oxera has quantified the direct benefit arising from the change in the competition dynamics of the 3+1 and 2+2 compared with the current (2013) route structure. The starting point of this exercise is the destination analysis conducted by SH&E for 2024, 2035 and 2050. This analysis predicts the frequencies of flights from each of Gatwick, Heathrow and other London airports[148] to specific destinations under the two expansion scenarios and the Do Minimum. This analysis therefore allows the number of overlapping routes in the Do Minimum, 2+2 and the 3+1 scenario to be estimated at the present time (2013) and in the years 2024, 2035 and 2050. If, for example, in the 2+2 scenario there are more overlapping routes, competition—and thus the reduction in fares—is likely to be greater.

The SH&E data also shows whether a destination that is served only by Heathrow in 2013, would, under the 2+2 scenario, continue to be served only by Heathrow or also be served by Gatwick and/or other London airports. Similarly, it shows how this specific destination would be likely to be served under the 3+1 scenario. It is therefore possible to identify the routes that would change from being served by one airport to being served by more than one airport, and would therefore result in a change from airline competition within an airport to airline competition between airports.[149]

As set out above, the empirical evidence suggests that a change in the topology of the route would be likely to have an impact on the fare level. There would therefore be an impact on fare levels arising from the difference in the number of overlap routes in the two expansion scenarios and whether the route would be operated by one airport or more than one airport.

SH&E has provided data which provides assumptions on the number of carriers on each route. This uses the frequency data and information about the destination city (i.e. whether it is a 'global' city) and the origin airport (i.e. Heathrow, Gatwick or other) to estimate the number of carriers that are likely to operate on a particular route. Oxera has used this data in the analysis of competition impacts to proxy the likely emergence of competition by reference to a change in the number of airlines on a route. These changes in competitive

[148] Oxera has not been provided with a breakdown of 'Other London airports' into Stansted, Luton, and London City. As such we have treated these airports as a single entity.
[149] Oxera has taken this analysis as given and has not independently verified the result of this analysis.

dynamics, based on the assumptions provided by SH&E, are shown in bold in Table A6.1.

Table A6.1 Number of airlines operating on a given route

			Frequency				
	Origin	**Global city**	**<8**	**<15**	**<35**	**<70**	**>=70**
Long-haul	LHR	Yes	**1**	**2**	3	4	5
	LHR	No	1	**1**	**2**	3	3
	LGW/other	Yes	**1**	**2**	2	3	4
	LGW/other	No	1	**1**	**2**	2	3
Short-haul	LHR	Yes	**1**	**2**	2	2	3
	LHR	No	1	1	**1**	**2**	2
	LGW/other	Yes	**1**	**2**	3	4	5
	LGW/other	No	1	**1**	**2**	3	4
Domestic	LHR	Yes	1	1	**1**	**2**	2
	LHR	No	1	1	**1**	**2**	2
	LGW/other	Yes	1	1	**1**	**2**	2
	LGW/other	No	1	1	**1**	**2**	2

Source: SH&E data provided for Heathrow and Gatwick; Oxera has assumed that the number of airlines operating on a route for 'Other London airports' operates in the same way as for Gatwick.

We then analyse the benefit to customers that could be expected as a result of competition and the resulting fare reduction. The steps followed in this analysis are as follows.

- For each destination set out by SH&E, Oxera identified whether the destination is currently (2013) served by Heathrow only, Gatwick only, other London airports only or a combination of these airports. We then identify how the destination will be served under the Do Minimum, 2+2 and 3+1 scenarios. This indicates whether a route will face a change in competition dynamics within the same airport (from a monopoly to duopoly or more), or competition with a route from another airport (from within-airport to between-airport competition).

- We then created scenarios for fare reductions for each change of route dynamics. While the mechanisms for the potential effects have a strong theoretical basis, the empirical evidence does not allow firm estimates. We have used evidence from InterVISTAS (analysis of European data) and the CC investigation into the potential Ryanair/Aer Lingus merger to develop a range of possible scenarios of fares reduction.

  The level of fares reduction is assumed to depend on the number of competing airlines serving the route—i.e. the price reduction increases with the intensity of competition. For example, an increase from 1 to 3 airlines leads to a greater price decline than an increase from 1 to 2 airlines. However, the price reductions decline with the number of existing airlines in the system.

Oxera has developed three scenarios that reflect different potential price reductions, and differ in terms of the initial price reduction assumed (i.e. for monopoly provision to duopoly) as a result of competition between airlines at a single airport, the price reductions when competition already exists on a route (e.g. 2 to 3 airlines), and the additional effects of competition between airlines at more than one airport. The range in fare reductions associated with each of these scenarios is included in Table A6.2.

These fare effects are quite large in some scenarios. For example, 22% for certain changes in the topology of competition in Scenario 1. However, Oxera considers that such fares reductions are within a reasonable range of the changes that could be expected from increased competition in the London system. They are less than those that occurred as a result of liberalisation of the airline market and therefore recognise that, while there is already a significant amount of competition in the market, there remains potential for it to be increased over many more routes than currently. The provision of a range of scenarios reflects the considerable uncertainty in the empirical evidence on the size of the effects of competition. All scenarios could potentially reflect reality, and as such, they should not be viewed as maximum, mid-range and minimum estimates.

Table A6.2 Fare reductions (%) from direct competition

	Scenario 1	Scenario 2	Scenario 3
Initial price reduction for competition at a single airport: 1 to 2 airlines	10	8	8
Price reduction from 2 to 3 airlines	5	6	4
Price reduction from 3 to 4 airlines	2.5	4	2
Price reduction from 4 to 5 or more than 5 airlines	1.25	2	1
Additional effect of competition between airports	7	6	5
Range of fare reductions applied	1.25–22	2–20	1–17

Note: The potential fare reductions that result from the assumptions in each scenario (i.e. adding up the first five rows) may be greater than the range applied (in the final row). This is because there are no routes in the model where the maximum fare reductions are applied (e.g. an increase from 1 to 4 or 5 airlines competing between multiple airports).

Source: Oxera analysis, based on literature reviewed in section 6.2.1.

Where there is a reduction in competition on a route (e.g. a route changes from being served by two airlines to being served by one airline), the inverse price effects to those in the table above have been applied (i.e. a 10% rise rather than a 10% reduction in fare).

The further steps in the quantification are as follows.

- To convert the price reductions on each route into monetary benefits, the above estimates were combined with estimates of passengers per flight and fares. For this purpose, the routes have been separated into domestic, short-haul and long-haul.[150] For each segment, an average fare has been assumed based on data provided by SH&E.[151]

- SH&E's assumptions about the average number of passengers per flight have been used,[152] which are differentiated by region of destination. These numbers range from 115 for flights to Eastern Europe, to 262 for flights to Latin America.[153]

- The percentage reduction in fares is then multiplied by the average fares and number of passengers on the relevant route (number of passengers per plane * frequency of flights) to estimate the monetary value of the reduction in fare (relative to the 2013 competitive dynamic) in each route under each scenario. Table A6.3 provides some sample routes using Scenario 3 fare reductions. The total monetary value of the fare reductions across all relevant routes is then calculated.

Table A6.3 Route-by-route analysis

City (airport)	Gatwick airlines 2013	Gatwick airlines 2050	Heathrow airlines 2013	Heathrow airlines 2050	London other airlines 2013	London other airlines 2050	Fare reduction	Average fare level by route type (£)	Total London pax on route, 2050	Total change in average fares 2050, relative to 2013 (£)
Guangzhou (CAN)	0	1	1	2	0	0	–17%	928	268,649	–42,382,145
Tampa (TPA)	1	2	0	0	0	0	–8%	928	101,810	–7,558,392
Dublin (DUB)	5	5	3	3	5	5	0%	168	2,260,760	0
Newcastle (NCL)	1	2	2	1	0	1	–2%	122	494,865	–1,207,470

Note: Competition benefits are based on scenario 3 fare reductions.

Source: Oxera analysis, based on SH&E data.

- The total value of fare reduction for the 2+2 scenario and the 3+1 scenario is then compared with one another and with the Do Minimum to estimate the net benefit of increasing capacity at Gatwick compared with Heathrow.

A6.3 Estimate of the competition benefits

The modelling of the price reductions set out in Table A6.2, combined with the route-by-route analysis (Table A6.3) leads to the direct competition impacts for the three fare-reduction scenarios. The net benefit of direct competition from

[150] SH&E has separated the route types as follows: all UK routes are classified as domestic; all routes to Western and Eastern Europe are classified as short-haul; routes to the Far East, ISC, North America, Latin America and the Middle East are all classified as long-haul. Routes to Africa are largely long-haul, with the exception of a few destinations on the north coast, which are classified as short-haul.
[151] These fares are £122 for a domestic round trip; £168 for a short-haul round trip and £928 for a long-haul round trip.
[152] Transfer passengers are included in the analysis. As the analysis considers the change in the average fare between London airports and a given destination only, we have not taken into account the other leg of a transfer passenger's journey. The analysis therefore assumes that transfer passengers experience the same price decline as origin and destination passengers. In practice, whether this is the case is likely to depend on whether there is competition between airlines/airports on the entire route (rather than just one leg of the journey), and on whether airlines can price-discriminate between origin/destination and transfer passengers.
[153] Oxera has made adjustments to the SH&E data to reconcile the passenger figures between the destinations forecasts (used in the competition analysis) and the core traffic forecasts (used in other workstreams).

Gatwick expansion compared with Heathrow expansion is included in Table A6.4.

Table A6.4 Direct competition impacts (£bn)

	Scenario 1	Scenario 2	Scenario 3
NPV from 3+1 scenario relative to Do Minimum	-3.7	-3.0	-2.5
NPV from 2+2 scenario relative to Do Minimum	10.4	10.2	7.7
Direct competition impact (NPV)	**14.1**	**13.3**	**10.2**

Source: Oxera analysis, based on SH&E data.

The results show that 3+1 leads to a reduction in competition relative to Do Minimum. In 3+1 it is expected that there would be increases in the numbers of airlines operating on overlapping routes. However, in the Do Minimum, there are more routes that change from being operated by one airport to being competed between airports. This latter effect outweighs the former. For instance, in the 3+1 scenario, Heathrow dominates the long-haul market, with very few long-haul flights departing from Gatwick or other London airports. However, in the Do Minimum, as capacity at Heathrow is constrained, a number of long-haul routes start operating from Gatwick or other London airports. This often occurs on the same routes as those already served at Heathrow, and there is therefore an increase in competition and a price reduction expected in the base case.

On the other hand, there are significant benefits of the 2+2 scenario relative to both the Do Minimum and 3+1. This is because the expansion of Gatwick leads to an increase in the number of airlines operating on overlapping routes and an increase in the number of routes that are competed between airports.

One factor that has not been taken into account in the discussion and analysis above is the effect of indirect competition. For instance, some passengers may engage in destination switching. As such, routes do not necessarily need to be overlapping in order for there to be competition benefits. In other words, some leisure passengers going on holiday may seek a beach holiday or city break and choose the destination with the cheapest fare. Therefore, non-overlapping routes may compete with overlapping routes and lead to a decline in fare across all routes.

The more intense competition in the market may also lead to greater innovation, which is passed through to customers in the form of lower fares. For example, in order to facilitate a commercial response to increasing competition on some routes, airlines might decide to not only change practices on those routes, but more generally across their business.

There is therefore the potential that there are wider effects on all routes irrespective of whether they are competed themselves—i.e. an indirect competition effect. This effect is additional to the direct impact.

Although there is little empirical evidence on the extent of this effect, it could be quite substantial. Oxera has provided illustrative estimates for the potential magnitude of this effect. This is estimated as the difference in impact between Heathrow and Gatwick expansion due to the greater intensity of competition which results from the Gatwick expansion case.

The indirect competition effect could be considered in several ways:

- apply this to all routes in the system. Oxera has modelled the impact of this potential spillover which results from the difference in competitive intensity from the Gatwick versus the Heathrow expansion. For every 1% reduction in fares (£4 of a return ticket) caused by this dynamic there is an additional £8bn in indirect competition effects;
- look at the effect on routes for which there are no changes in the dynamics of competition as a result of the expansion of capacity. In other words, it can be assumed that the indirect competition impact applies to all other routes that are not included in the direct competition impact in Table A6.4 above. For example, by 2050 there would be 50% of routes where price reductions are applied (and which are therefore taken into account in the direct impact in Table A6.4 above). If a 5% price reduction were applied to an average fare for passengers on non-competed routes, this would create a benefit of £20bn, over and above the direct impacts.[154]

These are illustrative examples of the possible magnitude of the indirect competition effect. Oxera considers that this effect could be large, and that it provides an input to the Commission's considerations on the effects of competition.

[154] This is an indicative figure calculated by using the number of routes that are not competed in 2050.

A7 Social impacts

WebTAG is more extensive than the Commission's appraisal framework in the social impacts that it requires to be assessed. These are:

- accidents;
- physical activity;
- security;
- severance;
- journey quality;
- option and non-use values;
- accessibility;
- personal affordability.

With the exception of accidents, these factors are assessed qualitatively on a seven-point scale: large adverse effect; moderate adverse effect; slight adverse effect; neutral; slight beneficial effect; moderate beneficial effect; large positive effect.

The remainder of this appendix considers these factors separately at a relatively high level.

A7.1 Accidents associated with increases in highways traffic

Highways data from Arup suggests that R2 could lead to about 16m additional highways trips per annum by 2040. This growth in traffic would be likely to increase the probability of road accidents. Using data from Arup and the DfT, the impact from accidents associated with the anticipated increase in highways traffic has been calculated in a relatively straightforward manner. The calculation should be interpreted as an order of magnitude rather than a precise quantification.

The data used in the calculation is provided in Table A7.1.

Table A7.1 Data used for quantifying the potential increase in accidents

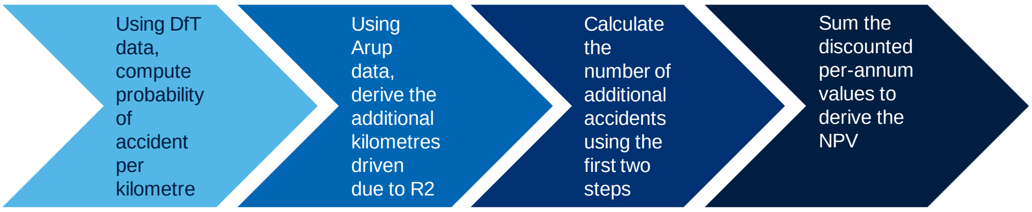
Data		Comment	Source
Number of accidents	145,571	Annual value for 2012, split into three categories: fatal, serious and slight	DfT
Total kilometres travelled	487bn	Annual value for 2012	DfT
Additional kilometres	0.9bn	Annual value for 2040	Arup
Annualisation factor	4,412	Derived using 2012 DfT traffic distribution data[1]	DfT
Value of prevention per accident	Various	Values in 2010 real terms, split into three categories: fatal, serious and slight	WebTAG data book
Passenger forecasts	Various	Used to scale the data across the appraisal period	SH&E

Note: The DfT data on number of accidents and total kilometres travelled is used to derive the probability of an accident per kilometre driven.[1] The annualisation factor is used to adjust the Arup data, which is for a peak hour in the morning.

Source: SH&E, DfT, WebTAG.

The quantification approach is illustrated in the figure below.

Figure A7.1 Approach to accidents quantification



Note: In the calculations, the type of accident was separated into three categories: fatal, serious, and slight. The quantification is undertaken for 2040 only and then scaled using Gatwick passenger forecasts.

Source: Oxera.

The results of the quantification indicate that the NPV of prevention of these additional accidents is £0.3bn for the appraisal period. This is displayed in Table A7.2 with the undiscounted per-annum value for 2040.

Table A7.2 Data used for accidents quantifcation

	2040	NPV
Value of prevention (£m, real 2010)	16	264

Note: NPV is calculated using the social discount rate. Source: Oxera.

Accidents associated with increases in ATMs

While the increase in ATMs associated with expansion at either Gatwick or Heathrow is likely to result in an increase in accident risk, there is no established methodology for assessing this increase. Given the generally good safety record of the aviation industry, this increase is not quantified. In any case, it is likely to be relatively small, although we note that an air accident at Heathrow is likely to have more serious impacts on the ground, relative to a similar incident at Gatwick.

A7.2 Physical activity

There is widespread acceptance of the welfare benefits of an active lifestyle.[155] However, given the nature of the expansion of airport capacity, it seems unlikely that such expansion will have a significant impact on the level of physical activity undertaken by the UK population. The rationale for this is that almost all passengers arrive and depart from airports by public transport or car, as they are typically carrying some form of luggage. They are also likely to continue to travel in this way, regardless of whether the airport is expanded.

Overall, however, the impact of the expansion of airport capacity is expected to be ‘slightly adverse’ for both scenarios.

A7.3 Security

WebTAG’s assessment of security requires an assessment against a number of indicators:[156]

[155] Department for Transport (2014), ‘TAG Unit A4.1: social impact appraisal’, p. 10.
[156] Department for Transport (2014), ‘TAG Unit A4.1: social impact appraisal’, p. 16.

- site perimeters, entrances and exits;
- formal surveillance;
- informal surveillance;
- landscaping;
- lighting and visibility;
- emergency call.

Given the unique circumstances surrounding airports, which present a secure environment, there does not appear to be any reason to expect levels of security to change at either Gatwick or Heathrow following expansion. Therefore, the impact of security is not assessed in detail and is thought to be 'neutral'.

A7.4 Severance

Severance occurs when residents are separated from community amenities by transport infrastructure. As with security, airports are uniquely placed in this regard, and this social impact is likely to arise only from changes to the surface access network. Given that the major road schemes relating to expansion at Gatwick are the rerouting of the A23 around the perimeter of the airport and the remodelling of existing junctions, it is unlikely that the surface access changes will be material, and this aspect is therefore scored 'neutral' for Gatwick.

While detailed surface access plans are not available for Heathrow, it is unclear what the impact of any changes in surface access on severance will be.

A7.5 Journey quality

WebTAG requires an assessment of the changes between the Do Minimum and the two Do Something options against the following criteria:

- traveller care (cleanliness, facilities, information, environment);
- travellers' views;
- traveller stress.

Table A7.3 provides a high-level assessment of the change in these factors in the Do Something options compared with the Do Minimum option.

Table A7.3 Journey quality assessment

Factor	Sub-factor	Gatwick R2	Heathrow NW
Traveller care	Cleanliness	Neutral. No expected change in cleanliness of terminals or surface access	Neutral. No expected change in cleanliness of terminals or surface access
	Facilities	Moderate beneficial. R2 expected to increase retail offering at Gatwick	Moderate beneficial. NW runway expected to increase retail at Heathrow
	Information	Neutral. No expected change in level of information provision or usefulness	Neutral. No expected change in level of information provision or usefulness
	Environment	Moderate beneficial. Additional capacity expected to reduce overcrowding, and new terminal to improve passenger conditions	Moderate beneficial. Additional capacity expected to reduce overcrowding, and new terminal to improve passenger conditions
Travellers' views		Neutral. Surface access changes unlikely to affect passenger views	Neutral. Surface access changes unlikely to affect passenger views
Traveller stress	Frustration	Moderate beneficial. Improvements in surface access likely to improve journey	Large adverse. Putting the M25 in a tunnel, and extensive surface access works on the

Factor	Sub-factor	Gatwick R2	Heathrow NW
			M25 and A4, likely to have adverse effects for some users
	Fear of potential accidents	Moderate beneficial. Improvements to surface access from existing roads provide benefits	Large adverse. Putting the M25 in a tunnel likely to increase some users' fear of accidents
	Route uncertainty	Neutral. Unlikely to materially affect users	Neutral. Unlikely to materially affect users

Source: Oxera.

Overall, it seems likely that the impact of airport expansion will slightly improve the journey quality for passengers under Gatwick R2, and be either neutral or slightly adverse for passengers under Heathrow NW.

A7.6 Option and non-use values

Intuitively, a system with capacity equally spread across two airports is more robust to severe disruption than a system where 75% of capacity is at one airport and 25% is at the other.

In the event of disruption at either airport in a 2+2 system, the unaffected airport will be able to accommodate some of the disrupted traffic. In a 3+1 system the smaller airport will be less able to handle disrupted traffic from the larger airport than if the airports were more equally sized. This cost will be only partially offset by the increase in the ability of the larger airport to accommodate disrupted traffic from the smaller airport. There is a net gain in resilience from the 2+2 system compared to the 3+1 system.

This intuition can be expressed more formally with an illustrative example based on simplifying assumptions.

Assume that both airports operate at full ATM (number of flights) capacity in both the 2+2 and 3+1 scenarios.

Assume that load factors (the percentage of seats occupied by passengers) are less than 100% and are the same at both airports in both scenarios. This means that each airport has some spare capacity to absorb passengers from the other airport. In the 2+2 scenario the spare capacity is the same at each airport; in 3+1 it is concentrated at the larger airport.

Assume that each airport experiences severe events (e.g. severe localised weather) and has to shut down completely for a whole day, and that such events occur once every three years. Assume, further, that all passengers who would have used that airport then use the other airport up until the point when the spare capacity at the other airport is used up. Any passengers in excess of the daily system capacity are lost forever.

Adding the lost passengers from a Heathrow shutdown to the lost passengers from a Gatwick shutdown gives the total lost passengers in the 2+2 and 3+1 scenarios.

Illustrative modelling (Table A7.4) shows that, for a range of load factors, the total number of lost passengers is less in 2+2 than under 3+1. The reason is that 3+1 gives an inefficient distribution of spare capacity, which results in some of this spare capacity being under-used when the smaller airport shuts down. This is a net loss to the system. The resilience benefit disappears at very low load factors because there is sufficient spare capacity at the small airport in the 3+1 scenario. The benefit also disappears at very high load factors as there is insufficient spare capacity at either airport.

Table A7.4 Lost passengers in 2+2 compared with 3+1

System capacity (pax per day)	Load factor	Lost pax		Difference in lost pax
		2+2	3+1	(3+1) - (2+2)
800,000	0%	-	-	-
800,000	10%	-	-	-
800,000	20%	-	-	-
800,000	30%	-	40,000	40,000
800,000	40%	-	120,000	120,000
800,000	50%	-	200,000	200,000
800,000	60%	160,000	280,000	120,000
800,000	70%	320,000	360,000	40,000
800,000	80%	480,000	480,000	-
800,000	90%	640,000	640,000	-
800,000	100%	800,000	800,000	-

Note: Daily passenger capacity is defined as 1,000 ATM per runway and 200 seats per ATM.

Source: Oxera analysis.

The example in Table A7.4 illustrates the mechanism through which a 2+2 system provides more resilience than a 3+1 system. The next step is to value the incremental resilience under a 2+2 system. This requires the analysis to be calibrated with realistic assumptions, in particular the following:

- **frequency and duration of disruption**—full shutdown for a whole day is a rare event but there are also less severe events that result in disruption that lasts for hours;
- **impact of disruption on passenger behaviour**—some passengers will switch to the other airport, some will travel from the original airport at a later date, and some will cancel completely;
- **net value of disruption per passenger**—the net value to the passenger of avoiding disruption will include the costs of avoiding disruption (e.g. travel between two airports);
- **distribution of value of disruption across passengers**—different passengers will place different values on avoiding disruption, with additional resilience most likely to benefit the passengers who place a high value on travel.

Nevertheless, a simple preliminary calculation can give a sense of the order of magnitude of the resilience gain under a 2+2 system.

Table A7.4 suggests that the avoided lost passenger numbers under a 2+2 system compared to a 3+1 system could be as much as 5% of daily system capacity (40,000/800,000) in the event of a severe disruption. As daily system capacity is forecast to be approximately 264m in 2040 (1.6m ATMs multiplied by approximately 150 passengers per plane, uplifted by 10% to provide a conservative estimate of capacity), in the event of a severe disruption, lasting for one day, 40,000 additional passengers would be able to fly under a 2+2 system. Assuming that such events occur once every three years (on average), the annualised gain in passengers would be approximately 12,000. Multiplying this by the average value of £200 per passenger (which is the average fare and, as such, provides a lower bound of the welfare impact because passengers typically value air travel at more than the fare) gives an estimated value of £52m for the resilience improvement under a 2+2 system.

The overall impact of the increased resilience from 2+2 is therefore thought to be a moderate beneficial impact.

A7.7 Accessibility

Accessibility refers to the ease with which people can access employment, services and social networks.

GAL has undertaken extensive analysis into how a second runway at Gatwick would result in improvements in the access of people in deprived areas to employment opportunities at an expanded Gatwick airport.

While the extensive surface access network that is in place to service both Gatwick and Heathrow contributes to accessibility by enabling non-users to access employment, services and their social network, it is unlikely that the additional surface access schemes required by additional runways will materially affect accessibility. This impact is therefore expected to be neutral for both schemes.

A7.8 Personal affordability

The personal affordability of travel is primarily a distributional question. In particular, the extent to which constructing an additional runway at Gatwick or Heathrow will change the personal affordability of air travel is important, as it directly affects how the benefits of that capacity expansion are distributed among the population.

There are substantial links to the assessment of the competitive effects of the two scenarios, with a 2+2 system likely to deliver lower overall fares, through both the increased intensity of competition and the lower costs which are required to be recovered from constructing the additional runway at Gatwick (approximately £7bn) compared with Heathrow (approximately £18bn).

Lower fares in the 2+2 scenario compared to both the Do Minimum and 3+1 scenarios are expected to provide a large beneficial impact. However, the 3+1 scenario is also expected to result in lower fares than Do Minimum and so is expected to have a moderate beneficial impact.

A7.9 Conclusions and summary

Table A7.5 Summary of social effects

	Gatwick	Heathrow NW
Accidents	Adverse	Adverse
Physical activity	Neutral	Neutral
Security	Neutral	Neutral
Severance	Neutral	Neutral
Journey quality	Neutral	Neutral/slightly adverse
Option and non-use values	Moderate beneficial	Slight beneficial
Accessibility	Neutral	Neutral
Personal affordability	Large beneficial	Moderate beneficial

Source: Oxera.

Overall, therefore, a 2+2 solution would appear to be slightly beneficial, while a 3+1 system would be neutral.

A8 Distributional impacts

As explained in section 2.4.7, distributional analysis of the impacts of expansion at Gatwick and Heathrow is at an early stage.

The impacts on noise, air quality and severance discussed in Appendices 5 and 7 can be distinguished by spatial area and therefore be mapped onto the community profile. This will permit detailed assessment of their distributional impacts. The initial screening to be conducted by 9 May will contain qualitative information of the type required by the Commission, and will be presented in the form specified by the DfT. It is summarised in Table A8.1.

Table A8.1 Distribution impacts pro forma: Gatwick expansion

Indicator	Appraisal output criteria	Potential impact (yes/no, positive /negative if known)	Qualitative comments	Recommend to proceed to step 2
User benefits	The value of user benefits TEE table is non-zero	Yes	Significant changes in user and provider surplus	Yes
Noise	Any significant change in households affected by noise	Yes	Significant changes in noise for Heathrow scheme	Yes.
Air quality	Changes in local air quality of an extent likely to affect health	No	Some increase in NOx and PM10 emissions, but unlikely to result in concentrations sufficient to affect health	No
Accidents	Any change in alignment of transport corridor (or road layout) that may have positive or negative safety impacts	Yes	Limited benefit from improved road layout	No
Security	Any change in public transport waiting/interchange facilities, including pedestrian access, expected to affect user perceptions of personal security	No	Very limited change in security	No
Severance	Introduction or removal of barriers to pedestrian movement, through either changes to road crossing provision or the introduction of new public transport or road corridors. Any areas with significant changes (>10%) in vehicle flow, speed, or percentage of HGV content	No	Very limited change in severance	No
Accessibility	Changes in routings or timings of current public transport services; any changes to public transport provision, including routing, frequencies, waiting facilities (bus stops/rail stations) and rolling stock; or any indirect impacts on accessibility to services (e.g. demolition and relocation of a school)	No	Very limited impact on routing of public transport, and little impact on severance	No
Affordability	In cases where the following charges would occur: parking charges (including where there may be changes in the allocation of free or reduced-fee spaces); car fuel and non-fuel operating costs (where, for example, re-routing or changes in journey speeds and congestion occur, resulting in changes in costs); road-user charges (including discounts and exemptions for different groups of traveller); changes in public transport fare s(where, for example, premium fares are set on new or existing modes or where multi-modal discounted travel tickets become available due to new ticketing technologies); public transport concession availability (where, for example, concession arrangements vary as a result of a move in service provision from bus to light rail or heavy rail, where such concession entitlement is not maintained by the local authority)	Yes	Likely to be a significant difference in affordability between options	Yes

Source: Oxera.

Whether, and in what cases, it is necessary to move on to a more detailed appraisal will vary by impact and distributional category. Detailed appraisal, where necessary, will follow the methodology set out in the relevant sections of WebTAG unit A4.2.

Any impacts on accidents are likely to be associated primarily with the changes in surface access discussed in Appendix 4, and initial indications are that they are unlikely to be substantial. Further analysis will produce precise estimates. It is worth noting that the direct impact of expansion on the size of the local economy, and hence on possible accident rates, is well within the scale of growth envisaged in current projections.

Impacts on user benefits and access from airport expansion are not primarily related to the characteristics of the local community surrounding the airport. They are likely to be similar, therefore, whichever option for expansion is chosen. In one important respect, however, they will not be the same. The accessibility of air travel to sections of the public will depend on the additional services offered under different expansion options and the fares charged to passengers. Lower fares and the scale of operation of LCCs, notably for short-haul leisure passengers, provide important benefits for middle- and lower-income groups. The passenger and fares forecasts set out in Appendix 3 indicate that the Gatwick option will be much more favourable in this respect. Therefore, further assessment of the distributional impacts of the different options is not considered appropriate at this stage.

A9 Wider economic impacts

A9.1 Introduction

In the context of a transport appraisal, wider economic impacts are the impacts of a change in the transport network which accrue to people and businesses beyond the users and providers of the transport network. For example, an increase in the connectivity of a city due to an improvement in the road network is likely to result in an increase in productivity for firms located in that city, as they can access a larger labour force and the size of the market accessible from that city increases. These wider economic impacts can make a significant difference to the business case for investments in transport networks, typically adding between 10% and 30% of the user benefits of the scheme.[157] However, the wider economic impacts arising from an increase in airport capacity may be significantly larger, as an airport does not only connect local, domestic markets, but also allows for increased international connectivity and trade.

The DfT’s appraisal framework (WebTAG) sets out a methodology for appraising the wider economic impacts of changes to the transport network, but is mainly focused on domestic road and rail schemes.[158] The mechanisms in WebTAG explain how, at the level of individual firms, the changes in transport costs affect output—these are known as ‘bottom-up’ effects. The Commission has considered the economic impact of additional runway capacity in some detail, considering high-level economic impacts from trade, increased foreign direct investment (FDI), and tourism. These are aggregate outcomes and can be considered ‘top-down’ effects of changes in the transport network.

There is a relationship between the top-down and the bottom-up effects, and it is important to consider the interplay between the two carefully. In principle, they should yield the same overall answer. Oxera has followed the bottom-up approach for quantifying a number of the wider economic impacts, and used the top-down approach where the results could inform the bottom-up calculation.

A9.2 Conceptual approach

When conducting an appraisal of the economic impacts of a change in the transport network, it is important to avoid double-counting any impacts by ensuring that the wider economic impacts are *additional* to the user and provider impacts.[159] Typically, there are three main ways in which a change in the transport network can affect economic welfare (in addition to the effects on users and providers of the network):

- through labour supply impacts;
- by increasing productivity in individual firms and sectors, either as a consequence of reducing transport costs (which, in imperfect markets, raises output by more than the reduction in user costs), or by delivering agglomeration economies and other efficiency improvements;
- by changing the structure of the economy, with resources moving from less productive to more productive sectors.

[157] Steer Davies Gleave (2011), ‘Wider economic impacts of transport investments in New Zealand’, September.
[158] Department for Transport (2014), ‘TAG Unit A2.1: Wider Impacts’, January.
[159] In a perfectly competitive market, there are no wider economic impacts, as all impacts of changes in the transport network accrue to either users or providers of the network.

This last point includes the impact on economic welfare of increased trade, FDI and tourism, when considering a project that affects international transportation infrastructure. The Commission acknowledges that its approach of considering trade, changes in FDI and tourism would result in wider economic impacts that are not necessarily additional to the user benefits.[160] However, Oxera has identified potential tax revenue impacts from trade, FDI and tourism that would be additional to user and provider impacts, and hence should be considered as a part of the wider economic impacts.

The next sub-sections consider these aspects in more detail.

A9.2.1 Labour supply impacts

Changes in the transportation network influence both the connectivity of an area and the costs of transport; in some cases, this results in a change in the labour supply of the connected areas, as it is less (or more) costly for individuals to commute to work. However, in the case of an expansion in airport capacity, it does not seem likely that this will affect the costs of transport or connectivity in a way that would change commuting patterns. Given the time and fare prices of air travel, it seems unlikely that many individuals would choose to commute via plane.

Oxera does recognise that there could be a labour supply effect if improvements in surface access to an airport as the airport expands do more than simply accommodate the higher demand generated, and so improve commuting opportunities. However, as there is no immediate reason for thinking that this will be the case, Oxera assumes that it is prudent not to quantify labour supply effects that might arise from additional airport capacity in the South East.

A9.2.2 An increase in the productivity of individual firms and sectors

There are two dimensions to this effect. First, an increase in connectivity reduces transport costs, which allows firms to sell goods and services profitably which would previously have been unprofitable to sell.[161] As consumers of these goods and services value them in imperfectly competitive markets at more than cost, there is an additional welfare impact from this increase in output, going beyond the reduction in user costs captured elsewhere. This impact is likely to apply as much to an increase in runway capacity as to other domestic transport schemes and should therefore be included in the wider economic impacts of a second runway at Gatwick or Heathrow.

Second, an improvement in the transport network often allows economic activity to become more concentrated in particular locations. This increase in the concentration of economic activity results in an increase in productivity as firms can draw from a larger pool of labour and are located closer together, resulting in a greater exchange of ideas, etc.[162] This increase in productivity due to increased agglomeration is an externality that will result in increased output, the welfare effects of which are not taken account of elsewhere in the economic appraisal and are therefore additional to the other benefits. However, it is important to note that this effect is likely to apply only to firms in the area of the airport, given the distances over which the effects typically operate.

[160] Airports Commission (2013), 'Interim report: appendix three: technical appendix', December, p. 9.
[161] Department for Transport (2014), 'TAG Unit A2.1: Wider Impacts', January, p. 2.
[162] Banister, D. and Berechman, J. (2000), *Transport investment and economic development*, Routledge, p. 95.

Oxera considers the area around Gatwick that is likely to benefit directly from increased agglomeration. These areas are the Gatwick Diamond and the Study Area, as defined in Optimal Economics' draft report.[163] Oxera has also included an indicative estimate of the agglomeration effects from an expansion of Heathrow.

A9.2.3 Change in the structure of the economy

A change in the transport network may facilitate a change in the structure of the economy, as more resources are used in highly productive sectors and fewer in less productive sectors. One way in which this may manifest itself is by increasing employment in the airports and/or tourism sectors, which are expected to expand due to increased demand for airport services and through the increase in connectivity driving an increase in tourist numbers. This switch in employment can result in people working in more or less productive jobs than previously, and output can be higher or lower as a result of this switch. As above, Oxera considers the impacts of changes to more or less productive jobs in two areas, the Gatwick Diamond and the Study Area[164]—essentially the area covered by the Coast to Capital (CtC) Local Economic Partnership (LEP)—and performs an analogous calculation for Heathrow NW.

Another way in which the structure of the economy is expected to change following the expansion in airport capacity is through the increase in trade and FDI arising from increased international connectivity. A top-down approach is used to inform calculations of this impact, using results of previous studies on the impact of trade and FDI on productivity. Moreover, due to increased connectivity, tourism is likely to increase and, as a result, more resources will be moved from non-tourism sectors to sectors of the economy that cater to tourists. This generally has an ambiguous impact on productivity, as tourism-related production may be a more or less productive use of resources than non-tourism-related output.

Changes in transport infrastructure can also affect the decisions of firms and workers about where to locate their business or where to work. These decisions can affect productivity, as workers are either more or less productive in different locations.[165] Consequently, there may be workers who move to more or less productive jobs, due to changes in the economic landscape resulting from the infrastructure investment. Workers moving to more or less productive jobs can have welfare effects due to either increased or decreased output. While the benefits to users and providers of the transport network will be captured elsewhere in the economic appraisal, the changes in tax from these productivity changes are not captured elsewhere, and are a part of the wider economic impact of airport expansion.

Oxera uses estimates of expansion-related employment presented in sections A9.1 and A9.3, which cover local economic impacts. Appendix 9 explains Oxera's analysis of the employment effects of expanding airport capacity in the South East, and the estimates of net job growth provided therein are used to calculate wider economic impacts in the current appendix.

[163] Optimal Economics and RPS, (2014), 'Gatwick R2 Local Economy Impacts', 8 May, p. 11.
[164] Defined in Optimal Economics and RPS (2014), 'Gatwick R2 Local Economy Impacts', 8 May.
[165] Department for Transport (2014), 'TAG Unit A2.1: Wider Impacts', January, para. 2.2.8.

A9.3 Approach to empirical analysis

A9.3.1 An increase in the productivity of individual firms and sectors

Output change in imperfectly competitive markets

An increase in runway capacity will increase the productivity of firms that will use the transport infrastructure, and hence will result in cost reductions for these firms. In markets that are perfectly competitive, competition drives prices down until they are closely aligned with marginal cost. Therefore, any cost reduction for businesses arising from the increase in runway capacity will be passed on to users through lower prices, all else being equal, and the welfare effects will be fully captured by the benefits to those users.

However, in imperfectly competitive markets, prices are normally higher than marginal costs and the wedge between prices and costs leads to a reduction in output, and hence to a welfare loss. If better transport, such as the increase in runway capacity at Gatwick or Heathrow, induces firms to increase output, wider benefits arise because the value placed by users on the additional output (indicated by the price paid—or the willingness to pay—for the additional output) exceeds the cost of producing it.

Where improved transport delivers cost savings to firms, one would therefore expect output to increase by more than the cost reduction.[166] The DfT recommends that this impact is estimated using a simplified approach, where it is calculated as a 10% uplift to business user benefits.[167] Oxera has estimated the business user benefits as shown in section 2.4.2, and Table A9.1 shows estimates of the benefits arising from output increases in imperfectly competitive markets.

Table A9.1 Benefit arising from output increases in imperfectly competitive markets

	Gatwick R2	Heathrow NW
NPV of business user benefit (£m)	4,344	3,116

Source: Oxera.

Agglomeration benefit

An increase in runway capacity in the South East of England will increase the number of passengers. This, in turn, will lead to higher cargo volumes at the airport where capacity is added, and increase the connectivity of businesses located in the airport's vicinity.

It is estimated that, at Gatwick, the increase in runway capacity would be likely to increase the number of passengers at the system level by 20%,[168] and the number of destinations by 23%.[169] At Heathrow, on the other hand, it is estimated that the addition of a runway would be likely to increase system-wide passenger numbers by 12% and the number of destinations by 15%.

The increase in traffic resulting from the increase in runway capacity will result in higher economic activity at the airport through direct, indirect and induced

[166] Department for Transport (2005), 'Transport, wider economic benefits, and impacts on GDP', discussion paper, July, para. 100.
[167] Department for Transport (2014), 'TAG Unit A2.1: Wider Impacts', January, para. 4.1.9.
[168] Oxera analysis of SH&E forecasts.
[169] Oxera analysis of SH&E forecasts.

effects, as defined in section A10.1. Additionally, increased airport capacity is likely to have catalytic effects, which occur when firms move their location, or new firms open, due to the increased connectivity at the expanded airport. Generally, due to the increased connectivity, the catalytic effects will result in job creation.

Overall, the direct, indirect and catalytic effects resulting from the increase in runway capacity will increase the clustering density of economic activity in the vicinity of the airport. There is evidence that the clustering of economic activity into spatial areas will create productivity benefits (‘agglomeration economies’), which are benefits in addition to those to the direct users of transport investments.[170]

The greater productivity in agglomerations arises from the fact that firms have access to larger product, input and labour markets; moreover, knowledge and technology spillovers are additional important aspects of agglomeration effects.[171]

A9.3.2 Estimating agglomeration effects

There is no hard and fast rule for how to measure agglomeration. The literature suggests that both the ‘proximity’ and ‘scale’ of economic activity in a specific area are important drivers of agglomeration effects.[172] In empirical studies, a measure of proximity (such as the distance or generalised cost for business and commuting travel between firms or workers) and of scale (such as employment or population accessible to firms) are combined to arrive at an agglomeration metric referred to as ‘effective density’.[173] Oxera uses geographic distance and employment numbers to calculate effective densities.[174]

Oxera has conducted a bottom-up calculation of agglomeration effects resulting from Gatwick expansion for the geographic area significantly affected by Gatwick.

As per section A10.1, Oxera calculates an employment increase of about 30,000 net new jobs (10,000 directly associated with the expansion of the airport and 20,000 catalytic jobs) in the Gatwick Study Area. Furthermore, Oxera assumes that 80% of Gatwick-related catalytic jobs—i.e. 80,000 jobs—will be spread across Greater London and the South East, again as per section A10.1.

The methodology for estimating the agglomeration effect in the Local Authority Districts (LADs) proximate to Gatwick is set out in Box A9.1.

[170] See, for example, Graham, D.J. (2007), ‘Agglomeration, productivity and transport investment’, *Journal of Transport Economics and Policy*, **41**:3, September, pp. 317–43.
[171] Department for Transport (2014), ‘TAG Unit A2.1: Wider Impacts’, January, para. 2.2.3.
[172] See, for example, Graham, D.J. (2007), ‘Agglomeration, productivity and transport investment’, *Journal of Transport Economics and Policy*, **41**:3, September, p. 327; and Venables, A. (2004), ‘Evaluating urban transport improvements: cost-benefit analysis in the presence of agglomeration and income taxation’, CEP Discussion Paper No 651, Centre for Economic Performance, September.
[173] For example, Department for Transport (2014), ‘TAG Unit A2.1: Wider Impacts’, January, suggests a combination of generalised cost and employment to calculate effective density; Graham, D.J. (2007), ‘Agglomeration, productivity and transport investment’, *Journal of Transport Economics and Policy*, **41**:3, September and Graham, D.J., Gibbons, S. and Martin, R. (2009), ‘Transport investment and the distance decay of agglomeration benefits’, January, use a combination of distance and employment.
[174] Following Graham, D.J., Gibbons, S. and Martin, R. (2009), ‘Transport investment and the distance decay of agglomeration benefits’, January; and Graham, D.J. (2007), ‘Agglomeration, productivity and transport investment’, *Journal of Transport Economics and Policy*, **41**:3, September.

Box A9.1 Methodology for estimating agglomeration effects

- Agglomeration effects are calculated based on effective density, which is a measure of the density of employment. Effective density is defined in the following manner:[175]

$$ED_i = \frac{E_i}{\sqrt{A_i/\pi}} + \sum_{j \neq i} \frac{Ej}{dij}$$

where E_i is total employment in LAD i, A_i is the geographic area of LAD i, and d_{ij} is the distance between LAD_i and LAD_j.

- The effective density is calculated for the baseline scenario and for Gatwick Option 3 for each year from 2021 to 2080. When calculating effective density for Option 3, employment numbers include the estimated increase in employment, as found in A10. The trend used to estimate job growth assumes a linear relationship between the number of additional passengers and the number of additional jobs.

- To calculate the benefit from agglomeration, the following formula is used:[176]

$$Agglomeration\ benefit_i = \left[\left(\frac{ED_{i,Option\ 3}}{ED_{i,Baseline}}\right)^{\epsilon} - 1\right] * GVA_i * E_i$$

where E_i is the baseline employment in LAD i, ϵ is the elasticity of output with respect to agglomeration, GVA_i is the baseline gross value added (GVA) in LAD i, and $ED_{i,\ option}$ is the effective density of an option as calculated above.

- ε is taken as the arithmetic mean of the agglomeration elasticity for consumer services (0.024) and producer services (0.083), as stated in WebTAG Unit A2.1. This is because agglomeration is be spurred on by increases in service sector employment, although the exact split between producer services and consumer services is hard to forecast.

- To calculate the agglomeration effect outside of the Study Area, the relative increase in employment due to Gatwick Option 3 for the Gatwick Study Area (3.1%) is compared with that for Greater London and the South East (0.8%). Assuming that the agglomeration impact is proportionate to the relative percentage of net new jobs in an area, this would imply that the average agglomeration impact for new jobs outside the study area is 27% of that for jobs in the Study Area.

- The total agglomeration benefit is then the sum of the agglomeration benefits in all of the LADs studied, plus the agglomeration effect in the wider area (i.e. Greater London and the South East).

Source: Oxera.

Forecasts for job numbers in the LADs near Gatwick have been taken from the Trip End Model Presentation Program (TEMPro), and distances between LADs

[175] Formula taken from Graham, D.J. (2007), ‘Agglomeration, productivity and transport investment’, *Journal of Transport Economics and Policy*, **41**:3, September, p. 327.
[176] Formula taken from Department for Transport (2014), ‘TAG UNIT A2.1 – Wider Impacts’, Transport Analysis Guidance (TAG), January, p. 26.

have been taken from freemaptools.com.[177] The geographic area of LADs, and GVA data, are taken from the Office for National Statistics (ONS). Finally, the elasticity of output with respect to agglomeration is the simple average of elasticities for service sectors listed in WebTAG A2.1.[178] Oxera assumes that material increases in employment will occur only in service sectors—which is supported by the most persuasive literature on the impact of airports on local/regional economies surveyed by SDG.[179] This literature suggests that an increase in air passengers leads to an increase in service sector employment in the local region, with no significant impact on other sectors.[180]

Using the approach above, an average impact of £61,830 NPV per additional job in the Gatwick Study Area is found, and an average impact of £16,657 NPV per additional job is found in the wider area. To calculate the agglomeration effect of Heathrow expansion, Oxera assumes that there will be the same pattern of agglomeration effects per job for expansion at Heathrow as in the area around Gatwick, and that effects per job in the wider area will also be the same. For catalytic jobs outside of the two study areas, it is reasonable to expect that, on average, their productivity will be similar regardless of which airport is the catalyst for their creation. However, the agglomeration effect for the Heathrow Study Area may be overestimated, as the average agglomeration benefit per new job is likely to be lower than in the Gatwick Study Area owing to the high concentration of employment around Heathrow.

In general, increased agglomeration in one area is caused by migration of jobs or workers from other locations to that area, and subsequently decreased agglomeration in those other locations. However, because the study areas used are so large, and include LADs that are considerable distances from the respective airports, it is reasonable to expect that many of the changes in agglomeration will occur within the Study Areas. Additionally, a high displacement rate of 50% used to estimate agglomeration effects, as well as the exclusion of all agglomeration effects for direct, indirect and induced jobs outside the study areas, should result in a sufficiently conservative estimate of agglomeration effects. Finally, as the labour force is expected to increase in the Gatwick Study Area, and the employment forecasts include a number of discouraged workers and unemployed people finding jobs as a result of Gatwick's expansion, it is plausible that the increased agglomeration in the South East may not result in materially lower agglomeration elsewhere.

It is important to note, too, that productivity increases have been calculated only for existing jobs. This is in order to avoid the possibility of double-counting increased productivity caused by agglomeration on new jobs created by Gatwick expansion. As the additional economic impact from switching to an airport-related job may already include agglomeration effects, Oxera cautiously omits an explicit calculation of the agglomeration effect on the new jobs instigated by the increase in airport capacity. Instead, Oxera takes the productivity differential between these jobs and non-airport-related jobs to already include any agglomeration impacts.

[177] Distances were taken from this website as it reports 'as the crow flies' distances, which are preferred for agglomeration analysis, as per Graham, D.J., Gibbons, S. and Martin, R. (2009), 'Transport investment and the distance decay of agglomeration benefits', January, pp. 9–10.
[178] Department for Transport (2014), 'TAG UNIT A2.1 – Wider Impacts', Transport Analysis Guidance (TAG), January, Table 1, p. 9.
[179] Percoco, M. (2010), 'Airport Activity and Local Development: Evidence from Italy', *Urban Studies*, **47**:11.
[180] Percoco, M. (2010), 'Airport Activity and Local Development: Evidence from Italy', *Urban Studies*, **47**:11.

Based on these estimates of the likely employment effects and the methodology set out in Box A9.1, Oxera has arrived at a high-level indicative estimate of the likely increase in GVA arising from an increase in the runway capacity at Gatwick. This estimate is shown in Table A9.2.

Table A9.2 Indicative agglomeration effects from airport capacity expansion (£m)

	Gatwick Study Area	Heathrow Study Area	Gatwick wider effects	Heathrow wider effects	Gatwick total	Heathrow total
Long-run increase in GVA (£m)	152	142	109	65	261	207
NPV of increase in GVA (£m)	1,821	1,699	1,308	785	3,130	2,485

Note: NPV valuation from 2021 until 2080. Oxera assumes that catalytic jobs and Heathrow Study Area jobs have the same NPV factor as Gatwick-related jobs in the study area.

Source: Oxera.

A9.3.3 Benefits from changes in the structure of the economy

Move to more or less productive jobs

The increase in runway capacity will increase employment in the vicinity of the expanded airport. The employees who fill the new jobs created as a result of an additional runway are likely to leave other employment in order to work in these new positions. There will therefore be a movement to the new positions from other jobs, where the jobs that have been left by job movers may be more or less productive than the jobs acquired by them.

Catalytic jobs are not included in this calculation, as there is no evidence to suggest that catalytic jobs would inherently be any more or less productive than other jobs in the area. This is because catalytic jobs are not directly related to either airport or its supply chain, but are at firms that have chosen to relocate (or open) due to the expanded airport capacity. For forgone jobs in the Study Area that are replaced by airport-related jobs, Oxera estimates a level of productivity based on the average wage in the South East. For the forgone jobs outside of the Study Area, it is difficult to construe a plausible estimate of productivity, and hence Oxera includes only airport-related jobs that displace other jobs in the Study Area in this calculation.

The net change in productivity due to the movement in jobs within an airport's vicinity is calculated by finding the difference between the average GVA per Gatwick-related job and the average GVA per non-Gatwick-related job in the South East. Optimal Economics has provided data that indicates that Gatwick-related wages are, on average, £1,900 higher in 2012 than non-Gatwick related wages in the South East. Optimal Economics further reports that 62% of GVA, on average, is made up of wages—and, assuming that this relationship holds for the new airport-related jobs as well, this implies that, by switching to Gatwick-related jobs, productivity is increased by about £2,900 per job in 2010 prices. Using the 2011 average Heathrow wage reported by Regeneris, the same approach implies that Heathrow jobs had a GVA of about £4,600 higher than the South East average.

Assuming a 2% GVA growth rate for both Gatwick and non-Gatwick jobs in the South East, by 2050, Gatwick-related jobs are expected to have a GVA of about £6,200 above that of the average job in the South East. Assuming the same growth rate, Heathrow jobs are expected to have about £9,900 more GVA than the average job in the South East.

However, as the benefits from increased GVA that accrue to employees and employers are already accounted for elsewhere in this appraisal, the wider economic impact of a move to jobs with different levels of productivity is reflected in changes in tax revenue. Oxera assumes that tax revenue is equal to 40% of the difference in GVA between the base case and each of the airport expansion options considered. Hence, the wider economic impact from a movement to more productive airport jobs is expected to be of the magnitude shown in Table A9.3.

Table A9.3 Indicative effects of moving to more/less productive jobs due to Gatwick expansion

	Gatwick Study Area	Heathrow Study Area
Long-run increase in GVA (£m)	25	63
NPV of increase in GVA (£m)	299	779

Note: NPV valuation from 2021 until 2080.

Source: Oxera.

A9.3.4 Increased trade, tourism and FDI

An increase in runway capacity will enhance aviation connectivity, which, in turn, will facilitate changes in the structure of the economy through the following channels:[181]

- increased trade in goods and services, and in FDI investment;
- increased tourism.

The literature points out that trade and FDI affect productivity in the domestic economy through four possible channels:[182]

- better resource allocation;
- deepening specialisation;
- higher return to investment in capital and R&D;
- technology spillovers.

These channels will increase the average level of productivity in the economy, and potentially also productivity growth.[183] SDG has undertaken a useful survey of the relevant literature.[184] Optimal Economics has undertaken an assessment of the wider impacts of a second runway at Gatwick, including effects on trade and FDI.[185]

Oxera has used the empirical results available from these reviews and other sources to derive estimates of the likely impact of an additional runway at

[181] Airports Commission (2013). 'Discussion paper 02: Aviation connectivity and the economy', March, p.13.
[182] Nordas, H., Miroudot, S. and Kowalski, P. (2006), 'Dynamic gains from trade', OECD trade policy papers no. 43, OECD Publishing, November, p. 2.
[183] Nordas, H., Miroudot, S. and Kowalski, P. (2006), 'Dynamic gains from trade', OECD trade policy papers no. 43, OECD Publishing, November, p. 4.
[184] Steer Davies Gleave (2014), 'Aviation and the Economy – Framework and Evidence', March.
[185] Optimal Economics (2014), 'Gatwick Airport Second Runway – Wider Economic Benefits', Final Report (Revised), January.

Gatwick or Heathrow on trade, FDI and tourism, and the changes in the structure of the economy that arise from these impacts, that is consistent with elements of the bottom-up methodology set out in WebTAG.

An important aspect of the analysis is the need to avoid double-counting, and in this context there are two such problems:

- overlaps between effects from different sources—for example, extra trade and the investment necessary to achieve it. In practice, such effects cannot generally be added together and should be regarded as alternative estimates of the same overall macroeconomic effect;
- the effects calculated from these sources will include some of the business user benefits analysed in Appendix 3, and it is necessary to identify only those benefits that are truly additional. The additional benefits achieved in imperfectly competitive markets have been described above, and in this section only the extra tax revenue from the tourism, trade and FDI effects can be regarded as genuinely additional.

Tourism

Increased connectivity will allow more passengers to travel to and from the South East of England, resulting in increased tourism. While the benefits from increased tourism that accrue to the tourists themselves are already captured elsewhere in the appraisal, the change in tax revenue resulting from changes in the number of tourists has not been quantified, and would be captured here as a part of the wider economic impacts.

Increased tourism can have an ambiguous effect on the UK economy—while more foreigners may come to the UK, resulting in higher expenditure, British residents may also travel outside of the UK more frequently and have higher aggregate expenditure abroad. Moreover, overseas tourism and domestic tourism are highly likely to be substitutes for one another in many cases. In the current case, however, Oxera does not find any credible wider economic impacts from changes in tourism that are not captured elsewhere, as there is no robust evidence that the tourism sector is more productive than other sectors in the economy from which productive resources would be taken if tourism were to expand. Moreover, some of the benefits that follow from increased tourism will be captured by the trade and FDI benefits calculations, especially as trade in services is also included in the calculations. Hence, Oxera has not included any explicit tourism wider economic impacts from the proposed airport capacity expansion.

Trade and FDI

Both trade and FDI may affect the structure of the economy, and research by PwC, commissioned by the Airports Commission, suggests that both will tend to rise with increases in connectivity. [186] While peer reviewers made clear that these relationships are associations, with causation likely to run in both directions, the wider literature does suggest that increased connectivity may well cause such increases. However, the PwC parameters are likely to overstate these effects, and so Oxera has scaled them down significantly in order to produce suitably cautious estimates of the wider benefits involved.

[186] PwC (2013), 'Econometric analysis to develop evidence on the links between aviation and the economy', Final report, Airports Commission, December.

The PwC work suggests that a 10% increase in airline seat capacity in the UK—which is what would be delivered by Gatwick R2—is associated with an increase of 1.9 percentage points in UK trade as a share of GDP.[187] In view of the very real concerns about causation—it is very likely that increased trade causes increased demand for air transport, as well as the other way around—Oxera has assumed that the causal impact of connectivity on trade is only 10% of the PwC association, or 0.19 percentage points. The wider literature surveyed by SDG makes it clear that there is no robust evidence on the true strength of this relationship, and so the arbitrary parameter adopted by Oxera should be regarded as a prudent assumption rather than a firm estimate.

Literature on the productivity gains from trade, summarised in OECD (2006), suggest that it increases by 0.39–3% for each percentage point increase in trade share.[188] SDG has also surveyed this literature, and closer examination of the two key studies in this area by Oxera suggests a narrower range of 0.5–0.75%.[189] On this basis, and using the cautious assumption about the effect on trade discussed above, UK productivity might be expected to rise by 0.1–0.14% as a consequence of the increase in connectivity delivered by Gatwick R2. This translates into an impact on GVA in 2050 of £3bn–£5bn a year.

However, as explained above, only the tax generated by this extra GVA should be counted as a genuinely additional benefit. This would amount to £1.3bn–£1.9bn a year, or £15bn–£23bn in NPV terms.

Using methodology developed in an earlier Oxera study,[190] Optimal Economics has estimated GVA impacts due to increased trade as a result of Gatwick Option 3 at £2.5bn a year, or £19bn in NPV terms, roughly in the middle of the range suggested above.[191] Furthermore, the effects cited by Optimal Economics include not just the tax element but the whole of the implied effect on GVA. The difference in the underlying estimates may be due to the fact that the earlier Oxera study focused on freight as an indicator of trade, whereas trade in services is also important and is included explicitly in the current estimate.

Oxera therefore concludes that an additional benefit of £20bn NPV is a prudent estimate of the wider benefits of Gatwick R2 through increased trade. This estimate is roughly halfway between the £15bn lower bound and the £23bn upper bound, and nearly matches Optimal Economics' estimate of trade effects. However, it must be stressed that this estimate is tentative, and should be taken only as an indicator of the potential order of magnitude involved.

Using the same methodology, it is possible to estimate the corresponding scale of trade effects from an expansion of Heathrow instead of Gatwick. In both cases the effects are driven by an increase in airline seat capacity, and the traffic forecasts produced by SH&E suggest that passenger numbers would increase by a smaller amount in the Heathrow option—i.e. by 7.3% rather than 10% of projected traffic in 2050. On that basis, Oxera estimates wider benefits from trade of around £15bn NPV from expansion at Heathrow, compared with £20bn for Gatwick. Again, this estimate is slightly above halfway in the estimated range

[187] Exports **plus** imports as a share of GDP.
[188] Nordas, H. K., Miroudot, S. and Kowalski, P. (2006), 'Dynamic Gains from Trade', OECD, 24 November,
[189] Frankel, J.A. and Romer, D. (1999), 'Does Trade Cause Growth', *American Economic Review*, **89**:3, June. Alcala, F. and Ciccone, A. (2004), 'Trade and Productivity', *Quarterly Journal of Economics*, **119**:2.
[190] Oxera (2009), 'What is the Contribution of Aviation to the UK Economy?', report to the Airport Operators Association.
[191] Optimal Economics (2014), 'Gatwick Airport Second Runway – Wider Economic Benefits', Final Report (Revised), January, p. 29. This is a separate calculation from the output generated by the additional employees arising from the expansion of Gatwick, which is reported elsewhere in this document.

(£11bn–£17bn in NPV) of wider economic benefits resulting from increased trade due to Heathrow's expansion.

As these estimates include trade in services, they cover some of the additional economic impacts that may be ascribed to tourism—such as the productivity gains from additional business passengers, and services purchased by additional tourists. Because no explicit tourism wider economic impact is quantified, the wider economic impacts of increased trade in services, including services provided to tourists, is captured here, and does not double-count the benefits included in any other portion of this appraisal.

As already noted, the impacts of extra aviation capacity on investment will contribute to the trade effects estimated above, and cannot be added together. The literature review by SDG notes that there are no robust estimates of the impact of connectivity on inward FDI, although surveys suggest that they are linked. The most robust study available suggests that a 10% increase in the stock of FDI in manufacturing raises productivity by 0.5%.[192] With manufacturing accounting for only 10% of UK output, the effect on national productivity would be 0.05%.[193]

The PwC research suggests, at first sight, that a 10% increase in seat availability increases the *flow* of inward FDI by 4.7%, which by 2050 might have raised the *stock* by around 8%, given average inflows per year of around 6% of the current stock. However, given the problems mentioned above of establishing causation, which also apply to FDI, it would be prudent to assume a much lower number in assessing the impact of enhanced connectivity; Oxera suggests a figure of 1%. This would translate into an increase in national productivity of 0.006%, equivalent in 2050 to around £0.25bn a year, or £2bn in NPV terms.

Thus the FDI effect appears likely to be significantly smaller than additional benefits from increased trade and, as already explained, cannot just be added to them. It therefore appears that the broad estimate of £20bn NPV for Gatwick expansion is a sensible order of magnitude to use for the overall effect of extra trade and FDI. For Heathrow, the corresponding number remains £15bn NPV.

A9.3.5 Overall effects

The sum of the wider economic benefits identified by this appraisal is reported in Table A9.4, which gives an indicative estimate of approximately £2.8bn in NPV terms for Gatwick and £21.4bn for Heathrow. These estimates are comparable with the Commission's figure of £10bn–£27bn NPV in benefits from additional airport capacity.[194] While the Commission conducts an analysis that is entirely top-down, Oxera's analysis is more detailed as it includes key elements for which a bottom-up approach has been taken.

[192] Haskel, J.E., Pereira, S.C. and Slaughter, M.J. (2007), 'Does inward foreign direct investment boost the productivity of domestic firms?', *Review of Economics and Statistics*, **89**.3.
[193] World Bank, 'World Development Indicators', available at http://data.worldbank.org/indicator/NV.IND.MANF.ZS, accessed on 14 April 2014.
[194] Equal to the net costs to the wider economy if capacity is not expanded, minus costs to users and providers if capacity is not expanded. Airports Commission (2013), 'Interim Report', December, p. 55.

Table A9.4 Wider economic impacts of additional capacity in the South East (£bn, NPV)

	Gatwick	Heathrow
Imperfect competition	4.34	3.12
Agglomeration	3.11	2.47
Switching jobs	0.30	0.77
Increased trade	20	15
Total wider economic impact	**27.75**	**21.35**

Note: NPV valuation from 2021 to 2080. Columns may not sum due to rounding.

Source: Oxera.

Additionally, when taken together with the direct benefits provided by each proposed airport expansion, the Heathrow benefits fall within the £30bn–£45bn total benefits that the Commission has outlined. On the other hand, benefits from Gatwick expansion are greater than the upper end of the range specified by the Commission

A10 Local and regeneration impacts

The local economy module of the Airports Commission appraisal framework states that the Commission will analyse the impact of airport expansion schemes on their local area and surrounding region, in terms of business and employment, regeneration, pressure on local services, housing and land use, and their contribution to wider economic development strategies. This appendix describes the approach adopted in this document.

RPS and Optimal Economics have analysed in detail the implications of expansion at Gatwick for the surrounding area, ranging from Croydon in the north to the south coast, an area covered by the 'Coast to Capital' (CtC) Local Economic Partnership (LEP).[195]

A10.1 The impact on Gatwick's economic footprint

The starting point for the analysis is the number of jobs associated with the airport and the number likely to be created as a result of R2, the 'economic footprint'.

The local jobs identified comprise:

- direct employment at the airport, distinguishing between on-airport and off-airport jobs;
- indirect employment in local businesses contributing to the supply chain;
- induced employment in the local area supported by spending by people in airport-related jobs.

Expansion of the airport would entail increases in passenger numbers and freight, and the projections are described in Appendix 3. These projections are used to estimate increases in jobs in each of the three above categories, after allowing for increasing productivity over time, which enables more passengers/freight to be handled by progressively fewer employees. Productivity growth of 1–2% a year has been assumed, in line with past trends, yielding gross employment increases (i.e. the total number of new jobs created by airport expansion) by 2050 of around 22,000. The direct employment estimates are based on work by SH&E (2013),[196] while the indirect and induced numbers are based on methodology used in 2009 work for the North Terminal Extension.[197] Using relevant local estimates of GVA per head, the increase in employment will account for £1.73bn of the local economy in 2050.[198]

However, the overall number of extra jobs in the local area will reflect not only the gross increases discussed above, but also the displacement of jobs that would otherwise have been filled in the area in the absence of R2. The net increase will be less than the gross increase, even in the unlikely event that R2 would itself result in a significant increase in local labour market participation or lower unemployment. Although guidance by English Partnerships on additionality (i.e. the relationship between gross and net new jobs)[199] does not give clear advice on this ratio, Oxera has tentatively assumed that the ratio of net to gross new jobs from this type of new development might be about 50% of the

[195] RPS, Optimal Economics, Arup (2014), 'Gatwick Airport runway 2: regional and local economic impacts and opportunities for regeneration', May, and RPS and Optimal Economics (2014), 'Gatwick R2 – Local economy impacts', 8 May.
[196] ICF SH&E (2013), 'Employment Forecasts R2 Vision', September.
[197] No reference is provided by Optimal Economics.
[198] RPS and Optimal Economics (2014), 'Gatwick R2 – Local economy impacts', 8 May.
[199] English Partnerships (2008), 'Additionality Guide', Method Statement Third Edition, October.

total gross increase in jobs. On this basis, Oxera's estimate of the net increase in jobs in the area might be around 10,000.

A10.2 Housing and land requirements

Some of the extra jobs created in the Gatwick area would be met by reduced out-commuting and increased inward commuting to the area, and by increasing participation in the labour force. The latter seems unlikely to be significant, given the low unemployment (just over 2%) and high participation (around 89%) in the area at present compared with the national average. As noted above, RPS and Optimal Economics indicate that around 80% of *airport-related* employment relates to people who live in the area. On this basis, the number of extra employees living in the area would be around 8,000. Given the average number of workers per household, estimated at 1.6 by RPS and Optimal Economics,[200] the corresponding increase in the number of households would be 5,000. Optimal Economics and RPS estimate the number of houses required to support *new* airport-related jobs as up to 9,300 in 2050/51;[201] however, this estimate is based on gross jobs created, resulting in a higher estimate than the 5,000 estimated by Oxera, which is based on net jobs created. A detailed examination of current development land available in relation to projected employment growth, disaggregated into districts and planning categories, suggests that there is enough available over the next two decades, and the implications of Gatwick expansion for housing need and land allocation should certainly be consistent with present planning policy, although there are likely to be local variations and challenges involved.[202]

A10.3 Catalytic impacts

'Catalytic' effects could add substantially to this number, however. The connectivity improvements delivered by expansion at Gatwick is likely to attract new businesses to the vicinity, and clustering of businesses in air travel-intensive sectors. Previous studies, such as RUCATSE (1993) and ATWP (2003), have not sought to estimate catalytic effects in the area. A study by Berkley Hanover Consulting for Surrey and Sussex local authorities in 2012–13 suggested large impacts, but no details are available and they cannot be treated as reliable. While there is no single established approach to quantifying the number of jobs that may arise from the catalytic effects of airport expansion, further work by Oxera has enabled a broad order of magnitude for these effects to be estimated. These estimates should not be considered to be definitive, but rather as suggesting an approach that could be investigated further to arrive at a definitive answer.

The most persuasive literature on the impact of airports on local/regional economies surveyed by SDG suggests that a 1% increase in air passengers from an airport leads to an increase of around 0.05% in service sector employment in the local region, with no significant impact on other sectors.[203] Higher estimates have been obtained from other studies, for the USA, but are less rigorous in eliminating bias through the use of appropriate econometric techniques, and so we use the more robust, lower elasticity.

On this basis, delivery of a 20% increase in passengers from London airports as a result of expanding Gatwick might result in a net increase in services

[200] RPS and Optimal Economics (2014), 'Gatwick R2 - Local Economy Impacts', 8 May, p. 42.
[201] RPS and Optimal Economics (2014), 'Gatwick R2 - Local Economy Impacts', 8 May, p. 42.
[202] RPS and Optimal Economics (2014), 'Gatwick R2 - Local Economy Impacts', 8 May, Section 4.
[203] Percoco, M. (2010), 'Airport Activity and Local Development: Evidence from Italy', *Urban Studies*, **47**:11.

employment in London and the South East of 1%, equivalent to 54,000 in London and 46,000 in the South East—i.e. 100,000 in total. Pro-rata, this would lead to an increase in the area around Gatwick of approximately 10,000 jobs. In practice, however, one would expect the area around Gatwick to receive more than a pro-rata share, as evidence suggests that companies tend to cluster around airports as they develop. As such, it is quite reasonable to suggest that service employment in the area around Gatwick might rise by 20,000 or more as a result of the catalytic impact of expansion at Gatwick.

For the purposes of analysis for this report, it is therefore assumed that the total net increase in employment in the area around Gatwick may be of the order of 30,000, including the 10,000 ‘economic footprint’ jobs estimated in section A10.1. It must be stressed that this is not a firm number based on rigorous empirical research, but rather an informed judgement about the possible order of magnitude involved.

A10.4 Regeneration

In order to assess the potential for regeneration as a result of the extra jobs generated by Gatwick expansion, RPS, Optimal Economics and Arup identified the most deprived and needy districts within the local area using the employment domain of the Index of Multiple Deprivation, and related them to travel times from Gatwick given the transport improvements currently planned as an indicator of potential benefits.

The CtC Economic Strategy targets Gatwick and the Sussex coast for growth and regeneration, consistent with housing and land allocations—which apply up to the late 2020s only. Expansion of Gatwick, and the potential associated catalytic effects on local industry, could make a significant contribution to realising these objectives, and analysis of local plans suggests opportunities for maximising benefits in key areas. The objectives of the Mayor’s London plan, to strengthen the North–South axis of the London economy and help regenerate Croydon and nearby areas of South London, would also be greatly facilitated.

To ensure that development is consistent with the CtC and London plans, and is targeted at deprived areas, GAL has drawn up a set of commitments, which include:[204]

- in partnership with local Councils, educational and skills development organisations, Gatwick building on existing initiatives to develop an industry-leading skills development and employment programme which will provide a framework for engaging all sections of the community. This will involve new schemes around schools education, an expanded skills development programme, apprenticeships, scholarships and supporting return-to-work, and supporting less able and mature sections of the population.
- an annual ‘Employment and Business Forum’ to encourage networking between on-airport companies and where companies can be advised of new plans and developments at the airport;
- building strong links with schools and other educational establishments in the target areas for regeneration and actively marketing jobs and work placement schemes at Gatwick there, including work placement arrangements;

[204] Gatwick (2014), ‘Updated scheme design: SD5 Development Strategies’, p. 10.

- the development of an employment strategy which facilitates the delivery of these benefits, including the creation of a Gatwick Life-Long Employability Programme. In partnership with local councils, educational and skills development organisations, Gatwick is building upon its existing initiatives with colleges to develop an industry-leading skills development and employment programme which will provide a framework for engaging all sections of the community. Oxera understands that this will involve new schemes around school education, an expanded skills development programme, apprenticeships, scholarships and supporting return-to-work, less able and mature sections of population.

A10.5 Heathrow

It is useful to compare the local effects of expansion at Gatwick with impacts on the corresponding area near Heathrow if that airport were to be expanded instead. Given that, in either case, the development would lead to an overall expansion in air travel, with no net abstraction from the other airport, the beneficial effects on the respective local economies would not be at the expense of the other—indeed, expansion at either would have catalytic effects that would spread partially to the neighbourhood of the other.

A study by Regeneris Consulting of the economic effects of expansion at Heathrow focuses primarily on a (non-overlapping) area called the 'Western Wedge'.[205] This area is significantly larger than the Gatwick Diamond or the CtC LEP, with 2.4m jobs compared with around 380,000 in the Diamond and 930,000 in the CtC. Using the same definition of airport-related employment, Regeneris estimates that expansion at Heathrow would generate 33,000 extra jobs in the Wedge and 46,000 in total by 2040. The 33,000 extra jobs (by 2040) is directly comparable to the extra 20,000 jobs (by 2050) likely to be generated in the CtC area by expansion at Gatwick, and the latter is predicated on more additional passengers (40m) than Regeneris assumes for Heathrow (about 30m)[206]—also a feature of the SH&E forecasts used in this document.

Thus the analyses available suggest that expansion at Heathrow would create more local airport-related jobs than expansion at Gatwick, in the respective years of study, despite generating a smaller increase in the number of passengers. In part this could reflect the fact that the Wedge is a bigger area than the CTC, but another difference is likely to be that Heathrow is a less efficient airport at the margin—i.e. when expansion is undertaken—than Gatwick. Although staff costs per passenger are not significantly different between the two airports at present, while Gatwick is not yet at full capacity, operating costs per passenger are much higher at Heathrow.[207] Overall, Heathrow is a relatively inefficient airport in cost terms.

As in the analysis of Gatwick expansion in previous sections, not all the extra airport-related jobs created by expanding Heathrow would be filled by local residents. Taking into account displacement, the net increase in jobs would be smaller—perhaps by a factor of one half. Nevertheless, there would be a 'catalytic' increase in jobs around Heathrow, as with Gatwick, although the analysis of such effects set out in section A10.2 relates them to the increase in passenger numbers from London airports. Since the SH&E forecasts suggest that Heathrow expansion would generate about three-quarters only of the extra

[205] Regeneris Consulting (2013), 'London Heathrow Economic Impact Study', September.
[206] Regeneris Consulting (2013), 'London Heathrow Economic Impact Study', September, p. 12.
[207] CAA (2012), 'Airport Operating Expenditure Benchmarking report', p. 14.

passengers by 2050 that Gatwick R2 would—30m rather than 40m—the catalytic effects on employment would be correspondingly reduced.

One final issue is the extent to which increases in the local economies around the two airports would be feasible without increased costs of overheating or congestion, a greater problem around Heathrow, or opposition which local planning authorities would reflect in tighter controls that inhibit expansion. While this document has not considered this, it will be an important consideration for the Commission as it reaches its decision.

A11 Government impacts

Oxera has assessed the impact of airport capacity expansion on the central government, focusing on the impact on tax receipts and central government expenditure and other benefits.

A11.1 Impacts on central government expenditure

R2 is predicted to be entirely funded by private sector capital, as outlined in the financial case.

The equivalent government funding position for Heathrow is estimated at £6bn.

A11.2 Impacts on indirect tax revenue

An intervention in the aviation industry can have both direct and indirect effects on public accounts. Direct effects can come from altering revenues from taxes directly imposed on aviation service providers, and indirect effects from passing taxes on to aviation service users in the form of changes to air fares. This appendix covers the second type of changes only.

The approach used by Oxera to assess the impacts on indirect tax revenue is explained below.

A11.2.1 Air Passenger Duty

APD is paid by air passengers as part of the air fare, with the amount of duty depending on the class of service and flight destination. A secondary effect of APD is that it affects the amount of disposable income of leisure passengers to spend on other goods and services in the economy, and, hence, the indirect tax revenues. In particular, because the air fares are exempt from VAT, an increase in APD would lead to lower tax revenues from VAT-eligible goods and services in the economy. This explains the difference in approach to quantifying the impact on tax revenues coming from growing numbers of business and leisure passengers:

business passengers

$$(1+t)\sum_{m,y}(APD_2 Pax_2 - APD_1 Pax_1)$$

leisure passengers

$$(1+t)\sum_{m,y}(APD_2 Pax_2 - APD_1 Pax_1) - t\sum_{ukm,y}(Airfare_2 Pax_2 - Airfare_1 Pax_1)$$

where:

m is market segment (both UK and international); *ukm* UK-only market segment; *y* year; *t* average level of indirect taxation in the economy; *1,2* index for Do Minimum and Do Something scenarios; and *Pax* number of passengers in a market segment *m/ukm*. [208]

Oxera estimates of the impacts on APD-related revenues are shown in Table A11.1. The key difference in the scenarios considered is the number of outbound passengers paying APD.

[208] In accordance with DfT (2014),'TAG Unit A5.2 Aviation appraisal', p. 7.

Table A11.1 Change in indirect tax revenues: APD (£m)

	Business	Leisure	Total
Discounted figures			
London system (2+2 Do Minimum)	1,391	2,515	3,906
London system (3+1 Do Minimum)	1,091	1,786	2,876
Non-discounted figures			
London system (2+2 Do Minimum)	5,288	9,512	14,800
London system (3+1 Do Minimum)	4,546	6,949	11,495

Note: Non-discounted figures are in 2010 prices, and discounted figures are in 2014 present values.

Source: DfT 'TAG Unit A5.2 Aviation appraisal', GAL,and Oxera analysis.

The analysis shows that the '2+2' R2 option is expected to have a greater positive impact on APD revenues than the '3+1' Heathrow NW option for both business and leisure passenger segments. The total effect of implementation of R2 in present values is estimated to be around £3.9bn compared with £2.9bn under Heathrow NW.

There are two main reasons for the difference between the effects of the two schemes:

- the number of APD destination bands has been reduced to two by merging the former bands B, C and D in line with the Finance Bill 2014;[209]
- the total passenger volumes used for this analysis are in general higher for R2 than for the Heathrow NW option.

A11.2.2 Fuel duty

Fuel duty is paid by air passengers travelling to/from an airport by car and is measured in pence/litre. It is therefore reasonable to expect higher revenues from fuel duty-related payments in the case of an airport expansion. This effect is captured by the following formula:

$$(1+t)\sum_{y}(FuelDuty_2 - FuelDuty_1)$$

where:

y is year; *t* average level of indirect taxation in the economy; *1,2* index of Do Minimum and Do Something scenarios; and *FuelDuty* total amount of fuel duty paid in year *y*.

Oxera estimates of the impacts on fuel duty-related revenues are shown in Table A11.2.

[209] HM Revenue & Customs and HM Treasury (2014), 'Overview of tax legislation and rates', 19 March, p. A70.

Table A11.2 Change in indirect tax revenues: fuel duty (£m)

	Business	Leisure	Total
Discounted figures			
London system (2+2 Do Minimum)	1,656	5,256	6,912
Non-discounted figures			
London system (2+2 Do Minimum)	7,373	24,856	32,229

Note: The effect of the increase in fuel duty revenues on VAT revenues is captured in calculations of VAT related to car traffic in section A11.2.3. Non-discounted figures are in 2010 prices, and discounted figures are in 2014 present values. 3+1 is assumed to be the same as 2+2.

Source: DfT ‘TAG Unit A5.2 Aviation appraisal’, GAL, Arup,and Oxera analysis.

In present-value terms, the positive effect of fuel duty-related revenues is estimated at around £6.9bn over the appraisal period. This result is mainly driven by the forecast increase in volumes of leisure passenger compared with business passengers from SH&E’s forecasts.

A11.2.3 VAT

The formula used to assess the impact on APD and fuel duty-related revenues captures a part of the impact on VAT-related revenues due to the inclusion of an indirect tax correction factor *t*. However, the main drivers of changes in VAT-related revenues are considered below:

VAT related to retail activities

As the expansion of an airport would almost always imply an increase in retail activity at the airport building, the VAT receipts are generally thought to grow as well. VAT-eligible items sold to business and leisure passengers would have effects on tax revenues according to the following formulae:

business passengers

$$\frac{(1+t)t_R}{1+t_R}\sum_y (Retail_2 - Retail_1)$$

leisure passengers

$$\frac{t_R - t}{1+t_R}\sum_y (Retail_2 - Retail_1)$$

where *y* is year; *t* average level of indirect taxation in the economy; t_R VAT rate on sales of retail activities; *1,2* index of Do Minimum and Do Something scenarios; and retail total sales of retail activities (£) in an airport, net of VAT.

It is worth noting that when leisure passengers purchase more goods subject to VAT at an airport building, they automatically reduce their disposable income to spend on other goods and services in the economy that are also subject to VAT. This effect is reflected in different formulae for the business and leisure categories of passengers.

Oxera estimates of the impacts on VAT-related revenues from retail activities are shown in Table A11.3.

Table A11.3 Change in indirect tax revenues: VAT related to retail activities (£m)

	Business	Leisure	Total
Discounted figures			
London system (2+2 Do Minimum)	9	30	39
Non-discounted figures			
London system (2+2 Do Minimum)	32	109	142

Note: Non-discounted figures are in 2010 prices, and discounted figures are in 2014 present values. The figures are based on GAL's assumptions on expected growth of retail activities. Due to absence of retail activities revenues split by leisure and business passengers, a conservative assumption of 50% for each category has been made. 3+1 is assumed to be the same as 2+2.

Source: GAL, PA Consulting, Oxera analysis.

The analysis showed that a £39m increase in government VAT-related revenues is expected throughout the appraisal period. This is mainly due to the effects coming from duty- and tax-free shops, as well as catering facilities at Gatwick Airport.

VAT related to car traffic

An increase in the number of passengers travelling to/from an airport would have an effect on indirect tax revenues. In particular, car users' spend on fuel, maintenance and other fares, such as parking or tolls, would increase VAT-related revenues for the government. Therefore, all VAT-eligible goods and services influenced by the increase in car traffic should be taken into account when assessing the impact on indirect tax revenues:

business passengers

$$\sum_y \frac{(F_2 - F_1)t_F(1+t)}{1+t_F} + \sum_y \frac{(M_2 - M_1)t_M(1+t)}{1+t_M} + \sum_y \frac{(N_2 - N_1)t_N(1+t)}{1+t_N}$$

leisure passengers

$$\sum_y \frac{(F_2 - F_1)(t_F - t)}{1+t_F} + \sum_y \frac{(M_2 - M_1)(t_M - t)}{1+t_M} + \sum_y \frac{(N_2 - N_1)(t_N - t)}{1+t_N}$$

Where:

y is year; *t* average level of indirect taxation in the economy; *1,2* index of Do Minimum and Do Something scenarios; F fuel costs, including indirect taxes (such as fuel duty); N non-fuel vehicle operating costs (tyres, maintenance, depreciation, etc.), including indirect taxes; M fares, tolls and other charges such as parking, including indirect taxes; and $t_{F,M,N}$ the rate of VAT on F, M and N.

Oxera estimates of the impacts on tax revenues regarding VAT from car traffic are shown in Table A11.4.

Table A11.4 Change in indirect tax revenues: VAT related to car traffic (£m)

	Business	Leisure	Total
Discounted figures			
London system (2+2 Do Minimum)	940	4	944
Non-discounted figures			
London system (2+2 Do Minimum)	1,022	18	1,040

Note: Non-discounted figures are in 2010 prices, and discounted figures are in 2014 present values. Due to the absence of car parking revenues split by leisure and business passengers, a conservative assumption of 50% for each category has been made. 3+1 is assumed to be the same as 2+2.

Source: DfT 'TAG Unit A5.2 Aviation appraisal', GAL, Arup,Oxera analysis.

The total positive effect on VAT revenues related to car traffic is estimated at around £0.9bn. The difference between the impacts of the business and the leisure passenger segments is driven by the different formulae above and is in accordance with WebTAG methodology.

A11.3 Impacts on rail franchise revenues

The UK government receives income from rail franchises, which should be captured in the Economic Impact Assessment. The revenues coming from the franchises that help to link Gatwick Airport directly with other destinations are dependent on the number of passengers travelling through the airport each year.

Oxera's estimates of the benefits from rail franchise with Gatwick and Heathrow Airports are shown in Table A11.5.

Table A11.5 Change in revenues from rail franchise (£m)

	Total
Discounted figures	
London system (2+2)	3,071
London system (3+1)	592
Non-discounted figures	
London system (2+2)	11,849
London system (3+1)	2,293

Note: Non-discounted figures are in 2010 prices, and discounted figures are in 2014 present values. The calculations are based on a rail mode share of 40% for Heathrow and extrapolated values for Gatwick (from 37% in 2014 to 50% in 2040); constant average rail fare of £15 in Gatwick and £7.5 in Heathrow (in 2014 prices).

Source: GAL,Oxera analysis.

The total change in rail franchise revenues is estimated at around £3.1bn for 2+2 and £0.6bn for 3+1. The difference between the impacts is mainly due to the higher total passenger volumes under 2+2 than 3+1.

A12 Glossary

AMI	acute myocardial infarction
APD	Air Passenger Duty
ATM	air transport movement
BCR	benefit–cost ratio
CAA	Civil Aviation Authority
CAPEX	capital expenditure
CO_2	carbon dioxide
Commission	Airports Commission
CtC (area)	Coast to Capital (area)
DALY	disability-adjusted life years
DECC	Department of Energy and Climate Change
Defra	Department for Environment and Rural Affairs
DfT	Department for Transport
DW	disability weight
EAT	end-around taxiway
FDI	foreign direct investment
FSC	full-service carrier
GAL	Gatwick Airport Limited
GHG	greenhouse gas
GSE	ground service equipment
GVA	gross value added
HAL	Heathrow Airport Limited
IGCB	Interdepartmental Group on Costs and Benefits
LAD	Local Authority District
LCC	low-cost carrier
LEP	Local Economic Partnership
mppa	million passengers per annum
NATS	National Air Traffic Services
NPV	net present value
NOx	nitrous oxide
ONS	Office of National Statistics
OPEX	operating expenditure
PA	PA Consulting Group
PM	particulate matter
QRA	Quantitative Risk Assessment
R2	Second Runway Development (at Gatwick)
tCO_2e	tonnes of CO_2 equivalent
TEE	Transport Economic Efficiency
TEMPro	Trip End Model Presentation Program
VAT	value-added tax
YLL	years of life lost
WebTAG	DfT's Transport Analysis Guidance (TAG)
WEI	wider economic impact
WHO	World Health Organization

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