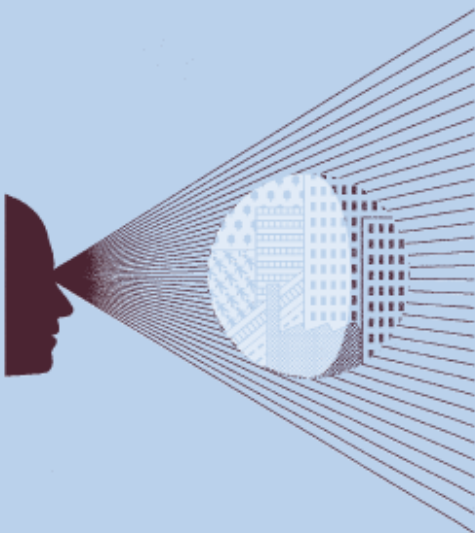


What is the contribution of aviation to the UK economy?

Final report prepared for
Airport Operators Association

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Summary of key findings

The aviation sector and its supply chain

Wealth and employment

- In 2007, measured as Gross Value Added (GVA), the aviation sector (ie, the activities of airports, airlines and aircraft service providers in the UK) directly generated £8.8 billion of economic output, or 0.7% of the total GVA of the UK economy.
- Adding the economic activity in aviation's supply chain, which provides economic inputs to the sector, increases the above figures to a total 'economic footprint' of £18.4 billion, or 1.5% of the UK economy. This does not include any additional economic output (known as 'induced' output) generated by the spending of wages earned in the sector.
- Aviation's economic footprint has increased by 8.3% in real terms since 1995.
- GVA as a measure of wealth does not fully capture the increasing benefits to passengers (consumer surplus) through trends such as the declining price of flying. Between 1995 and 2008, the number of aviation passengers increased by 81% and freight volumes grew by 33%. Given this, the overall economic value to consumers of aviation services has increased at a significantly faster rate than the aviation GVA.
- Aviation directly provides 141,000 jobs in the UK, or 0.5% of total UK employment. This rises to 234,000 (0.85% of UK employment) when the supply chain employment is also taken into account.
- Employees in aviation are more productive (measured as average GVA per employee) than employees in the economy as a whole, generating £62,000, compared with £46,000 nationally.

Tax revenues

- Aviation contributes about £4.8 billion in tax revenues to the Exchequer, or 0.9% of UK overall tax revenue in 2007/08. A further £3 billion is contributed by its supply chain.
- Before Air Passenger Duty (APD), an aviation sector-specific departure tax, is taken into account, the aviation sector pays about 32.5% of the wealth it generates (as GVA) in tax. This is very similar to the figure for the UK economy as a whole (32.1%).
- When the revenue raised by APD is included, aviation's tax contribution (as a percentage of GVA generated) rises to 54.5%. This is significantly higher than the total UK economy equivalent of 32.1%. The tax burden faced by the UK aviation sector is currently higher than that faced by other European countries.
- In 2007, on a central estimate, aviation's tax and regulatory burden is up to £0.6 billion more than its environmental costs. While higher or lower cost scenarios can be developed depending on assumptions, the study uses the government's central estimate for climate change, adding costs for noise and air quality.

Aviation's effects in the wider economy

- The study estimates some effects on the wider economy of a number of present and possible future aviation policy scenarios. Building on existing evidence, it looks in particular at the following three types of effect that the sector has on the development of the UK's long-term productive potential, which in turn determines its prosperity:
 - **connectivity**—where reduced travel times and a larger choice of destinations lead to benefits such as better access to new markets;
 - **trade**—where lower transport costs and factors such as air freight's ability to allow smaller inventory holdings and the rapid shipping of perishable goods lead to greater specialisation and the benefits of increased trade flows.
 - **investment**—where aviation allows UK businesses to make and manage investments abroad, and facilitates inward investment, generating jobs and wealth.

- The benefits of these effects are aviation-specific, and would not come about if the resources used by the aviation sector were redeployed elsewhere in the economy. It should be noted that the three mechanisms provide alternative estimates of the wider economic effects, but they are likely to overlap and so the three effects cannot be simply added together to identify the overall impact.

Effect of the planned APD increases—in 2009 and 2010

- The loss of jobs as a result of planned increases in APD is likely to be a short-term effect, with employees eventually finding work in other sectors. However, for illustration, the study translates all forgone GVA into estimated changes in employee numbers. Using this approach, it finds that, by 2020, jobs in the wider economy could be reduced by 1,400 (connectivity), 7,700 (trade), and 22,300 (investment).
- By 2030, the planned APD increases could reduce the sector’s economic footprint by about £40m (as direct GVA). Economic activity in the wider economy could be reduced by £70m (connectivity), £330m (trade) and £1,170m (investment). Increased revenue from APD of about £1.06 billion could be offset by reduced receipts to the Exchequer from the wider economy of £30m (connectivity), £140m (trade) and £450m (investment).

Possible policy scenarios

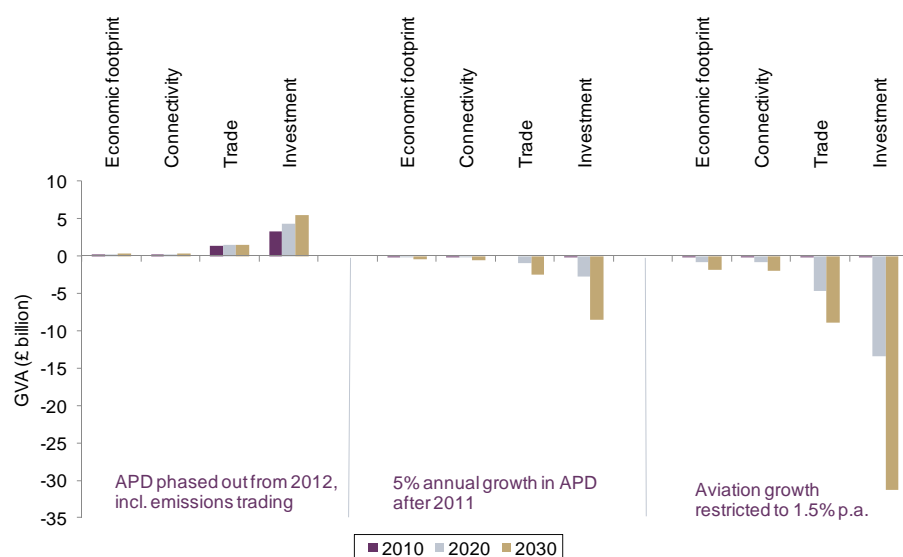
The study estimates the effects on the wider economy of a large number of possible future public policy scenarios. Three such scenarios are:

- a 5% annual increase in APD after 2011, which results in the average return airfare rising from £258 to £323;
- phasing out APD from 2012 as aviation enters the EU Emissions Trading Scheme. This implies that the average return airfare remains stable at £261;
- 1.5% annual growth in aviation capacity to 2020 (followed by 0.5% to 2030). This could arise under a restrictive future aviation policy, which allowed aviation to grow only at its expected rate of technological improvement. It would result in the average return airfare rising from £258 to £323.

Wealth generation in the wider economy

By 2030, growth in APD of 5% a year could reduce the sector’s annual GVA by £450m, with wealth created in the wider economy reduced by £500m (connectivity), £2.6 billion (trade) or £8.3 billion (investment). In contrast, phasing out APD from 2012 could increase the sector’s GVA by £300m, with wealth created in the wider economy increased by £340m (connectivity), £1.6 billion (trade) or £5.5 billion (investment). However, restricting growth to 1.5% a year could reduce the sector’s GVA by £1.8 billion, with wealth created in the wider economy reduced by £1.9 billion (connectivity), £9 billion (trade) or £31 billion (investment).

Wealth impact



Tax receipts from the wider economy

By 2030, 5% annual growth in APD could increase direct sector tax receipts by £6.2 billion, but reduce them in the wider economy by £200m (connectivity), £1 billion (trade) and £3.4 billion (investment). In contrast, phasing out APD from 2012 could reduce direct sector tax receipts by £5.3 billion, but increase them in the wider economy by £100m (connectivity), £700m (trade) and £2.3 billion (investment). However, restricting growth to 1.5% a year could reduce direct sector tax receipts by £4.6 billion, with the effect compounded in the wider economy yielding £800m (connectivity), £3.7 billion (trade) and £13 billion (investment).

Tax impact



Employment in the wider economy

Changes to the number of jobs in the aviation sector as a result of policy measures affecting the sector are likely to be a short-term effect, with employees eventually finding work in other sectors. However, for illustration, the study translates all changes to GVA triggered by policy changes into estimated changes in employee numbers. Using this approach, it estimates that, by 2030, 5% annual growth in APD could lead to a reduction in jobs of around 12,000 (connectivity), 55,000 (trade) and 190,000 (investment) employees. In contrast, phasing out APD from 2012 could see an increase in employment of 8,000 (connectivity), 37,000 (trade) and 129,000 (investment). Restricting growth to 1.5% a year could result in a reduction in jobs of 46,000 (connectivity), 210,000 (trade) and 7,300,000 (investment).

Employment impact



Executive summary

The future of the UK aviation sector (ie, the activities of airports, airlines and aircraft service providers in the UK) has been the source of considerable political, media and public debate in the past decade, especially since the publication of the 2003 Future of Air Transport White Paper.

The economic contribution of aviation to the UK economy has also been under scrutiny. The industry itself has commissioned a significant body of research, which identifies that the sector makes a substantial contribution to the wider economy in terms of income, investment and employment. At the same time, organisations opposed to the expansion of the aviation sector on environmental grounds have challenged the industry on the basis that such research may fail to capture the environmental costs associated with the development of aviation.

In light of this ongoing debate, the Airport Operators Association (AOA) commissioned Oxera to provide an independent assessment of the wider contribution of aviation to the UK economy.

The aviation sector and its supply chain make a significant contribution to the economy (referred to as the '**economic footprint**'), including through the contribution of the sector to the UK's economic output, the employment generated by the sector, and its tax contribution to the Exchequer.

While some substitution with other modes of transport and technologies is possible (such as rail for short-haul flights, sea freight and video-conferencing), in particular over longer distances the opportunities of substitution of aviation freight and passenger transport services are more limited. Aviation affects the wider economy by, for example, establishing international connectivity and strengthening countries' ability to trade and specialise, and in doing so enhances the supply potential of the economy.

Aviation therefore generates significant additional benefits (**supply-side effects**) for the economy, over and above its economic footprint. In turn, this leads to improved living standards (see Box 1).

Box 1 Why are supply-side effects important?

In the long term, the output of an economy, using standard measures of output such as Gross Value Added (GVA) or the prosperity of the population living in an economy (eg, measured using GVA per head), is determined by the underlying productive potential or supply side of the economy.

The supply side depends on the size of workforce and the productivity with which labour is used in the production of output (growth in the size of the workforce increases the size of the economy, and growth in productivity delivers growth in average incomes).

As discussed in this study, the aviation sector can result in supply-side changes as the structure of the economy adjusts to the presence of the sector or to changes in its size.

The terminology used in the literature assessing the contribution of the aviation sector to the economy often refers to supply-side effects as the 'catalytic' contribution of aviation to the economy. These catalytic effects may be interpreted as the medium- to long-term spillover benefits of the sector's presence to other industries and to the overall performance of the

economy. As such, the supply-side effect terminology can be regarded as synonymous with catalytic effects.

Objectives and approach

Quantifying the overall economic effects generated by the aviation sector is complicated because it requires a valuation of the impact of removing the aviation sector. Importantly, however, the policy debate that the current report intends to inform pertains to changes in policy relating to the aviation sector and their potential impact on the development of the sector itself (ie, on its economic footprint), as well as on its ability to improve the supply side.

The first objective of this study is to quantify the sector's economic footprint in terms of GVA, employment and tax contribution. Using supply-side mechanisms (connectivity, international trade and investment), the impact of a number of scenarios of policy changes which may affect the aviation sector is then assessed in terms of GVA and tax contribution to the Exchequer. These include changes in taxation, in the regulatory system, and in demand management affecting airport capacity. The study goes on to examine the impact of these policy change scenarios on the economic footprint and the supply side of the economy in terms of economic growth and productivity, jobs and tax revenue for the Exchequer.

The second objective of the study is to assess the evidence in relation to the following.

- How do the tax and regulatory measures compare with the environmental costs associated with the sector?
- Does the aviation sector 'pay its share' in tax? This question is assessed in comparison to both the wider UK economy and the aviation sector in other EU countries.

Conceptual framework and types of economic impact assessed in this study

In looking at the economic impacts of the production of a sector's outputs, it is common to treat these effects in isolation from what else might be happening in the economy (ie, 'gross effects'), and this has been the focus of several previous studies on the aviation sector.

There are circumstances where this is an appropriate measure, but, except over very short time periods, there is a risk that this approach fails to account for the fact that resources in the economy (eg, labour and capital) that are not used in the aviation sector would otherwise be used somewhere else, and would produce some other output. In many instances, it is more appropriate to estimate the difference in impact on the economy if resources are, on the one hand, used in aviation, and, on the other, redeployed somewhere else in the economy.

To address these issues, this report analyses the impact of the sector in two additional ways:

- the net effects of the production activity are calculated by taking into account the impact of substitution of resources employed in the aviation sector to other sectors of the economy. In this case, the main impact relates to the difference in productivity between aviation (a high-productivity sector) and the average across the economy as a whole;
- the supply-side effects of the sector (largely driven by the use of aviation services in the wider economy) are considered through changes in the overall productivity of the economy. In assessing the supply-side benefits, the focus is on gross effects. However, as shown in this study, these are significant and therefore should not be ignored when assessing the impact of policy towards the aviation sector.

The economic footprint of the aviation sector

The aviation sector is a significant contributor to the UK economy in its own right: it directly generates £8.8 billion of economic output (measured as GVA), or 0.7% of the total GVA of the UK economy. This increases to £18.4 billion and 1.5% as a share of the total GVA of the UK economy when the economic activity needed to supply the inputs purchased by the sector is taken into account.

Overall, the aviation sector total GVA has increased by 8.3% since 1995 in real terms.

Simply assessing the economic footprint of the activities needed to supply the outputs of the aviation sector may, however, understate the full value placed by businesses and consumers on the sector's outputs, as the value placed by consumers may exceed the price paid for these outputs. Given the growth in freight and passenger volumes, the overall economic value to users of the sector's output has increased significantly since 1995.

A proxy for the overall change in the value of benefits generated by aviation is physical (rather than monetary) output. Between 1995 and 2008, the number of aviation passengers increased by 81% and freight volumes grew by 33%. This translates into an annual growth rate of 4.7% in passenger numbers and 2.2% in freight volume.

Moreover, the aviation sector makes a significant contribution to employment and tax revenues in the UK economy.

- The sector accounts for 141,000 jobs in the UK (or 0.5% of total UK employment), which rises to 234,000 (0.85% of UK employment) when supply chain employment is also taken into account.
- Aviation has a higher labour productivity than the economy average: £62,000 GVA per employee versus the £46,000 equivalent amount for the economy-wide average.
- The sector is estimated to contribute directly around £4.8 billion of revenue to the Exchequer, or 0.9% of UK overall tax revenue in 2007/08, with an additional £3 billion via its supply chain.

The exact estimate of aviation GVA, tax contribution and employment depends on the specific definition of aviation. For the purpose of this study, a narrow definition of the aviation sector has been adopted.

The supply-side effects of aviation

In the longer term, the main influence of the aviation sector on the economy is likely to be the way in which it facilitates improvements in productivity outside the sector. For example, aviation enhances the ability to conduct international trade by increasing connectivity between the UK and international destinations (and can increase connectivity within the UK), which can lead to increased investment and two-way trade.

Unlike the effects from the impact of the production of aviation outputs, these effects would not generally be reproduced if the resources used in the production process were redeployed in other parts of the economy—ie, the particular benefits are not offset by crowding out of resources that might otherwise be used elsewhere in the economy. Instead, they reflect the means by which efficiency in the use of existing resources in the rest of the economy may be enhanced.

Some of these effects have been the subject of significant analysis, although the evidence base is still limited in a number of areas. Therefore, this analysis can estimate the impact for some, but not all, of the likely effects in the wider economy.

Policy scenario analysis

The impact on the economic footprint of the sector (allowing for a substitution of resources) and the wider impacts of the sector on the supply side of the economy have been estimated against a number of policy options. The modelling approach used is relatively simple, and designed to provide an indication of the magnitude of impacts that may be expected from a relatively small change in the supply or price of aviation services.

The policy options cover a range of plausible policies that could be adopted or which would arise by default, in the case of the planned APD increases in 2009 and 2010 and the inclusion of the sector in the EU Emissions Trading Scheme (EU ETS) in 2012.

In assessing the impact of policy scenarios, a view needs to be taken as to what would happen in the absence of policy changes (a baseline scenario). The impact on GVA and employment of any policy change is then assessed relative to the baseline. Two baseline scenarios are used in this report.

- DfT passenger forecasts and underlying assumptions from forecasts for the sector produced in 2009 (the ‘DfT baseline’).¹
- A baseline scenario that starts from the DfT’s forecasts and then includes the impact of the planned 2009 and 2010 changes in APD, and the EU ETS marginal cost of carbon view of the Department of Energy and Climate Change (DECC) (referred to as ‘B3’). This baseline is chosen for most scenarios since these changes are fairly certain and as such it is of most relevance. The impact of choosing this baseline scenario over the DfT baseline is to *reduce* the estimated impacts.

A comparison of the direct effects on the sector and the supply-side effects generated by the aviation sector via connectivity, trade and investment mechanisms shows that aviation’s impact on the supply side of the economy is significant. This highlights the importance of taking into account the impact on the rest of the economy when evaluating policies pertaining to the aviation sector.

The examples below indicate the range of outcomes of the policy scenario analysis.

Table 1 **Examples of policy scenarios**

Scenario	Baseline used	Description
Baseline	DfT	B3: APD planned 2009 and 2010 changes, EU ETS marginal cost of carbon at DECC rate
Baseline	DfT	B4: APD planned 2009 and 2010 changes
High financial burden	B3	H4: 5% real growth in APD plus noise and local air pollution costs covered
Low financial impact from security and carbon costs	B3	L2: Carbon costs covered through EU ETS, no APD from 2010, security costs covered by general taxation
Constrained-capacity scenarios	B3	C2: 1.5% growth in capacity to 2020, 0.5% growth in capacity to 2030

The following figures compare the direct impact on the economic footprint of the sector (allowing for the substitution of resources) and the impact via the connectivity, trade and investment mechanisms in 2010, 2020 and 2030. The comparison highlights that even the lowest estimate of the supply-side mechanism impact (connectivity) on GVA and tax revenues exceeds the direct impact on the sector.

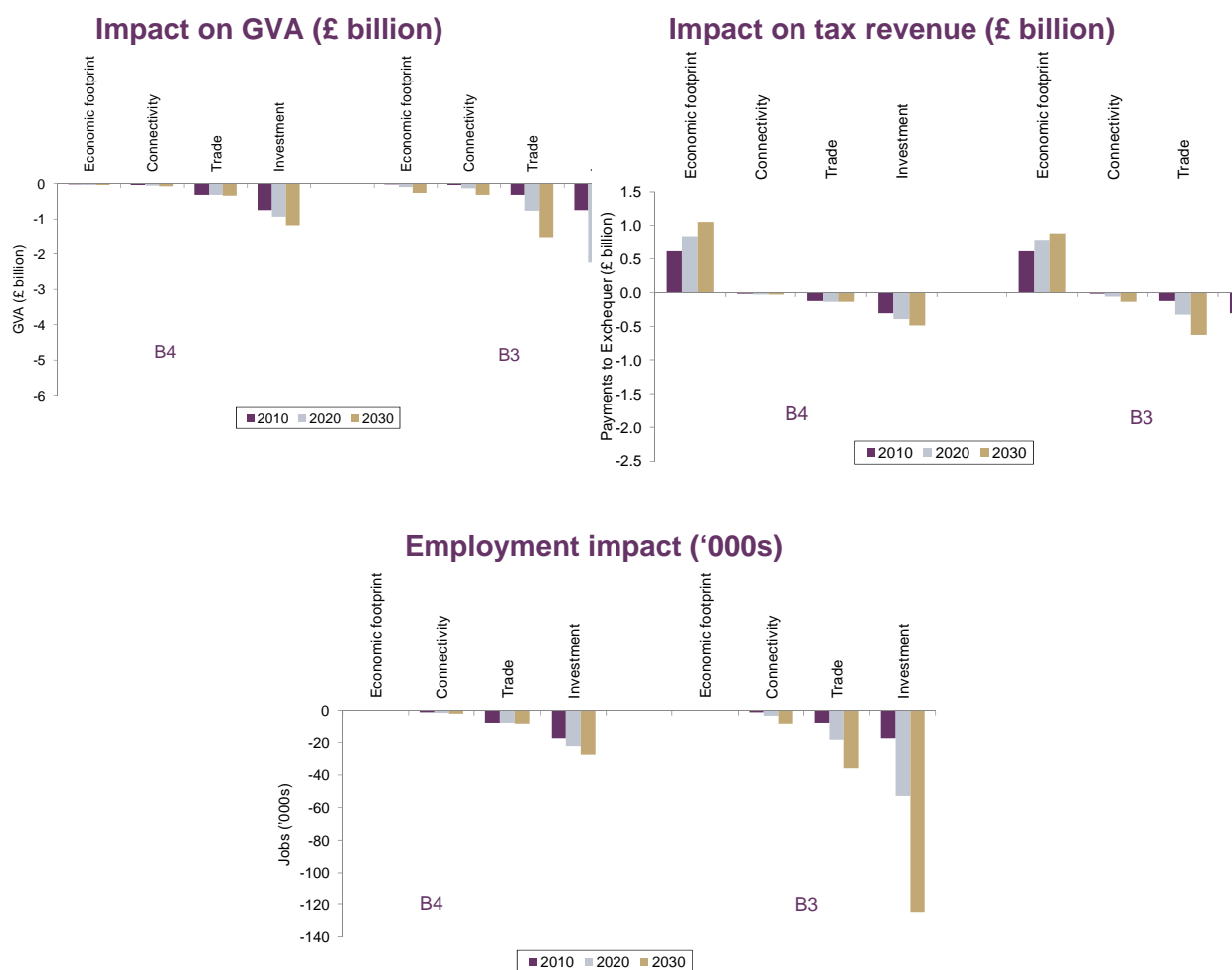
¹ DfT (2009), ‘UK Air Passenger Demand and CO₂ Forecasts’, January.

Furthermore, the analysis shows the impact on employment. Changes in GVA may translate into changes in productivity (eg, a reduction in GVA may lead to a downward pressure on wages and profits), changes in employment levels, or a combination thereof. In practice, most of the changes are likely to translate into a reduction in productivity. Therefore, while the impact on the level of jobs can be estimated, these should only be regarded as the illustrative impact if the policy changes were translated exclusively into employment rather than productivity effects.

The interpretation of the policy scenarios in Figure 1 is illustrated in the following example (B4).

- The impact of the planned APD increases in 2009 and 2010 (B4) on direct GVA is a reduction of around £40m in 2030. This impact is reinforced by reductions via the supply-side mechanisms of £70m (connectivity), £330m (trade) and £1,170m (investment).
- The estimated increase in direct tax revenue of around £1.06 billion in 2030 compares to a reduction in revenue of £30m (connectivity), £140m (trade) and £450m (investment).
- Assuming that the policy impact translates into employment rather than productivity changes, the employment impact via supply-side mechanisms is an estimated reduction of around 2,000 (connectivity), 8,000 (trade) and 28,000 (investment) employees in 2030. Since, as is likely, the impact translates into a reduction in wages and hence productivity, the GVA impact is underestimated. There is no net direct impact since jobs lost in aviation would be redeployed in other sectors of the economy.

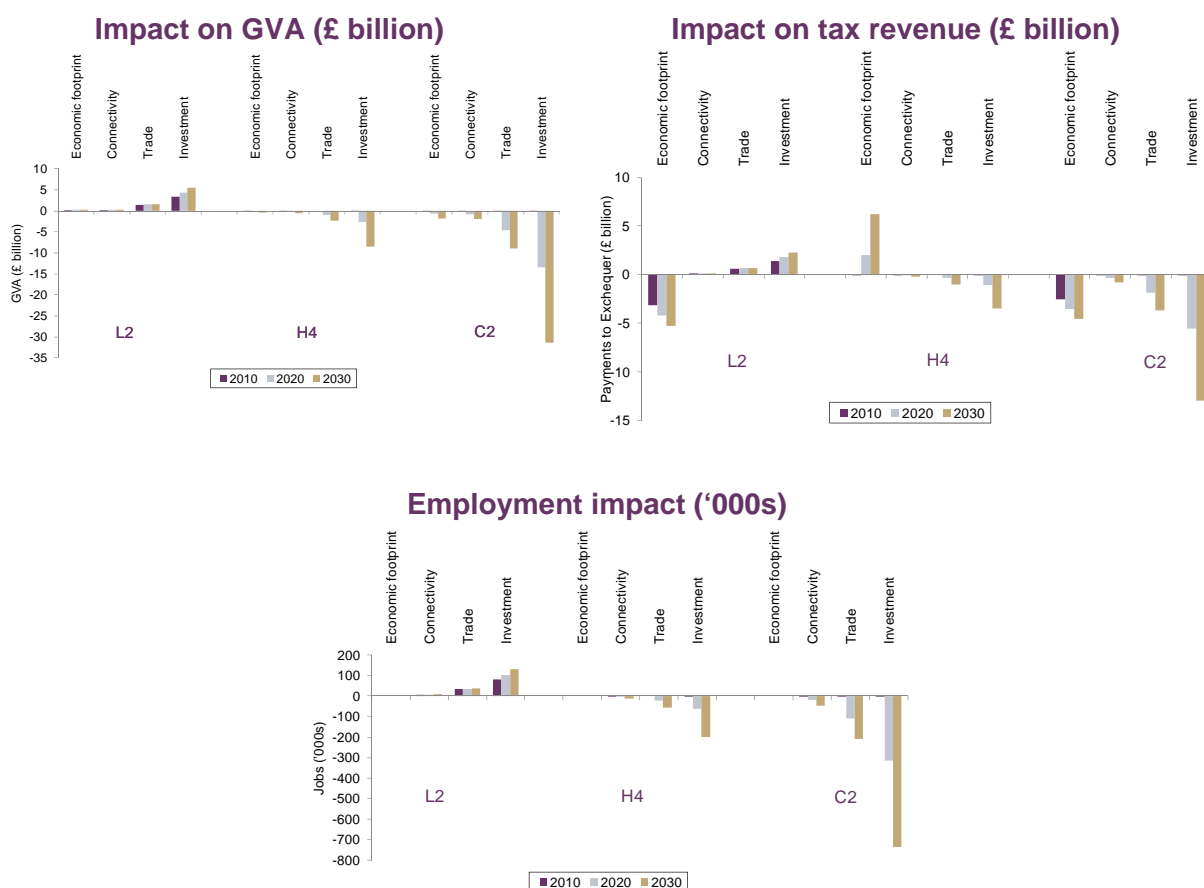
Figure 1 Impact of policy scenarios on the economic footprint of the sector and via supply-side mechanisms (relative to the DfT baseline scenario)



The interpretation of the policy scenarios in Figure 2 is illustrated in the following example (C2).

- Demand management that restricts capacity growth to 1.5% up to 2020 and 0.5% to 2030 (C2) results in a reduction in direct GVA of around £1.8 billion. The corresponding impacts via the supply-side mechanisms are further reductions of £2 billion (connectivity), £9 billion (trade) and £31 billion (investment).
- The estimated decrease in overall tax revenue due to lower APD receipts, and reduced activity in both the aviation sector and the wider economy is significant. The estimated reduction in direct tax revenue is around £4.6 billion in 2030, with a further reduction in revenue of £800m (connectivity), £3.7 billion (trade) and £13 billion (investment) via the supply-side mechanism.
- Assuming that the impact translates into employment rather than productivity changes, the employment impact via supply-side mechanisms is an estimated reduction of around 46,000 (connectivity), 210,000 (trade) and 740,000 (investment) employees. Since, as is likely, the impact translates into a reduction in wages and hence productivity, rather than jobs, the GVA impact is underestimated. There is no net direct impact as jobs lost in the aviation sector would be replaced by expanding employment in other sectors of the economy.

Figure 2 Impact of policy scenarios on the economic footprint of the sector and via supply-side mechanisms (relative to B3)



Therefore, when evaluating policy options, ignoring the supply-side effects of aviation could lead to outcomes significantly different to those expected.

Assessment of aviation sector tax contribution and environmental costs

Building on existing evidence, such as that developed by the DfT, an assessment of the sector's tax and regulatory burden and environmental costs reveals the following insights.

- In 2007, the annual tax and regulatory burden on the aviation sector exceeds the cost of negative externalities (carbon emission costs, noise and local air quality) by up to £0.6 billion (real 2007 prices) when considering central estimates of the climate change costs of the sector. This figure is expected to rise to £0.7–£1.1 billion by 2012 as a result of the increases in APD planned for 2009 and 2010. Given the difficulties in determining the true climate change costs, uncertainty remains around these estimates.
- Compared with its GVA, the aviation sector tax base is taxed a similar amount to the economy overall before accounting for APD (around 32% of GVA), and this contribution is significantly higher once APD is taken into account (54% in aviation compared with 32% for the economy overall). As such, in 2012 the expected contribution of aviation through APD, the EU ETS and the Carbon Reduction Commitment (CRC) exceeds the central estimate of external environmental costs by £0.7–£1.1 billion. When this contribution (over and above environmental costs) is added to other taxes raised within the sector, the total as a proportion of GVA exceeds that within the economy overall.

- The tax burden faced by the UK aviation sector via APD is higher than that resulting from aviation taxes in other European countries, where lower or no aviation taxes are in place.

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1 Introduction

The contribution of the aviation sector ((ie, the activities of airports, airlines and aircraft service providers in the UK) to the UK economy has been the subject of significant debate for several years. The industry itself has commissioned a significant body of research, which identifies that the sector makes a substantial contribution to the wider economy in terms of income, investment and employment. At the same time, organisations opposed to the expansion of the aviation sector on environmental grounds have challenged the industry, on the basis that such research may fail to capture the environmental costs associated with the development of aviation.

Understanding the mechanisms by which aviation may contribute to the UK economy, while also taking into account its environmental impacts, is particularly critical at this juncture, for a number of reasons:

- a General Election is due to be held by June 2010, and the development of parties' policies during the lead-up to the election and thereafter will need to take into account the economic and environmental issues associated with the aviation sector;
- important decisions on the development of the UK's transport infrastructure, including how to deal with congestion at airports, are being discussed by policy-makers and will have to be made in the near future;
- tax and regulatory decisions that may affect the industry may not be optimal unless they are taken in the context of the wider economic and environmental consequences associated with aviation.

In light of this debate, the Airport Operators Association (AOA) commissioned Oxera to provide an independent assessment of the wider contribution of aviation to the UK economy.

1.1 Objectives of the study

The aviation sector and its supply chain make a significant contribution to the economy (referred to in this report as the 'economic footprint'), including through the contribution of the sector to the UK's economic output, the employment generated by the sector and its tax contribution to the Exchequer.

While some substitution with other modes of transport and technologies is possible (such as rail for short-haul flights, sea freight and video-conferencing), in particular over longer distances the opportunities of substitution of aviation freight and passenger transport services are more limited. The ability of aviation to establish international connectivity, to strengthen countries' ability to trade and specialise, and to make labour more mobile—ie, enhancing the supply potential of the economy—results in aviation generating significant additional benefits for the economy, over and above its economic footprint. This, in turn, leads to improved living standards in the UK and worldwide. Quantifying the overall economic effects generated by the aviation sector is a complicated task since it requires a valuation of the impact of removing the aviation sector. Importantly, however, the policy debate which the current report intends to inform is about *changes* in the policy relating to the aviation sector, and their potential impact on the development of the sector itself (ie, on its economic footprint), as well as on its ability to improve the supply-side potential of the economy.

Box 1 Why are supply-side effects important?

In the short term, the output of an economy can depend on changes on the *demand side*, such as the fiscal policy measures used by governments around the world to stimulate economic activity to help the recovery from recession.

However, in the long term, the output of an economy, using standard measures of output such as the gross value added (GVA), or the prosperity of the population living in an economy (eg, measured using GVA per head), is determined by the underlying productive potential or *supply side* of the economy.

The supply side depends on the size of the workforce and the productivity with which labour is used in the production of output (growth in the size of the workforce increases the size of the economy, and growth in productivity delivers growth in average incomes).

Sources of productivity growth can be divided into:

- intra-sectoral productivity improvements, perhaps due to investment in physical and human capital (eg, in technology and education);
- improvements in average productivity, brought about by changing inter-sectoral resource allocation; or
- the emergence of new technologies or sectors in the economy with higher than average productivity which displace lower-productivity activities.

As discussed in this study, the aviation sector can result in supply-side changes as the structure of the economy adjusts to the presence of the sector, or to changes in its size.

The terminology used in the aviation literature assessing its contribution to the economy often refers to supply-side effects as the ‘catalytic’ contribution of the aviation sector to the economy. These catalytic effects may be interpreted as the medium- to long-term spillover benefits of the sector’s presence to other industries and to the overall performance of the economy. As such, the supply-side effect terminology can be regarded as synonymous with catalytic effects.

The first objective of this study is to quantify the sector’s economic footprint and then to analyse the links and mechanisms through which the sector influences the wider economy. A number of scenarios of changes in policies which may affect the aviation sector are reviewed. These include changes in taxation, in the regulatory system, and in demand management, all of which affect airport capacity. The study then examines the impact of these policy change scenarios on the economic footprint and on the supply side of the economy, in terms of economic growth and productivity, jobs and tax revenue for the Exchequer.

The second objective of the study is to assess the evidence in relation to two issues that are regularly debated within the context of the aviation sector.

- What is the cost to the sector of a series of tax and regulatory measures which may be introduced? How do these costs compare with the environmental costs associated with the sector?
- Does the aviation sector ‘pay its share’ in tax? This question is assessed in comparison to both the wider UK economy and the aviation sector in other EU countries.

1.2 Evidence base and approach

In undertaking the study, Oxera has independently identified the relevant base of evidence, although in some areas it has asked AOA and its members to supply relevant data which highlights how the concepts apply in their cases. In addition to considering the economic evidence from academic sources, Oxera has developed some simple and illustrative

modelling approaches to calculate the magnitude of the sector's economic footprint and, using scenario analysis, to illustrate the policy measures that may affect the level of growth in aviation output, and hence have an impact on the wider economic contribution of the sector.

1.3 Report structure

The report is structured as follows:

- section 2 presents a conceptual framework for the analysis of the economic impact of the aviation sector;
- section 3 sets out the economic footprint of the sector in terms of economic output, jobs and tax revenue contribution to the Exchequer;
- section 4 assesses the supply-side economic effects generated by the sector;
- section 5 develops policy scenarios in relation to changes in aviation taxation, the regulatory system and demand management, and illustrates their potential impact on the sector's economic footprint within the economy and on its ability to contribute to the wider economy by improving its supply-side potential. The impact is assessed by reference to changes in economic output, jobs and tax revenue for the Exchequer relative to a baseline scenario.
- section 6 reviews the tax and regulatory burden facing the aviation sector, and compares this against both the environmental costs of the sector and the relative tax contribution across the UK as a whole, as well as with the sector's tax burden in a number of European countries.

Supplementary information on the approaches and assumptions used in the main report is provided in the appendices.

- Appendix 1 explains the methodology used to assess the economic footprint of aviation.
- Appendix 2 presents a literature review on the aviation sector's contribution to the wider economy.
- Appendix 3 provides additional information on the policy scenario analysis.
- Appendix 4 presents supporting information for the tax and regulatory burden analysis in section 6.

2 Conceptual framework and types of economic impact assessed in this study

Key messages

The aviation sector's impact on the economy comprises a number of related components, including both the impact of the *production* of the sector's outputs and, more importantly, the longer-term benefits that the sector brings to the economy through the *consumption* by businesses or consumers of those outputs. These latter effects arise from factors including increased connectivity, reduced transport costs, and greater mobility of labour.

In looking at the economic impacts of the production of a sector's outputs, it is common to treat these effects in isolation from what else might be happening in the economy (ie, gross effects), and this has been the focus of several previous studies on the aviation sector. There are circumstances where this is an appropriate measure, but, except over very short time periods, there is a risk that this approach fails to account for the fact that resources in the economy (eg, labour and capital) that are not used in the aviation sector would be used somewhere else, and would produce some other output. In many instances, it is more appropriate to estimate the difference in the impact on the economy if resources are, on the one hand, used in aviation, and, on the other, redeployed somewhere else in the economy.

To address these issues, this report analyses the impact of the sector in two additional ways:

- the net effects of the production activity are calculated by taking into account the impact of substitution of resources employed in the aviation sector to other sectors of the economy. In this case, the main impact relates to the difference in productivity between aviation (a high-productivity sector), and the average across the economy as a whole;
- the supply-side effects of the sector (largely driven by the use of aviation in the wider economy) are considered through changes in the overall productivity of the economy. In assessing the supply-side benefits, the focus is on gross effects. However, as shown in section 5, these are significant and therefore should not be ignored when assessing the impact of policy pertaining to the aviation sector.

The wider impacts on the sector may be measured in various ways. GVA measures the contribution of a sector to the economy in terms of the value of output (ie, revenue from sales) less the costs of the (non-employment) inputs purchased and other costs incurred.² Other important indicators include the tax revenue generated and employment.

The aviation sector gives rise to economic impacts, which include direct impacts, such as the employment and income generated by the sector, and the benefits to consumer welfare that arise from access to air travel, such as time savings and reduced congestion for other transport modes. At the same time, it generates environmental impacts, including carbon emissions, noise and air quality. When considering how policies may affect the sector, it is important to take all of these factors into account.

² GVA is calculated mainly by reference to wages paid and profits arising from the activity in question. This is broadly equivalent to the revenue generated by sales, minus the non-wage costs incurred in making those sales.

2.1 Conceptual framework

Measures of contribution

The impacts of the aviation sector can be measured using indicators which pick up the effects of the activity within the sector. The impact of air transport activity that enables people or freight to be moved along aviation transport routes includes both the direct production of the air transport services as well as wider effects through changes to the structure of the economy.³ Examples of such supply-side effects include changes in the location decisions of firms outside the aviation sector, increases in the productivity of these firms as a result of the benefits of using aviation sector outputs (eg, direct freight links to export destinations), and increased scale and specialisation in production.

This study focuses on the following indicators.

- **GVA flowing directly from the sector.** This indicates the value (expressed in terms of the prices charged or in constant prices) of outputs created by the industry, less the costs of purchased inputs. In essence, it represents the sum of profits and wages (pre-tax) that are generated as a result of an economic activity of a sector or the economy overall. GVA therefore captures the productivity associated with the use of resources (labour and capital) by the aviation sector.
- **Volume of output of the sector.** This indicates the value of the output as seen from the perspective of the consumer or purchaser. GVA measures the value of the output of the sector in terms of the wages and profits of the producers, but does not capture the full value that the consumer receives from the product if, for example, some of the output comprises bought-in materials and services. Even gross output itself may not capture the full benefits if some consumers would, in principle, be willing to pay higher prices.
- **Employment.** The impact of the industry on employment, both directly and indirectly, is also considered.
- **Productivity.** This relates to the efficiency with which inputs such as capital and labour are used in the economy, and is an important driver of the national income of the economy. Measured as GVA per employee, it can be used to capture changes in both sectoral productivity and productivity in the wider economy. However, when measured in this way, the results can miss changes in the level of output per worker if the proportion of bought-in materials and services changes (for example, as a result of technical changes). Therefore, in interpreting productivity measured as GVA per employee, the impact of changes in the way in which outputs from the sector are produced also needs to be taken into account.
- **Tax revenue.** The capacity to generate revenue for the Exchequer is particularly important given the current fiscal position of the UK. The impact that a change in aviation tax might have overall depends on both its direct impact on taxes in the sector as well as its impact on the ability of the economy to develop and provide a tax base in the longer term.

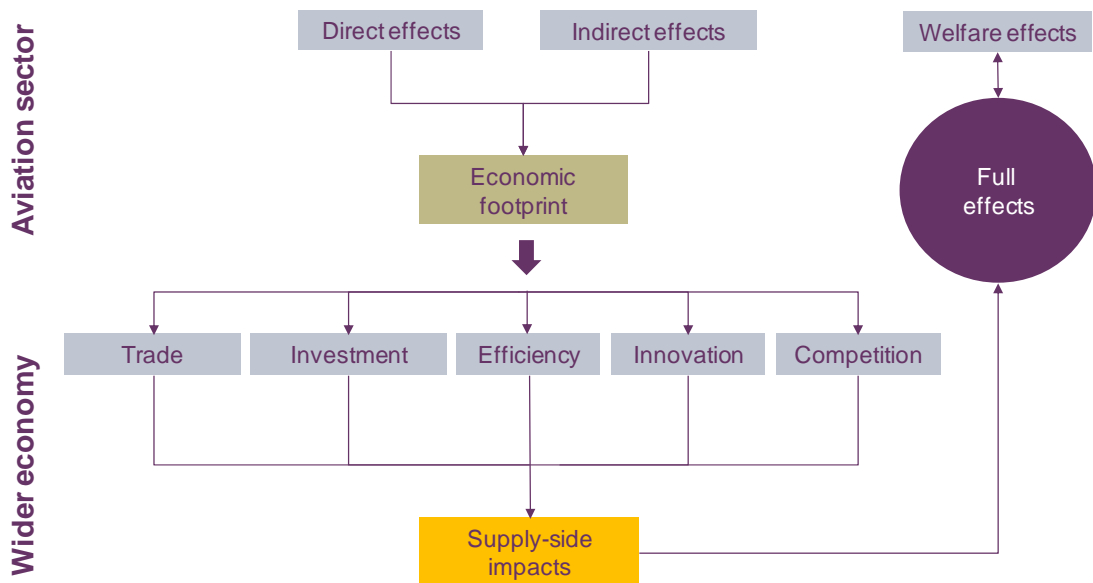
The above measures are closely related: the main economic output (GVA) requires inputs such as labour, capital and materials. Remuneration of employment, an important part of GVA, depends on workers' productivity (GVA/employees). Output will only be purchased if consumers receive some benefit from doing so. The tax contribution of a sector, which is paid out of gross profits and wages (ie, GVA), depends on the detailed characteristics of the sector and relevant tax rates, but is greater the higher the GDP and the higher the productivity, particularly with respect to the economy as a whole.

³ These are referred to in the report as 'supply-side effects', and include impacts that are often referred to in the economic literature as 'catalytic effects'.

Types of contribution

The figure below shows the types of economic effects of airports and how they relate to each other.

Figure 2.1 Economic effects of airports



Note: The economic footprint, supply-side and welfare impacts are determined simultaneously, hence a two-directional arrow from welfare effects to full effects.

Source: Oxera.

The economic footprint of the aviation sector arises from the production of the sector's output. This includes the direct activities of firms within the aviation sector itself, as well as the generation of activity from suppliers to the industry. The effects are as follows.

- **Direct contribution to the economy by the sector**—effects arising directly from the activities of the aviation sector, including the contribution of its GVA to the economy, the creation of employment opportunities within the sector, and tax revenue generated by the sector. These effects are measured using data from the Office of National Statistics (ONS).
- **Indirect contribution to the economy by the sector**—effects created by the sector's supply chain as a result of transactions with suppliers, their suppliers, and so on. The suppliers use the revenues generated by the sector to create employment, tax revenue, GVA and exports. These indirect contributions are measured using information from input–output tables, which capture the many relationships between different sectors of the economy. The direct and indirect contribution of aviation represents the **economic footprint** of the aviation sector.
- **Direct welfare benefits to consumers and producers**—these benefits arise directly from the consumption of the products or services of the sector. Benefits may include consumer or producer surpluses that are not included in market prices, and hence are also not included in standard macroeconomic measures such as GVA. Direct measurement of these surpluses is not practical,⁴ but to provide a high-level indication of how welfare impacts of the sector have increased over time, changes in the volume of

⁴ Consumer surplus is not directly observable and would require detailed modelling of the shape of the demand curve for aviation, which is beyond the scope of this study.

freight and transport services purchased are presented in this study (section 3) as a proxy indicator.

In addition to these impacts, which flow directly from the production of outputs, the aviation sector has wider impacts which affect the **supply side** of the economy and which are likely to emerge over longer time periods. Increases in the availability of transport links and reductions in the time or financial costs of transport between two points can affect the productivity of the economy as a whole. Improved connectivity allows for higher output, higher profits and/or higher wages within the same mix of activities in the economy, while reduced transport costs can change the mix of activities that are possible within the economy. Reduced transport costs can also increase the level of competition in any particular location, and the increased flow of ideas from using transport links can spur innovation (over and above any impact from increased competition). All of these factors have influences *outside* the aviation sector and hence are not picked up in any measurement of the output of that sector. As a result, other means of estimating the impact of the activities of the sector on the wider economy are needed. This is covered in more detail in section 4 and Appendix 3.

The payment of wages by the aviation sector—and wages paid by aviation sector suppliers to their employees—generates additional spending in the economy. This spending itself creates employment, and the effect of this demand can also be measured by the impact on GVA or employment (ie, it is measured as an *induced* impact of the sector). However, when these effects are added to the direct and indirect effects of all sectors across the economy, the sum would exceed economy-wide GVA, which is not economically very meaningful. These effects are therefore excluded from the report (and are not shown in Figure 2.1). Such induced effects are only part of the wider process of macroeconomic adjustment which delivers total national output as measured by total GVA, the sum of its constituent sectors.

Gross and net, and short- and long-term impacts

In any consideration of the effects of policy and other changes, such as changes in aviation taxes and regulations, it is important to look at the **gross** effects of airport-related activities (as described above).

In addition, where appropriate, it is important to take into account what activities, if any, those resources currently used in the aviation sector, in the form of capital, labour and land, would otherwise be used for in the absence of the aviation sector. It is possible—indeed likely—that, without the airport, workers and other resources would be productively employed elsewhere in the economy. For example, a DfT study has noted that:

In a perfectly functioning labour market the effects of expansion in airport related—or other types of—employment would largely be reflected in higher levels of regional GDP and earnings, with offsetting ‘crowding out’ of employment in other sectors rather than lower overall unemployment.⁵

In the long term, all resources can be assumed to be re-employed elsewhere in the economy, and hence a judgement is required about the characteristics (eg, the productivity) of the activity which re-employs these resources. This measurement can be thought of as the **net** impact of the sector. For example, if a reduction in demand for air travel were offset by some increase in demand for high-speed rail or video-conferencing, or if such a reduction were replaced by an alternative leisure activity, the gross impact of that change in demand for aviation services is calculated on the basis that there is no substitution on either the supply or demand side, while the net calculation takes into account the offsetting effects of these other activities.⁶

⁵ Department for Transport (2002), ‘Regional Air Services coordination study’, October 22nd.

⁶ In a resource-constrained economy it is unrealistic to view any sector’s activity as purely additive. Thus, in the long term, any activity in one sector can be seen as ‘crowding out’ some activity in another sector or sectors. In the short run, resources in the

To calculate the net impact of the economic footprint of the sector, it is not possible to predict precisely where any displaced demand will end up, and therefore what relative shifts in demand would take place in the economy. As a first approximation, it is appropriate to look at the net effects on the assumption that demand (and hence output) shifts to a set of activities that has an average impact on the economy. In this case, the net impact of changes affecting the sector would be positive if the aviation sector (and its suppliers) is more productive than the average in the economy.

The analysis of supply-side effects focuses on gross impacts. A change in the size of the aviation sector would lead to changes in the supply-side effects associated with the aviation sector, and to consequential changes in activity in other parts of the economy, either through standard economic transmission mechanisms or as a result of government policy intervention. Assessing the net impact would require assumptions to be made about any accompanying changes in other sectors not caused by the change in aviation itself, and whether the potential supply-side benefits of the change in aviation are stronger or weaker than those from other sectors which might be replaced by those generated by the aviation sector.

This distinction would be particularly relevant if, for example, higher taxes on aviation meant lower taxes elsewhere in the economy or higher public investment, thus offsetting to some extent the damaging impact of a smaller aviation sector. The gross impact could be used as a first approximation of the net impact only if the resources freed up for alternative use could only be redeployed to activities with very low productivity. Therefore, while any full analysis of the supply-side consequences of a reduction in the size of the aviation sector would need to compare the loss in supply-side benefits with any potential gain in such benefits that may arise from growth in other sectors of the economy, in practice these cannot be specified in general terms.

As shown in section 5, the gross supply-side benefits of aviation are significant and should therefore not be ignored when assessing the impact of policy pertaining to the aviation sector.

The following section sets out the approach adopted in this study to operationalise the measurement of gross and net effects.

2.2 The economic contributions of aviation measured in this report

2.2.1 GVA impact resulting from the economic footprint of the aviation sector

Gross impact

Information on aviation GVA is readily available and is a measure of the wages and profits generated by the activities undertaken within the sector (its economic footprint) together with taxes paid. The **direct** GVA measures wages and profits for activities that are directly classified as aviation (eg, operating an airport or offering freight and passenger transport services); **indirect** GVA measures the inputs bought by the direct activities (eg, the activity of supplying electricity to that airport). However, GVA may not fully capture the benefits to consumers (both end-users and the industry) because of the possibility of consumer surplus, as discussed earlier (see Box 2.1 below). Furthermore, the volume of outputs (ie, passengers and freight volume used as a proxy measure) is relevant when analysing the impact of the sector because this takes into account materials and services bought in from overseas, which are not captured by either direct or indirect GVA.

The gross impact of the aviation sector is set out in section 3.

economy will rarely, if ever, adjust instantaneously, so reductions in output in one sector may occur without immediate growth in another sector, and increased demand for resources in one sector may, if no spare resources are available, result in inflation, rather than in increased output until the economy can react.

Net impact

Taking into account the possibility, over the longer term, that resources being used in the aviation sector may be redeployed elsewhere in the economy, a *net* impact of direct GVA has also been calculated for the purposes of this study when examining the impact of policy scenarios undertaken in section 5 of this report. This calculation assumes that these resources would be redeployed at the average productivity (ie, generation of wages and profits) of the economy as a whole. The net impact on GVA of policies affecting the aviation sector is therefore calculated as follows:

net impact on aviation GVA = gross GVA impact – GVA under alternative resource use valued at the average of the UK economy.

The GVA impact is then translated into revenue contribution to the Exchequer and jobs (see section 3 for an explanation of the approach).

Box 2.1 Limitations in using GVA as a measure of the overall value of a sector

The methodology used to calculate the GVA of a sector of the economy, or the economy as a whole, is subject to some limitations which need to be taken into account when interpreting the results. Only under very restrictive conditions does GVA measure the overall welfare benefits for UK consumers and producers. The main constituents of the measure of GVA are wages and profits in the industry. These two elements measure the difference between the costs of the inputs purchased by the industry and the revenue realised from the sale of the outputs from that industry. Thus, GVA ignores not only those materials and services (such as fuel) bought in from overseas to supply the output, but also those bought in from domestic suppliers and their suppliers. The indirect GVA measure includes the latter, but not imports. (Exports of aviation services, which benefit overseas residents, are included however, and if trade in aviation were balanced there would be no net impact.)

In addition, GVA measures the value of output and consumption at market prices; this might understate the true benefits to consumers if some consumers were willing to pay higher prices. The extra benefit to consumers of the consumption of those outputs, over and above the price they actually pay, is termed 'consumer surplus'.

In order to measure changes over time in the value that consumers obtain from a sector, it is appropriate to focus on volume measures or GVA at constant prices (called 'real' GVA). However, for various reasons, these two types of measure may give different answers. For example:

- technical or market changes may lead to a reduction in the GVA content per unit of output of the sector. If, for example, imported materials (such as fuel) were to rise as a proportion of the overall output of the sector, the growth of real GVA would be less than the growth in output volume;
- the price index used to deflate GVA to transform it into real terms might be measured with error, and thus might be inconsistent with the true prices underlying output volumes. If, for example, estimated GVA price increases were biased upwards, real GVA growth would be understated.

Therefore, in looking at the changes in the economic importance of a sector, it is important to consider changes in output volumes as well as in real GVA. In recent years, the 'apparent' or 'measured' real GVA of the aviation sector has stayed broadly constant (see Figure 3.5 in section 3), even though the output delivered to consumers (including commercial consumers) has been increasing, reflecting the significant increase in the efficiency with which the outputs from the aviation sector are delivered (and the concomitant increase in consumer surplus).

However, changes in real GVA, assuming they are correctly measured, do provide insights into changes in both the domestic economic resources used and the real outputs of the sector. In undertaking the scenario analysis, the impacts have been translated into changes in GVA of the sector compared with a baseline of no change in policy. Both the baseline and the scenarios contain the same assumptions about changes in total factor productivity, so the changes in GVA estimated represent (relative) changes in output seen from the consumer perspective.

The wider economic impacts of the aviation sector are mostly linked to the actual output of the services provided, not the GVA, because they arise from the use of the outputs (ie, transportation of goods and passengers) not solely from the total paid to domestic producers for that type of service.

2.2.2 Direct outputs

The direct outputs of the sector are essentially passenger and freight transport journeys, for which output volume measures are readily available, and can act as a proxy, at least in terms of direction, for the level of welfare benefits that the sector is delivering to customers. Section 3 shows the trends in output of the aviation sector.

2.2.3 GVA impact resulting from supply-side mechanisms

Within this context, wider economic impacts may arise from the following broad drivers of economic performance and mechanisms in the wider economy:

- the provision of connectivity;
- the reduction of transport costs;
- transport hub location and associated agglomeration effects;
- an enhanced ability to conduct international trade, including trade in tourist services;
- increased investment and innovation in other sectors of the economy;
- strengthened competition in other sectors of the economy;
- an increased supply of labour to other sectors of the economy.

In measuring the impact of these wider effects, it is necessary to use a realistic (and useable) 'counterfactual' (ie, a judgement about the size and economic contribution of the aviation sector in the absence of policy shocks). The approach adopted here is then to simulate changes in the size (and economic contribution) of the aviation sector that may arise under a series of different policy scenarios. Hence, with respect to estimating the wider impacts, the focus in this study is on estimating the state of the economy if the aviation sector develops at a different rate to that assumed under the counterfactual, as a result of changes in policy. The impact of policy scenarios is discussed in section 5.

As discussed above, the analysis of supply-side impacts focuses only on gross effects. The GVA impact is then translated into changes in revenue contribution to the Exchequer (and in the number of jobs).

The assessment of the economic contribution of the aviation sector is undertaken as follows.

- Section 3 examines trends in the economic footprint of the aviation sector.
- Section 4 sets out the wider impacts on the supply side of the economy.
- Section 5 uses evidence on the economic footprint and supply-side effects to construct policy scenarios of the effects of changes in the level of taxation and in regulation.

3 The economic footprint of the aviation sector

Key messages

The aviation sector is a significant contributor to the UK economy in its own right: it directly generates £8.8 billion of economic output (measured as GVA), or 0.7% of the total GVA of the UK economy (in 2007).

This increases to £18.4 billion, or a 1.5% share of the total GVA of the UK economy, when the economic activity needed to supply the inputs purchased by the sector is accounted for.

Overall, aviation sector total GVA has increased by 8.3% since 1995 in real terms. Simply assessing the economic footprint of the activities needed to supply the outputs of the aviation sector, however, may understate the full value placed by businesses and consumers on the sector's outputs, as the value placed by consumers may exceed the price paid for these outputs. Given the growth in freight and passenger volumes, the overall economic value to users of the sector's output has increased significantly since 1995.

A proxy for the overall change in the value of benefits generated by aviation is physical (rather than monetary) output. Between 1995 and 2008, the number of aviation passengers increased by 81% and freight volumes grew by 33%. This translates into an annual growth rate of 4.7% in passenger numbers and 2.2% in freight volume.

Moreover, the aviation sector makes a significant contribution to employment and tax revenues in the UK economy.

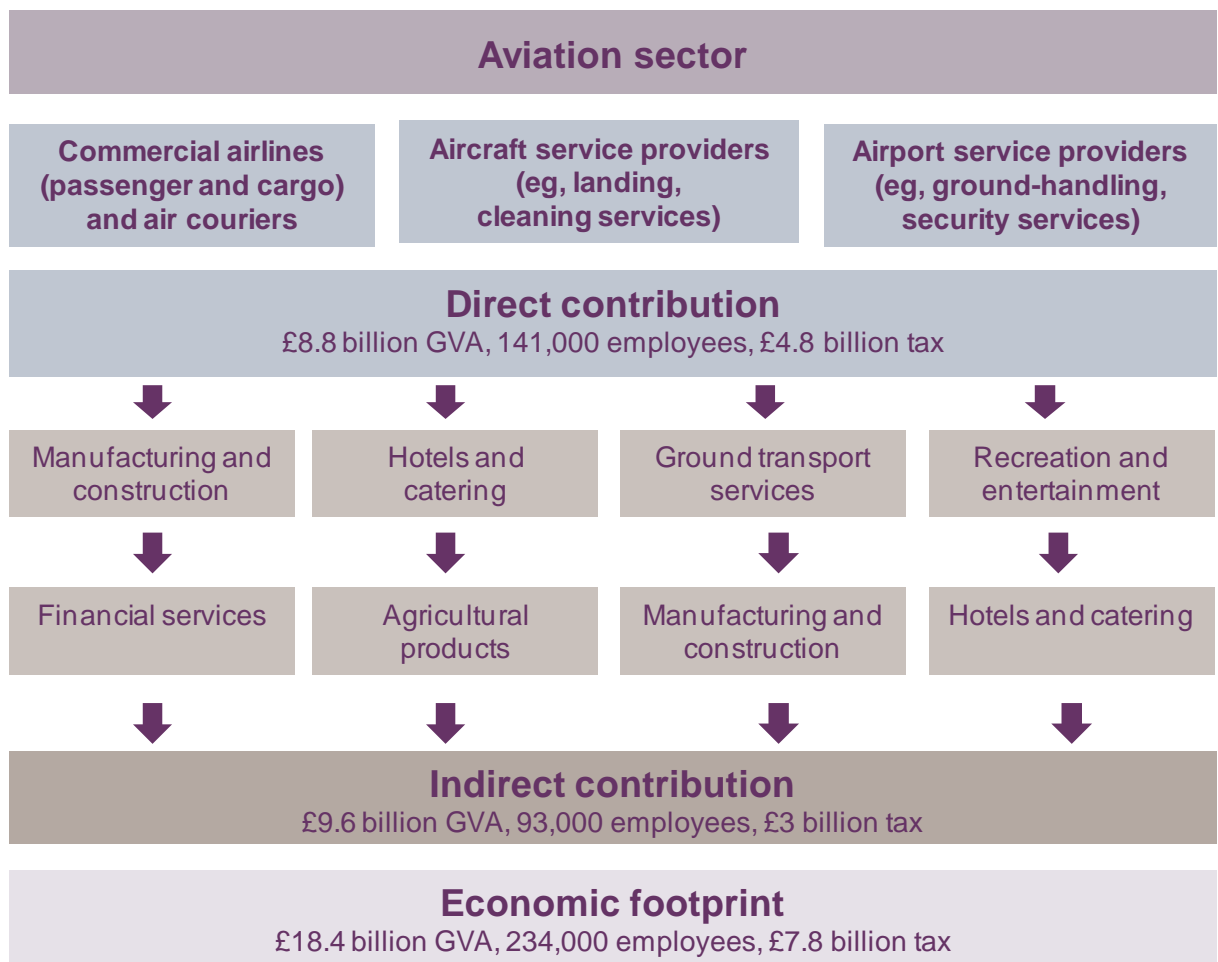
- The sector accounts for 141,000 jobs (0.5% of UK employment), which rises to 234,000 (0.85% of UK employment) when the supplier base is also taken into account.
- Aviation has a higher labour productivity than the economy average: £62,000 GVA per employee versus the £46,000 equivalent amount for the economy-wide average GVA per employee.
- The sector is estimated to directly contribute around £4.8 billion of revenue to the Exchequer, or 0.9% of UK overall tax revenue in 2007/08, and contributes an additional £3 billion through its supply chain.

The exact estimate of aviation GVA, tax contribution and aviation depends on the specific definition of aviation. For the purpose of this study, a narrow definition of the aviation sector has been adopted.

These figures do not account for the impact in the economy of spending by employees (ie, the *induced* effect). This is because similar effects would arise if the labour used in aviation were redeployed in another sector of the economy. The changes in supply-side benefits associated with productivity impacts caused by the consumption of the outputs are illustrated separately in section 4.

The aviation sector plays a significant role in the UK economy, giving rise to both a *direct contribution* from the activities of airports, airlines and aircraft service providers, and an *indirect contribution* from economic activity within the supply chain. Together, these make up the sector's economic footprint. These are broadly summarised in Figure 3.1 below.

Figure 3.1 The aviation sector and its economic footprint in 2007



Source: Oxera.

As discussed in section 2, the economic footprint captures only imperfectly the overall economic contribution of a sector since it not only ignores supply-side benefits, but may also understate the full value that consumers and producers place on output from the sector. This is especially important to bear in mind in respect of the aviation sector, which has enjoyed broadly stable GVA and employment (albeit with a declining share in comparison with the UK overall), but a significant increase in output. Section 5 discusses the supply-side benefits of aviation through the impacts of different policy options.

3.1 Approach to measuring the economic footprint

The following data sources and approaches have been used to quantify the sector's economic footprint.

- The direct contribution of the aviation sector, in terms of its GVA, is recorded in the national accounts produced by the ONS.⁷ The indirect contribution, which needs to take into account the relevant links between the aviation sector and the sectors that make up its supply chain, is quantified using input–output analysis (published by the ONS), a widely used methodology in impact assessment of an industry or a policy. Further details of the methodology and the data used are included in Appendix 1.

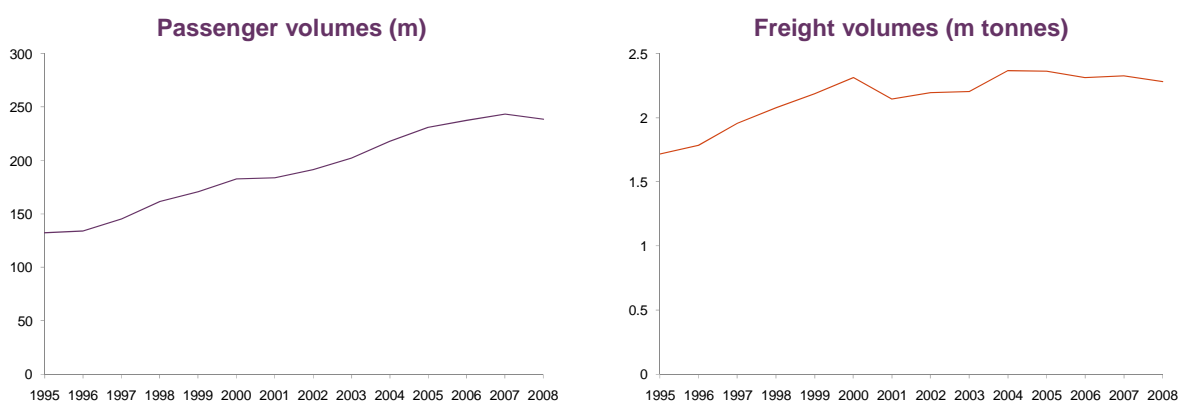
⁷ The aviation sector is defined, according to the UK Standard Industry Classification, as 'Air transport' (SIC 62) and 'Supporting air transport services' (SIC 63.23). The impact of hotel and catering services associated with aviation is not included in this analysis. See Appendix 1 for further discussion.

- Figures on direct employment in the sector are taken from the Annual Business Inquiry.⁸ The indirect employment estimate is obtained by assuming that the employment intensity per unit of economic output (employment per GVA) is equal to the UK economy average. Using this assumption in conjunction with the indirect GVA estimate provides a high-level estimate of the number of employees employed in the aviation sector supply chain.
- The direct tax contribution is taken from estimates from a previous study, with updates where relevant.⁹ After allowing for an increase in the tax burden since then (notably in APD), the figure provides an approximation of the tax contribution of the aviation sector in 2008/09. An estimate of the indirect tax contribution is estimated, assuming the aviation supply chain contributes similar proportions of income tax, corporate tax and National Insurance Contributions to the economy overall (32% in 2007/08). Since other taxes, such as the excise duties and business rates payable by the various parts of the aviation sector supply chain, are excluded,¹⁰ this figure is likely to underestimate the actual contribution by the sector.¹¹

3.2 Developments in aviation output and prices

Figure 3.2 plots the growth in passenger and freight volumes since 1995. Over this period, passenger numbers have been steadily increasing, rising by around 80% from 132m in 1995 to 240m in 2008 (or 4.7% pa). The volume of freight transported has increased from 1.7m tonnes in 1995 to around 2.3m tonnes in 2008 (or 2.2% pa), with a broadly flat profile since 2000.

Figure 3.2 Passenger and freight volumes



Source: Civil Aviation Authority (CAA), 'UK Airport Statistics', various years.

The increase in overall volumes is attributable to a number of factors, including growth in average income, which stimulates travel demand and trade in goods and services; a reduction in the price of air travel, driven partly by an increase in competition in the sector; and technological progress (over the longer term) including the emergence of low-cost airlines.

Figure 3.3 shows the trend since 1993 in average fares for a one-way international journey taken by UK passengers departing from the UK. The figure also shows freight prices, where country-specific prices are less readily available, and worldwide air revenue per ton-

⁸ <http://www.statistics.gov.uk/abi/>.

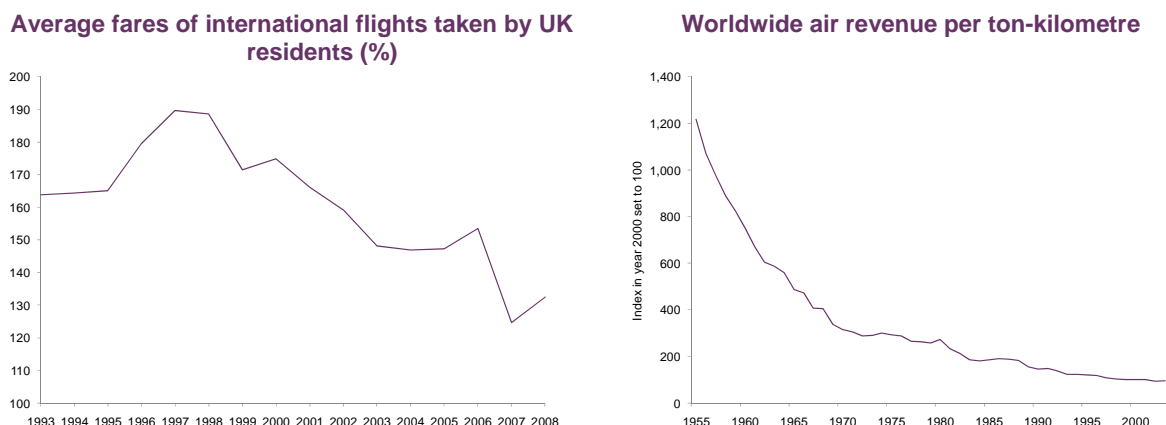
⁹ Oxford Economic Forecasting (2006), 'The Economic Contribution of the Aviation Industry in the UK'.

¹⁰ The UK total tax burden as a proportion of GVA was around 41% in 2007/08.

¹¹ HM Treasury (2009), 'Budget 2009', April, and Oxera calculations.

kilometre. Both highlight the significant reduction in prices—in particular, the freight price series shows that, between 1955 and 2004, the price of freight per ton-kilometre fell from \$3.87 to under \$0.30 (in 2000 real prices).¹²

Figure 3.3 Trends in aviation transport costs



Note: The figures are for one-way passenger fares.

Source: Passenger fares provided by the ONS. Freight fares reproduced from Hummels, D. (2007), 'Transportation Costs and International Trade in the Second Era of Globalization', *Journal of Economic Perspectives*, 21:3, Summer, p. 138.

3.3 GVA generated by the aviation sector

Figure 3.4 below shows the change in GVA (measured in 2007 prices) generated by the aviation sector both directly and indirectly through its supply chain.¹³ In 2007, direct GVA was estimated at £8.8 billion of GVA, and at a 0.7% share of the total GVA of the UK economy.¹⁴ The direct GVA reflects the wages, profits and taxes generated by the aviation sector, but does not capture expenditure on goods and services by firms active in the aviation sector, which generates further value-added in the economy. This is captured by the indirect GVA. Hence, it is necessary to consider the total (direct plus indirect) GVA generated by the aviation sector.

The total GVA generated by aviation has been more or less steady since 1995, in the region of £15.3 billion–£18.7 billion in real terms.¹⁵ However, total UK GVA has been increasing in real terms, so the proportion of total GVA accounted for by the sector has declined somewhat, from around 1.9% in 1995 to around 1.5% in 2007.¹⁶

¹² Hummels, D. (2007), 'Transportation Costs and International Trade in the Second Era of Globalization', *Journal of Economic Perspectives*, 21:3, Summer.

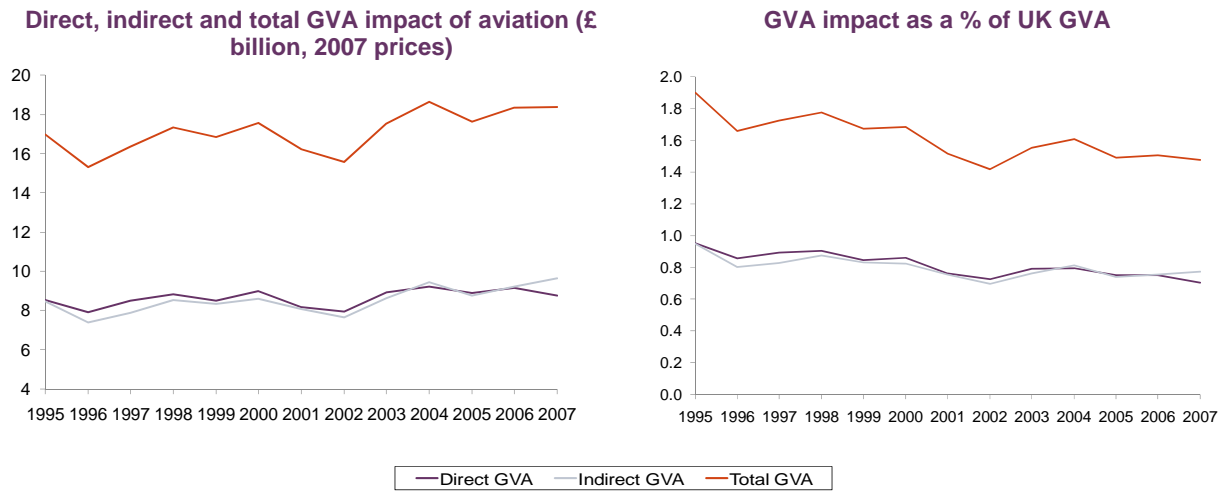
¹³ GVA excludes the intermediate consumption of domestic and imported goods and services, and therefore reflects the value added by a sector to the national economy.

¹⁴ A study by Oxford Economic Forecasting (OEF) in 2006 estimated the aviation GVA for the UK at £11.4 billion in 2004 (in 2004 prices). This contribution includes only the direct GVA of aviation, defined as the GVA of air transport, supporting air transport activities, and hotel, retail and catering activities of airports. OEF does not provide an estimate for the indirect contribution of the sector. Oxford Economics Forecasting (2006), 'The Economic Contribution of the Aviation Industry in the UK', October. The estimate of direct GVA of £8.8 billion in 2007 (2007 prices) excludes the contribution of the catering and hotels services associated with aviation, although part of this sector may be captured in air transport (SIC 62) and ancillary air transport services (SIC 63.23). Moreover, in so far as many companies in the aviation sector contract out such services, the impact is captured in the indirect GVA contribution. As such, the definition of aviation GVA and the resulting estimate in this study is a conservative estimate of the direct impact of the aviation sector. For further discussion see Appendix 1.

¹⁵ GVA has been deflated using an aviation-specific price index provided by the ONS.

¹⁶ To account for the significant differences in the development of prices at the UK overall level and the aviation sector—the price level of aviation services has fallen, whereas that for the UK overall has risen—the UK overall figures have been deflated using a general inflation index (specifically, the GDP deflator), while aviation GVA has been deflated using an aviation-specific price index provided by the ONS.

Figure 3.4 GVA generated by the aviation sector and share in UK GVA



Source: ONS, and Oxera analysis.

As discussed above, GVA only imperfectly captures the overall value of its services to the economy when looked at from the customer perspective. As shown in Figure 3.3 above, the nominal price level for aviation transport services has declined significantly (while the overall price levels in the economy have, on average, risen). This reduction in prices reflects, at least partly, greater competition and the associated lower costs (including labour costs) and margins, together with increased productivity and technological improvements.

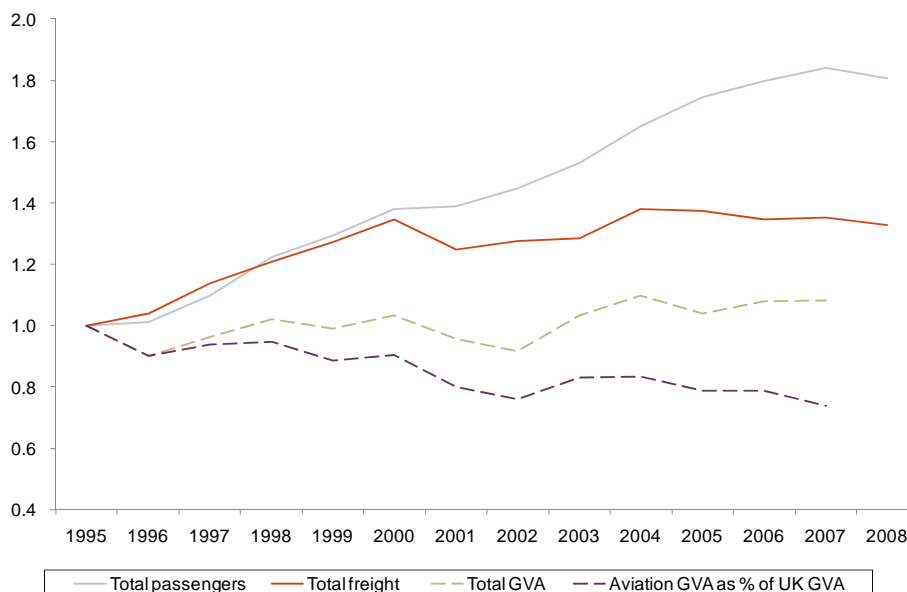
Analysis of fares in the UK by the Civil Aviation Authority (CAA) suggests that average one-way fares paid by UK passengers have declined significantly over the past ten years.¹⁷ The decline is more marked for business passengers, for whom the average fare for flights to the EU 25 has fallen from around £210 in 1999 to around £110 in 2007. Over the equivalent period, leisure passengers have also tended to pay less, with average fares falling from around £90 to £60 (all measured in 2005 prices).

Physical output—passengers or freight volumes—has also been rising or is steady. Figure 3.5 below shows that the output of the sector in terms of passengers and freight transport has increased significantly faster than the sector GVA. This indicates that the value of the services provided by the sector, proxied here by demand for the physical output, is significantly greater than implied by changes in the GVA of the sector. The real price of air fares has been falling while physical output has been rising, implying significant increases in productive efficiency. This may be consistent with lower trend growth in GVA, or due to a declining share of GVA of the economy because of the way GVA is measured. It is notable that the deflator used by the ONS in calculating real GVA for aviation tends to rise steadily over time, whereas air fares and freight rates have been falling.¹⁸

¹⁷ CAA (2009), 'UK Business Air Travel: Traffic Trends and Characteristics', May.

¹⁸ The impact of quality changes adds further complexity to the measurement of the true impact. A move to lower prices and quality, as with the growth of no-frills airlines, would tend to raise measured volumes and real GVA, but would overstate the improvement in benefits to consumers.

Figure 3.5 Growth in physical output (passenger and freight volumes) and GVA (total and as % of total GVA) (1995 = 1)



Note: Figures for GVA available up to 2007 only. Figures indexed to 1995 to allow direct comparison of growth rates.

Source: ONS; CAA, 'UK Airport Statistics', various years; and Oxera calculations.

3.4 Employment in the aviation sector

Employment is another important indicator of the impact of aviation on the UK economy. Figure 3.6 below shows the total employment impact of aviation, broken down into direct employment and indirect employment (eg, the labour required to produce the additional output generated in the economy to supply inputs to the aviation sector). Over the past ten years, direct employment has been around 125,000 jobs (headcount),¹⁹ whereas indirect employment is estimated to be around 93,000.²⁰ Total employment over the period is around 220,000 employees. In 2007, the sector accounted for 141,000 jobs, which rises to 234,000 when the supplier base is taken into account.²¹

Figure 3.6 also shows that the role of aviation in terms of total national employment has been more or less stable at around 0.5%, which increases to around 0.85% when indirect employment is also included.²²

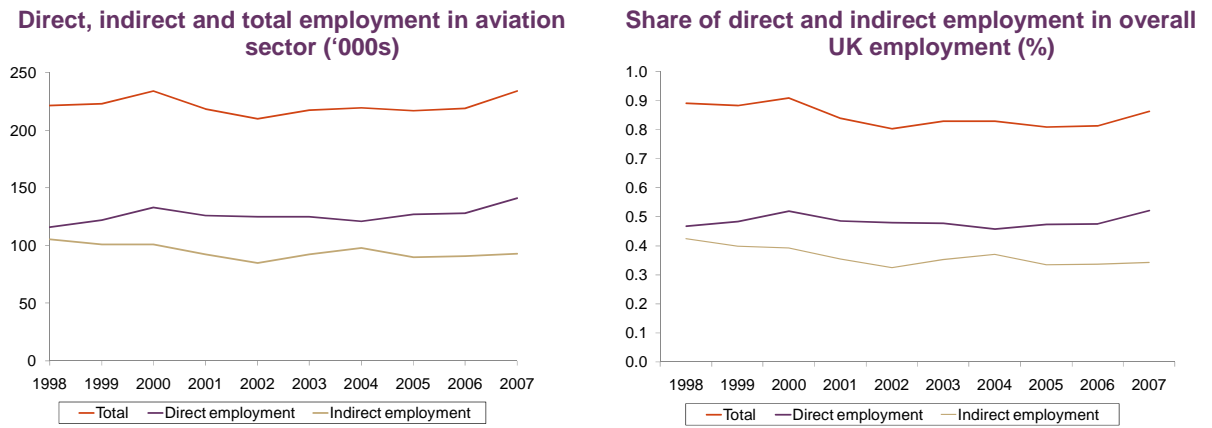
¹⁹ Headcount measures of employment count all full- and part-time employees on an equal basis. When measuring employment on a full-time equivalent (FTE) basis, this figure would be around 10% lower. Consistent measures of FTEs in the aviation sector are not readily available; hence the focus on headcount measures of employment.

²⁰ The approach to estimating indirect employment is described on Annex 1.

²¹ Oxford Economic Forecasting (2006) estimated the contribution of aviation to UK employment in 2004 at 523,000 jobs. This includes direct (186,000), indirect (167,000) and induced employment (88,000) as well as the employment for travel agents (82,000). Oxera's estimate of direct and indirect employment, of 234,000 employees, relates to OEF's estimate of 353,000. The difference arises due to the exclusion of other aviation-related employment, such as retail outlets, the use of more recent input output data, and differences in the methodologies used to calculate indirect employment. As discussed in section 2, this report does not focus on induced impact. However, to the extent that airlines increasingly offer flights directly through online services rather than through travel agents, this employment impact is included. For further discussion of the employment impact calculation, see Appendix 1.

²² The direct employment figures have been sourced from the Annual Business Inquiry (ABI). An alternative dataset containing estimates of aviation sectors is NOMIS, but this data does not have the same coverage. Where comparable figures are available (eg, 'Air transport', SIC 62), these showed that ABI figures are, on average, somewhat higher than those of NOMIS (with the exception of 2004), by between 14,000 and 660 employees.

Figure 3.6 Direct and indirect employment generated by the aviation sector



Source: Annual Business Inquiry (ABI); NOMIS; and Oxera analysis.

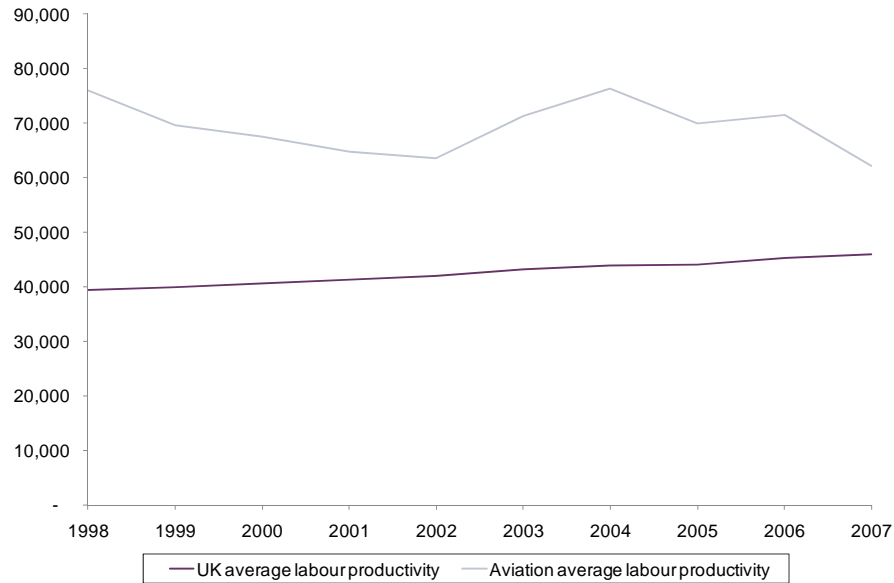
Figure 3.7 below compares productivity in the aviation sector, measured as GVA per employee, and overall UK productivity.²³ The figure demonstrates that output per employee has been consistently higher than average productivity in the UK.²⁴ The recent increase in fares competition, however, is likely to have had an impact on GVA, due to falling profit margins. This is one possible explanation for the decline in GVA per employee in the aviation sector, from around £76,000 per employee in 2004 to around £62,000 per employee in 2007; measuring productivity in real terms should, in principle, correct for this, but it appears not to do so given the price deflator currently used. Aviation-sector GVA per employee was still 35% higher than the average GVA per employee of UK businesses overall, although this may be due, in part, to the higher than average capital intensity of the sector in comparison with that of the UK economy overall.²⁵

²³ The productivity figures have been estimated using GVA data from the ONS National Accounts, ABI data on aviation employment, and NOMIS data on UK employment. The ABI data provides employment data at a disaggregate level for most sectors of the economy, but not for the financial services sector, and hence underestimates total UK employment. For economy-wide employment, therefore, NOMIS data is used.

²⁴ Productivity is defined as GVA (at 2007 prices) per headcount measure of employee. Counted on an FTE basis, measured GVA per FTE would be just under 10% higher in comparison with a GVE per employee measure. Another measure of productivity which more directly measures the actual input per worker would be GVA per hour worked; however, suitable data on hours worked is not readily available.

²⁵ See, also, Oxford Economic Forecasting (2006), 'The Economic Contribution of the Aviation Industry in the UK', pp. 17–18.

Figure 3.7 Comparison of labour productivity in aviation and in the UK as a whole (£, 2007 prices)



Source: ABI; ONS National Accounts; NOMIS; and Oxera analysis.

3.5 Tax revenue contribution

The aviation sector is a significant contributor to revenues of the Exchequer. An estimate of the size of its contribution is provided below, and the tax and regulatory burden on the aviation sector is examined in more detail in section 6.

Direct tax contribution

The tax contribution of the sector in 2007/08 is estimated as follows, and summarised in Table 3.1 below.

- The revenue figure generated through income tax, National Insurance Contributions and corporate tax applied to the activities of airlines and airports is based on data relating to 2004/05 (sourced from research by Oxford Economics Forecasting published in 2006)²⁶ converted to 2007 prices. The calculation makes the assumption that the average tax rate has remained constant and that the contribution of the aviation sector has remained constant in real terms. Given that GVA and employment in the sector have been broadly similar, this appears to be a reasonable assumption.
- APD revenue, which more than doubled between 2004/05 (£864) and 2007/08 (£1,994m), is added to the above figure,²⁷ leading to an overall estimate of around £4,846m.

²⁶ Oxford Economics Forecasting (2006), 'The Economic Contribution of the Aviation Industry in the UK', October.

²⁷ 2008/09 revenue from APD was £1,939m in nominal terms. HM Revenue & Customs, 'Tax receipts and tax payers', available at http://www.hmrc.gov.uk/stats/tax_receipts/menu.htm.

Table 3.1 Direct contribution of the aviation sector to Exchequer tax revenue in 2007/08 (2007 prices)

Category	£m
Income tax	1,517
National Insurance Contributions	929
Corporate tax from airlines	194
Corporate tax from airports	212
Air Passenger Duty	1,994
Total	4,846

Note: Figures refer to estimates based on Oxford Economics Forecasting, except APD, which is the 2007/08 actual revenue.

Source: Oxford Economics Forecasting (2006), 'The Economic Contribution of the Aviation Industry in the UK', October; HM Revenue & Customs, 'Tax receipts and taxpayers', available at http://www.hmrc.gov.uk/stats/tax_receipts/menu.htm; and Oxera.

To the extent that the above estimate excludes payments such as VAT, excise duties, stamp duties, and business rates, the total figure presented in the table is an underestimate. For example, using a high-level assumption, business rates paid by UK airports are in the region of £155m.²⁸

Overall, therefore, the aviation sector is estimated to make a direct contribution of £4.8 billion to tax revenues, which corresponds to around 0.9% of total revenues in 2007/08.²⁹ Since only part of the total aviation tax contribution is included in Table 3.1, the figure underestimates the sector's total contribution. When changing the basis of comparison to include only those tax categories presented in the table, the figure increases to 1% (excluding APD)³⁰ and 1.6% (including APD).³¹

Indirect tax contribution

A high-level estimate of the tax contribution of the supply chain is obtained by using the assumption that the sectoral contribution (as a share of GVA) is the same as for the economy overall—ie, 32% in 2007.³² On this basis, the indirect tax contribution via the aviation sector supply chain was £2.3 billion in 2007/08.³³

²⁸ Business rates are calculated using the rateable value and the multiplier set by the government for four major airports: Heathrow, Liverpool, Birmingham and Manchester. These airports generate total business rates of £71m, and account for about 46% of UK passenger volume. Due to data limitations, business rates at other airports are estimated assuming that tax receipts are proportional to passenger numbers. The assumption that, on average, each passenger contributes £0.65 to business rates leads to an estimated total tax receipt of £155m. Airport rateable values are taken from Bond, P. and Brown, P. (2006), 'Rating Valuation Principles and Practice', p. 10. The multiplier is taken from *Bestpractice*, 'Legal Q&A: vacant premises payment rates', <http://www.bestpracticemagazine.co.uk/best-practice/features/2211152/legal-q-vacant-premises-payment-for-multiplier>. Passenger numbers taken from CAA, 'UK Airport Statistics'.

²⁹ Based on total tax revenues in 2007/08 of £515.9 billion. Source: HM Treasury (2009), 'Budget 2009', April.

³⁰ Of a UK total of £294.1 billion in 2007/08.

³¹ Of a UK total of £295.3 billion in 2007/08.

³² The taxes considered are income tax, National Insurance Contributions and corporation taxes. For 2007/08, the total from these tax receipts was £294.1 billion. Source: HM Treasury (2009), 'Budget 2009', April. Other taxes, such as business rates, have not been included due to the difficulty in attributing the relevant shares to the supply chain of the sector. UK The total GVA of the UK economy was £1,245.7 billion in 2007, resulting in a tax contribution as a share of GVA of 24%.

³³ This represents 24% of indirect aviation GVA, or £9.6 billion. As a number of taxes have been excluded from the calculation, this estimate is likely to underestimate the actual contribution to UK tax revenues of the UK aviation sector supply chain.

4 The supply-side effects of aviation

Key messages

In the longer term, the main influence of the aviation sector on the economy is likely to be the way in which it facilitates improvements in productivity outside the sector. For example, aviation:

- reduces the cost of the transportation of people and goods, relative to alternatives;
- enhances the ability to conduct international trade, by increasing connectivity between the UK and international destinations (as well as increasing connectivity within the UK), which can lead to increased investment and two-way trade.

Unlike the effects arising from the impact of the production of aviation outputs, these effects would not generally be reproduced if the resources used in the production process were redeployed in other parts of the economy—ie, these particular benefits are not offset by the crowding out of resources that may otherwise be used elsewhere in the economy. Instead, these effects reflect the means by which efficiency in the use of existing resources in the rest of the economy may be enhanced.

Some of these effects have been the subject of significant analysis, although the evidence base is still limited in a number of areas. Therefore, this analysis is able to estimate the impact of some, but not all, of the likely effects in the wider economy.

This section identifies the mechanisms through which the aviation sector plays a role in enhancing the productive capacity of the wider economy.

It is the contribution of the aviation sector to the supply potential of the economy, as an important driver to the global economy, which represents its lasting impact. While there is a significant body of literature dedicated to describing and quantifying the wider effects of this driver,³⁴ there is no consensus on the size of these effects. Historically, aviation demand has tended to grow in line with, or faster than GDP, but it is unclear how much of this growth is the result of growth in the economy, or to what extent the growth of the economy can be attributed to the increased output of the aviation sector. The complexity lies in identifying the channels through which the supply of aviation services affects the overall size of GDP, and establishing a clear causality running from aviation to improved economic performance.

This section describes the wider effects of the aviation sector on production, investment, employment and income in the economy over the longer term. Unlike the direct and indirect impacts of the aviation sector—which, in the long term, could be replaced by other economic activities—the effects on the supply side of the economy are likely to be permanent. As such, to the extent that they are positive, they are of vital importance to the overall size of the economy.

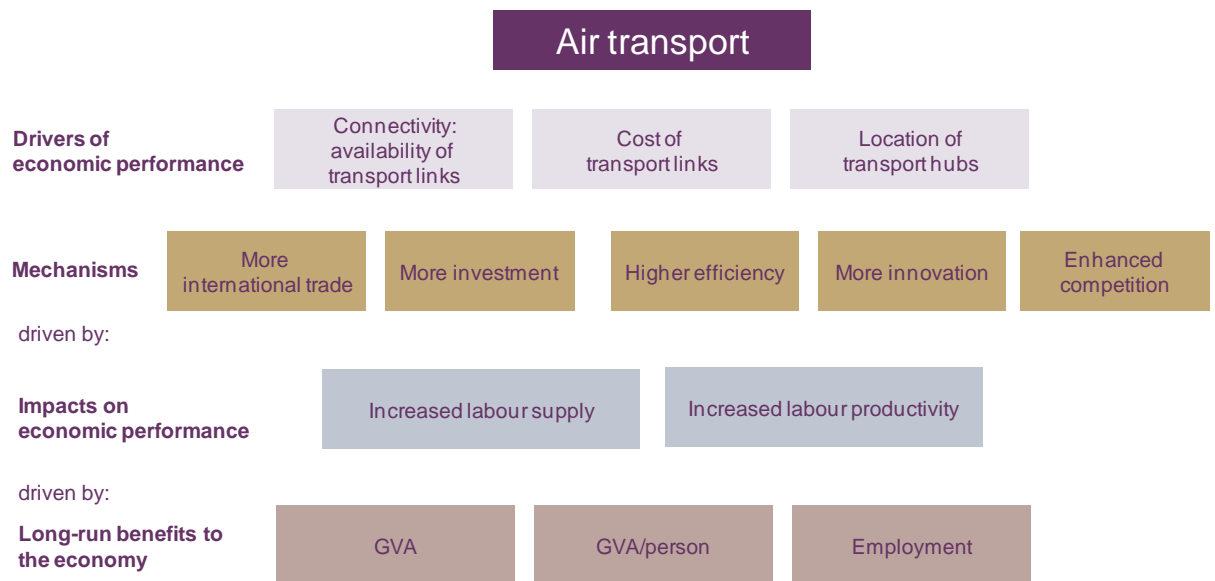
The literature identifies a range of ways in which aviation may affect the economy, and these can be categorised as follows.

- **Aviation sector drivers of overall economic performance.** These represent the means by which changes to the aviation transport system, such as new infrastructure or policy changes, affect other segments of the economy. They include the impact of changing transport costs, changing connectivity, and the location of transport hubs.

³⁴ Often described as 'catalytic' effects in the literature.

- **Transmission mechanisms.** Given any set of changes to the drivers noted above, a set of wider effects may occur within the economy, spread due to increased efficiency, competition and international trade; investment and innovation; and structural changes in the economy.
- **Impacts on economic performance.** These transmission mechanisms may lead to the further development of the economy through an increase in the labour supply or improvements in productivity (of both labour and capital).
- **Long-term benefits** to the economy. These may be measured in terms of changes in GVA, employment or productivity.

Figure 4.1 Supply-side effects of air transport



Source: Oxera.

A more detailed examination of the links between the provision of aviation services and changes in the wider economy is set out in Appendix 3. In summary, however, the increase in the provision of air transport links, and the reduction in the unit costs of using those links, can be expected to have an impact on the efficiency of the wider economy in the following ways.

- **Reduced transport costs.** The lowering of transport costs reduces the relative cost disadvantage faced by producers that are ‘further away’ from the point of consumption or onward use in a production chain. This will tend to enhance competition (potential suppliers now come from a wider area) or reduce unit costs where there are economies of scale (a single point of production can now serve a wider area). Increased competition in turn tends to drive innovation and efficiency gains. These cost (and hence price) reductions feed through into greater productivity (output per unit of input) and higher GDP.
- **Greater connectivity.** These will tend to reduce transport costs once the wider costs to the consumer (or user) of aviation services are taken into account (eg, travel time). The impact of increased connectivity can be expected to be similar to a reduction in transport cost.
- **Development of transport hubs.** The co-location of related firms around transport hubs can itself increase the productivity and innovation of those firms.

- **Increased international trade.** In addition to reducing the prices of goods and/or services as the cost of transportation falls, lower transport costs may encourage the development of specialisations which then increase bi-directional trade flows. These increased trade flows represent further reduced prices as producers can now reap cost advantages from, for example, economies of scale. An often-debated issue is the contribution made by the aviation sector to tourism. This is further discussed in Box 4.1 below.
- **Reduced inventory holding costs.** Better transport links or reduced transport costs enable companies to spread the sourcing of inputs across a wider area and to increase the potential responsiveness of the supply chain. Again, this can reduce the costs of production (and hence prices).
- **Greater flexibility of labour supply.** In the same way as the pool of potential suppliers increases with reduced freight transport costs, so the pool of potential labour increases with the reduction in transport costs for people. This, in turn, may make the labour market more flexible, which can both increase the average productivity of labour and reduce the inefficient allocation of labour when economies undergo change (for example, when the location of spare labour resources does not match the location of current demand for labour).
- **Investment and innovation.** In addition to increasing the geographic scope of suppliers, additional transport links and lower transport costs can facilitate both inward and outward investment. The greater choice of investment locations should improve the efficiency with which those investments are made. Innovation can also spread along transport links which, all other things being equal, should increase the speed with which new innovations are adopted in the wider economy.

The ways in which the outputs of the aviation sector can influence the wider economy, other than those captured by the measurement of aviation sector GVA, are varied. Most of the analysis of these impacts is based on very detailed empirical analysis which seeks to understand relatively small differences in the supply or price of the outputs of the sector. Attempting to model some of the wider effects using complex computable general equilibrium (CGE) models may be attempted; however, the option of removing the aviation sector altogether is not up for debate. It is not, therefore, realistic to provide a measure of the differences in the overall efficiency of the economy with and without any aviation services. Instead, in section 5 below, modelling is undertaken of the relationship between changes in air transport and economic variables of interest through various mechanisms (namely, connectivity, trade and investment). The impact of different, but realistic, policy options going forward is then assessed. Given the nature of the data that is available to quantify the impact of these factors, this represents a more realistic approach.

The modelling approach used is relatively simple, and is designed to provide an indication of the magnitude of the impacts that may be expected from a relatively small change in supply or price. Further details on the literature on supply-side effects associated with aviation are set out in Appendix 2.

Box 4.1 The impact of aviation on tourism

An issue which has received attention in studies assessing the impact of the aviation sector is the role that aviation plays in facilitating inbound and outbound tourism. For example, OEF, on the basis of information from the International Passenger Survey published by the ONS, estimates that the expenditure of British residents flying to destinations outside the UK exceeded the expenditure of inbound air-travellers to the UK by around £18 billion in 2005, resulting in a 'tourism deficit' in the UK.³⁵ A recent study by Loughborough University presents the evidence and outlines the debate regarding the tourism deficit in more detail.³⁶

While the tourism industry is an important part of the UK economy, the present study does not include a quantification of the impact of changes in the aviation sector on the tourism deficit, particularly regarding the impact of different aviation policy options. The rationale for ignoring any impacts of the size, or changes in the size, of this deficit is as follows:

- following the logic of the framework set out in section 2, net receipts from tourism expenditure do not measure the net contribution/loss to the UK economy;
- instead the impact would need to be measured in terms of the net GVA impact on the UK economy of a tourism deficit and/or changes in that deficit;
- in the long term, the UK economy is at full capacity and as such in order to provide the services required to attract, for example, an additional £18 billion to balance the travel trade account would require diverting resources from other sectors of the economy into the parts that would service this additional expenditure;
- this redistribution of productive resources would have a net GVA impact to the extent that the average GVA per employee (direct and indirect effects) in the different sectors would be different. This is not the difference between the aviation sector and the rest of the economy, but between the tourism sector's activity and the activity that these resources would generate in the absence of an enlarged tourism sector);
- The tourism sector does not have a particularly high GVA per employee, so the net GVA impact is likely to be small, and could go in either direction.

Furthermore, in terms of the wider impacts of the aviation sector on the economy (see section 5), the mechanisms by which these impacts have been analysed do not appear to be dependent on the direction of travel of leisure travellers. As a result it a tourism expenditure deficit or surplus would not be expected to have an impact on these effects.

³⁵ Oxford Economics Forecasting (2006), 'The Economic Contribution of the Aviation Industry in the UK'.

³⁶ Omega (2009), 'Economic Benefits of Aviation - Technical Report', January, prepared by Gillingwater, D., Mann, M. and Grimley, P., Loughborough University.

5 Policy scenario analysis

Key messages

The impact of various scenarios on the economic footprint of the sector (allowing for a substitution of resources) and the wider impacts of the aviation sector on the supply side of the economy have been estimated against a number of policy options. These options cover a range of plausible policies that might be adopted (or which would arise by default in the case of the APD increases in 2009/10 and the inclusion in EU ETS in 2012).

Within this context of potential outcomes, the following points are of interest.

- The comparison of the direct effects on the aviation sector, and the supply-side effects generated by the aviation sector through the greater connectivity, trade and investment mechanisms, shows that their impact is significant. This highlights the importance of taking into account the impact on the rest of the economy when evaluating policies with respect to the aviation sector.
- The following policy scenario results provide an indication of the range of outcomes of the scenario analysis. It is of note that even the lowest estimate of the supply-side mechanism impact (connectivity) exceeds the direct impact on the sector.
 - The impact on direct GVA of planned **increases in APD in 2009 and 2010** is a reduction of around £40m in 2030. This impact is reinforced by reductions through the supply-side mechanisms of £70m (connectivity), £330m (trade) and £1,170m (investment). The estimated *increase* in direct tax revenue of around £1.06 billion in 2030 compares to a *reduction* in revenue of £30m (connectivity), £140m (trade) and £450m (investment).
 - **Restrictive demand management**, restricting capacity growth to 1.5% in the period up to 2020 and to 0.5% in the period up to 2030, results in a reduction in direct GVA of around £1.8 billion. The corresponding impacts resulting from the supply-side mechanisms are further reductions of £2 billion (connectivity), £9 billion (trade) and £31 billion (investment). The estimated decrease in overall tax revenue—due to lower APD receipts, and reduced activity in the aviation sector and the wider economy—is significant. The estimated reduction in direct tax revenue is around £4.6 billion in 2030, with a further reduction in revenue of £800m (connectivity), £3.7 billion (trade) and £13 billion (investment) through the supply-side mechanism.
- Therefore, when evaluating policy options, ignoring these wider effects could lead to outcomes significantly different to those expected.

As noted in the Introduction to this report, the aviation sector has been the focus of significant debate in the lead-up to the next general election. Political parties have begun to outline their proposals for how the sector may develop, alongside their wider policy proposals for the transport and infrastructure sectors. It is therefore conceivable that the policy environment faced by the aviation sector could change significantly in the future. In particular, tax and regulatory burdens may be increased, or changes to policy in demand management could affect capacity at airports. In addition, demand may change as a result of other policies pursued by governments (eg, the construction of more high-speed rail links).

To provide an overview of the impact that different policy scenarios may have on the aviation sector and, by extension, on the wider economy, a simple spreadsheet model has been constructed to examine the impacts of four broad types of scenario, each with several variants.

For each scenario, the change in the economic footprint (allowing for the substitution of resources with other sectors of the economy) is calculated in terms of GVA and tax relative to a baseline scenario (see section 2 for a discussion of the calculation of the net impact). The types of scenarios (with variations within each) are as follows:

- **baseline**—with assumptions taken directly from forecasts for the sector produced in 2009 by the DfT.
- **high financial burden on aviation sector**—in which existing aviation taxes are increased, or new ones imposed;
- **low financial impact**—in which the financial impacts arising from security and carbon costs are alleviated;
- **capacity-constrained**—in which growth in infrastructure does not meet demand, and therefore becomes a binding constraint on output.

The impact of these scenarios on the wider economy (through supply-side mechanisms in terms of GVA, employment and tax) is then presented, again in the form of the difference between a baseline and the specific scenarios.

The findings regarding the economic footprint of the sector and the impact via through supply-side mechanisms can be compared to obtain an indication of the overall impact of the implementation of policies that increase or reduce the regulatory and tax burden on the aviation sector. The analysis illustrates that, for some policy packages which would result in significant increases in the tax burden in addition to reducing the GVA of the aviation sector and the wider economy, the increased cost of air transport results in a lower net tax increase or, for some scenarios, results in a net reduction in overall tax revenue as result of reducing activity in the wider economy.

5.1 Development of scenarios

A number of scenarios have been developed to test the impact of various policies which will affect the aviation sector in the future. The overall modelling approach is relatively simple, reflecting the scope of the exercise and the objective of obtaining illustrative magnitudes for the economic effects associated with the aviation sector in the UK.

The DfT's passenger forecasts presented in its January 2009 and March 2009 publications form the starting point for the analysis.³⁷ The approach used in the modelling is to then consider how different treatments of taxes and regulatory changes may affect the development of the sector—in particular, as a result of the changes faced by consumers in terms of fares. Evidence on elasticities consistent with that used by the DfT is then used to consider how the number of passengers may evolve over the period from 2007 to 2030. From this analysis, the impact on the wider economy can then be assessed.

5.1.1 Baseline scenario

An initial baseline is defined as follows.

- **Passenger forecasts:** total terminal passengers, as set out in the January 2009 DfT report, 'UK Air Passenger Demand and CO₂ Forecasts',³⁸ are used to form the initial baseline.

³⁷ DfT (2009), 'UK Air Passenger Demand and CO₂ Forecasts', January. Available at <http://www.dft.gov.uk/pgr/aviation/atf/co2forecasts09/co2forecasts09.pdf>.

³⁸ Ibid.

- **Fares:** the starting point is taken from the ONS, which indicates that the average one-way fare for international flights for UK residents in 2008 was £129 (in 2007 prices). For simplicity, it is assumed that these remain constant in real terms. Since the analysis is undertaken by comparing the effects of policy changes on the changes in fares, any variations in the baseline fare assumption have only a small impact on the results.
- **APD:** the DfT baseline includes the levels of APD per flight (as at 2008). However, the increases that will take effect from November 2009 and 2010 have also been taken into account in all the baseline scenarios in this category.
- **EU ETS:** while the DfT baseline does not include the planned inclusion of aviation in the EU ETS from 2012 (although the DfT has run a sensitivity on this), it does incorporate a test to ensure that the tax raised from APD is sufficient to ensure that the industry covers the social cost of its carbon emissions. In the DfT baseline, this test is passed within its assumptions, so the DfT's baseline does not include any of the additional costs of carbon that the aviation industry will face when incorporated into the EU ETS.
- **Price elasticity:** to maintain simplicity, the modelling is undertaken at the aggregate level of passengers, using average fares and elasticities reflecting the weights of different types of passenger. An overall average fare elasticity of around -0.5 has been used, which is consistent with the evidence quoted in the DfT 2009 report, allowing for weightings of different types of passenger.
- **Other costs:** costs such as security are implicit within the baseline; however, no costs are assumed for noise impacts (although, as a percentage of total costs, these are low).

Against this initial baseline, the changes brought about by four assumptions regarding potential policy are estimated. These four scenarios incorporate the planned changes in APD for 2009 and 2010. Scenarios B1 to B3 allow for both the APD and ETS changes; while Scenario B4 allows for the impact of the changes in APD only and, as such, allows the impact of the APD increase to be assessed. Scenarios B1 to B3 look at the impact of including the aviation industry in the EU ETS under three assumptions of the level of carbon costs that the industry could face:

- B1: 15% of carbon emission permits are bought at auction, with carbon costs remaining constant in real terms at the current EU ETS forward price for 2012;³⁹
- B2: fares incorporate the marginal cost of carbon set at 2012 forward rates;
- B3: fares incorporate the marginal cost of carbon set at the rate used by the UK Department of Energy and Climate Change (DECC).⁴⁰

5.1.2 High financial burden scenarios

Several alternative scenarios are then modelled, which test for alternative approaches to the potential evolution of APD. For example, the impact of replicating the increases identified for 2009 and 2010 in 2014 is tested, as are cases involving 3% and 5% annual increases in real APD from 2011 (Scenarios H1 to H3). Scenario H4 investigates the impact of adding additional noise taxes on top of scenario H3. Moreover, the impact of assuming a higher elasticity to fare changes is tested (Scenarios H5 to H8). This reflects that elasticities are generally valid only over small ranges of changes in price and may under-represent the demand response to more significant changes.⁴¹ In each of these scenarios, the impact of

³⁹ Using the forward price quotes by the European Climate Exchange on August 24th 2009. The carbon price used is €18/tonne in 2009 prices, or equivalently £14/tonne in real 2007 prices.

⁴⁰ DECC (2009), 'Carbon Valuation in UK Policy Appraisal: A Revised Approach', July.

⁴¹ Using a higher elasticity assumption is also of interest since the DfT's average elasticity of around 0.5 assumes that business travel is not affected by price changes (ie, it has a price elasticity of 0). Over the longer term, this may be too strong an assumption, and at least some switch towards other transport modes or technologies may be expected.

pricing emissions at the social cost of carbon set out by DECC is assumed. These scenarios show the impact of increasing APD over and above the changes announced for 2009 and 2010, as well as the impact of adding a noise tax. The comparison is undertaken relative to a baseline where the sector is already paying additional costs for carbon (ie, scenario B3).

5.1.3 Low financial impact from security and carbon costs

Two low-financial-impact scenarios are considered. In each case, carbon costs are covered by the industry, but the extent of the tax burden beyond this is assumed to be lower than under the baseline scenario.

- L1: the ADP and carbon costs are set as in scenario B3, which forms the baseline for comparison. Security costs are paid for from taxation. This scenario illustrates the impact of switching the funding of the costs of security from the aviation industry to the general taxpayer, assuming that the APD increases of 2009 and 2010 are implemented.
- L2: in this scenario, APD is assumed to be abolished from 2010 and it is assumed that the sector pays its carbon costs as per scenario B3, whereas taxpayers fund security costs. When compared against scenario B3, this shows the impact of reducing the tax burden for aviation while ensuring that it continues to meet its carbon cost through the EU ETS.

5.1.4 Constrained-capacity scenarios

Finally, scenarios are considered in which the growth of the aviation sector is limited—for example, by the imposition of constraints on growth in capacity. In scenario C1, no growth in demand is assumed to take place from 2010, while in scenario C2, growth in capacity is in line with the rate of efficiency improvements in emissions, taken from a 2008 report by Sustainable Aviation,⁴² implying 1.5% growth in passengers from 2010 to 2020, and 0.5% thereafter. In the model, it is assumed that price increases will come into effect such that demand is reduced to the restricted levels identified in the scenarios.

The impact of capacity constraints is assessed against scenario B3, which includes the impact of the APD increases in 2009 and 2010, as well as the introduction of the EU ETS assuming the DECC cost of carbon.

Table 5.1 below gives an overview of the four types of scenarios, as well as the variations implemented within each scenario.

⁴² Sustainable Aviation (2008), 'CO₂ Roadmap', December. Available at: <http://www.sustainableaviation.co.uk/images/stories/key%20documents/sa%20road%20map%20final%20dec%202008.pdf>.

Table 5.1 Overview of policy scenarios

Scenario	Description
Baseline	
B0	DfT baseline
B1	APD planned 2009 & 2010 changes, EU ETS financial cost at forward 2012 carbon price (15% auctioning)
B2	APD planned 2009 & 2010 changes, EU ETS marginal cost of carbon at forward 2012 price
B3	APD planned 2009 & 2010 changes, EU ETS marginal cost of carbon at DECC rate
B4	APD planned 2009 & 2010 changes
High financial burden	
DfT fare elasticity (0.5)	
H1	Stepped change in APD in 2014 & 2015 equal to 2009 & 2010 changes
H2	3% real growth in APD
H3	5% real growth in APD
H4	5% real growth in APD plus noise and local air pollution costs covered
Higher fare elasticity (0.7)	
H5	Stepped change in APD in 2014 & 2015 equal to 2009 & 2010 changes
H6	3% real growth in APD
H7	5% real growth in APD
Low financial impact from security and carbon costs	
L1	Carbon costs covered by aviation through EU ETS and APD, security costs covered by general taxation
L2	Carbon costs covered through EU ETS, no APD from 2010, security costs covered by general taxation
Constrained-capacity scenarios	
C1	0% growth in capacity
C2	1.5% growth in capacity to 2020, 0.5% to 2030

Source: Oxera.

The fare and passenger number assumptions underlying the scenarios in this study are detailed in Appendix 3.

The following sections set out the impact of each of these scenarios and the fares and passengers and on the economic footprint of the sector (section 5.2) and, via supply-side mechanisms (connectivity, international trade and investment) on the wider economy (section 5.3).

Section 5.4 provides a combined summary of the impact on the economic footprint, and the wider impact of the supply-side mechanisms. Readers who wish to gain only an overview of the overall impact may wish to skip the detailed discussion of the various scenarios in sections 5.2 and 5.3 below.

5.2 Impact of policy scenarios on economic footprint

The first set of modelling results shows the impact on the economic footprint (allowing for substitution) of each policy scenario on a number of indicators, including:

- passenger fares;
- passenger volumes;
- net GVA, including the impact on aviation sector GVA as well as any corresponding effects associated with the substitution of resources used in the aviation sector with those elsewhere in the economy;
- tax revenues paid to the Exchequer, including APD and other aviation taxes, as well as changes in taxes arising from the substitution of activity to other sectors of the economy.

A key assumption in this section is that any changes in employment arising from reduced or increased activity in the aviation sector are fully transferred to other sectors in the economy. Thus, once the direct and indirect effects are taken into account, there is no net employment change. Similarly, as further discussed below, supply-side impacts on GVA are likely to translate into productivity changes (ie, changes in wages and profits) rather than changes in employment.

The impact on GVA identified in any given scenario reflects the following factors.

First, the level of output of the aviation sector is determined on the basis of the impact of changes in airfares. It is assumed that the GVA of the aviation sector adjusts proportionately to the level of output (ie, passenger demand) in the sector. The substitution impact arises from the transfer of employment into other sectors of the economy. However, since the average productivity of the aviation sector (around £70,000/employee) is greater than that for the economy as a whole (£45,000/employee), the transfer of activity from aviation to other sectors generates a fall in GVA.

Tax revenue is calculated on a similar basis, taking into account the change in tax revenue associated with any change in the APD (or security cost recovery) scenario. While EU ETS revenues from the auctioning of permits could be treated as tax revenue, the scenarios do not include these in the tax revenue assessment. The substitution of aviation activity for other activity in the economy is also taken into account. While the tax share per unit of GVA for aviation is broadly similar to that for the economy as a whole when APD is excluded, the productivity difference between aviation and the rest of the economy means that the substitution will have some impact on overall tax revenues. The net tax revenue impact is therefore a combination of the direct impact of the policy change, and the partly offsetting impact of the substitution effect.⁴³

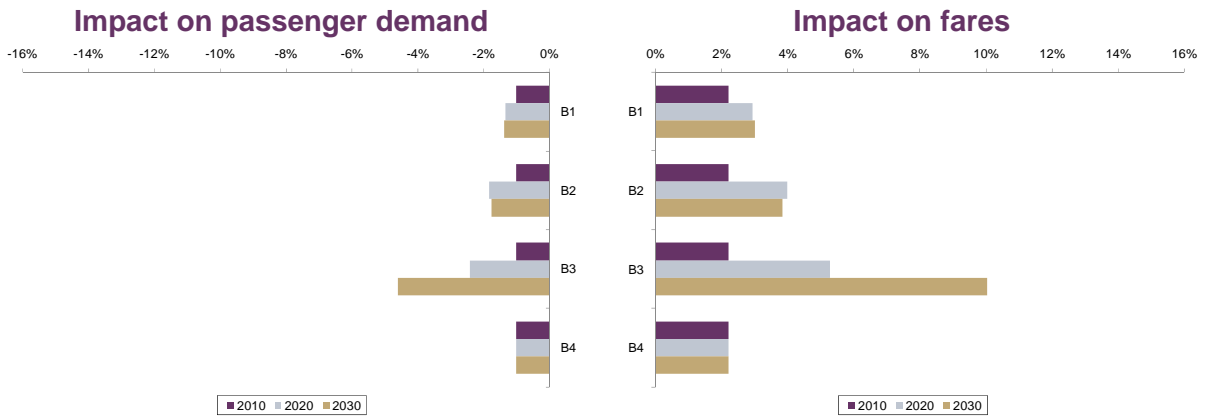
Each type of scenario is dealt with in turn.

5.2.1 **Baseline scenarios with additional costs of carbon**

Figure 5.1 below presents the fare and passenger impacts associated with the announced increases in APD (scenario B4), along with three different assumptions on the additional costs of carbon. Each of these scenarios is measured relative to the DfT baseline of no increase in APD and no additional cost of carbon.

⁴³ As set out in more detail in section 6.3, in 2007/08 the tax share (excluding APD) of GVA for the aviation sector and for the wider economy were broadly similar, at around 30%. Given that these figures exclude some taxes for which specific information for aviation is not known, it is assumed that the tax incidence for these taxes is similar.

Figure 5.1 Baseline scenarios: impact on demand and fares



Note:

B1: APD planned 2009 & 2010 changes, EU ETS 15% auction and forward 2012 carbon cost;

B2: APD planned 2009 & 2010 changes, EU ETS marginal cost of carbon at forward 2012 price;

B3: APD planned 2009 & 2010 changes, EU ETS marginal cost of carbon at DECC rate;

B4: APD planned 2009 & 2010 changes.

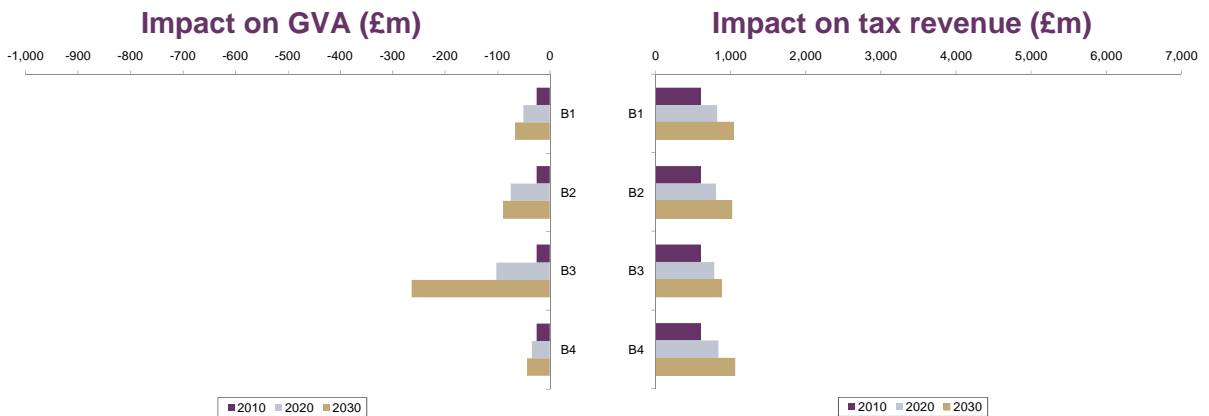
Source: Oxera.

The key points to note from this figure are as follows.

- The impact of the announced increases in APD in 2009 and 2010 together generate a fares increase of around 2%, leading to a 1% reduction in passenger demand.
- The EU ETS impact comes into effect from 2012, and by 2020 generates a further impact of around 0.7% on fares and 0.35% on passenger demand. In 2020, under a scenario in which only the financial costs with 15% auctioning are accounted for. These scenarios assume that only the financial costs to the industry are passed through to customers, which may underestimate the total impact of entry into EU ETS.
- In those scenarios under which the marginal cost of carbon is passed through, the impacts are somewhat greater, rising to around 4% of fares (2% for passenger demand).
- Together, the announced increase in APD plus the impact of allowing for the cost of carbon, using the traded price of carbon as measured by DECC, would lead to an increase in fares of up to around 10% in real terms relative to the DfT baseline scenario, reducing demand by around 5%.

The impact on prices and volumes affects direct and indirect GVA and tax revenues to the Exchequer, as shown in Figure 5.2 below.

Figure 5.2 Baseline scenarios: net direct economic impact



Note:

- B1: APD planned 2009 & 2010 changes, EU ETS 15% auction and forward 2012 carbon cost;
- B2: APD planned 2009 & 2010 changes, EU ETS marginal cost of carbon at forward 2012 price;
- B3: APD planned 2009 & 2010 changes, EU ETS marginal cost of carbon at DECC rate;
- B4: APD planned 2009 & 2010 changes.

Source: Oxera.

Figure 5.2 can be interpreted as follows: the impact of the APD increase in 2009 and 2010 will lead to a reduction in GVA, prior to the inclusion of longer-term supply-side effects, of around £50m per year. The inclusion of the sector in the EU ETS has an impact of a similar order of magnitude, depending on the specific assumptions for the impact on fares associated with its introduction. The effects on GVA are increased as the fares impact of the EU ETS is assumed to be larger—for example, in a scenario in which the opportunity cost of carbon prices, as determined by the DECC analysis, is used. In this case, the significant increases in carbon prices over time, alongside the increases in APD from 2009 and 2010, lead to a loss of GVA of up to around £260m by 2030.

The reduction in GVA in these cases reflects the lost output in the sector as fewer passengers are willing to fly at higher prices as the increase in APD and the cost of the EU ETS take effect. With fewer passengers, the amount of flights (and employees) in the sector is also expected to fall. This is only partly offset by the absorption of these resources into other, less productive (ie, equal to the economy-wide average), parts of the economy.

On the other hand, the direct impact on the tax-take from the sector of the increase in APD⁴⁴ under the above scenarios is positive, at around £1 billion by 2030. This value itself depends on the elasticity of demand for aviation services. With the assumption of inelastic demand, the increase in the APD rate leads to a higher total revenue from APD from the sector, despite the reduction in the output from the sector, as noted above. The substitution effect leads to some reduction in revenues, due to the different productivity of the aviation sector relative to the average, although this does not outweigh the APD increase. However, these calculations do not take into account the wider impacts on the economy of lost aviation output, which are dealt with in section 5.3.

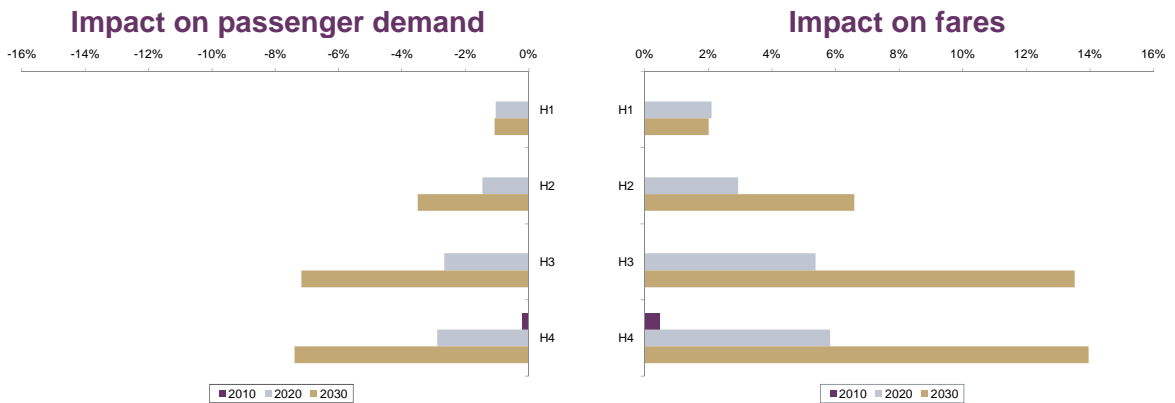
5.2.2 High aviation-specific tax scenarios

Figure 5.3 sets out the fares and the passenger demand impacts associated with a number of high tax policy scenarios. These include further growth in APD over time, as well as measures to incorporate the cost of noise into fares. It is important to note that these figures are compared with the known policy environment (defined as scenario B3), and so the effects are incremental to those previously identified as arising from the introduction of APD

⁴⁴ Revenues from auctions from permits are not included in the tax revenue estimates. These would depend on the number of permits auctioned and the price achieved per auctioned permit.

increases in November 2009 and 2010, as well as the EU ETS impact. Figure 5.4 repeats the analysis with a higher sensitivity of demand to fare levels of 0.7 instead of 0.5.

Figure 5.3 High financial impact scenarios: impact on demand and fares, relative to B3, baseline elasticity of response (0.5)



Note:

H1: Stepped change in APD in 2014 & 2015 equal to 2009 & 2010 changes;

H2: 3% real growth in APD;

H3: 5% real growth in APD;

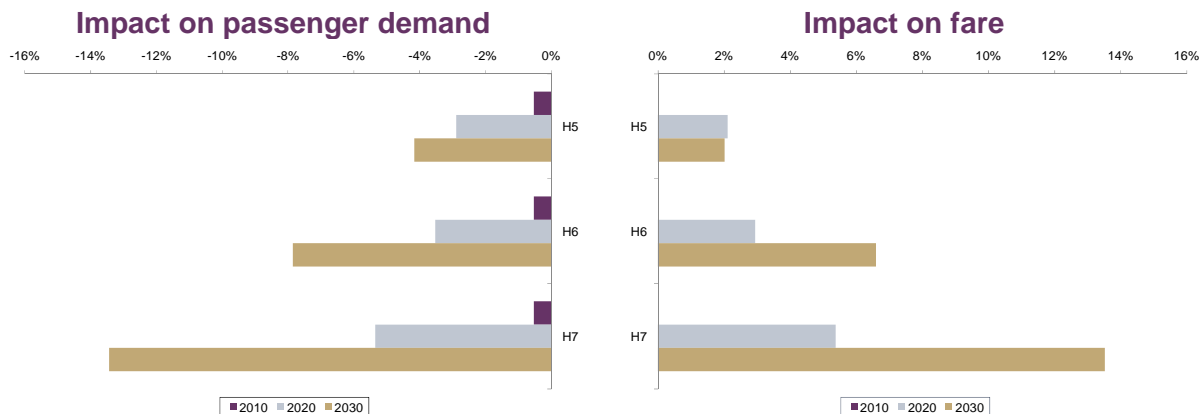
H4: 5% real growth in APD plus noise and local air pollution costs covered.

Source: Oxera.

The key points to note from Figure 5.3 are as follows.

- There is no impact in 2010 from APD, since the scenarios include changes only from 2011.
- The impact of the stepped change in APD is around 2% in fares relative to B3 (1% in passenger demand terms).
- Assumptions of APD growth lead to significant further impacts on fares, rising to 5.5% in 2020 and 13.5% in 2030 in the case of a 5% annual growth rate. These translate into significant impacts on passenger demand (of around 3 and 7% for 2020 and 2030 respectively).
- The current estimates of noise costs are relatively low on a per-passenger basis, and so there is a limited incremental impact associated with noise.

Figure 5.4 High financial impact scenarios: impact on demand and fares, relative to B3, higher fare elasticity (0.7)



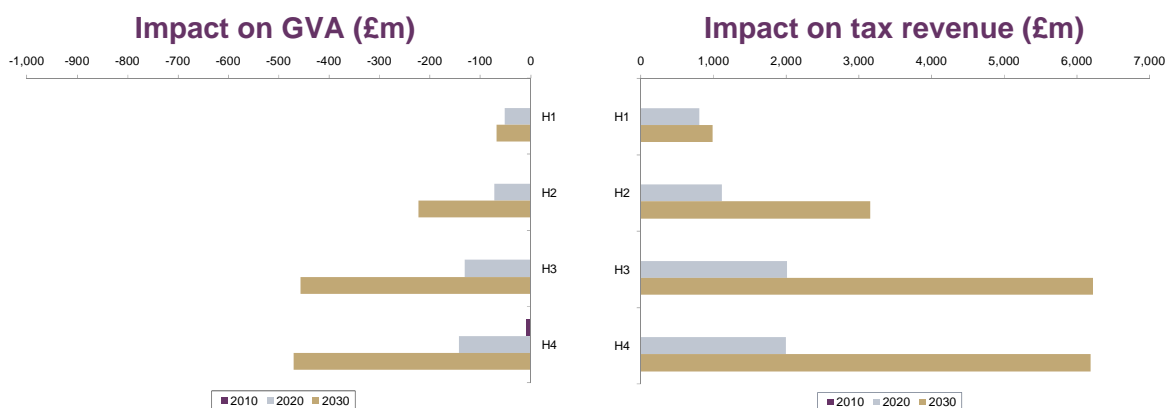
Note: H5: Stepped change in APD in 2014 & 2015 equal to 2009 & 2010 changes;
 H6: 3% real growth in APD;
 H7: 5% real growth in APD.
 Source: Oxera.

The key points to note from this figure are as follows.

- There is a small impact in 2010, which reflects the impact of the higher elasticity on demand in the opening year of the model. The fares impact is, however, still zero since there is no change in the level of fares in the scenario relative to the baseline.
- The impact of the increase in elasticity to 0.7 is to amplify the passenger demand impact associated with any given fares differential. Therefore, in this case, the impact on passenger demand is substantially greater than in Figure 5.3.
- The impact on passenger demand, relative to Scenario B3, is around 2–5%, depending on the scenario for increases in APD in 2020, rising to just over 2–13% by 2030.

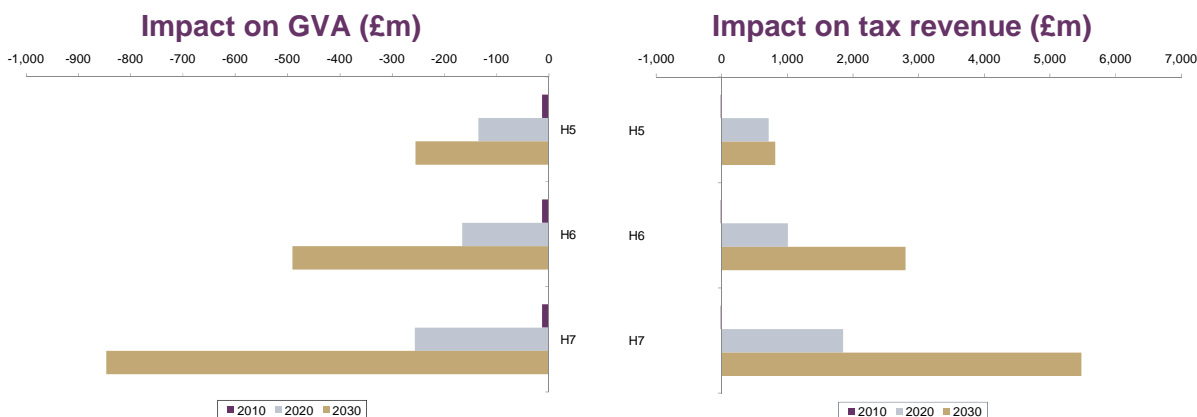
The impacts of the high tax scenarios on direct and indirect GVA and tax revenue are set out in Figures 5.5 and 5.6.

Figure 5.5 High financial impact scenarios: net direct economic impact, relative to B3, baseline fare elasticity (0.5)



Note:
 H1: Stepped change in APD in 2014 & 2015 equal to 2009 & 2010 changes; H2: 3% real growth in APD;
 H3: 5% real growth in APD; H4: 5% real growth in APD plus noise and local air pollution costs covered.
 Source: Oxera.

Figure 5.6 High financial impact scenarios: net direct economic impact, relative to B3, higher fare elasticity (0.7)



Note:

H5: Stepped change in APD in 2014 & 2015 equal to 2009 & 2010 changes; H6: 3% real growth in APD; H7: 5% real growth in APD.

Source: Oxera.

Figures 5.5 and 5.6 can be interpreted as follows: the impact of the alternative APD scenarios on direct and indirect GVA and tax revenue depends on the rate of increase in APD assumed under each scenario. In the scenario with the highest increase in APD (5% per year in real terms), the overall impact on direct and indirect GVA is significant—it rises to £130m by 2020 and around £450m by 2030. These figures represent reductions in GVA over and above those associated with the ‘known’ policies—ie, the 2009 and 2010 APD increases and the EU ETS effect.

Even the more modest increases in APD, such as repetition of the 2009 and 2010 increases in 2014 and 2015, or 3% annual growth from 2010, would lead to a reduction in GVA in the economy, of around £50m–£150m per year by 2020, and more by 2030. In each of these cases, the impact on aviation GVA is greater than the figures stated above, although the reallocation of resources to other sectors of the economy (with lower productivity, equal to the economy average) partly mitigate this loss.

The significant increases in APD would, however, lead to an increased tax-take for the Exchequer. This could be on the order of £2 billion by 2020, under a scenario with 5% growth in APD, relative to the tax-take assumed to arise in that year under existing policies. The main component of this estimate is the increase in APD (itself partly offset by any volume effects); however, taking account of the shift from aviation to other sectors tends to reduce the total direct and indirect tax impact associated with each of the ‘high tax’ scenarios. Again, these calculations exclude wider supply-side effects in the economy.

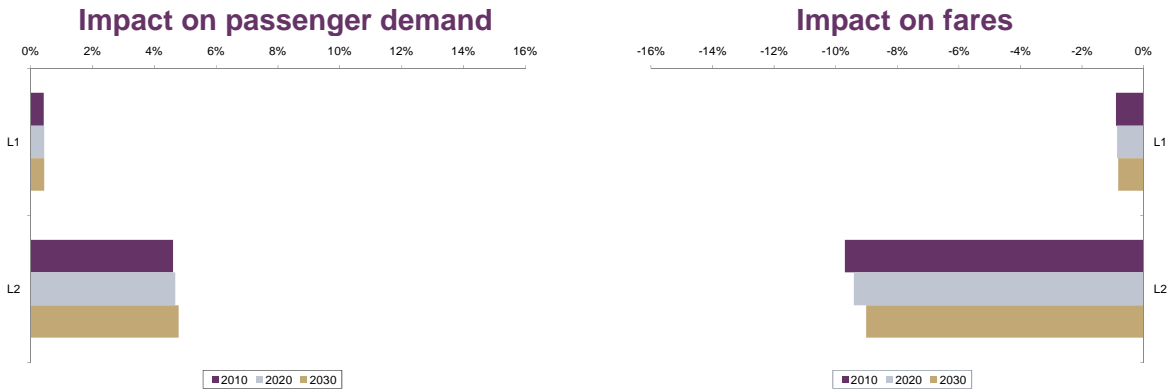
The analysis above assumes that the impact of the tax changes over time does not lead to any change in the elasticity of demand. As noted earlier in the section, however, with repeated tax increases there may be a threshold above which passengers increasingly choose not to fly. If a higher elasticity of 0.7 is used, the impact on GVA associated with a 5% increase in APD could be as much as £800m by 2030. In the higher elasticity scenarios, the tax-take from the industry will also be somewhat reduced relative to the prior case, since the associated volume effect will be stronger. Therefore, in this case, the direct and indirect impact on tax revenue will be £5.4 billion by 2030, rather than the £6.2 billion associated with the lower elasticity calculation.

5.2.3 Lower financial impact scenarios

Figure 5.7 below now considers the impact of lowering the financial burden on the aviation sector scenario. As previously noted, this allows for the exclusion of security costs, to be

funded by government, and, in a further case, only the costs of carbon are assumed to be covered (ie, without imposition of APD).

Figure 5.7 Low financial impact scenarios: impact on demand and fares, relative to B3



Note:

L1: external costs less security compared with B3;

L2: Carbon costs covered through EU ETS, no APD from 2010, security costs covered by general taxation.

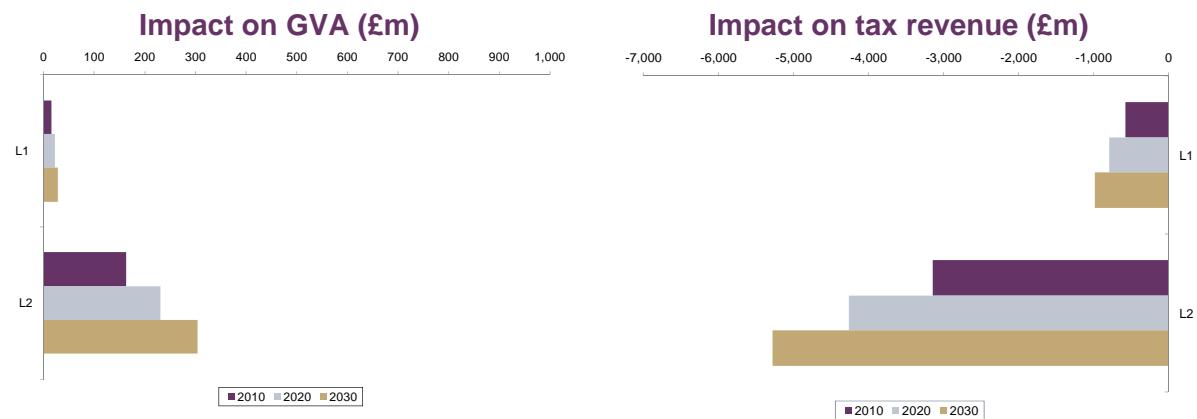
Source: Oxera.

The key points to note from this figure are as follows.

- The impact of reducing industry responsibility for recovery of security costs would be relatively modest, in that this would enable fares to fall by around 1%.
- The impact of retaining the aviation sector in the EU ETS, but removing APD, is significant, and would lead to an increase in demand of up to around 9% relative to the relevant baseline scenario (B3).

The impact of the lower tax policy scenarios on direct and indirect GVA and on the amount of tax revenue generated are set out in Figure 5.8 below.

Figure 5.8 Low financial impact scenarios: net direct economic impact, relative to B3



Note:

L1: external costs less security compared with B3;

L2: Carbon costs covered through EU ETS, no APD from 2010, security costs covered by general taxation.

Source: Oxera.

While the high tax scenarios lead to a reduction in direct and indirect GVA but an increase in tax revenue relative to the baseline, the lower tax policy scenarios have the opposite effect. The GVA benefit could be significant in a case where APD is eliminated from 2010—at over £300m per year. The impact of the transfer of security costs to government would be less, but would grow over time since the cost of security per passenger is assumed to remain constant, and the number of total passengers increases over time.

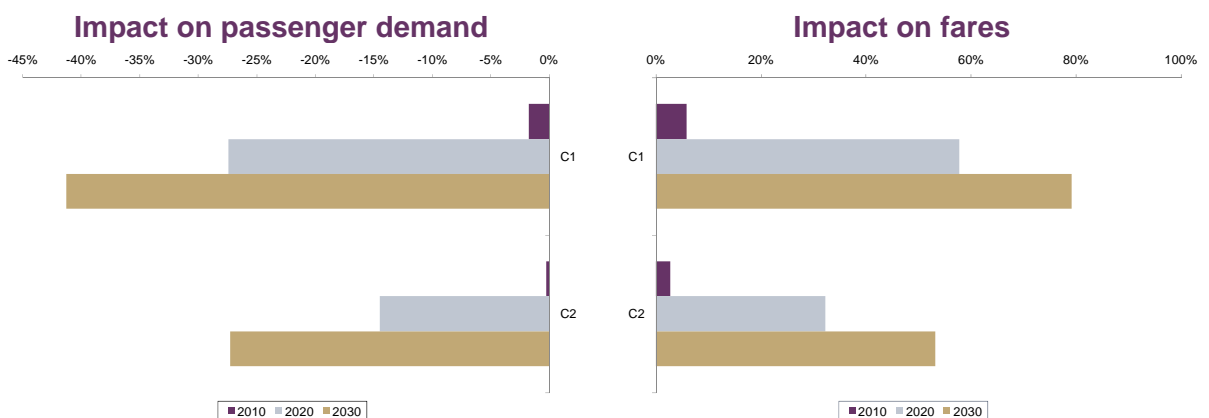
The tax revenue from the sector would decrease substantially in the event of either the removal of APD or the transfer of security costs to the government (although, if this is seen as a social obligation to be borne by the taxpayer, it is arguable whether the latter can be classified as leading to a reduction in the net tax revenue from the sector). While some of this lost tax revenue would be recovered (due to the fact that increased activity in aviation would provide higher tax revenues than the equivalent activity in other sectors), the net impact would be a loss of revenue in 2020 of around £1 billion in the case of the removal of security costs, or £5.3 billion in the case of the removal of APD.

In each of these cases, however, aviation would continue to cover the costs of carbon and to provide a similar amount of tax revenue to that generated by other sectors. Finally, the potential longer-term supply-side effect of growth in aviation on the economy would also need to be considered (see section 5.3).

5.2.4 Capacity-constrained scenarios

Figure 5.9 below identifies the impact of the imposition of capacity constraints on the industry. This is approximated by scenarios under which the level of passenger demand growth is assumed to be feasible, given restrictive demand management policies that may be adopted. When compared with B3, these scenarios show how significant the impact of introducing capacity or demand limits could be, even after allowing for the APD increases announced in 2008 and due to take effect in 2009 and 2010.

Figure 5.9 Capacity-constrained scenarios: impact on demand and fares, relative to B3



Note:
 C1: 0% growth in capacity;
 C2: 1.5% growth in capacity to 2020, 0.5% to 2030.
 Source: Oxera.

The key points to note from this figure are as follows.

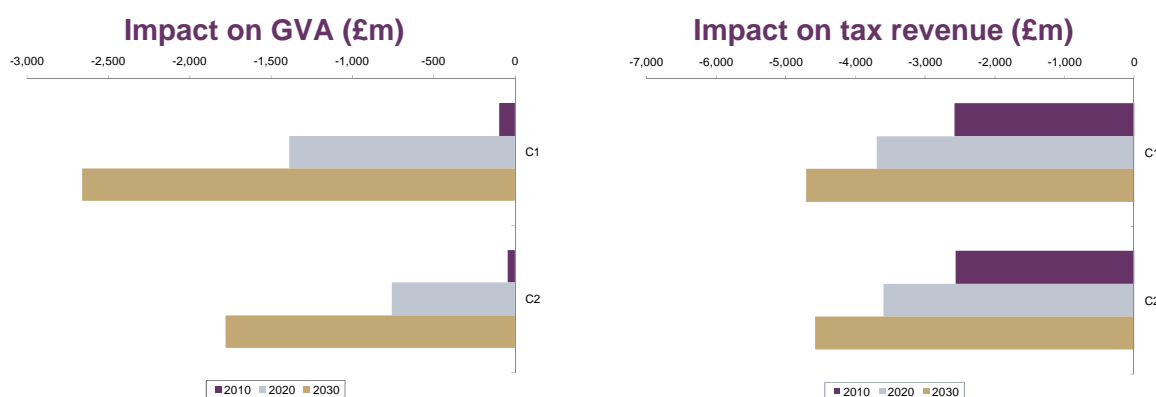
- The impact of restrictive demand management which leads to low or zero growth would be very significant relative to the baseline scenario. The implied increases in fares which would restrict demand growth to the levels shown above are high, although it could be noted that, in the event of alternative regulatory mechanisms being adopted, such fare increases would not necessarily occur (for example, if fares were to become regulated

as underlying excess demand grows over time). By 2020, fares would need to rise by around 60% or more relative to the baseline if demand growth were to be addressed through the price mechanism.

- The impact of the above constrained growth options relative to the baseline is similarly significant—indeed, even more so than the impact of changes in APD over time. By 2030, the level of passenger demand would be around 41% less than under baseline B3 in the case of the zero growth in capacity scenario, or 27% less in the case of the limited growth scenario.

The direct and indirect impact on GVA and tax yield associated with the capacity-constrained scenarios is set out in Figure 5.10.

Figure 5.10 Capacity-constrained scenarios: net economic impact, relative to B3



Note: C1: 0% growth in capacity;
 C2: 1.5% growth in capacity to 2020, 0.5% to 2030.
 Source: Oxera.

The capacity constrained scenarios are shown to significantly reduce aviation sector GVA, along with reduced tax revenues of around £4.5 billion as a result of the significant fall in passenger volumes. The figure only shows the impact on aviation GVA that results from the reduction in passenger volumes. In practice, the capacity constraint is also likely to result in significant fare increases. The significant scarcity rents that may arise as a result of demand management, and the extent to which these can be captured by either the aviation sector or the government, would increase aviation GVA, government revenues or both.

Summary of policy scenario impacts on economic footprint

The impact of the policy scenarios on passengers, fares and the economic footprint of aviation (allowing for the substitution of resources) is summarised in Table 5.2 below. There are no changes in employment arising from reduced or increased activity in the aviation sector since any changes in that sector are assumed to be fully transferred to other sectors of the economy.

Table 5.2 Summary of policy scenario impact on economic footprint (allowing for substitution of resources)

Scenario	GVA			Tax (£m)		
	2010	2020	2030	2010	2020	2030
Baseline						
B1: APD planned 2009 & 2010 changes, EU ETS financial cost at forward 2012 carbon price (15% auctioning)	-25	-51	-66	608	822	1,038
B2: APD planned 2009 & 2010 changes, EU ETS marginal cost of carbon at forward 2012 price	-25	-74	-90	608	803	1,019
B3: APD planned 2009 & 2010 changes, EU ETS marginal cost of carbon at DECC rate	-25	-103	-263	608	780	878
B4: APD planned 2009 & 2010 changes	-25	-35	-44	608	835	1,056
High financial burden						
DfT fare elasticity (0.5)						
H1: Stepped change in APD in 2014 & 2015 equal to 2009 & 2010 changes	0	-52	-68	0	805	993
H2: 3% real growth in APD	0	-72	-223	0	1,116	3,159
H3: 5% real growth in APD	0	-131	-456	0	2,015	6,220
H4: 5% real growth in APD plus noise and local air pollution costs covered						
Higher fare elasticity (0.7)						
H5: Stepped change in APD in 2014 & 2015 equal to 2009 & 2010 changes	-14	-135	-255	-15	719	816
H6: 3% real growth in APD	-14	-166	-490	-15	1,013	2,805
H7: 5% real growth in APD	-14	-257	-847	-15	1,854	5,482
Low financial impact from security and carbon costs						
L1: Carbon costs covered by aviation through EU ETS and APD, security costs covered by general taxation	15	21	28	-576	-791	-985
L2: Carbon costs covered through EU ETS, no APD from 2010, security costs covered by general taxation	163	230	304	-3,142	-4,264	-5,277
Constrained-capacity scenarios						
C1: 0% growth in capacity	-98	-1,387	-2,663	-2,575	-3,697	-4,710
C2: 1.5% growth in capacity to 2020, 0.5% to 2030	-46	-757	-1,782	-2,566	-3,596	-4,575

Source: Oxera analysis.

5.3 Supply-side effects

As set out in section 4, there are a number of mechanisms by which changes in the level of output in the aviation sector will generate wider effects on the economy. Therefore, each set of policy scenarios will be associated with an impact on the productive capacity of the wider economy that is over and above the direct and indirect (substitution) effects described in section 5.2.

The evidence base for quantifying the extent of the wider effects is mixed: for some of the identified mechanisms, relatively little evidence on the magnitude is available; while, for others, evidence is more readily available. In particular, evidence on the impacts of the aviation sector on trade, connectivity and investment are discussed below.

It is important to note that the effects described below all represent different mechanisms by which the impact of aviation on the economy may be characterised. However, because there are overlaps between the mechanisms, it is not possible simply to add the effects together to derive the total impact. For example, the impact of aviation in terms of improving connectivity may enhance business relationships between the UK and abroad, which could lead to higher levels of investment and trade, and enhanced efficiency as businesses increase their scale of production. While this does not imply that these mechanisms are mutually exclusive (or fully overlapping), for the purpose of this report a conservative approach has been taken. In particular, the results are interpreted as providing alternative estimates of the impact of the various policy scenarios on the economy.

As discussed in section 4, one of the issues in measuring the impact of aviation on the wider economy through the various mechanisms is the need to allow for a potential dual causality—ie, does aviation cause economic growth to be higher, or does higher economic growth lead to an increase in the use of aviation services, or both? Failure to account for dual causality would attribute the entire effect to aviation alone, and thus might potentially overestimate the impact. The discussion of each of the mechanisms notes the extent to which the various estimates might be affected by dual causality.

Box 5.1 Estimating the impact of policy scenarios on employment

Changes in GVA may translate into changes in productivity (eg, a reduction in GVA may lead to a downward pressure on wages and profits), changes in employment levels, or a combination thereof. In practice, most of the changes are likely to be translated into a reduction in productivity. Therefore, while the impacts of changes in GVA on the level of jobs can be estimated, these should only be regarded as illustrative impacts of what might occur if policy changes were exclusively translated into employment rather than productivity effects.

The estimation of GVA and tax impacts shown in this report assumes that the supply-side impact of the policy scenarios is translated into reductions in employment. If, as is likely, the impact translates into changes in productivity rather than employment, the GVA and tax revenue impacts shown in this report *underestimate* the actual impact.

The trade, connectivity and investment drivers are examined below in turn, before being quantified.

5.3.1 Trade effects

To consider the impact of changes in aviation policy on the scope for trade—and hence the wider economy—it is useful to take as a starting point the current role played by the air transport sector in facilitating trade. Trade by air freight accounts for a relatively small proportion (0.8% in 2007) of total UK trade by weight, with most international freight being transported by sea (89.5% in 2007). However, the proportion of transported goods by *value* is much greater for the aviation sector, at around 32% for imports and 44% for exports, in 2007.⁴⁵ This reflects the fact that the value per unit of weight carried by air freight is much greater than that carried by sea, reflecting the characteristics of aviation; namely, that it provides rapid access across long distances, and that the costs of air freight are more sensitive to weight than those for sea transport. Aviation therefore has an important role to play in facilitating trade, particularly for goods with high value-to-weight ratios (such as express packages), or for goods and services for which time is particularly costly (for example, agricultural products requiring refrigeration).

Looking more closely at the air freight sector, it is useful to distinguish between two types of capacity offered: *belly-load* freight, which accounts for the majority of air freight and is available on passenger flights; and *freight-only* flights, which tend to dominate the mail and express parcels sectors. The distinction between these two types of freight may be relevant if they are affected differently by changes in taxation or regulatory policy.

⁴⁵ Hummels (2007), op. cit.

When identifying the impact of policy scenarios on the wider economy through trade effects, three factors need to be considered:

- how does the change in the policy environment affect the volume of air transport?
- given the impact on air transport, what might be the overall impact on trade?
- how might a change in the level of trade in goods and services affect the economy—in particular, the level of GDP, taxation revenue in the wider economy (and, assuming output changes translate into employment rather than productivity, the number of jobs)?

The following sets out the three steps followed in quantifying the supply-side impact of policy scenarios through the trade mechanism. Further details on the literature on the trade effects associated with aviation are set out in Appendix 2.

Step 1: Impact of the policy environment on air transport

The ways in which the policy scenarios could affect the air freight sector will depend on the specific scenario being considered, and, in particular, on the way in which any changes in regulation, taxation and the approach to demand management are implemented.

Taking APD as an example, air transport may be affected in a direct or indirect way. For APD levied uniquely on a per-passenger basis, the direct tax raised from air freight itself would be zero. However, if an increase in APD were to lead to a reduction in passenger demand—and hence in the volume of flights to and from the UK—belly-load capacity for freight would, nevertheless, be reduced. This would be expected to have a significant impact on the volume of goods traded by air, for a number of reasons.

- As the number of passenger flights reduces, the total capacity available for freight will fall, which may lead to higher average prices per unit of freight. Alternatively, airlines may increase charges for air freight in order to cover part of the increased cost of operating the passenger service if APD is increased. The amount of capacity reduction will depend on the size of any reduction in passenger demand, particularly in cases in which the primary economic driver for the route is the provision of the passenger service. It is assumed that the reduction in passenger demand will be followed by a reduction in passenger capacity as airlines seek to maintain economically viable load factors; and, furthermore, that belly-load capacity will fall in the same proportion.
- While some existing freight could be expected to shift to other available flights, there is a limit to how far such a shift can offset the reduction in freight capacity. In particular, average load factors for freight on passenger flights in the UK are over 80%,⁴⁶ in comparison with international levels estimated at 67%.⁴⁷
- It may not be possible to divert some trade to alternative flights, either due to changes in the destinations served or to reduction in the frequency of services.
- For some routes, utilisation rates may be higher in one direction than the other due to the nature of the goods traded between the countries in question. Much as a commuter rail line often has a relatively low average load factor (due to the impact of high utilisation) in the direction of commuter traffic, but low utilisation in the reverse direction, this will place a limit on the extent to which load factors may be increased.

Freight-only flights would not be affected in the scenario of a change in passenger taxes, and indeed may be used to a greater extent. This would limit the extent to which air freight would

⁴⁶ DfT, 'UK air freight study report', available at www.dft.gov.uk/pgr/aviation/airports/ukairstudyreport?page=12.

⁴⁷ Defra (2005), 'The Validity of Food Miles as an Indicator of Sustainable Development, Annex 1', July.

be affected by such a tax, although the impact of a policy measure affecting air freight has not been modelled in this study.

If, however, tax policy were changed to cover all flights, rather than passengers (for example, by moving to a per-plane tax), the effects on air freight would occur directly as well as indirectly, through the impact on belly-load capacity.

For the purposes of modelling the effects of the scenarios, it has been assumed that 25% of the lost capacity impact is offset through the substitution of freight to remaining services. Furthermore, recognising that some volumes may switch to freight-only flights, or modes, it is assumed that 80% of the reduced level of freight is not lost, but rather switches to alternative modes. It has also been assumed that freight-only services are unaffected by the policy changes. These might therefore be seen as conservative estimates of the impacts of the various scenarios.

Step 2: Impact on overall trade

Given that air transport accounts for only a proportion of the total of traded goods, the modelling adjusts the estimated impact of the policy scenarios on air freight to account for the proportion of air trade relative to the total trade. This is around 32% by value for imports and 44% for exports, and the modelling assumes that 60% of trade is belly-load freight.⁴⁸ In addition, the share in freight-only traffic is estimated to rise. A simple assumption is made that the share in belly-load freight declines linearly from 60% in 2010 to 40% in 2030.⁴⁹ The outcome of this calculation is to provide an estimate of the percentage change in total freight to and from the UK in relation to any given policy option affecting the aviation sector.

Step 3: Impact on the economy

Finally, the impact of any reduction in trade is linked to the wider effects on the economy, on the basis of evidence of the relationship between trade and economic development. Studies covering a wide range of countries indicate both that there is a significant relationship between trade and economic growth, and that this relationship operates in both directions—ie, additional trade can generate increased levels of per-capita income. The evidence suggests that the relationship may be one-to-one (ie, a given percentage increase or decrease in trade has an equivalent longer-term impact on GVA) or greater, and for the modelling a one-to-one relationship is assumed.⁵⁰ From the impact of changes in policies on trade—and hence GVA—further calculations on taxation (and employment) effects are derived through application of the average relationships between GDP and these variables.⁵¹

5.3.2 Connectivity effects

As for the trade-based mechanism, the impact of policy changes affecting the aviation sector through the connectivity mechanism is quantified through the following steps.

- Step 1: the impact of changes in aviation policy on the sector is identified;
- Step 2: the impact of changes in aviation demand on measures of international connectivity is identified;

⁴⁸ Hummels (2007), op. cit.

⁴⁹ This assumption is informed by evidence used in the following publications from the Department for Transport (2000), 'UK Air Freight Study Stage 1, MDS Transmodal', August; 'UK Air Freight Study Stage 2, MDS Transmodal', August 2001; and Halcrow (2002), 'SERAS Stage 2, Appraisal Findings Report—Supporting Documentation: Freight Forecasting', May 2002.

⁵⁰ Noguera, M. and Siscart, M. (2005), 'Trade raises income: a precise and robust result', *Journal of International Economics*, 65, 447–60. This study uses an instrumental variable approach to mitigate potential dual causality between trade and GVA, and produces an estimate of the trade effect. As sensitivities, Noguera and Siscart ran the model with alternative specifications suggested in previous literature on their dataset, giving them a range of estimates from 0.82 to 1.23. As such, their preferred estimate is within the range, and provides further confidence in using this estimate. A potential caveat is that the estimate is obtained from examining the trade and income relationship across 97 countries, and is not specific to the UK. However, the use of an extensive dataset is required to estimate robustly the relationship between trade and economic growth.

⁵¹ The change in tax revenue is assumed to occur at a rate equal to the tax share in overall GVA (around 40%). Labour productivity is assumed to equal the UK economy average (at around £40,000 per employee).

- Step 3: changes in connectivity are linked to GVA and changes in tax revenues (and jobs).

Further details on the literature on aviation and connectivity are set out in Appendix 2.

Step 1: Quantifying the impact of changes in aviation policy on the sector

The impact of the scenarios on the aviation sector is captured through effects of changes in costs, due to taxation or regulation, relative to the baseline. Assuming both that costs are recovered from consumers and that consumers respond to any cost changes by demanding more or less in the way of aviation services, the amount of aviation output is estimated.

Step 2: Quantifying the impact of changes in aviation demand on connectivity

The link between changes in aviation and the level of connectivity is crucial. The aviation sector enhances the degree of connectivity in the economy as follows:

- aviation provides access to international markets;
- greater capacity, frequency and a greater number of destinations served increase the opportunities for business and cultural exchange.

Connectivity is difficult to quantify because, by its very nature, it is multi-dimensional. In essence, connectivity relates to the ability and ease with which destinations may be reached from a point of origin (or vice versa). The more destinations that can be accessed, the greater the capacity and the traffic between these destinations, and the more frequent the services to the destinations in question, the greater the level of connectivity will be. However, connectivity may also be affected by other characteristics, such as the relative importance of the destinations served and the cost of accessing them.

Since quantifying the effect of each of these characteristics would require extensive modelling beyond the scope of this study, a simplifying assumption is made that connectivity is indirectly related to the level of aviation demand. The reasoning for this assumption is as follows.

- Assuming that airlines manage capacity in order to retain viable load factors, capacity should move in line with demand, at least in the longer run.
- While capacity could be reduced by changing the number of flights or by offering less capacity per flight, it is unclear whether changes in fleet mix in future will lead, on average, to larger or smaller aircraft. On the one hand, greater use of very large aircraft, such as the A380, could lead to larger aircraft, on average; on the other, greater penetration of smaller aircraft (used primarily by point-to-point operators) could work in the opposite direction. A starting point for the analysis here is that changes in frequency would move in proportion to changes in overall demand.
- Finally, the impact of a change in passenger demand on the number of destinations served may be considered. If the pattern of routes is such that there are many routes of marginal profitability, which are rendered viable only through the impact of interlining at hub airports, then a significant reduction in demand could lead to many routes becoming unprofitable to operate. In this case, the sensitivity of the number of destinations to changes in demand could be high; on the other hand, it may be that airlines respond to changes in demand by preserving the number of destinations that they serve, albeit at reduced levels of frequency.

Given the absence of detailed evidence on these issues, and given that the size of these impacts will depend on a range of local factors, a range of 0.5–1 is deemed to be reasonable for the sensitivity of connectivity to changes in aviation demand. This implies a fares elasticity of connectivity of around 0.25–0.5 (given the DfT assumption of fares of approximately 0.5). Therefore, for example, in a policy scenario leading to a cost increase of 5% relative to the

baseline, the impact on aviation demand may be a reduction of 2.5%, and the associated impact on connectivity would be estimated at 1.25–2.5%. The results shown in this report use the lower bound of this range.

Step 3: Quantifying the impact of changes in connectivity on GVA and tax revenues

Finally, the relationship between changes in connectivity and impacts on the economy has been identified in reports, including a study by the International Air Transport Association (IATA), which finds a statistical relationship between connectivity and productivity on the basis of evidence across 48 countries. The relationship identified suggests that a 1% increase in connectivity leads to a 0.007% increase in productivity, and, assuming no change in the supply of labour, in GVA.⁵² While there might be an issue of dual causality, the estimate represents by far the lowest among the estimates reported in the literature. As such, the estimate can be regarded as conservative.⁵³

5.3.3 Investment effects

A third way of estimating the longer-term potential impact of aviation on the wider economy is to assess how it may facilitate higher levels of investment. Since investment will increase the total capital available with which labour can work, output per employee will, over time, be related to the volume of investment in the economy.

Aviation policies may play a role in attracting increasingly mobile investment, both domestic and foreign. These changes in a region's capital stock are likely to have wider effects on the overall economy.

The availability of air transport links affects investment decisions by companies and individuals, potentially encouraging businesses to locate or expand in a region. As such, policies that facilitate greater use of aviation may raise the level of investment in, and thus the underlying productivity of, the UK.

A number of studies address this link between aviation, the level of investment, and GDP, in various ways. For example:

- international transport links are a determining factor in the choice of business location, and may thus encourage inward investment. A survey of Europe's top companies found that 52% considered transport links to be a vital factor in deciding on the location of their businesses, and 58% identified good access to markets, customers and/or clients as essential;⁵⁴
- domestic firms are provided with opportunities to invest in and manage foreign-based assets;
- as transport links induce inward investment, new technologies or management techniques can be emulated by other firms, which may increase underlying productivity and therefore GVA.⁵⁵

The above factors, derived from empirical studies, suggest that aviation can enhance the level, and productivity, of investment within a region that is well served by aviation links. While the links identified above affect the level of investment, and ultimately economic

⁵² See, for example, International Air Transport Association (2007), 'Aviation Economic Benefits', IATA Economics Briefing 08, summary report, available at: <http://www.iata.org/ps/publications/aviation-benefit.htm>.

⁵³ A recent study surveyed the evidence on the link between connectivity and productivity, and identified this as the lower bound in a range of 0.007 to 0.13 provided by the empirical literature evidence. The next lowest estimate is 0.06, significantly exceeding the estimate in the IATA study. See Colin Buchanan Associates (2009), 'Economic impacts of hub airports', report for British Chambers of Commerce, July.

⁵⁴ BAA Heathrow (2007), 'Economic benefits of Heathrow – At the heart of the UK economy'.

⁵⁵ Cooper, A. and Smith, P. (2005), 'The Economic Catalytic Effects of Air Transport in Europe', *Eurocontrol*, July, 1–73.

outcomes, in a complex way, using the evidence from the above studies provides an estimate of the link between the level of aviation, investment and GDP. The following sets out the steps followed in quantifying the impact of aviation on GVA, using the investment mechanism. Further details on the literature on investment effects associated with aviation are set out in Appendix 2.

Step 1: Identifying the link between air transport usage and investment

A change in the volume of air passengers will result in a change in air transport usage, which is considered as a proxy for the strength of a country's aviation links. Cooper and Smith (2005) estimate that a 10% increase in air transport usage will tend to cause a 1.6% increase in investment in the long run.⁵⁶

Step 2: Identifying the change in GVA resulting from increased investment

A change in the level of investment is positively correlated with changes in GVA since the level of the capital stock per employee is a major determinant of labour productivity. The analysis assumes that a 1% increase in the capital stock translates into a 0.35% increase in GVA.⁵⁷

The measured impact on GVA relative to the baseline scenario associated with the various policy scenarios is shown below.

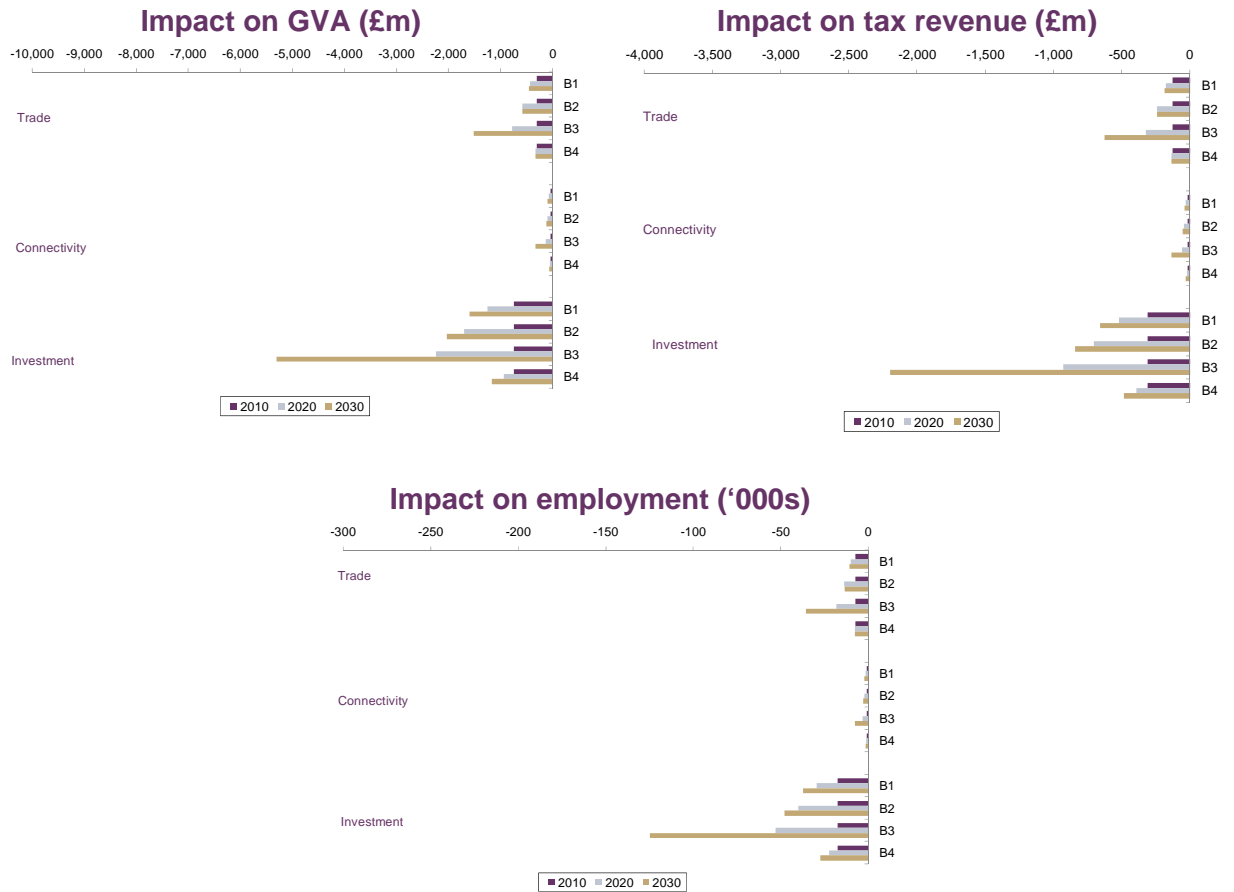
5.3.4 Baseline scenarios with additional costs of carbon

Figure 5.11 below shows the impact on the GVA of the wider economy of the baseline scenarios with additional costs of carbon and the announced changes in APD that could be expected from the effects of trade, connectivity and investment.

⁵⁶ Cooper and Smith (2005), op. cit. This figure may overestimate the impact due to potential dual causality between investment and air transport usage. As such the estimated investment effect may be regarded as the top end of the true effect of investment on GVA.

⁵⁷ Cooper and Smith (2005), op. cit.

Figure 5.11 Baseline scenarios: economic impact transmitted through supply-side mechanisms on the wider economy (relative to DfT baseline)



Note:

- B1: APD planned 2009 & 2010 changes, EU ETS 15% auction and forward 2012 carbon cost;
- B2: APD planned 2009 & 2010 changes, EU ETS marginal cost of carbon at forward 2012 price;
- B3: APD planned 2009 & 2010 changes, EU ETS marginal cost of carbon at DECC rate;
- B4: APD planned 2009 & 2010 changes.

Source: Oxera.

The key points to note from this figure are as follows.

- The impact of the planned increases in APD, together with the EU ETS effect, would be expected to lead to a fall in GVA across the economy in the range of £60m to £1.7 billion by 2020. This is in comparison to an impact from direct and indirect effects of around £70m, as identified in section 5.2. The interpretation of this is that the significant reduction in output within the aviation sector lowers productivity in the wider economy, through the trade, connectivity and investment mechanisms described earlier. A much greater impact is identified when the cost of carbon is incorporated, as per the DECC scenario, in which case the GVA impact may be as high as £2.3 billion by 2030. Although the impacts of these mechanisms cannot be simply added together, their combined effect may be greater than any individual effect.
- The impact on the tax yield could be upwards of £2 billion per annum by 2030. This reflects the reduced capacity of the economy over the longer term to produce value, which reduces the tax base. This suggests that there is a significant risk that the announced increases in APD may be counterproductive from the taxation perspective over the longer term.

5.3.5

High aviation-specific tax scenarios

Figure 5.12 shows the impact on the wider economy of the scenarios under which APD is raised significantly and a noise tax is introduced. (Only the results for the standard price elasticity are shown. Increasing the price elasticity increases the magnitude of the shown effects.)

Figure 5.12 High financial impact scenarios: impact transmitted via supply-side mechanisms to the wider economy (relative to B3)



Note:

H1: Stepped change in APD in 2014 & 2015 equal to 2009 & 2010 changes;

H2: 3% real growth in APD;

H3: 5% real growth in APD;

H4: 5% real growth in APD plus noise and local air pollution costs covered.

Source: Oxera.

The key points to note from this figure are as follows.

- The impact of the increases in ADP beyond those already planned depends on the size of the assumed growth rate for APD, but would have a negative impact of £900m by 2020 based on the effect on trade, rising to over £2 billion by 2030. These impacts are estimated to be larger when taking account of evidence on investment, and connectivity effects are lower.
- The negative impact on taxation is also significant. Depending on the size of any increase in APD, the impact could be between £140m and £380m by 2020, based on the trade mechanism, with, again, higher and lower effects based on the investment and connectivity mechanisms.
- The loss of tax revenue to the Exchequer if APD were to rise at 5% per annum in real terms would be substantial due to the loss of capacity in the wider economy. Estimates

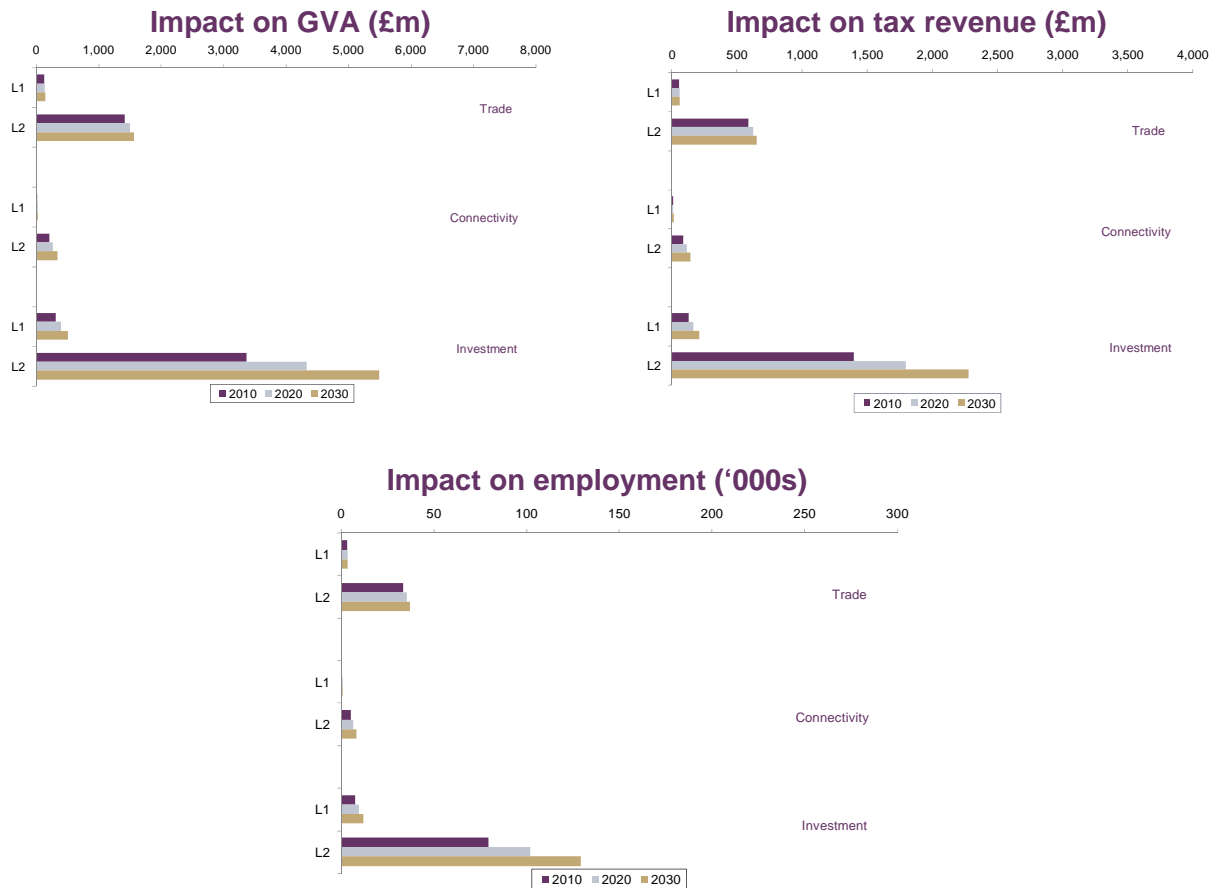
of this effect range from around £100m per annum to over £3.5 billion per annum by 2030.

5.3.6

Low financial impacts from security costs and carbon emissions

Figure 5.13 shows the impact on the wider economy of the scenarios under which security costs are covered from taxation and ADP is replaced by carbon costs (scenario L2).

Figure 5.13 Low financial impact scenarios: impact transmitted via supply-side mechanisms to the wider economy (relative to B3)



Note:

L1: Carbon costs covered by aviation through EU ETS and APD, security costs covered by general taxation;

L2: Carbon costs covered through EU ETS, no APD from 2010, security costs covered by general taxation.

Source: Oxera.

The key points to note from this figure are as follows.

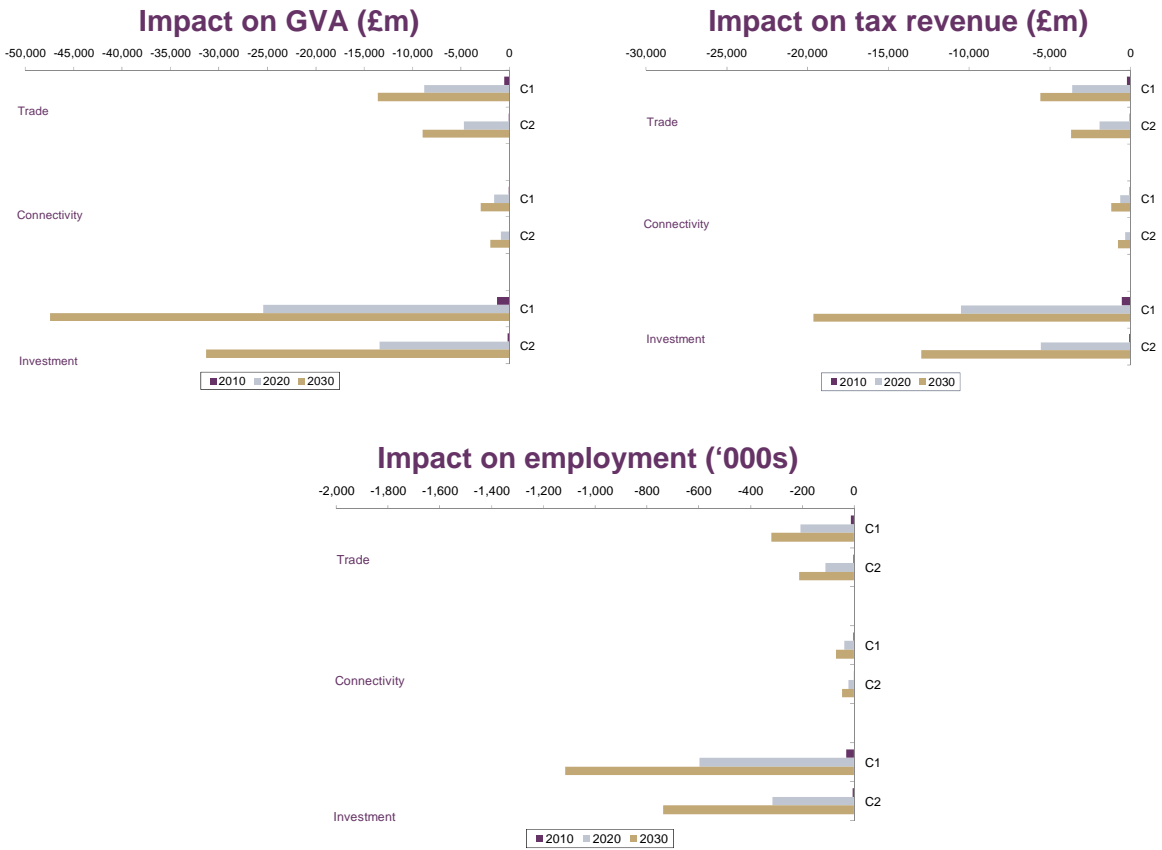
- The impacts of covering security costs from taxation are relatively minor.
- The positive impact on the economy from the elimination of APD once aviation is covering its carbon costs through entry into the EU ETS is significant for the economy. The increase in GVA could amount to around £1.5 billion based on the trade impacts, or up to £5.5 billion based on the investment impact, although the connectivity mechanism provides a lower estimate.
- The lower tax scenario—under which the industry continues to cover its carbon costs, but does not pay APD (L2)—would provide additional economic output generating around £600m additional tax revenue as estimated using the trade mechanism, with a substantially larger potential increase based on the impact of increased aviation output in generating additional investment in the economy.

5.3.7

Capacity-constrained scenarios

Figure 5.14 shows the impact on the wider economy of those scenarios under which airport capacity is artificially constrained.

Figure 5.14 Capacity-constrained scenarios: impact on demand and fares (relative to B3)



Note:
 C1: 0% growth in capacity;
 C2: 1.5% growth in capacity to 2020, 0.5% to 2030.
 Source: Oxera.

The key points to note from this figure are as follows.

- Constraining airport capacity has a very significant impact on GVA and tax revenues. Again, estimates of this impact vary according to the mechanism used. The trade-based effect indicates a loss of economy-wide GVA of around £9 billion by 2020 in the zero-growth scenario. Over the longer term, by 2030, the impact of reduced aviation output relative to a baseline case in which the industry covers its full cost of carbon, as well as bearing the planned increases in APD in 2009 and 2010, could be over £30 billion.
- This type of constraint is much more significant for the wider economy than the impact of the other policy measures modelled, given the greater impact of such policies on the level of aviation output, and hence the ability of the sector to generate wider economic benefits.
- In addition, the constraints on the ability of the aviation sector to expand would have a significant impact on the ability of the Exchequer to generate tax revenue. The estimated impacts on tax revenue from the wider economy range from a reduction of between £0.5 and £10 billion, in the case of the zero growth scenario, and nearly double these estimates by 2030.

5.4 Summary of policy scenario analysis

The following tables summarise the outcomes of the policy scenario analysis, allowing a direct comparison of the policies' GVA and tax revenue impact on the economic footprint and via the supply-side mechanisms. As discussed above, the supply-side effects represent the different mechanisms through which the impacts of aviation on the economy may be characterised. However, because there are overlaps between these mechanisms, it is not possible simply to add the effects together to derive the total impact. While this does not imply that the mechanisms are mutually exclusive (or fully overlapping), for the purpose of this report a conservative approach has been taken. In particular, the results are interpreted as providing alternative estimates of the impact of the policy scenarios on the economy.

A comparison of the direct impacts and the supply-side impacts highlights the importance of taking into account the impact on the rest of the economy when evaluating policies with respect to the aviation sector. While there is some uncertainty around the size of the supply-side effects, ignoring these wider effects when evaluating policy options could lead to outcomes significantly different to those expected.

Table 5.3 below compares the baseline policy scenario impacts on the economic footprint of the aviation sector (allowing for substitution) and the impact on the sector through the supply-side mechanisms. The following general patterns are evident from this comparison, further illustrated with an example.

- **GVA impact**—even the lowest estimate of the supply-side mechanism impact (connectivity) exceeds the direct impact on the economic footprint. For example, the impact on direct GVA of the planned APD increases in 2009 and 2010 (Scenario B4) is estimated to lead to a reduction of around £40m in 2030, and the corresponding reductions resulting from the supply-side mechanisms are £70m (connectivity), £330m (trade) and £1,170m (investment).
- **Tax impact**—while the estimated increase from APD proceeds is significant, the scenario analysis demonstrates a significant offsetting effect, which reduces or in some instances outweighs the impact of a direct increase in revenue. Again, using scenario B4 as an example, the estimated increase in direct tax revenue of around £1.06 billion in 2030 compares to a reduction in revenue of £30m (connectivity), £140m (trade) and £450m (investment).
- **Employment impact**—assuming that the impact translates into employment rather than productivity changes, the employment impact via supply-side mechanisms is an estimated reduction of around 2,000 (connectivity), 8,000 (trade) and 28,000 (investment) employees. Since, as is likely, the impact translates into a reduction in wages and hence productivity, rather than jobs, the GVA impact is underestimated. There is no net direct impact as jobs lost in the aviation sector would be replaced by expanding employment in other sectors of the economy.

Table 5.3 Summary of baseline scenarios

Scenario	GVA (£m)			Tax (£m)			Employment ('000s)		
	2010	2020	2030	2010	2020	2030	2010	2020	2030
B1: APD planned 2009 & 2010 changes, EU ETS financial cost at forward 2012 carbon price (15% auctioning)									
<i>Net impact on economic footprint</i>	-25	-51	-66	608	822	1,038	0	0	0
Connectivity	-47	-79	-100	-19	-33	-41	-1	-2	-2
Trade	-314	-435	-456	-130	-180	-189	-7	-10	-11
Investment	-748	-	-1,597	-310	-520	-661	-18	-30	-38
		1,256							
B2: APD planned 2009 & 2010 changes, EU ETS marginal cost of carbon at forward 2012 price									
<i>Net impact on economic footprint</i>	-25	-74	-90	608	803	1,019	0	0	0
Connectivity	-47	-107	-127	-19	-44	-53	-1	-3	-3
Trade	-314	-591	-582	-130	-245	-241	-7	-14	-14
Investment	-748	-	-2,038	-310	-707	-844	-18	-40	-48
		1,706							
B3: APD planned 2009 & 2010 changes, EU ETS marginal cost of carbon at DECC rate									
<i>Net impact on economic footprint</i>	-25	-103	-263	608	780	878	0	0	0
Connectivity	-47	-141	-332	-19	-58	-137	-1	-3	-8
Trade	-314	-780	-1,517	-130	-323	-628	-7	-18	-36
Investment	-748	-	-5,309	-310	-932	-	-18	-53	-125
		2,251				2,199			
B4: APD planned 2009 & 2010 changes									
<i>Net impact on economic footprint</i>	-25	-35	-44	608	835	1,056	0	0	0
Connectivity	-47	-59	-73	-19	-25	-30	-1	-1	-2
Trade	-314	-329	-336	-130	-136	-139	-7	-8	-8
Investment	-748	-948	-1,175	-310	-393	-487	-18	-22	-28

Source: Oxera analysis.

Table 5.4 compares the high financial burden policy scenario impact on the economic footprint of the aviation sector (allowing for substitution) and the impact via the supply-side mechanisms. The following general patterns are evident from this comparison, further illustrated with an example.

- **GVA impact**—even the lowest estimate of the supply-side mechanism impact (connectivity) exceeds the direct impact on the economic footprint. For example, assuming that following the planned increases in 2009 and 2010, and assuming that APD continues to grow by 5% in real terms (Scenario H4),⁵⁸ direct GVA is estimated to be reduced by £470m in 2030, and the corresponding reductions via supply-side

⁵⁸ The scenario also assumes that aviation covers its noise and local air pollution costs. This impact is relatively minor.

mechanisms are further reductions of £530m (connectivity), £2.4 billion (trade) and £8.5 billion (investment).

- **Tax impact**—while the estimated increase from APD proceeds is significant, the scenario analysis demonstrates a significant offsetting effect which reduces or in some instances outweighs the direct revenue increase impact. Again, using scenario H4 as an example, the estimated increase in direct tax revenue of around £6.2 billion in 2030 compares to a reduction in revenue of £220m (connectivity), £1 billion (trade) and £3.5 billion (investment).
- **Employment impact**—assuming that the impact translates into employment rather than productivity changes, the employment impact via supply-side mechanisms is an estimated reduction of around 13,000 (connectivity), 57,000 (trade) and 200,000 (investment) employees. Since, as is likely, the impact translates into a reduction in wages and hence productivity, rather than jobs, the GVA impact is underestimated. There is no net direct impact since jobs lost in the aviation sector would be replaced by expanding employment in other sectors of the economy.

Table 5.4 Summary of high financial burden scenarios (with DfT fare elasticity of 0.5)

Scenario	GVA (£m)			Tax (£m)			Employment ('000s)		
	2010	2020	2030	2010	2020	2030	2010	2020	2030
H1: Stepped change in APD in 2014 & 2015 equal to 2009 & 2010 changes									
<i>Net impact on economic footprint</i>	0	-52	-68	0	805	993	0	0	0
Connectivity	0	-61	-77	0	-25	-32	0	-1	-2
Trade	0	-337	-352	0	-139	-146	0	-8	-8
Investment	0	-972	-1,232	0	-402	-510	0	-23	-29
H2: 3% real growth in APD									
<i>Net impact on economic footprint</i>	0	-72	-223	0	1,116	3,159	0	0	0
Connectivity	0	-85	-251	0	-35	-104	0	-2	-6
Trade	0	-469	-1,149	0	-194	-476	0	-11	-27
Investment	0	-1,353	-4,022	0	-561	-1,666	0	-32	-95
H3: 5% real growth in APD									
<i>Net impact on economic footprint</i>	0	-131	-456	0	2,015	6,220	0	0	0
Connectivity	0	-155	-516	0	-64	-214	0	-4	-12
Trade	0	-858	-2,357	0	-355	-976	0	-20	-55
Investment	0	-2,475	-8,250	0	-1,025	-3,417	0	-58	-194
H4: 5% real growth in APD plus noise and local air pollution costs covered									
<i>Net impact on economic footprint</i>	-8	-142	-471	-6	2,002	6,193	0	0	0
Connectivity	-10	-168	-532	-4	-69	-220	0	-4	-13
Trade	0	-929	-2,432	0	-385	-1,007	0	-22	-57
Investment	-161	-2,682	-8,512	-67	-1,111	-3,525	-4	-63	-200

Source: Oxera analysis.

Table 5.5 compares the low financial burden policy scenario impact on the economic footprint of the aviation sector (allowing for substitution) and the impact via the supply-side

mechanisms.⁵⁹ The following general patterns are evident from this comparison, further illustrated with an example.

- **GVA impact**—even the lowest estimate of the supply-side mechanism impact (connectivity) exceeds the direct impact on the economic footprint. For example, assuming that allowing carbon costs to be covered through the EU ETS, and APD to be abolished from 2010 onwards, and allowing for security costs to be covered by general taxation (Scenario L2), direct GVA is estimated to increase by £300m in 2030, and the reinforcing effects via the supply-side mechanisms are further increases of £340m (connectivity), £1.6 billion (trade) and £5.5 billion (investment).
- **Tax impact**—the direct tax revenue reduces significantly with only part of the reduction in APD being offset by increases in tax revenues from the aviation sector.⁶⁰ Under scenario L2, direct tax revenue is estimated to decline by £5.3 billion in 2030. However, some of this is offset by increases in tax revenues via the supply-side mechanisms, namely £140m (connectivity), £650m (trade) and £2.3 billion (investment).
- **Employment impact**—assuming that the impact translates into employment rather than productivity changes, the employment impact via supply-side mechanisms is an estimated increase of around 8,000 (connectivity), 37,000 (trade) and 129,000 (investment) employees. Since, as is likely, the impact translates into a reduction in wages and hence productivity, rather than jobs, the GVA impact is underestimated. There is no net direct impact since jobs gained in the aviation sector would be offset by a reduction in employment in other sectors of the economy.

Table 5.5 Summary of low financial burden scenarios

	GVA (£m)			Tax (£m)			Employment ('000s)		
	2010	2020	2030	2010	2020	2030	2010	2020	2030
L1: Carbon costs covered by aviation through EU ETS and APD, security costs covered by general taxation									
<i>Net impact on economic footprint</i>	15	21	28	-576	-791	-985	0	0	0
Connectivity	19	25	32	8	10	13	0	1	1
Trade	131	139	145	54	57	60	3	3	3
Investment	311	400	507	129	166	210	7	9	12
L2: Carbon costs covered through EU ETS, no APD from 2010, security costs covered by general taxation									
<i>Net impact on economic footprint</i>	163	230	304	-3,142	-4,264	-5,277	0	0	0
Connectivity	211	271	344	87	112	142	5	6	8
Trade	1,417	1,502	1,571	587	622	650	33	35	37
Investment	3,372	4,335	5,497	1,396	1,795	2,276	79	102	129

Source: Oxera analysis.

Table 5.6 compares the capacity constrained policy scenario impact on the economic footprint of the aviation sector (allowing for substitution) and the impact via the supply-side mechanisms. The following general patterns are evident from this comparison, further illustrated with examples.

⁵⁹ Only estimates based on the DfT's assumed price elasticity are shown. Assuming a greater response to fares increases the size of impacts.

⁶⁰ As discussed, EU ETS revenues are not included as tax revenue.

- **GVA impact**—even the lowest estimate of the supply-side mechanism impact (connectivity) exceeds the direct impact on the economic footprint. For example, assuming that demand management restricts capacity growth to 1.5% up to 2020, and 0.5% to 2030 (Scenario C2) results in a reduction in direct GVA by around £1.8 billion, and the corresponding impact via the supply-side mechanisms are further reductions of £2 billion (connectivity), £9 billion (trade) and £31 billion (investment).
- **Tax impact**—the estimated decrease in overall tax revenue, due to both lower APD receipts and reduced activity in the aviation sector and the economy, is significant. Under scenario C2, the estimated reduction in direct tax revenue is around £4.6 billion in 2030 with a further reduction in revenue of £800m (connectivity), £3.7 billion (trade) and £13 billion (investment).
- **Employment impact**—assuming that the impact translates into employment rather than productivity changes, the employment impact via supply-side mechanisms is an estimated reduction of around 46,000 (connectivity), 211,000 (trade) and 737,000 (investment) employees. Since, as is likely, the impact translates into a reduction in wages and hence productivity, rather than jobs, the GVA impact is underestimated. There is no net direct impact since jobs lost in the aviation sector would be replaced by expanding employment in other sectors of the economy.

Table 5.6 Summary of constrained-capacity scenarios

	GVA (£m)			Tax (£m)			Employment ('000s)		
	2010	2020	2030	2010	2020	2030	2010	2020	2030
C1: 0% growth in capacity									
<i>Net impact on economic footprint</i>	-98	-1,387	-2,663	-2,575	-3,697	-4,710	0	0	0
Connectivity	-81	-1,589	-2,965	-34	-658	-1,228	-2	-37	-70
Trade	-546	-8,813	-13,555	-226	-3,650	-5,614	-13	-207	-319
Investment	-1,299	-25,429	-47,443	-538	-10,531	-19,648	-31	-598	-1,115
C2: 1.5% growth in capacity to 2020, 0.5% to 2030									
<i>Net impact on economic footprint</i>	-46	-757	-1,782	-2,566	-3,596	-4,575	0	0	0
Connectivity	-13	-839	-1,958	-5	-348	-811	0	-20	-46
Trade	-85	-4,653	-8,953	-35	-1,927	-3,708	-2	-109	-211
Investment	-203	-13,427	-31,336	-84	-5,560	-12,977	-5	-316	-737

Source: Oxera analysis.

Assessment of aviation sector tax contribution and environmental costs

Key messages

- In 2007, the annual tax and regulatory burden on the aviation sector exceeds the negative externalities by up to £0.6 billion (real 2007 prices) when considering central estimates of the climate change costs of the sector. This figure is expected to rise to £0.7–£1.1 billion by 2012 as a result of the increases in APD announced for 2009 and 2010. However, given the difficulties in determining the true climate change costs, uncertainty remains around these estimates.
- Compared with its GVA, the aviation sector tax base is taxed a similar amount as the economy overall before accounting for APD (around 32% of GVA), and this contribution is significantly higher once APD is taken into account (54% in aviation compared with 32% for the economy overall). As such, the expected contribution of aviation through APD, the EU ETS and the CRC exceeds the central estimate of external environmental costs by £0.7–£1.1 billion in 2012. When this contribution (over and above environmental costs) is added to other taxes raised within the sector (corporation tax, national insurance and income tax), the total as a proportion of GVA exceeds that of the economy overall.
- The tax burden faced by the UK aviation sector via APD is higher than that resulting from aviation taxes in other European countries, which either have lower or no aviation taxes.

The aviation sector is subject to a range of taxes and regulations. These may be designed to raise revenue for general government expenditure, or to offset negative environmental externalities. Taxes can help address environmental costs, either by encouraging changes in the behaviour of end-users, or by using the revenues collected to implement measures to counteract such effects. In addition to taxes, various regulations may be implemented in order to address issues such as safety and security.

This section looks at the tax and regulatory burden in the aviation sector and summarises evidence on costs, before considering the evidence on the extent to which the sector ‘pays its way’ relative to other sectors, and whether it covers its negative externalities. The tax burden on the aviation sector in the UK is also compared to the tax burden in other European countries.

The tax and regulatory burden which are addressed in this section include the following:

- Air Passenger Duty (APD);
- the European Union Greenhouse Gas Emission Trading System (EU ETS);
- Administered Incentive Pricing;
- the Carbon Reduction Commitment (CRC);
- aviation security.

While these do not represent the total tax burden of the sector (eg, business rates and National Insurance Contributions are excluded), a number of key findings of the analysis may be noted.

- By 2012, the total tax contributions of the aviation sector, together with the costs associated with its regulatory burden, are expected to be greater than its negative externalities by around £0.7–£1.1 billion (real 2007 prices) when valuing climate change

costs on the basis of the DfT's central estimate. However, given the difficulties involved in determining the true extent of climate change costs, uncertainty remains around these estimates.

- Compared with its GVA, the aviation sector tax base is taxed a similar amount as the economy overall before accounting for APD (around 32% of GVA), and this contribution is significantly higher once APD is taken into account (54% versus 32% compared with the economy overall).
- When compared with aviation sectors in some other European countries, the UK aviation sector is found to face a higher tax burden. This is primarily due to the application of APD in the UK, with other European countries imposing lower or no aviation-specific taxes.

6.1 Aviation taxes and the regulatory burden

6.1.1 APD

APD is an excise duty charged on the carriage of chargeable passengers travelling from UK airports (subject to the flight in question falling within the rules of the scheme). APD is paid by the operator of the aircraft. The focus of APD is on raising revenue rather than on mitigating climate change improvements, given the structure of how it is assessed. Rather than being directly linked to the emissions associated with flights, it is applied on a per-passenger basis. However, the application of different levels of APD for different distance bands will tend to lead to at least some correlation between APD and emissions. In particular, the charge is currently lower for flights to European Economic Area (EEA) destinations (and those in the European Common Aviation Area) than for flights outside the EEA, with further banding of the APD by distance to be introduced in November 2009.⁶¹

The November 2008 pre-Budget report set out plans to increase the rates of APD in November 2009 and November 2010. The timeline of historical changes to APD and the revenues raised from the scheme are set out in Appendix 4 (see Table A4.1).

Impact of APD

The impact on average fares of the changing level of APD is shown in Table 6.1.

⁶¹ HM Revenue & Customs (2009), 'Changes to Air Passenger Duty. Summary: Intervention & Options', March, available at <http://www.hmrc.gov.uk/ria/apd-reform-ia.pdf>.

Table 6.1 Impact of changing APD on air fares

	Impact of APD (real 2007 prices)
Average return fare in 2008:UK residents, international travel to and from the UK¹ (£)	258.4
Average level of APD (£)²	
2008	17.5
2009	19.2
2010	23.3
Estimated return fare following APD change:(average fare in preceding year plus APD increase in given year) (£)	
2009	260.1
2010	264.1
Increase in air fare as a result of increase in APD relative to 2008 level (%)	
2009	0.7
2010	2.2

Source: ¹ ONS analysis conducted in August 2009. ² Assumes passenger composition across APD bands as follows: reduced rate (Band A: 75%, Band B: 7%, Band C: 11%, Band D: 1%) and standard rate (Band A: 2%, Band B: 1%, Band C: 1%, Band D: 0.2%). This composition has been derived from DfT (2009), 'UK Air Passenger Demand and CO₂ Forecasts', January, Table B5; and AOA data.

APD generated revenues of around £1.86 billion in 2008/09, with the Treasury estimating that this will fall to around £1.8 billion in 2009/10.⁶²

6.1.2 EU Emissions Trading Scheme

The EU ETS is a legally binding cap-and-trade scheme for carbon emissions, with the objective of reducing carbon emissions across the EU. Aviation will be included within the scheme from 2012 onwards, on the basis that carbon emissions from the aviation sector impose costs on the wider economy through their effects on climate change.

By imposing a price on carbon emissions, the EU ETS results in the costs of emissions being internalised by the sector. This will lead to increased incentives to reduce emissions, as well as to higher prices, reflecting the extent to which the industry is able to pass on the additional carbon costs.

Impact of the EU ETS

The EU ETS is expected to result in auction revenues of around £75–£115m in 2012 (in real 2007/08 prices) to the Treasury, depending on the level of the carbon allowance price (see Table A4.2 for details). The overall financial burden on the aviation sector is expected to be higher than this (at £171–£261m), as the sector will purchase emissions allowances both through government auctions and from the emissions trading market. The costs imposed on the aviation sector by the EU ETS will increase over time if the proportion of auctioned allowances is increased.

The relevant costs relating to the estimation of the impact of the EU ETS on air fares concern the opportunity costs of carbon emissions (£594–£906m).⁶³ These equal not just the costs of purchasing carbon allowances, but also the value of free allowances received, as firms have

⁶² See Table A4.1.

⁶³ This assumes that total carbon emissions from the aviation sector equal 42.7MtCO₂ in 2012. EU ETS allowances are valued at between £14/tonne (or the equivalent 2012 forward EU allowance price of €18/tonne) and £21/tonne (DECC assumptions). See Table A4.2 for details.

the opportunity to reduce their emissions and sell their free allowances. Airlines may be expected to pass through a proportion of these opportunity costs into airfares, just as the power sector has been passing through the opportunity costs of free EU ETS allowances into power prices.

Analysis conducted for Defra suggests that there is likely to be nearly 100% pass-through of the costs of emissions allowances for the majority of customers (see Appendix 4).⁶⁴ On this basis, the impact of the EU ETS on air fares in 2012 would amount to £5.0–£7.6 per passenger.

6.1.3 Administered Incentive Pricing

Administered Incentive Pricing has been applied to the allocation of spectrum to users across sectors, and has been introduced because spectrum is a scarce resource, with the use of spectrum by one entity preventing its use by other entities. By pricing spectrum, the UK regulator, Ofcom, intends to provide incentives and signals for its efficient use.

The pricing of aeronautical VHF channels is expected to be introduced in 2010.

Ofcom is expected to launch its second consultation on aeronautical Administered Incentive Pricing later in 2009, after which there will be greater clarity on its impact on the aviation sector.

6.1.4 Carbon Reduction Commitment

To be introduced in 2010, the CRC covers CO₂ emissions not already covered by the EU ETS and Climate Change Agreements.⁶⁵ Its objective is to reduce carbon emissions from the large non-energy-intensive sector, primarily by driving the uptake of energy efficiency measures.

The price of CRC permits will be fixed at £12/tonne for the first three years and will then be subject to full auctioning from April 2013. Revenues from the scheme will be recycled to participants via direct payment, which means that the scheme will remain revenue-neutral to the Exchequer. The recycling will be based on a combination of factors: the carbon emissions of the participants in 2010/11 and their performance relative to others.

The latest regulatory impact assessment on this policy was published in March 2009 and did not examine the impact on the aviation industry specifically.⁶⁶ The AOA has, however, provided to Oxera some estimates of the costs imposed by the CRC on specific airports.

Considering the DfT's forecasts for passenger numbers in 2012, the total costs of the CRC to airports may be expected to equal around £11m (real 2007/08 prices). These are derived from per-passenger costs estimated to equal £0.03–£0.10/passenger across a range of airports (if the full costs are passed through).⁶⁷ The average per-passenger cost weighted by passenger numbers across airports is estimated to equal £0.04/passenger across all airports—a figure that is substantially lower than the APD and EU ETS impacts. Nevertheless, the CRC may have a significant impact at the level of individual airports, particularly for regional airports that are not capacity-constrained and may face difficulty in increasing their level of airport charges.

6.1.5 Aviation security

With security measures at airports being enhanced in August 2006 to deal with the threat of terrorism, security costs have become an increasing proportion of airport costs in the UK. For

⁶⁴ Vivid Economics (2007), 'A study to estimate ticket price changes for aviation in the EU ETS', November.

⁶⁵ Defra, 'Carbon Reduction Commitment: Policy background', www.defra.gov.uk. Organisations will be obliged to take part in the CRC if they are in excess of a given threshold of electricity usage. The scheme's terms will cover large public and private organisations around the UK.

⁶⁶ DECC (2009), 'Updated Regulatory Impact Assessment on the Carbon Reduction Commitment (CRC)'.

⁶⁷ See Appendix 4.

instance, for the 2008–13 regulatory price control period, Heathrow’s security costs account for around 14% of its allowed operating expenditure (OPEX), with those for Gatwick equalling 25% of OPEX.⁶⁸

The average per passenger costs of security measures across a range of airports been estimated at around £2.4/passenger in 2007/08 in real 2007/08 prices based on data from airports compiled by the AOA. Applying these per passenger cost estimates to all UK passengers, results in an overall cost estimate of up to £400–500m in that year. Given that Oxera has used data from a range of sources to compile an aggregate figure on security costs, these figures should be considered an approximation.⁶⁹

Identifying what the ‘right’ amount of security is, and who should pay for it, is difficult. The first question depends on the level of risk, the potential social and economic consequences of terrorism incidents, and the extent to which the security measures in place reduce the probability of incidents occurring. These should be compared against the costs imposed (in terms of both financial impact and lost time) to ensure that a proportionate level of security requirements remains in place. The question of who should pay is also challenging. The industry clearly does not impose costs in the same way as it imposes carbon emissions on society; nevertheless, security arrangements for aviation need to reflect the actual or perceived risk associated with travelling by air. Given that the wider responsibility for security lies with government, an argument may be made that at least a proportion of security costs arising from government-imposed requirements should be covered by taxpayers rather than the industry. Indeed, in a number of European countries and the USA, the government does make a contribution towards airport security costs. In the UK, however, these costs are incurred entirely by the airports themselves.

While large regulated airports may be in a position to recover security costs through their airport charges, smaller regional airports tend to face greater competition from other airports, including regional airports in other countries at which low-cost airlines may wish to establish routes. Consequently, they may be able to pass through a lower proportion of these costs to users.

6.1.6 Summary of regulatory and tax impact

Table 6.2 summarises the regulatory and tax burden on the aviation sector, focusing on APD and the EU ETS, which form the majority of the burden.

Table 6.2 Summary of estimate regulatory and tax burden (real 2007 prices) (£ billion)

	2007	2012
Air Passenger Duty	1.99	2.44
EU ETS financial costs, 2012		0.171–0.261
Carbon Reduction Commitment		0.011
Security costs (upper bound)	0.4–0.5	0.4–0.5
Administered Incentive Pricing		Unknown
Total	2.4–2.5	3.0–3.2

Source: HMRC; Department for Transport (2009), ‘UK Air Passenger Demand and CO₂ Forecasts’, January; information provided by the AOA to Oxera on July 10th 2009 and September 1st 2009; and Oxera analysis.

⁶⁸ CAA (2008), ‘Economic Regulation of Heathrow and Gatwick Airports 2008–2013: CAA Decision’, March 11th, Tables 5-6, 5-7, 5-10 and 5-11, available at http://www.caa.co.uk/docs/5/ergdocs/heathrowgatwickdecision_mar08.pdf

⁶⁹ The estimate was compiled using DfT/CAA passenger numbers and information on security costs provided by AOA from its members.

6.2 Does aviation pay its way?

The objectives of imposing taxes are twofold: to pay for public spending and to provide incentives for efficient responses to externalities. These issues are addressed below, first assessing the size of the externalities created by the aviation sector, before comparing the UK aviation sector's tax burden with the average tax burden in the economy and with that across the EU.

6.2.1 The aviation tax burden relative to externalities

A range of externalities arise in the aviation sector, imposing costs on the rest of the economy; examples include:⁷⁰

- climate change effects due to emissions of CO₂ and other greenhouse gases;
- the impact on local air quality through emissions of NO_x and SO₂;
- noise;
- the impact on landscape, heritage and habitats for wildlife;
- congestion on roads to airports, which can create CO₂ impacts, but may also lead to delays for both airline passengers and other road users.

As the largest of the externalities of aviation arises through its climate change impacts, this has formed the focus of most of the studies looking at the costs imposed by aviation. While local air quality and noise effects have also been quantified, the analysis of landscape and congestion effects is limited. The externalities of aviation estimated by the DfT are considered below.

Climate change

The DfT demand and CO₂ forecasts published in January 2009 provide the most recent analysis of the climate change impacts of aviation.⁷¹ The forecasts:

- show that emissions from domestic flights and flights departing the UK equalled 37.5MtCO₂ in 2005;
- confirm that the appropriate value of the radiative forcing effect should equal 1.9 (lying in the 1–4 range). This factor incorporates the heightened impact on climate change of emissions at altitude.
- use DECC's guidance, published in 2007, on the shadow price of carbon.⁷²

The uncertainty regarding the radiative forcing is reflected in the wide range used by the DfT. Table 6.3 summarises the results of this analysis.

⁷⁰ <http://www.dft.gov.uk/pgr/aviation/airports/ccinvestigation.pdf>

⁷¹ Department for Transport (2009), 'UK Air Passenger Demand and CO₂ Forecasts', January.

⁷² Defra (2007), 'How to use the Shadow Price of Carbon in policy appraisal', August.

Table 6.3 Climate change costs of aviation (2007 prices) (£ billion)

Scenario	2005	Implied 2007 costs	Implied 2012 costs
Radiative forcing factor¹			
1	0.9	1.0	1.1
1.9	1.7	1.7	1.9
4	3.4	3.5	3.9
Shadow price of carbon			
Central + 20%	2.1	2.1	2.3
Central	1.7	1.7	1.9
Central –10%	1.5	1.6	1.8

Note: The DfT forecasts were in real 2006 prices. These were inflated to real 2007 prices using the GDP deflator. The implied 2009 and 2012 costs have been estimated by multiplying the 2005 costs by the ratio of CO₂ emissions in 2009 (40.2Mt CO₂) and 2012 (42.7Mt CO₂) by those in 2005 (37.5Mt CO₂). Emissions in 2009 and 2012 have been obtained by linearly interpolating DfT data between 2005, 2010 and 2015.¹ An IPCC study in 1999 estimated the RFI to equal 2.7, with a sensitivity range of 2 to 4. See Intergovernment Panel on Climate Change (1999), 'Aviation and the Global Atmosphere', quoted in Department for Transport (2009), 'UK Air Passenger Demand and CO₂ Forecasts', January, para 3.18. This was based on evidence from a 1992 fleet. More recently, the RFI was estimated by Sausen et al. to equal 1.9. See Sausen, R., Isaksen, I., Grewe, V., Hauglustaine, D., Lee, D.S., Myhre, G. et al. (2005), 'Aviation Radiative Forcing in 2000: An Update on IPCC (1999)', *Meteorologische Zeitschrift*, **14**: 4, 555–61, quoted in Department for Transport (2009), 'UK Air Passenger Demand and CO₂ Forecasts', January, paragraph 3.18. This analysis was based on a 2000 fleet, and incorporated better scientific understanding which mostly reduced contrail radiative forcing. The DfT modelling uses the figure 1.9 from this analysis as the central estimate.

Source: Department for Transport (2009), 'UK Air Passenger Demand and CO₂ Forecasts', January.

Local air quality

DfT analysis in 2003 found that the local air quality impacts for all passengers at UK airports in 2000 lay in the £119–£236m range.⁷³ This was based on a 2002 study by CE Delft which estimated that the costs of all emissions from a local air quality measured on the basis of health and environmental impacts equalled €1–€2/passenger.

Noise

In its estimation of the externalities of aviation in 2003, the DfT estimated that the monetary value of the effects of noise caused by aviation ranged between 36 and 40 pence/passenger at Heathrow.⁷⁴ At other airports in the south-east, these costs were less than 5 pence/passenger. On this basis, the total noise costs of aviation were estimated at £25m in 2000.

Applying aviation costs of 40 pence/passenger to Heathrow Airport results in total noise costs from that airport equalling £33m in 2007 and £36m in 2012 (in real 2007 prices). Assuming costs of 5 pence/passenger at all other airports results in noise cost estimates of £10m and £11m across those airports in 2007 and 2012 respectively, resulting in aggregate costs of £44m and £47m in the two years.

6.2.2

Summary

Comparing estimates of the externalities of aviation with the tax burden on the sector, Table 6.4 shows that the total tax burden is up to £0.6 billion higher than the negative externalities of the sector in 2009, using the DfT's central estimate of the climate change costs of aviation based on a radiative forcing factor of 1.9.

Furthermore, after the inclusion of the sector in the EU ETS and the introduction of the CRC, the extent by which the tax burden covers the negative externalities rises. Under the central

⁷³ http://www.hm-treasury.gov.uk/d/Aviation_Environment.pdf

⁷⁴ http://www.hm-treasury.gov.uk/d/Aviation_Environment.pdf

estimates of the climate change costs of aviation, the tax burden is expected to be £0.7–1.1 billion higher than the negative externalities.

However, in reviewing these results, the considerable uncertainty surrounding the estimates of the radiative forcing factor and consequently around the economic and environmental impact of aviation on climate change (alongside its other negative externalities) needs to be borne in mind.

In particular there is debate around the appropriateness of using a multiplicative radiative forcing index to measure the impact of non-CO₂ emissions at altitude. This is because its value is expected to vary over time as different non-CO₂ gases remain in the atmosphere for differing lengths of time, and therefore the relative concentrations of long- and short-lived gases changes over time.⁷⁵

Note also that Table 6.4 does not incorporate the full tax burden of the sector, instead covering the direct taxes placed on the sector alone. The full burden is dealt with in section 6.3.

Table 6.4 External costs versus regulatory burden on aviation, real 2007 prices (£ billion)

	2007	2012
Total costs		
Government carbon emissions cost assessment (including the radiative forcing factor)	1.7	1.9
Noise ¹	0.04	0.04–0.05
Local air quality ¹	0.2–0.3	0.2–0.4
Total	1.9–2.1	2.1–2.3
Regulatory burden		
APD	2.0	2.4
APD + EU ETS	2.0	2.6–2.7
APD + EU ETS + CRC	2.0	2.6–2.7
APD + EU ETS + CRC + security costs	2.4–2.5	3.0–3.2
Net impact (total tax raised less costs)	0.3 to 0.6	0.7 to 1.1

Note: ¹ Per-passenger costs assumed to remain constant over time.

Source: HMRC; Department for Transport (2009), 'UK Air Passenger Demand and CO₂ Forecasts', January; information provided by the AOA to Oxera on July 10th 2009 and September 1st 2009; HM Treasury and Department for Transport (2003), 'Aviation and the Environment. Using Economic Instruments', March; and Oxera analysis.

The key message from Table 6.4 is that the sector, taking account of APD alone, will cover its environmental costs, including the impact of radiative forcing when using the central estimate of climate change costs.⁷⁶ Furthermore, in the UK the aviation sector contributes a significant amount towards national security, which in other countries is often funded by taxpayers. Adding this contribution leads to a further increase in the margin by which contributions exceed the external environmental costs, of £0.7–£1.1 billion.

⁷⁵ For example, Sustainable Aviation (2008), 'Non-CO₂ Climate Change Effects of Aviation Emissions', November, available at <http://www.sustainableaviation.co.uk/images/stories/key%20documents/nonco2papernov08.pdf>

⁷⁶ The fact that climate change costs are based on projections made in 2005 (see Table 6.3) means that passenger volumes, and hence emission costs, are likely to be *higher* than if demand assumptions had been used that fully reflect the economic cycle. In order to attempt to allow for differences in economic conditions not reflected in the projections made in 2005, the comparison between costs and tax contributions in this section is based on 2007/08 figures, rather than 2008/09 actuals or 2009/10 projected revenues. It is of note, however, that, when using the 2008/09 or 2009/10 APD figures, the difference between tax contribution and external costs balance is reduced, but remains positive.

6.3 Comparison of aviation tax burden with UK average

The aviation sector is often criticised for not contributing its fair share of tax due to its exemption from VAT and fuel duty. To examine this, the total tax contributed by the sector to the Exchequer can be compared with the average tax burden across the economy as a whole. To ensure a similar basis for this comparison, the tax payments are expressed as a percentage of their respective GVA, and only tax categories for which information is readily identifiable and attributable to the aviation sector (but nonetheless covering a significant proportion of the tax contribution) are compared.

Aviation contributes to the UK Exchequer through its payment of personal income tax and National Insurance Contributions of its employees, corporation tax on profits and APD. However, it is exempt from VAT on its sales (as are all public transport and exports from the EU) and fuel duty (as is the case for all public transport). As set out in section 3.1 (Table 3.1) and replicated below, the total contribution from these taxes from the aviation sector is estimated to be around £4.8 billion. This underestimates the total tax collected from the sector since it does not account for other taxes such as excise duties and business rates.⁷⁷

Tax revenues across the wider economy are generated from income tax, National Insurance Contributions, corporation tax, VAT and fuel duties, as well as other taxes such as excise duties, stamp duties and business rates. To ensure comparability with the tax contribution of aviation, it is initially assumed that contributions from other taxes, such as excise duties, stamp duties and business rates, are similar and proportional to the respective GVAs, in which case their exclusion would not affect any relative assessment of the tax contribution of the aviation sector.⁷⁸ Using information on tax revenues from the HM Treasury's Budget 2009 report,⁷⁹ the economy's overall contribution from income tax, National Insurance Contributions, corporation tax and fuel duties is calculated to be £399.6 billion.

Table 6.5 summarises the assumptions and findings of the comparison.

Table 6.5 Comparison of direct tax contribution of aviation and the wider economy (£ billion, 2007/08)

Category	Aviation	UK economy
Income tax	1.5 ¹	147.4
National Insurance Contributions	0.9 ¹	100.4
Corporate tax	0.41 ¹	46.3
APD	2.0 ¹	0.0
VAT	0.0	80.6
Fuel duties	0.0	24.9
Total tax contribution	4.8¹	399.6
GVA	8.8	1,245
Tax to GVA ratio	54.5%	32.1%

Note: Aviation does not pay VAT and fuel duties. ¹ Figures taken from Table 3.1, which in turn are based on Oxford Economic Forecasting (2006), and HM Treasury (2009), 'Budget 2009', April; Source: Oxford Economic Forecasting (2006); ONS; HM Treasury (2009), 'Budget 2009', April; and Oxera analysis.

⁷⁷ Reliable data is not available to estimate the amount of these taxes contributed by aviation.

⁷⁸ APD is also excluded from the contribution of the overall-economy figure. However, this has only a minor impact on the comparison—including APD would increase the economy wide tax to GVA ratio by only 0.2%.

⁷⁹ HM Treasury (2009), 'Budget 2009', April

As detailed in Table 6.5, the tax revenue received from the wider economy in 2007/08 was around £400 billion and is equivalent to a tax to GVA ratio of 32.1%. Hence, aviation, which as a tax base contributes 54.5% of its GVA, contributes significantly more than the economy on average.

Comparison of tax contribution using different assumptions

Several alternative assumptions could be made in comparing the tax contribution of aviation and the overall UK economy.

- **Excluding APD from the comparison.** A major component of the total tax contribution of aviation to the UK Exchequer is the tax revenue from APD. APD receipts have increased by around a 50%, from £806m in 2001/02 to £1,994m in 2007/2008.⁸⁰ Excluding the APD contribution of around £2 billion in 2007/08, the total tax to GVA ratio for aviation is estimated at 32.5% in 2007/08, which is similar to the corresponding ratio of 32.1% for the economy overall.
- **Including both direct and indirect aviation GVA and tax contribution.** While a detailed estimation of the tax contribution of supply chain of the aviation sector has not been undertaken, a simple estimate can be made as was done in section 3, whereby the tax contribution is assumed to be similar to that of the economy on average (ie, around 32%). The total tax contribution thus estimated is £7.8 billion.⁸¹ With estimated combined GVA of around £18.4 billion,⁸² the tax to GVA ratio is 43%, which is significantly higher than the economy average of 32%. If APD is excluded from the calculation, the contribution is similar to the economy overall at around 32%.
- **Including an estimate of other taxes paid by the aviation sector and the economy.** As discussed above, the contributions from other taxes are assumed similar and proportional to the respective GVAs. For the economy overall, including all tax revenues,⁸³ the tax to GVA ratio is 41.4% in 2007/08 (compared to around 32% excluding other taxes). Including an estimate of other taxes on the basis of the assumption that these are paid in proportion to GVA (ie around 9.3% of GVA) shows the following:
 - as a proportion of direct aviation GVA, the tax contribution is 65% (52% when including total GVA and tax) if APD is included in the comparison, which is significantly higher than the contribution of 41.4% for the economy overall
 - as a proportion of direct aviation GVA, the tax contribution is around 42% as a proportion of direct GVA (and when including total GVA and tax) when excluding APD from the comparison, which is similar to the contribution of £41.4 for the economy overall.

Therefore, compared with its GVA, the aviation sector tax base is taxed a similar amount as the economy overall before accounting for APD, and this contribution is significantly higher once APD is taken into account.⁸⁴

While a full analysis of the overall costs and benefits of the aviation sector is beyond the scope of this study, a combination of the analyses on whether aviation's contribution is 'fair' (as presented in this section) and whether it covers its costs (as presented in section 6.2)

⁸⁰ This is equivalent to an increase in its share in overall tax from 0.25% (in 2001/02) to 0.44% (in 2007/08). The planned increases in 2009 and 2010 will further increase this tax burden.

⁸¹ £4.8 billion in direct tax and £3 billion from the activities of the supply chain.

⁸² £8.8 billion from aviation directly and £9.6 billion from the activities of the supply chain.

⁸³ This raises the tax revenues in 2007/08 to around £516 billion. HM Treasury (2009), 'Budget 2009', April.

⁸⁴ The contrast with other public transport sectors is also significant. A study by Volterra showed that in 2000/01 the rail and bus sectors were net recipients of tax revenues (ie, subsidies exceeded tax revenues from the sector), compared with the aviation sector's significant tax contribution. See Volterra (2003), 'Fiscal Treatment of Public Transport', November.

can be used to draw broad conclusions. As shown in section 6.2, the expected contribution of aviation through APD, the EU ETS and the CRC exceeds the external environmental costs by £0.7–£1.1 billion, although there is uncertainty around this estimate. When this contribution (over and above environmental costs) is added to other taxes raised within the sector (corporation tax, National Insurance Contributions and income tax), the total as a proportion of GVA exceeds that within the economy overall.

6.4 Comparison of UK aviation tax burden with other European countries

The tax burden borne by aviation includes APD as well as other airport-related taxes, such as security charges and airport tax. A comparison of the tax rates across European countries shows that the tax burden borne by the aviation sector in the UK is higher than its European counterparts.

Table 6.6 presents a comparison of APD rates in the UK and other European countries, where available for 2008. The tax rate for each type of passenger is significantly higher in the UK than in France (the APD equivalent in Netherlands was recently abolished), while many other European countries do not impose any tax on passengers. The APD rates in the UK are currently higher than aviation taxes paid in other European countries.⁸⁵

Table 6.6 Aviation taxes in Europe, 2008 (€)

Country	APD				Other taxes
	EEA economy	EEA business	International economy	International business	
UK	13	25	51	102	
France	1	4	10	40	Civil aviation tax ('Solidarity Tax') of €3.92 (domestic and EEA) and €7.04 (other international) per passenger
Netherlands ¹	(11.25)		(45)		
Ireland					Airport tax €2.5–€13 per passenger Tax on departing passengers €2 per passenger (flights within 300 kilometres of Dublin Airport) and €10 per passenger (other destinations)
Greece					Airport tax €2.5–€13 per passenger
Ireland					Airport development tax of €12–€22 per passenger
Denmark					Abolished transportation tax of €10 in 2007

Note: ¹ The Dutch Government abolished these taxes from July 2009. Figures are for short- and long-haul flights respectively. A survey undertaken by Manchester Airport indicates that there are no aviation-specific taxes in Austria, Belgium (proposals recently rejected), Finland, Germany, Portugal, Sweden, Switzerland and Spain. Source: Manchester Airport (2009); GreenAir (2009), 'Dutch Government ditches eco ticket tax in efforts to halt declining traffic at Amsterdam Schiphol', news release, March 30th, <http://www.greenaironline.com/news.php?viewStory=412>; Association of European Airlines (2009), 'Air passenger tax is bad for the economy—official', news release, March 27th, <http://files.aea.be/News/News270309.pdf>

⁸⁵ Some European countries levy VAT on domestic flights, whereas the UK does not. This implies that the taxes on domestic flights in the UK may be lower than those in other jurisdictions, although the tax burden on international flights from the UK remains higher.

A1 Input–output methodology

The input-output methodology used to assess the indirect contribution of aviation presented in section 3 is described below, together with a discussion of the assumptions implicit in the model. The underlying data sources are also detailed, together with any adjustments made to the data.

A1.1 Description of modelling methodology

An input-output table represents the relationships across sectors in an economy between the use of resources in production and consumption, and provides a picture of the flows of products and services in the economy. For example, it shows the amount of hotel and catering services used in the production of one unit of aviation services. Similarly, it shows the amount of agricultural products that would be needed to produce the extra amount of catering service. These production relationships for the whole economy, which form the basis of the indirect contribution of aviation (discussed in sections 2 and 3), are represented in the ONS's Analytical input–output (IO) tables.⁸⁶

The first step of the estimation used the Analytical IO tables to calculate the amount of gross output produced in the economy from a given level of aviation input through its supply chain. The indirect GVA generated by aviation in the economy is then assessed from the amount of value added corresponding to the output produced by each sector. The indirect impact on employment is quantified as the level of employment required to produce the calculated amount of indirect GVA, given the level of productivity in the economy.⁸⁷ The latest version of the Analytical IO tables presents such relationships disaggregated by 138 sectors is available for the year 1995.⁸⁸ This level of disaggregation allows a more precise estimate of the impact of aviation.

The ONS also provides data on the output and GVA of the aviation sector from 1995 to 2007 and the analysis presented in this report is limited to these years.⁸⁹ Data is available for 'Air Transport' (category 96 in the IO tables, corresponding to SIC 62). Aviation also includes associated 'Supporting air transport services' (SIC 63.23) and hotel and catering services. However, the IO tables provide data for 'Ancillary transport services' (SIC 63) as a whole, not separately for 'Supporting air transport activities' (SIC 63.23). The impact of all supporting transport services has thus been adjusted downwards to account for the impact of supporting air transport activities only (see section A1.3 for further details).

The impact of aviation has been measured as the sum of the impacts of Air transport (SIC 62) and Supporting air transport services (SIC 63.23).

The impact of hotel and catering services associated with aviation is not included in this analysis; this is because part of this sector is already captured in SIC 62 and 63.23. For example, if an airport sub-contracts its catering services, this will be captured as an indirect impact through its expenditure on that service. The hotel and catering services associated with aviation could also have an impact through expenditure by air passengers. However, for a significant number of passengers, this is akin to induced impacts (discussed in section 3);

⁸⁶ http://www.statistics.gov.uk/about/methodology_by_theme/inputoutput/default.asp

⁸⁷ A preferred approach would be to use the productivity of each sector; however, the overall UK productivity was used owing to the lack of availability of such detailed data.

⁸⁸ These tables, however, were published only in 2002.

⁸⁹ This is available from Supply and Use tables for the respective years and can be found at http://www.statistics.gov.uk/about/methodology_by_theme/inputoutput/archive_data.asp and http://www.statistics.gov.uk/about/methodology_by_theme/inputoutput/latestdata.asp.

for example, expenditure by a passenger in an airport restaurant implies reduced expenditure in some other restaurant or on other goods and services in the economy, and hence may have a negligible net impact on the economy. However, for some traveller categories (eg, transient passengers), expenditure by passengers at airports may be additional to the UK economy, as it substitutes for expenditure in their destination country.

A1.2 Assumptions in the input–output model

As discussed in section 3, the two distinct impacts—direct and indirect—have been calculated in terms of GVA, employment and tax. The direct GVA and employment generated by aviation are available directly from the ONS,⁹⁰ while its indirect GVA and employment have been calculated using the IO Analytical tables for 1995. This part of the analysis requires certain assumptions that are implicit in the IO methodology.

- **Factor supplies meet demand.** The basic version of IO analysis assumes that the supply of factors of production (eg, labour) do not constrain the production of output, and hence the supply of output of a sector will increase to match demand. This assumption may be unrealistic in periods of very high demand, which might cause labour shortage. However, the economy usually operates at the natural rate of employment, which is below the full employment rate; hence, it is reasonable that the increases in the output of sectors, if modest, will not be hindered by a lack of resources.
- **Relative prices remain constant:** the analysis assumes that the relative prices of sectoral outputs remain constant.
- **Factor proportions remain the same.** The IO tables used in the analysis do not take into account changes in production processes and technologies that might occur in the economy following the introduction of a new policy, and hence, are static in nature. This assumption might not be unrealistic in the short run since production technologies for most products do not change significantly over a period of a few years.

In the context of quantifying the historical footprint of aviation, the most relevant assumption is likely to be the constant factor proportions. This issue would have been partly mitigated were the annual IO tables available for each year after 1995. However, the unavailability of such tables and the consequent use of the 1995 tables imply that the analysis assumes that the pattern of resource use in production is stable over time. This assumption might be particularly restrictive if the use of imports in the production of goods in the UK changes significantly, since imports constitute leakages from the economy. If, for example, aviation uses a greater proportion of imported goods in 2005 than in 1995, its contribution to the UK economy is proportionately lower in 2005.

The direct and indirect impacts of aviation reflect the impact of the presence of the aviation sector in the economy. This gives an indication of the immediate impact or footprint of aviation, but does not reflect other potential impacts on the pattern of production and consumption in the economy. For example, aviation competes with other modes of transport (eg, high-speed rail) and, in its absence, these other transport sectors may compensate for some, although not all, of the loss in aviation GVA. Similarly, resources used in the aviation business might be expected to be deployed elsewhere in the economy if no longer used in aviation. These changes are also likely to be associated with changes in the prices of aviation relative to other sectors.

The IO analysis does not take into account such changes following from a change in demand or aviation policy. Other methodologies, such as computable general equilibrium (CGE)

⁹⁰ The GVA data is available from annual Supply and Use Tables http://www.statistics.gov.uk/about/methodology_by_theme/inputoutput/archive_data.asp. The employment figures are taken from ABI.

models, can be used to take into account changes in relative prices, substitutions in consumption and production, and supply-side constraints. However, such models are considerably complex and outside the scope of this project.

While the analysis in section 3 presents the gross contribution in GVA, employment and tax, the policy scenario analysis in section 5 computes the net contribution by adopting simple assumptions about the rate at which the resources (ie, employees) generating aviation GVA following a policy shock may be deployed in the wider economy (at the overall economy average) and focusing on the difference between the loss in aviation GVA (employment and tax) and the overall economy average GVA (employment and tax)

A1.3 Estimation of indirect employment

The employment generated in the supply chain of the aviation sector is the number of employees that are required to produce the GVA generated due to aviation's expenditure, given the employment intensity per unit of GVA in the supply chain. Analysis of data on sectoral GVA and employment indicate that the employment intensity of sectors where aviation generates a high GVA, is significantly higher than the average UK business.

Using the employment intensity of the supply chain, the indirect employment impact in 2007 (which arises due to the production of GVA worth £9.6 billion in the supply chain) was estimated to be 93,000. This is lower than the indirect employment generated in the period 1998 – 2000, ie, around 101,000; this is primarily due to the decrease in the employment intensity of the key sectors in the supply chain.

The indirect employment generated, in relation to the direct employment, correspond to an employment multiplier of 0.66 in 2007.⁹¹ The employment multiplier is estimated to be in the range of 0.9 – 0.7 over the period 1998-2006.⁹²

A1.4 Data sources and adjustments

The quantification of direct and indirect impact uses data from multiple sources. The primary source of data is the ONS National Accounts, but where these do not provide disaggregated data, data from the ABI has been used. The employment data for the aviation sector has been sourced from ABI, while that for the UK is taken from NOMIS.⁹³

As discussed above, the Analytical IO tables do not provide disaggregated data for 'Supporting air transport activities' (SIC 63.23). To calculate the indirect contribution of supporting air transport services, the impact of all supporting transport services was first calculated using the IO analysis. This impact was then adjusted downwards using the share of supporting air transport services (SIC 63.23) in the GVA of 'Auxiliary transport services' (SIC 63); such disaggregated GVA data is available from ABI.

Furthermore, all output and GVA figures for the UK have been converted to 2007 prices using the UK GDP deflator; the corresponding aviation sector figures have been converted to 2007 prices using an aviation-specific deflator provided by the ONS. Table A1.1 details the sources of each type of data.

⁹¹ The direct employment was 141,000 while the indirect employment was 93,000 in 2007.

⁹² Other sources of the relationship between direct and indirect employment based on specific surveys have suggested similar ratios; See, for example, Type I employment multipliers in the Scottish input output tables - <http://www.scotland.gov.uk/Topics/Statistics/Browse/Economy/Input-Output/Multipliers>. Also see Oxford Economics Forecasting (2006), 'The Economic Contribution of the Aviation Industry in the UK', October.

⁹³ This service provides official labour market statistics from the ONS.

Table A1.1 Main data sources

Variable	Sector	Source
Output by year	Aviation, UK	Supply and Use Tables (National Accounts)
GVA by year	Aviation, UK	Supply and Use Tables (National Accounts)
GVA by year	Supporting air transport services (SIC 63.23)	ABI
Employment	Aviation	ABI
Employment	Other sectors	Health and Safety Executive; ABI
Employment	UK	NOMIS
GDP deflator	Aviation, UK	ONS ¹
Aviation deflator	Air transport	ONS

Source: ¹ ONS (2008), 'The GDP implied deflator', *Economic & Labour Market Review*, **2** (6), June.

A2 Supply-side effects of aviation: literature review

This appendix reviews some of the body of literature which assesses the wider economic contribution made by the aviation sector, and the literature examining the economic effects associated with transport infrastructure more generally. As such, it complements the evidence described in section 5, which is used to quantify the impact of policy scenarios on the wider economy.

A2.1 Drivers of economic performance

The availability and cost of transport services are key drivers of economic performance. As noted in Figure 4.1 and considered below, these may be driven by separate, but inter-related, mechanisms: improvements in connectivity between cities, regions, or countries; reductions in transport costs; and the location of transport hubs.

A2.1.1 Improvements to connectivity

Growth in air transport enables enhanced links to worldwide destinations. Often described as 'connectivity', in this context it reflects the range and economic importance of destinations, frequency of service, and the number of onward connections available through each country's aviation network. Better connectivity means that businesses are better able to access and enter new markets.

Because of its multi-dimensional nature, connectivity is difficult to quantify. In essence, it relates to the ability and ease with which destinations may be reached from the point of origin in question (or vice versa).

Transport connectivity has been addressed in a number of recent studies of the air transport sector. For example, a study on the degree of connectivity at London's Heathrow Airport, as measured by a range of indicators, such as numbers of destinations serviced compared with main Continental Europe hubs such as Frankfurt, Paris Charles de Gaulle and Amsterdam Schiphol, concluded that the level of connectivity of Heathrow had declined in both absolute and relative terms over the past 20 years due to growing congestion.⁹⁴ The importance of connectivity as a means of providing access to markets and business links was also highlighted in a 2003 DfT report,⁹⁵ which indicated that accessibility and proximity to an internationally linked aviation hub can have a major impact on inward investment or reinvestment location decisions. In particular, the study showed that 53% of members of the Confederation of British Industry (CBI) stated that international competitiveness is linked to access to aviation, with 46% stating that air links are key to UK investment decisions.⁹⁶ A number of other surveys are referred to in the report, all of which cite access to Heathrow/Gatwick as key reasons for locating in the area.

A2.1.2 Reductions in transport costs

Aviation services may reduce transport costs between a given origin–destination pair relative to alternative transport options, possibly owing to the long distance between the destinations, leading to high costs by surface transport, or because a change in the service pattern enables direct air links where previously only indirect links were available.

The notion of transport costs should in principle capture all relevant considerations associated with the service on offer. While price (per tonne transported, or unit of distance) is

⁹⁴ Colin Buchanan Associates (2009), 'Economic impacts of hub airports', report for British Chambers of Commerce, July.

⁹⁵ Department for Transport (2003), 'Aviation, Core Cities and Regional Economic Development', December, pp. 1–60.

⁹⁶ Ibid.

a critical component, a range of other factors also influence decisions by businesses and individuals about whether to travel (or ship goods), and if so, how. These include:

- **time:** the value of time spent in transit is a significant driver of total transport costs, whether for individuals or in terms of freight. In general, it is the end-to-end journey which is most important to consider in this regard;
- **frequency:** improved frequency can reduce transport costs, by allowing for shorter waiting times and better targeting of departure or arrival times;
- **quality:** other characteristics of transport include reliability, punctuality and the quality of the travel experience.

The characteristics of air transport are such that it generates major savings in the cost and duration of journeys beyond a certain length, and thus brings significant benefits to producers and consumers. By the same token, an increase in the price of aviation—eg, brought about by an increase in taxation or the regulatory burden on the sector, or an increase in price resulting from restricting airport capacity below demand—raises the cost to businesses and consumers.

Improvements in the efficiency of air transport have enabled significant reductions in the cost of shipping goods by air. For example, Swan (2007) showed that price and production costs for air travel have declined by about 1% annually since 1970.⁹⁷ As air shipments tend to be of higher value and lighter weight than products shipped by alternative modes, the *ad valorem* cost of air freight—ie, the transport cost needed to move £1 worth of goods—is also decreasing.

Harrigan (2005) estimated that the relative cost of air transport declined by 40% between 1990 and 2004.⁹⁸ As a result, air freight is of growing importance in cargo logistics, accounting for about 40% of international trade by value. Such reductions in costs have contributed to the high rate of growth (nearly 6% per year from 1950 to 2004) in world trade.⁹⁹ Similarly, Baier et al. (2001) examined the relative contribution of transport cost reductions, income growth, tariff liberalisation and income convergence to the growth of world trade for several OECD countries between the late 1950s and the late 1980s. Their modelling indicates that income growth explains about 67% of the growth in world trade, tariff-rate reductions about 25%, and reductions in transport costs about 8%, while income convergence has had almost no impact.¹⁰⁰

In addition to enabling growth in trade, changes in air transport costs may have an impact on patterns of global trade. For example, Hummels (2006) found that the elasticity of air freight costs with respect to distance declined significantly, from 0.43 in 1974 to 0.045 in 2004. That is, doubling the distance resulted in a 43% increase in air freight costs in 1974, but only a 4.5% increase in air freight costs in 2004. As a result, the distance of the average air shipment has increased, while that of the average ocean shipment has fallen over time.¹⁰¹ Overall, the evidence suggests that the decline in aviation transport costs has played a part in the growth and the changing patterns of world trade, and that any increase in costs—for example, due to higher taxes—at least partly reverses the reductions in transport costs witnessed over previous decades, and as such could have a significant effect on the economy.

⁹⁷ Swan, W. (2007), 'Misunderstandings about Airline Growth', *Journal of Air Transport Management*, **13**, 3–8.

⁹⁸ Harrigan, J. (2005), 'Airplanes and Comparative Advantage', NBER Working Paper No. 11688.

⁹⁹ Hummels (2007), *op. cit.*

¹⁰⁰ Baier, S. L., Bergstrand, J. H. (2001), 'The growth of world trade: tariffs, transport costs, and income similarity', *Journal of International Economics*, **53**:1, 1-27.

¹⁰¹ *Ibid.*

A2.1.3 Location of transport hubs

The presence of transport hubs often creates a basis for the attraction of significant levels of economic activity, an effect known as ‘agglomeration’. The process of agglomeration around transport hubs, such as international airports, is often driven by production benefits—firms choose to locate in these areas because such locations confer a high level of productivity.¹⁰² These areas will have high productivity due to the proximity among firms, leading to reduced transaction costs associated with moving individuals and goods. Perhaps more importantly, firms may benefit from being close to one another, as agglomeration can produce knowledge and technological transfers or spillovers.¹⁰³ While these effects are difficult to quantify, the greater number of patent citations (of 5–10 times) from spatially concentrated areas suggests that knowledge spillovers do occur between firms,¹⁰⁴ and may thus enhance the level of innovation.

An increase in urban densities and market size, which may arise in response to the development of transport hubs, also produces positive externalities for firms, industries and cities as a result of the increased scale of economic activity.¹⁰⁵ It is estimated that the doubling of city size is associated with an increase in productivity of between 3% and 8%.¹⁰⁶ The clustering of firms creates a tendency for labour and suppliers to concentrate nearby. For example, firms which require similar types of specialised skills will create incentives for highly skilled labour pools to relocate. These dense urban labour markets allow for better qualitative labour matching between an employer’s needs and a worker’s skills, and reduced search costs for employees and firms due to the large size and depth of the labour market,¹⁰⁷ leading to potential increases in productivity.¹⁰⁸ For instance, a doubling of employment density in an area may increase average labour productivity by as much as 5%.¹⁰⁹ Higher productivity also implies that wages will be higher (because labour is paid a wage equal to its marginal product), with an estimated elasticity of real wages with respect to city size of between 7% and 12%.¹¹⁰

Suppliers also have an incentive to locate near the cluster of firms (as this allows for more face-to-face interaction with clients and potentially a better understanding of their needs), which will expand the choice and availability among specialised inputs for businesses.¹¹¹ The externalities arising from shared inputs, as well as the increase in the number of goods or services produced, enlarges the scale of the industry. Nakamura (1985) suggests that a doubling of industry scale may lead to a 4.5% increase in productivity, which will ultimately contribute to a rise in GDP.

As such, airports may facilitate or expedite the clustering of firms and the positive externalities associated with agglomeration. The improved connectivity and accessibility offered by airports create the environment and infrastructure for the clustering of high-order producer services, including law, finance, real estate and management consultancy. These industries, which require easy access to airports, will be drawn to these profit-maximising

¹⁰² Eddington, R. (2006), ‘Transport’s role in sustaining the UK’s productivity and competitiveness’, The Eddington Transport Study: Main Report.

¹⁰³ Eddington (2006), op. cit.

¹⁰⁴ Rosenthal, S.S., and Strange, W.C. (2004), ‘Evidence on the Nature and Sources of Agglomeration Economies’, chapter 49 in *Handbook of Regional and Urban Economics*, Vol. 4, p. 2120.

¹⁰⁵ Ormerod, P., Cook, W., and Roswell, B. (2006), ‘Why distance doesn’t die: Agglomeration and its Benefits’, Working Paper 17, GLA Economics, June, pp. 1–39.

¹⁰⁶ Department for Transport Eddington Study Research Annex (2006), ‘Agglomeration in the UK and the role of transport policy’.

¹⁰⁷ Ibid.

¹⁰⁸ Rosenthal and Strange (2004), op. cit.

¹⁰⁹ Ciccone, A. (2002), ‘Agglomeration Effects in Europe’, *European Economic Review*, **46**, 213–27.

¹¹⁰ Rosenthal and Strange (2004), op. cit.

¹¹¹ Nakamura, R. (1985): ‘Agglomeration economies in urban manufacturing industries: a case of Japanese cities’, *Journal of Urban Economics*, 17, 108–24.

locations.¹¹² Also, as explained in section A2.2.3, airports reduce transportation costs and travel time, which are increasingly important components for businesses, especially those that adopt just-in-time inventory systems.¹¹³ Airports may play an important role in attracting and retaining industry in the surrounding area. Cooper and Smith (2005) explain that better air transport encourages domestic and foreign businesses to locate in the area, or provides the impetus for businesses already in the area to expand. As firms relocate, there will be benefits from the introduction of new technologies and management techniques that other firms can emulate, which may raise productivity and increase GDP.¹¹⁴ Although other transport modes may afford some of these benefits, air travel is often the mode with the fastest journey time and greatest flexibility, especially on long-haul routes.

The agglomeration of economic activities may also produce what Flores-Filloly and Nicoliniz (2006) describe as 'aerotropoli'. These are large industrial areas characterised by a high concentration of commercial activities in the areas surrounding airports.¹¹⁵ These aerotropoli are created when service operators, supplying a range of aviation and non-aviation services, locate near the airport. A reduction in search and operating costs also allows firms to deliver their products more quickly and increase the value-added of their activities. Aerotropoli may grow to include various activities and infrastructure, including retail and distribution centres, office and research parks, and residential developments. This may further increase competitiveness of firms in the area, in particular in the case of cargo airports.¹¹⁶

Greenaway and Kneller (2008) also find that spillovers associated with agglomeration can raise the probability of export market entry, and create additional productivity benefits once entry has occurred. Aviation facilitates firms' export activities, enabling these exporting firms, on average, to be 5.4% more productive than non-exporting firms.¹¹⁷

While transport hubs are not the only contributing factor to the process of agglomeration, or the growth of cities, the evidence cited above illustrates that air transport can make a positive contribution. Even where some activity within an agglomeration zone may substitute for reductions in economic activity elsewhere, the increases in productivity associated with spillovers and externalities are likely to generate additional benefits in the economy.

A2.2 Transmission mechanisms

The drivers identified in section A1.1 lead to a series of impacts on the economy, and the mechanisms by which these impacts may be propagated throughout the economy are examined below, looking at international trade; investment and innovation; economic efficiency; and competition.

A2.2.1 International trade

There is a vast amount of literature on the interaction between transport costs and trade. Given that the gains from trade need to outweigh the associated transaction costs, in the form of direct costs for the transportation service, but also due to the value associated with the transit time, the primary mechanism by which air transport may enhance trade is by providing a viable, rapid option for transporting goods. One of the major locational decision factors, particularly for export-oriented businesses, is proximity to airports with wide transport

¹¹² ACI Europe (1998), 'Creating Employment and Prosperity in Europe', September 18th, pp. 1–30.

¹¹³ Flores-Filloly, R. and Nicoliniz, R. (2006), 'Aerotropolis: an aviation-linked space', presentation to the 4th International Industrial Organization Conference and IAE seminar, June 16th.

¹¹⁴ Cooper and Smith (2005), op. cit.

¹¹⁵ Although these are usually considered in the context of cargo airports, there is less specialisation among airports in Europe, as many airports provide services for cargo and passengers.

¹¹⁶ Flores-Filloly and Nicoliniz (2006), op. cit.

¹¹⁷ Greenaway, D. and Kneller, R. (2008), 'Exporting, productivity and agglomeration', *European Economic Review*, **52**, 919–39.

links. This is relevant in terms of direct freight transport options for high value-to-weight products, but more generally in facilitating business relationships in potential export markets.

The time required to transport goods imposes a cost on trade for two reasons:

- inventory holding: the greater the duration of the transit, the higher the costs associated with holding inventory. In particular, where there is significant variation in arrival times, firms may need to hold larger buffer stock at final destinations;
- depreciation or degradation of the value of the product in question may be related to transit time. The rate of depreciation may be greatest for products which spoil, such as agricultural products; or, where information value is important, as in the case of newspapers.

Lengthy transportation periods both add to the cost of and reduce the propensity for trade. A recent study has identified that each additional day a good spends in transport reduces the probability of the USA sourcing from a country by 1–1.5%. Each day saved in shipping is worth 0.8% of the manufactured goods' value.¹¹⁸ Hummels (2007) also finds that the reduction in costs resulting from the introduction of fast transport (air transport and faster ocean vessels) is estimated to be equivalent to reducing a hypothetical import tax on manufactured goods from 32% to 9% between 1950 and 1998. Hence, in addition to facilitating trade in the first place, the decline in aviation costs has contributed to a reduction in the cost of manufactured goods. As the UK relies on air transport for a significant proportion of its international trade, changes in air freight transport costs are likely to have a particularly important effect on trade flows (in terms of an effect on trade volumes or patterns of trade) between the UK and the rest of the world.¹¹⁹ For instance, in 2007, the UK imported, by value, around 32% of its goods and exported around 44%, which compares with 18.1% of import value and 25% of export value by air in the EU 27.

The time savings afforded by air transport have also shifted the composition of trade towards more time-sensitive goods, such as from commodities to complex manufactures, and contributed to a growth in world trade at a relatively rapid pace. The effect of the decline in transport costs on increasing trade volumes is previously described in A1.1.2.

Overall, the empirical evidence on the relationship between transport costs, time, and trade volumes bears out this conceptual link. For example, a study by Limao and Venables (2001) shows that a 10% increase in transport costs reduces trade volume by 20%. Similarly, recent studies find that an increase in transport time by 10% reduces bilateral trade volumes by between 5% and 8% (Hausman et al. 2005; Djankov et al. 2005).¹²⁰

The degree to which developments in the air transport system affect the overall economy through the mechanism of trade depends on two factors: the extent to which new options for trade arise in line with the creation of additional, or less costly, transport options (this issue has been addressed above); and the impact of increased levels of trade on the economy.

The interaction between trade and national income levels is important. While this report does not purport to fully synthesise this extensive area of economic research, it is worth bearing in mind the following mechanisms by which trade may enhance the economy.

- Specialisation: trade allows regions or countries to specialise in areas of comparative advantage, which are areas in which they are relatively more productive.

¹¹⁸ Hummels (2007), op. cit.

¹¹⁹ Hummels, D. (2009), 'Globalization and Freight Transport Costs in Maritime Shipping and Aviation', *Transport for a Global Economy: Challenges and Opportunities in the Downturn*, Forum 2009, May 26th–29th, Leipzig.

¹²⁰ Hausman, W.H., Lee, L.L. and Subramanian, U. (2005), 'Global Logistics Services, Supply Chain Metrics and Bilateral Trade Patterns', mimeo, World Bank, October. Djankov, S., Freund, C. and Pham, C.S. (2005), 'Trading on time', mimeo, World Bank.

- Economies of scale: the process of specialisation allows a second-order impact on productivity, through scale economies.
- Enhanced competition: trade may reduce transport costs and provide greater opportunities for firms to compete. However, as discussed in section A1.2.4 below, the overall effect is likely to be ambiguous.

The evidence on the interaction between trade and income levels shows high correlation between the two variables. While there is some debate about the direction of causality, a report by Noguer and Siscart (2005) examining this question in detail, using extensive trade data previously unavailable to researchers, found that increased levels of trade (as a share of GDP) lead to higher levels of income per capita, with an elasticity of around 1 (ie, an increase in the trade intensity of GDP of 1% leads to an increase in GDP per capita of around 1%).¹²¹

A2.2.2 Investment and innovation

A further mechanism by which changes in the air transport system may affect the economy is through increased levels of investment and innovation. The transmission mechanism can operate both by providing domestic firms with opportunities to identify and manage investments in foreign-based assets,¹²² and by enabling inward investment.

The impact of improved air transport on investment decisions has been examined in the literature. Cooper and Smith (2005), for example, found a positive correlation between air transport usage and business investment based on data from 24 European countries, and that growth in air transport usage led to an increase in the level of business investment across the EU by 5.8% between 1994 and 2003, which, given the link between business investment and GDP, has contributed to growth in GDP of around 2%. The authors reached the broad conclusion that the overall economic impact of air transport in Europe has been to raise both investment and underlying productivity.¹²³

The above findings are also consistent with survey data. For example, a survey of 500 of Europe's top companies found that 52% of companies considered transport links an essential factor when choosing where to locate, while 58% identified good access to markets, customer or clients as vital.¹²⁴

A2.2.3 Economic efficiency

Each of the drivers of change identified in section 4 (increased connectivity, reduced transport costs, and location of transport hubs) would be expected to have an impact on economic efficiency. Other sectors in the economy may benefit from these drivers since their direct transport costs would be lower as a result of the change.

In the first instance, improved connectivity and reduced transport costs would be expected to have the greatest impact on those sectors that are heavily transport-intensive (and, in particular, may be aviation-intensive). For example, a 2004 report by the DfT suggests that the banking, finance and insurance sectors are heavily dependent on air freight and air services, requiring six times more air travel than other businesses.¹²⁵

Evidence from several studies discusses the issue that knowledge-intensive industries, such as pharmaceuticals, financial and business services, and high-tech sectors are aviation-intensive because they place a significant value on face-to-face meetings, rapid delivery of

¹²¹ Noguer, M. and Siscart, M. (2005), 'Trade raises income: a precise and robust result', *Journal of International Economics*, 65, 447–60.

¹²² This effect is described in IATA (2006), 'Airline Network Benefits', IATA Economics Briefing No. 3. January.

¹²³ Cooper and Smith (2005), op. cit.

¹²⁴ Cushman & Wakefield, Healey & Baker (2007), 'European Cities Monitor', in BAA Heathrow (2008), 'Economic benefits of Heathrow: At the heart of the UK economy'.

¹²⁵ Department for Transport (2004), 'The importance of Transport in Business' Location Decisions'.

high-value goods, and supporting a mobile workforce.¹²⁶ For instance, car manufacturer, Nissan, relies on the rapid supply of time-sensitive goods due to its just-in-time inventory system, especially when part shortages occur and urgent air freight delivery is required. Nissan also mentions that the speed of delivery and/or the reliability offered by air transport are critical for specialist car parts.¹²⁷

The efficiency mechanism is wide-ranging, in that many of the other mechanisms identified in this section may also be expected to lead to improved efficiency. In any case, given the direct link between efficiency and improved economic performance, it is important that any link between aviation and the efficiency of production in other sectors is well understood.

In addition to direct reductions in transport costs due to the availability of, or improvement in, aviation links, the aviation sector may have positive effects on the efficiency of firms and the economy as a whole in a number of ways, which include:

- enabling economies of scale: where air transport links open up new markets for domestic firms, they may be able to benefit from achieving scale economies, allowing them to maintain or improve competitiveness with other firms, while also lowering prices in the domestic market;
- providing real options to respond to demand volatility: in the presence of demand risk, importers need to consider what mode of transport to use. Ocean transport is cheaper, but, due to long timescales for delivery, a shipment of a fixed quantity has to be ordered significantly in advance of its ultimate availability in the market in question. The importer loses out if demand turns out to be below forecast. On the other hand, air transport is more expensive per tonne transported, but also more responsive. The importer faces much less risk of a demand shock occurring after the firm order has been arranged. With this improved information, the firm can optimise the size of the air shipment so as to maximise profit. Empirical evidence from US data supports this theory: firms subject to demand volatility ship a larger share of their freight by air.¹²⁸
- bringing about shifts in the structure of the economy towards higher-value products. Changes in the relative costs of production of different activities may have second-round effects as production and consumption are shifted towards the higher-value activities. Those activities for which the cost of production falls most will tend to grow as a share of the economy, leading to enhanced levels of productivity. However, the underlying cause for such restructuring relates to changes in the efficiency of production of different products.

The above analysis suggests that firms can use aviation to hedge against demand volatility. In particular, this may suggest that, to the extent that demand is more volatile during a recessionary period, there may be a benefit in having the option to be able to alter orders at short notice in response to unanticipated changes in the level of demand.

A2.2.4 Enhanced competition

The aviation sector enables enhanced competition between firms, by reducing the cost of entry into new geographic markets. Increased connectivity, including frequency of access to potential markets at lower costs, can act both to provide domestic firms with increased market opportunities, strengthening their worldwide competitiveness, and to enhance the prospect for entry by foreign firms. The exposure to foreign markets may encourage firms to

¹²⁶ See, for example, Colin Buchanan Associates (2009), op. cit.

¹²⁷ Interview conducted by Newcastle Airport with Nissan, July 2009.

¹²⁸ Schaur, G. (2007), 'Hedging Price Volatility Using Fast Transport', Conference Paper presented at the 10th Annual Conference on Global Economic Analysis, Purdue University, USA, April. The elasticity of the aviation share is about 7% for the first lag of the demand volatility, falling slowly to about 2% for the third lag of demand volatility (p. 24).

become more efficient and effective in order to remain competitive.¹²⁹ Such increased competition could come about in different ways:

- for goods such as manufactured products, particularly those with high value to weight ratios, air transport can facilitate entry into the domestic market, enhancing consumer welfare directly and stimulating improved performance by domestic firms (or enabling domestic resources to be refocused towards more productive areas or areas of comparative advantage. In this way, air transport may facilitate the process of specialisation);
- air transport may also lead to inward investment, which may increase competition in the domestic market. As domestic firms are exposed to international competition, they are incentivised to improve performance by adopting best practice.

Vickerman (2007) reports that the effect of transport on competition, and the benefits associated with competition, seems to be ambiguous or minimal at best.¹³⁰ A reduction in transport costs, such as the reduction in the costs of air freight and business travel experienced over the past decades, can lower barriers to entry into new markets, encouraging greater levels of competition between domestic and foreign firms. These increased competitive pressures can also have an offsetting effect, however, as firms may gain access to large markets and benefit from greater returns to scale. In the long run, this may drive firms out of the market and reduce the number of competitors. As such, any impact of increased competition due to lower transport costs should be neutral, and will be captured by direct user benefits (such as lower prices), with few wider economic benefits due to more competition.¹³¹ Vickerman also notes that there may be exceptions where the introduction of new transport links has a significant impact on transport costs and induces market restructuring. However, this is unlikely to occur in industrialised countries such as the UK since any improvements to the already well-developed transport infrastructure are likely to have only marginal impacts.¹³²

A2.3 Impacts on economic performance

As noted above, changes in the air transport system may affect economic activity in a number of ways, through its impact on enhanced international trade, business costs and efficiency, increased market size, greater innovation and investment, and increased levels of competition in the economy. Lower transport costs may also improve the flexibility of the economy, enabling it to respond more efficiently to changes in demand and supply conditions. These effects lead to improved economic performance by generating increased levels of labour supply in the economy or improving productivity.

These mechanisms will all affect the economy, and be captured through increases in either the supply or the productivity of labour, or both. The links between these elements of overall economic performance, and the mechanisms identified above, are described below.

A2.3.1 Supply of labour

At the global level, the potential labour force can be regarded as more or less fixed in the short term. However, the participation and deployment of the labour force in particular

¹²⁹ OEF (1999), 'The Contribution of the Aviation Industry to the UK Economy: Final Report', November.

¹³⁰ Vickerman, R. (2007), 'Recent Evolution of Research into the wider economic benefits of transport infrastructure investments', in OECD (2008), 'The Wider Economic Benefits of Transport: Macro-, Meso- and Micro-economic Transport Planning and Investment Tools', Round Table 140, International Transport Forum, pp.1–208.

¹³¹ This will be the case for most firms which compete in imperfectly competitive markets. In perfectly competitive markets, the effect will also be neutral, but through a different channel, as prices reflect the marginal costs of production, and this does not depend on the precise number of firms in the market.

¹³² Vickerman, R. (2007), 'Recent Evolution of Research into the wider economic benefits of transport infrastructure investments', in OECD (2008), 'The Wider Economic Benefits of Transport: Macro-, Meso- and Micro-economic Transport Planning and Investment Tools', Round Table 140, International Transport Forum, pp. 1 208.

countries and markets vary, and is likely to respond to improvements in the availability and cost of transport. In practice, this may depend more on short-distance surface transport options than on aviation; nevertheless, the availability of low-cost international travel does affect the provision of labour around the world. Furthermore, by contributing to higher living standards in the longer term, aviation contributes positively to the global labour supply.

There are a number of mechanisms by which aviation services may affect the supply of labour. One direct mechanism is that inexpensive air links provide a means by which some employees, who may not wish to move permanently to the location of their employment, may commute on a weekly basis.¹³³

In addition, air transport plays an important role in increasing the pool of labour available to companies beyond national boundaries by bringing previously separate labour markets closer together.¹³⁴ Workers' decisions to migrate are shaped by many factors, with income being the primary consideration in most cases. Nevertheless, to the extent that low-cost air transport reduces the costs of migration—in terms of both its financial impact (with low prices offered by low-cost airlines) and its social impact (with frequent, low-cost flights allowing migrant workers to be well connected to their families, reducing the social/psychological challenge of migration)—it may lead to increased labour mobility. This has allowed an increase in short-term migration as a way to address short-term labour/skill shortages. Such an increase in labour mobility would be particularly valuable in the course of the business cycle—for example, allowing increases in the labour supply during periods of strong growth.

While the above factor relates to travel by migrant workers, other authors have noted the impact that leisure travel for the purpose of visiting friends and relatives may have on the degree of integration of labour markets.¹³⁵

A number of other studies have identified that the increased labour mobility which is made possible through air transport links may have persistent, rather than temporary, benefits to the local economy. Air travel enables companies to attract high-skill, high-quality employees because the attractiveness of working at such firms is enhanced by easy air access to other regions. These skilled employees then create technology transfers and knowledge spillovers in the local economy.¹³⁶ Returning migrant workers—for example those returning from Silicon Valley in the USA—will tend to bring new skills, expertise and professional ties.¹³⁷

A2.3.2 Labour productivity

In addition to facilitating increases in labour supply in those areas where skills or labour shortages are most evident, developments in the air transport system may have an impact on the productivity with which that labour is used. Given that improvements in labour productivity are the basis for growth in prosperity (for example, as measured by per-capita income growth), this is likely to be the most significant longer-term benefit that aviation can confer on the economy.

As has been noted throughout this section, the aviation sector will affect labour productivity in several ways including the following.

- Reduced operating costs: the most direct way in which productivity is enhanced is through the reduction in direct transport costs (inclusive of time savings). This ensures that the total cost of production is reduced relative to the counterfactual, and enables labour to be transformed more efficiently into marketable goods and services. The

¹³³ Cooper and Smith (2002), op. cit.

¹³⁴ Button, K.J. and Vega, H. (2008), 'The Effects of Air Transportation on the Movement of Labour', *Geo Journal*, **71**:1, 67–81.

¹³⁵ Oum, Fu and Zhang (2009), op. cit.

¹³⁶ Ishutkina, M. and Hansman, J. (2009), 'Analysis of Interaction between Air Transport and Economic Activity', International Center for Air Transport.

¹³⁷ Eddington (2006), op. cit.

extent of this impact will depend on the aviation intensity of each sector, and what counterfactual may be assumed in terms of alternative modes of transport, and so can only be assessed on a case-by-case basis.

- Economies of scale: by enhancing the range of export markets which may be economically served from a given region, improved connectivity can allow firms to increase total sales, and derive economies of scale. This implies that growth in output will generate increased value through improved labour productivity, and may translate into lower prices for consumers, or, in cases where markets are imperfectly competitive, increased levels of firm profitability.
- Higher levels of capital and innovation: to the extent that transport hubs (including international airports) act as both an attractor of investment and increase the returns to investment by enabling a wider range of markets to be accessed by firms, returns to capital will grow. This will lead, in turn, to a structural increase in the level of investment in the economy. The level of labour productivity in the economy is directly influenced by the amount of capital per employee.
- Skills transfer and spillover benefits: the literature on ‘agglomeration’ benefits emphasises that increased density of employment—for example, in areas around airports—can enhance productivity. This occurs through spillover benefits, in which the presence of skilled employees can enhance the productivity of other (skilled or unskilled) employees due to the transfer of knowledge. Aviation facilitates this process by increasing the attractiveness to skilled employees of working within such regions.
- Changes to dynamic structure of the economy: an important factor to consider is that initial changes in the level of productivity of labour may be reinforced by rebalancing of the structure of the economy as new investment signals and prices are faced. As more productive segments of the economy grow more quickly relative to less productive industries, the average level of productivity will tend to increase.
- In addition to the backward links to the economy through the expenditure of aviation on other sectors, aviation contributes through forward links—ie, the use of aviation services by other sectors. A number of key sectors rely on aviation for transport services, which is an essential input in most sectors.

A3 Policy scenarios

A3.1 Scenario data assumptions

The assumptions used for the modelling underlying the analysis presented in section 5 are set out in the tables below, including passenger numbers for the DfT baseline (B0) and policy scenarios; average fares for the baseline (B0) and policy scenarios; and the carbon price and emission assumptions used in the scenarios. Additional assumptions of the baseline (and scenarios) are as per DfT (2009).¹³⁸

Table A3.1 Impact of taxes and capacity constraints on passenger numbers ('000s)

	2010	2020	2030
Impact of known policy changes on passenger fares and demand			
B0: DfT baseline	249,344	344,785	433,857
B1: APD planned 2009 & 2010 changes, EU ETS financial cost at forward 2012 carbon price (15% auctioning)	248,210	342,721	431,181
B2: APD planned 2009 & 2010 changes, EU ETS marginal cost of carbon at forward 2012 price	248,210	341,982	430,442
B3: APD planned 2009 & 2010 changes, EU ETS marginal cost of carbon at DECC rate	248,210	341,088	424,961
B4: APD planned 2009 & 2010 changes	248,210	343,228	431,888
Impact of high financial impact scenarios (relative to B3), baseline fare elasticity (0.5)			
H1: Stepped change in APD in 2014 & 2015 equal to 2009 & 2010 changes	248,210	339,530	422,992
H2: 3% real growth in APD	248,210	338,918	418,532
H3: 5% real growth in APD	248,210	337,120	411,776
H4: 5% real growth in APD plus noise and local air pollution costs covered	248,210	337,120	411,776
Impact of high financial impact scenarios (relative to B3), higher elasticity (0.7)			
H5: Stepped change in APD in 2014 & 2015 equal to 2009 & 2010 changes	247,617	336,788	417,324
H6: 3% real growth in APD	247,617	335,857	410,537
H7: 5% real growth in APD	247,617	333,121	400,255
Impact of low financial impact policy scenarios			
L1: Carbon costs covered by aviation through EU ETS and APD, security costs covered by general taxation	248,676	341,729	425,772
L2: Carbon costs covered through EU ETS, no APD from 2010, security costs covered by general taxation	248,210	347,396	432,937
Impact of capacity constraints on passenger fares and demand (versus B0, DfT baseline)			
C1: 0% growth in capacity	239,942	239,942	239,942
C2: 1.5% growth in capacity to 2020, 0.5% to 2030	243,599	282,707	297,164

Source: Oxera analysis.

¹³⁸ DfT (2009), 'UK Air Passenger Demand and CO₂ Forecasts', January.

Table A3.2 Impact of taxes and capacity constraints on average return fares (£)

	2010	2020	2030
Impact of known policy changes on passenger fares and demand			
B0: DfT baseline	258	258	258
B1: APD planned 2009 & 2010 changes, EU ETS financial cost at forward 2012 carbon price (15% auctioning)	264	266	266
B2: APD planned 2009 & 2010 changes, EU ETS marginal cost of carbon at forward 2012 price	264	269	268
B3: APD planned 2009 & 2010 changes, EU ETS marginal cost of carbon at DECC rate	264	272	284
B4: APD planned 2009 & 2010 changes	264	264	264
Impact of high financial impact scenarios (relative to B3), baseline fare elasticity (0.5)			
H1: Stepped change in APD in 2014 & 2015 equal to 2009 & 2010 changes	264	278	290
H2: 3% real growth in APD	264	280	303
H3: 5% real growth in APD	264	287	323
H4: 5% real growth in APD plus noise and local air pollution costs covered	264	287	323
Impact of high financial impact scenarios (relative to B3), higher fare elasticity (0.7)			
H5: Stepped change in APD in 2014 & 2015 equal to 2009 & 2010 changes	264	278	290
H6: 3% real growth in APD	264	280	303
H7: 5% real growth in APD	264	287	323
Impact of low financial impact policy scenarios			
L1: External costs less security v B3	262	270	282
L2: Carbon costs covered through EU ETS, no APD from 2010, security costs covered by general taxation	264	249	261
Impact of capacity constraints on passenger fares and demand (versus B0, DfT baseline)			
C1: 0% growth in capacity	280	429	509
C2: 1.5% growth in capacity to 2020, 0.5% to 2030	271	360	435

Source: Oxera analysis.

Table A3.3 Scenario assumptions

	2010	2020	2030
EU allowance price, €/tCO ₂ , real 2007, 2012 forward price ¹	17.5	17.5	17.5
EU allowance price, £/tCO ₂ , real 2007, DECC assumptions ²	20.6	23.9	66.6
Aviation sector CO ₂ emissions from departing flights, UK, MtCO ₂ ³	41.0	50.3	58.4

Source: ¹ European Climate Exchange (<http://www.ecx.eu/>), Settlement Price on August 24th 2009. ² DECC (2009), 'Carbon Valuation in UK Policy Appraisal: A Revised Approach', July. ³ DfT (2009), 'UK Air Passenger Demand and CO₂ Forecasts', January, p. 60.

A4 Tax and regulatory burden

This appendix provides some further background to the tax and regulatory burdens examined in section 6. The focus is on the structure of APD, the EU ETS and the CRC, and on the methodology used to estimate their impacts.

A4.1 Air passenger duty

Introduced in 1994 with two separate bands (for passengers travelling within or outside the EEA), APD has increased gradually over time, and was structurally changed in February 2007 to apply separate rates according to class of travel (see Table A4.1). From November 2009, it will be split further into four bands for each class of travel, with separate bands beginning at every additional 2,000 miles travelled. The move from two to four bands is to ensure that APD is more reflective of differences in the climate change impacts of flights travelling differing distances. However, the differentiation in rates by class of travel implies that APD remains inefficient in terms of providing the appropriate environmental signals.

Table A4.1 Evolution of APD, nominal rates and revenue raised

	Nov 1994	Nov 1997	Apr 2001	Feb 2007	2008/09	Nov 2009	Nov 2010
APD rate, £/passenger							
Lower rate							
Band A	5	10	5	10	10	11	12
Band B	10	20	20	40	40	45	60
Band C	10	20	20	40	40	50	75
Band D	10	20	20	40	40	55	85
Standard rate							
Band A	5	10	10	20	20	22	24
Band B	10	20	40	80	80	90	120
Band C	10	20	40	80	80	100	150
Band D	10	20	40	80	80	110	170
APD revenue, £ billion							
Actual	0.084 (1994/95)	0.493 (1997/98)	0.806 (2001/02)	0.971 (2006/07)	1.994 (2007/08)		
Estimated					1.862		
Projected						1.758 (2009/10)	

Note: APD currently comprises two bands according to travel distance, with separate rates applied to European and other destinations. From November 2009, it will be divided into four bands according to travel distance from London: Band A (0–2,000 miles), Band B (2,001–4,000 miles), Band C (4,001–6,000 miles) and Band D (over 6,000 miles).

Source: HM Treasury (2009), Tax receipts and taxpayers, Table 1.2, http://www.hmrc.gov.uk/stats/tax_receipts/menu.htm. HM Revenue & Customs (2009), 'Changes to Air Passenger Duty. Summary: Interventions & Options', March, www.hmrc.gov.uk/ria/apd-reform-ia.pdf. House of Commons Library (2009), 'Air Passenger Duty: recent debates & reform', July 22nd, <http://www.parliament.uk/commons/lib/research/briefings/snbt-05094.pdf>. BATA, 'Air Passenger Duty', www.bata.uk.com/Web/Documents/data/APD/WebAPD.pdf.

A4.2 EU Emissions Trading Scheme

The EU ETS is a legally binding cap-and-trade scheme for carbon emissions, with the objective of reducing emissions across the EU. Historically, the scheme has placed a cap on emissions from the EU, individual Member States and individual installations. The installations are allocated emissions allowances equivalent to this cap. The approach to the initial allocation of emissions allowances is now changing, and installations may be required to purchase all or a proportion of their allowances via periodic auctions, instead of being allocated allowances for free.

Under a cap-and-trade scheme, participants can choose how they comply with their caps, either by reducing their emissions or, if their emissions exceed the cap, by buying additional emissions allowances from other participants. In particular, if the costs of emissions abatement are greater than the price of an emissions allowance then installations can be expected to buy additional allowances above their allowed cap. Similarly, installations whose abatement costs are lower than the price of an emissions allowance are likely to emit less than their emissions cap, and sell any excess allowances. The price of allowances is a function of supply and demand.

Such a trading system implies that the costs of emissions abatement by the economy as a whole are minimised, with those installations and industries reducing emissions for whichever party incurs the lowest cost of doing so. It is therefore not essential for individual industries to meet the same 'average' target reductions. Indeed, this would not be economically efficient from a cost-minimisation point of view.

Aviation is not currently included in the EU ETS, but will be from 2012 for all flights originating in and departing from the EU.¹³⁹ The allowances will be allocated as follows.

- In 2012, the total quantity of allowances allocated to the aviation sector will equal 97% of the sector's 2004–06 emissions. 15% of these allowances will be auctioned in 2012.
- From 2013 onwards, the total allowance allocation will be equivalent to 95% of average 2004–06 emissions, and the auctioned volumes may be increased over time. The number of allowances to be auctioned in each year by each Member State will be determined according to its emissions as a proportion of the emissions of all Member States over a predetermined historical period.

Outside of the EU ETS, the UK has set a target to reduce emissions from aviation to 2005 levels by 2050. The DfT is also pressing for an international agreement to be reached at the UN Climate Change Conference in Copenhagen in December 2009 with regard to the reduction of emissions from aviation and shipping. The objective is to set realistic sectoral targets for global aviation and maritime emissions that are consistent with limiting climate change to no more than 2°C above pre-industrial levels.¹⁴⁰ Were such an agreement to be reached, its specific impact on the aviation sector is unclear at this stage. The focus here is therefore on the likely effects of the sector being included in the EU ETS.

A4.2.1 What are the tax and fare impacts of the EU ETS?

Table A4.2 estimates the impact of the EU ETS in terms of taxes raised, the financial burden on the aviation sector and increase in air fares.

¹³⁹ Directive 2008/101/EC of the European Parliament and of the Council of 19 November 2008 amending Directive 2003/87/EC so as to include aviation activities in the scheme for greenhouse gas emission allowance trading within the Community', and Department for Transport (2009), 'Low Carbon Transport: A Greener Future', July.

¹⁴⁰ Department for Transport (2009), 'Low Carbon Transport: A Greener Future'.

Table A4.2 Costs imposed by the EU ETS on aviation, 2012, real 2007 prices

	2012
Emission volumes	
UK aviation emissions (mtCO ₂) ¹	42.7
Cap on UK Emissions(mtCO ₂) ²	35.8
Auctioned volumes (%)	15.0
Auctioned volumes(mtCO ₂)	5.4
Extra emissions (over the cap) (mtCO ₂)	6.9
Costs and prices, real 2007 prices	
EU allowance price (2012 forward price) (£/tonne)	14 ³
EU allowance price (DECC assumptions) (£/tonne) ⁴	21
Shadow price of CO ₂ emissions assumed in January 2009 DfT analysis (€/tonne)(now superseded by the DECC assumptions above)	29 (24)
(in real 2009 prices)	
€/£	1.2
Number of passengers	
Estimated number of passengers departing from the UK (m) ⁵	119.6
Costs based on DECC assumptions	
Cost of auctioned CO ₂ (revenue to the Exchequer) (£m)	114.6
Cost of emissions above the cap (£m)	146.4
Tax raised through the EU ETS (auctioned volumes <i>times</i> EU allowance price) (£m)	114.6
Financial burden on aviation sector (auctioned volumes and emissions above the cap <i>times</i> EU allowance price) (£m)	260.9
Opportunity cost of carbon emissions (total carbon emissions <i>times</i> EU allowance price) (£m)	905.9
Impact on fares (opportunity costs <i>divided by</i> number of passengers) (£/passenger)	7.6
Costs based on current forward price	
Cost of auctioned CO ₂ (revenue to the Exchequer) (£m)	75.1
Cost of emissions above the cap (£m)	96.0
Tax raised through the EU ETS (auctioned volumes <i>times</i> EU allowance price) (£m)	75.1
Financial burden on aviation sector (auctioned volumes and emissions above the cap <i>times</i> EU allowance price) (£m)	171.1
Opportunity cost of carbon emissions (total carbon emissions <i>times</i> EU allowance price) (£m)	594.1
Impact on fares (opportunity costs <i>divided by</i> number of passengers) (£/passenger)	5.0

Source: ¹ Linear interpolation of 2010 and 2020 emissions projections, as developed in DfT (2009), 'UK Air Passenger Demand and CO₂ Forecasts', January. ² 97% of average 2004–06 emissions. ³ The price reported by the European Climate Exchange on August 24th 2009 was €18/tonne. ⁴ DECC (2009), 'Carbon Valuation in UK Policy Appraisal: A Revised Approach', July. ⁵ DfT (2009), 'UK Air Passenger Demand and CO₂ Forecasts', January.

A4.2.2 Pass-through of EU ETS costs

Analysis conducted for Defra suggests that there is likely to be nearly 100% pass-through of the costs of emissions allowances for the majority of customers.¹⁴¹ It is on this basis that the

¹⁴¹ Vivid Economics (2007), 'A study to estimate ticket price changes for aviation in the EU ETS', November.

full opportunity costs of carbon emissions, as estimated in Table A4.2, have been assumed to pass through into fares.

Table A4.3 sets out the results of the analysis on cost pass-through for a sample of illustrative markets. The degree of pass-through depends on various assumptions such as the number of firms serving the market and the elasticity of demand.

Table A4.3 Illustrative cost pass-through rates

North-west England to Nice	London to New York (mixed business and leisure)	Freight (not time-sensitive)	Freight (time-sensitive)
90–100%	110–150%	95–110%	80–150%

Source: Vivid Economics (2007), 'A study to estimate ticket price changes for aviation in the EU ETS', November, Table A, <http://www.defra.gov.uk/environment/climatechange/trading/eu/pdf/ticketprices-report.pdf>

A4.2.3 Impact of the EU ETS on aviation profitability

The rise in air fares as a result of the EU ETS can be expected to result in some decline in demand. In theory, if demand is 'inelastic' there will be a consequent decline in revenues, and vice versa. With demand for aviation being shown to be relatively inelastic, the decline in demand results in a rise in revenues. Analysis into the profit impact of the EU ETS on the aviation sector suggests that allowances equal to 20–40% of pre-EU ETS levels will need to be allocated free of charge to ensure that aviation profits remain at pre-EU ETS levels.¹⁴² The volume of free allowances would need to equal 40–70% if there are fewer than three airlines serving a particular route and assuming characteristics of largely leisure-only services.

A4.3 Carbon Reduction Commitment

Based on estimates of CO₂ emissions from a range of airports, provided by the AOA to Oxera, it has been estimated that the costs of the CRC will range from £0.03 to £0.10/passenger across airports (see Table A4.4). The average per-passenger cost across all airports for which data has been made available, weighted by the number of passengers, is estimated at £0.04/passenger, which equals a total of £11.3m across all passengers in 2012 (in real 2007 prices).

¹⁴² Vivid Economics (2008), 'A Study to Estimate the Impacts of Emissions Trading on Profits in Aviation', A report for Defra and DfT, January.

Table A4.4 Costs of Carbon Reduction Commitment on airports, real 2007 prices

Airport	CO ₂ (tonnes)	Allowance price in 2012 (£/tonne, real 2007 prices) ¹	Cost of CRC (£)	No. of passengers (2008)	Cost of CRC (£/passenger)	Fuels
Based on 2008/09 emissions						
Airport 1	1,312	10.9	14,263	409,782	0.03	Electricity and heating oil
Airport 2	10,803	10.9	117,444	1,150,620	0.10	Electricity and heating oil
Airport 3	14,338	10.9	155,874	3,789,418	0.04	Electricity, heating oil and gas
Airport 4	72,573	10.9	788,971	23,137,379	0.03	Electricity and service partner gas ²
Airport 5	530,000	10.9	6,360,000	149,318,580	0.04	–
Airport 6 (based on emissions in 2010/11)	–	10.9	135,960	5,393,930	0.03	–

Note: ¹ The carbon price under the CRC equals £12/tonne in 2012. This has been deflated to real 2007 prices to equal £10.9/tonne. ² Gas use by the airport is already covered by the EU ETS.

Source: Information provided by the AOA to Oxera on July 10th 2009 and September 1st 2009.

The estimates of the CRC costs presented in this table necessarily represent an upper limit on the actual costs, given that some of them will be recycled back to the airports depending on their position in the CRC league table. Nevertheless, this figure gives the up-front costs to the airports of purchasing emissions allowances in April of any given year, with recycling not taking place until October. As such, this highlights the differences between the direct cash-flow implications of the CRC incurred when buying permits, and the actual net costs incurred following receipt of the recycled payment.

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