THE CONTRIBUTION OF THE AVIATION INDUSTRY TO THE UK ECONOMY

FINAL REPORT

OXFORD ECONOMIC FORECASTING

November 1999

Foreword

On 20th July 1998 the Integrated Transport White Paper was published. The White Paper stated that *"As recommended by the Transport Select Committee in May 1996, we will prepare a UK airports policy looking some 30 years ahead. This will develop the application to UK airports of the policies set out in this White Paper - of sustainable development, integration with surface transport and contribution to regional growth"* - Para 3.189.

In response to the publication of the Integrated Transport White paper, a consortium of the United Kingdom's major airport operators, airlines and DETR agreed that a study of the contribution of aviation to the national economy should be commissioned to inform the wider sustainable aviation policy debate. In April 1999, Oxford Economic Forecasting Ltd were selected to undertake this work after a rigorous selection process.

Whilst the scope of this study is focused purely on the effects of aviation on the economic performance of the UK, such as the jobs it creates or investment it sustains, it is recognised that this report is only one part of what is needed to inform the debate. Thus, separate studies to assess the environmental and social inclusion consequences of the future development of aviation will be necessary to enable all of the factors relating to the sustainable development of aviation to be considered. The aviation industry supports the principles of sustainable development.

For the first time, this report encompasses the entire aviation industry and has been produced with the co-operation and support of that industry, working with DETR.

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November 1999

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The Contribution of the Aviation Industry to the UK Economy

Executive summary

This report presents the results of analysis undertaken by Oxford Economic Forecasting (OEF) of the contribution of the aviation industry to the UK economy.

The most important contribution aviation makes to the UK economy is through its impact on the performance of other industries and as a facilitator of their growth. And this contribution is likely to be more important in the UK than many other countries given the UK's geographical position as an island on the edge of Europe. But aviation also makes a contribution in its own right.

Aviation is a substantial industry

In 1998, the industry:

- Contributed £10.2 billion to GDP, 1.4% of the total.
- Directly employed 180,000 people in the UK, 0.8% of the total. In terms of the number of people directly employed in the industry, therefore, aviation is similar in size to car manufacturing, hotels or telecommunications services but around half the size of food manufacturing or computing and related activities.
- Supported up to three times as many additional jobs through the supply chain, induced effects and jobs depending on inbound and outbound travellers. (These additional jobs could still exist in the long run without the aviation sector, but they are likely to do so only at somewhat lower real wages and living standards.)
- Produced around two and half times as much value-added per head as the average across all UK industries, helping to support the government's vision of a high-productivity economy.
- Exported £6.6 billion of services, 11% of UK exports of services and 3% of total UK exports.
- Transported a further £35 billion of UK exports, over 20% of all exports of goods.
- Contributed £2.5 billion to the Exchequer, on a conservative estimate.
- Invested £2.5 billion a year over the past 5 years, 3% of total UK business investment.

A key component of the UK's transport infrastructure

Aviation contributes to economic growth in the UK in several ways. Most importantly, the industry is part of the transport infrastructure on which many other parts of the economy depend. Evidence suggests that improvements in that infrastructure boost productivity growth across the rest of the economy. There are a number of ways this might come about:

- Better transport links expand the market. This allows greater scope for economies of scale, increased specialisation in areas of comparative advantage, and stiffer competitive pressures on companies, encouraging them to become more efficient. Air transport takes this a stage further than most other forms of transport through its role in facilitating world trade. This in turn means aviation supports foreign direct investment both into and out of the UK, which is often accompanied by improved technology.

- Networking acts as a spur to innovation. And aviation can allow effective networking and collaboration over longer distances, for example between companies in the UK and other countries.

- An improved transport infrastructure can improve the profitability of investment in other sectors, and so encourage greater innovation by companies - increasing the size of potential markets could allow the fixed costs of innovation to be spread over larger sales, for example.

We find evidence that transport infrastructure has a noticeable impact on productivity. Our econometric analysis, based on disaggregated industry-level data for the UK, is towards the conservative end of the range of earlier research. We estimate that a 10% increase in the provision of transport services increases overall UK productivity by 1.3%. Given the average growth we have seen in transport services over recent years, this implies that the average impact of transport growth on the increase in total output in the whole economy is of the order of £800 million a year.

Aviation boosts the rate of economic growth

There are several reasons for believing that the impact of transport growth on the economy is not all due to land- and sea-based transport. We have therefore assumed that aviation has contributed as much to productivity growth as other modes of transport for the same growth in output, even though we have been unable to identify in the data a separate effect for aviation from that caused by the transport infrastructure as a whole. Since the majority of the growth in transport output recorded in the National Accounts for the UK in the last 10 years has actually been growth in aviation, we estimate the average impact of aviation growth on the increase in total output in the whole economy is of the order of £550 million a year.

In addition to this key role of facilitating productivity growth throughout the economy, aviation also matters for growth because:

- It is a rapidly growing sector in its own right - over the past 10 years it has grown four times as rapidly as the economy as a whole and by 2015 it is projected to rise to 2.1% of GDP from 1.4% in 1998.

- Typically, sectors of the UK economy which we are likely to depend on for future growth make relatively heavy use of aviation. The very fact that these sectors are growing fast means that they represent an ever larger proportion of national output. The implication of this is that the future health of the UK economy as a whole is likely to become more dependent on aviation. Conversely, it implies that restrictions on the expansion of aviation could constrain overall economic growth.

- Good air transport links are one of the key considerations affecting where international companies choose to invest - it is unlikely to be purely coincidence that the UK is the

number one European country both as a recipient of foreign investment and in terms of the frequency and choice of international destinations offered for air travel. In particular, the evidence suggests that good air transport links are important if the UK is to attract inward investment in a number of high technology sectors such as electronics and life sciences, as well as in many long-established industries such as the car industry, which depend increasingly on just-in-time deliveries. They are also important to attracting investment in a number of key functions, such as head office and R&D. For other sectors, air transport access plays a significant part in firms' international location decisions, although it is probably not an over-riding consideration.

Restricting aviation would hit growth and competitiveness

Not all of these effects are unique to aviation, by any means. But the industry is perhaps unusual in contributing to activity and growth in so many different ways. This means there are dangers to the UK economy from restricting the supply of aviation. We estimate that a 25 million a year reduction in the number of passengers, spread proportionately across all types of passengers, would mean that GDP would be expected to be nearly £4 billion a year (in 1998 prices) lower by 2015. This is equivalent to around three times the annual net capital spending by the Department of Health and the NHS Trusts, for example.

The impact on the economy of restricting the number of passengers would depend on the types of passengers most affected. The main impact on the economic performance of the economy arises from business passengers and freight. On the other hand, if a reduction in passengers came entirely from leisure or transfer passengers, there would be a more limited impact on GDP, but there would still be important welfare consequences.

25 million passengers represents a fairly modest reduction in the total number of passengers envisaged by 2015. It is the equivalent, for example, of seeing 3½% a year growth in passengers rather than the 4% growth that underlies our base case. If the number of passengers were not allowed to grow at all over 1998 levels, the estimated effect would be to reduce the level of GDP by 2015 by around 2½% - more than £30 billion (in 1998 prices), or the equivalent of around four-fifths of the total UK education budget, for instance. Indeed, the increasingly severe difficulties in travelling that such a scenario would probably entail highlight the risk that the UK could lose its reputation as a good place for international business. If this were to happen in an increasingly globalised world economy, there is a risk that the impact of lost investment could spiral beyond the level allowed for in our scenarios, with potentially more damaging long-term effects on the competitiveness of the UK economy.

Of course, aviation is not only unusual in the number of ways it contributes to economic activity in the UK. It is also unusual in the degree to which it sparks debate over the sustainability of growth and the environmental impact of its activities. This is outside the terms of reference of this report. What we have demonstrated, though, is that there would be significant economic implications of restricting the growth of aviation which need to be taken into account alongside environmental considerations in considering future policy towards aviation.

The Contribution of the Aviation Industry to the UK Economy

Introduction

This report presents the results of analysis undertaken by Oxford Economic Forecasting (OEF) of the contribution of the aviation industry to the UK economy, focussing particularly on the economic implications of meeting current and prospective demand for air travel. The analysis is centred on the economic contribution to the UK economy as a whole, and was commissioned by the Airport Operators Association (AOA) and the British Air Transport Association (BATA) and their members, and by the Department for Environment, Transport and the Regions (DETR). A full list of the sponsoring organisations is presented in Annex A.

This study draws together different strands of thought on the economic significance of aviation and of the economic impact of individual airports into an overall assessment of the economic importance of the industry. In doing so, it draws on previous research undertaken by a number of groups, and a full list of references is provided. In addition, OEF wrote to a wide range of organisations to solicit their views on the issues raised by this study. We are very grateful to those who responded, who are listed in Annex B.

The rest of this paper is organised as follows:

- Chapter I looks at what aviation contributes to today's economy. This includes its substantial contribution to current UK employment, output, investment, trade, government finances etc. And we discuss the vital role played by the aviation industry in the success of the UK tourism industry. But these standard accounting measures do not reflect the full contribution of the aviation industry to economic welfare. For example, for many the value of being able to fly for holidays, to visit relatives or for business substantially exceeds the costs that they have to pay to do so. We therefore also seek to quantify these wider benefits.

- Chapter II describes the importance of the aviation industry to economic growth in the UK. There are four critical aspects to this:

  - First, we show the direct contribution of aviation as a source of growth in its own right.

  - Second, we show that those sectors which are likely to be the main sources of economic growth over the next 15-20 years are typically the most dependent on aviation. Restricting their access to air travel is therefore likely to constrain their ability to grow.

  - Third, we illustrate the importance of good air transport links to encouraging inward investment into the UK and to encouraging firms already located here to base new projects in this country.

  - Fourth, we discuss the contribution that growth in air services makes to productivity growth across the economy as a whole.

- Chapter III looks at the overall contribution of the aviation industry to the UK economy, presenting the results of a detailed model combining the different mechanisms outlined in the rest of the report.

- Chapter IV offers some conclusions, bringing together the analysis presented in the rest of the report.

I. What Does Aviation Contribute to Today's Economy?

Introduction

The most important contribution aviation makes to the UK economy is through its impact on the performance of other industries and as a facilitator of their growth. But it also contributes to economic activity in its own right. So we set out first the size and significance of aviation itself - in terms of the number of people directly employed in the industry, for example, aviation is similar in size to car manufacturing, hotels or telecommunications services but around half the size of food manufacturing or computing and related activities.

The aviation industry is defined in this report as those activities that are directly dependent on transporting people and goods by air to, from or within the UK. This covers airline and airport operations, and includes scheduled and charter flights for passengers and freight, general aviation[1], aircraft maintenance, air traffic control and regulation, and activities directly serving air passengers, such as check-in, baggage-handling, and on-site retail and catering facilities. Not all of these activities necessarily take place at an airport - for example, some airlines have head office functions or ticketing centres at other locations.

The UK National Accounts separately identify only part of the aviation industry as defined in this report. The Standard Industrial Classification heading 'air transport' (SIC 62) only covers the activities of airlines. Employment statistics are also available for SIC 6323 which covers the activities of airport operators, ground service personnel and air traffic control under the 'other supporting air transport activities'. And it is also possible to obtain the value-added of SIC 6323 once every five years from the weights used to construct the output measure of GDP. However, it is not possible to identify separately from the official statistics the activities of, for example, air cargo handlers, retailers, caterers and hotels at airports, and surface transport links to airports.

There are many other activities that are closely tied to the aviation industry. UK aerospace manufacturers[2], for example, sell aircraft to UK airlines. They are, however, highly international businesses, with the majority of their sales to foreign companies and so we do not treat them specifically as part of the aviation industry as defined here. But we do look closely at how the aviation industry contributes to the success of the rest of the economy.

In this chapter, we illustrate the contribution of the aviation industry to today's economy on a number of different measures:

- We begin by looking at the contribution made by the aviation industry to current UK output and employment, including employment in related activities.
- We then show the financial contribution of aviation to profits, taxes and the balance of payments.
- Next, we discuss productivity and investment in the aviation industry in the UK.
- These standard accounting measures do not, however, reflect the full contribution of the aviation industry to economic welfare in the UK. For example, for many the value of being able to fly for holidays, to visit relatives or for business substantially exceeds the costs that they have to pay to do so. We therefore also seek to quantify these wider benefits.

[1] See Annex C for a brief discussion of general aviation.
[2] See Annex C for a brief discussion of aerospace.

(i) Output and employment in the aviation industry

In an increasingly globalised economy, the aviation industry is a vital element of the UK's transport infrastructure. In 1998, it handled 160 million passengers, of which around a quarter were business passengers. And it transported 2.1 million tonnes of freight, including pharmaceuticals, spare parts for cars and ships, computer components, diamonds, and fresh fruit and flowers. Freight carried included an estimated £35 billion of UK exports in 1998, over 20% of all UK exports of goods by value, and £41 billion of imports. (Annex D presents some background information on the scale and relative importance of the different types of air traffic.)

The success of British businesses in the aviation industry means that the sector itself now represents a substantial part of UK plc. Calculating the contribution of the aviation industry to GDP, known as its 'value-added' (ie the value of its output net of the value of the intermediate inputs it purchases) is complicated by the narrow definition of air transport used in the National Accounts. Our estimates are constructed as follows:

- The value-added by airlines (SIC 62) in 1998 is officially put at £5.3 billion in 1995 prices (the base year used for calculating and presenting the National Accounts), which is equivalent to 0.8% of UK GDP. (This has risen on average by 8.2% a year over the last ten years, while overall GDP has risen by an average of 1.9%.)

- Official estimates for the value-added by the air transport supporting activities (ie SIC 6323) are only available for 1995, when the figure was £2.5 billion. Assuming that this figure has risen since then in line with output for all activities supporting transport (ie SIC 63, which includes support to road, rail and sea as well)[3] would put value-added in 1998 by airport operators, ground service personnel and air traffic control at £2.8 billion in 1995 prices, which is 0.4% of GDP.

- We assume that value-added per employee in the rest of the aviation industry (covering employees in such areas as retail and catering concessions, or in hotels on airports) is equal to the value-added per employee in the national distribution, hotels and catering sector. This suggests that the value-added by these elements of aviation in 1998 was £1.3 billion at 1995 prices, or 0.2% of GDP.

Taking these estimates together implies that total value-added by the UK aviation industry in 1998 was £9.4 billion in 1995 prices and £10.2 billion in 1998 prices. This is equivalent to 1.4% of GDP[4].

Studies have been undertaken at nearly all of the major airports in recent years to assess how much employment is associated with their activities. These have involved detailed questionnaires sent to companies based at airports and in the local vicinity asking how many of their staff are employed on tasks related to the airport, and what purchases they make from other companies as inputs to the provision of services related to the airport.

Using these surveys, it is therefore possible to get a comprehensive estimate of total **direct employment** for most airports - that is, employment that is wholly dependent on airport-related activities, whether on-site at the airport or off-site. There are, however, a number of adjustments that have to be made to the various survey findings before we can estimate direct employment in the aviation industry for the UK as a whole:

- Studies have been conducted at different airports at different times. We have therefore had to update some of the findings to provide estimates for 1998. This was done by assuming that productivity growth at any individual airport (as measured by passenger numbers per employee)

[3] This is likely if anything to understate the growth of activities specifically supporting air transport given the growth of air transport itself, but in the absence of hard and fast data we have deliberately made a conservative assumption. SIC 63 has grown at an average rate of 2.1% a year over the last 10 years.

[4] GDP is measured here at basic prices, since this is the normal approach used to measure GDP in terms of output.

has been in line with the national average for the industry from the date of the original survey to 1998. (In some cases we have used preliminary estimates from new airport studies where it is clear that this is likely to be more accurate.)

- A similar methodology was adopted to estimate employment at airports for which we do not have the results of detailed employment surveys.

- Different studies have adopted different conventions for adjusting the number of part-time employees to a full-time equivalents basis. We have placed the studies on a common basis by assuming that two part-time posts are equivalent to one full-time position.

- Separate allowance has been made for employees in:
  (i) air traffic control and associated regulatory activity, to the extent that such jobs cannot be allocated to specific airports – for which estimates have been provided by CAA.
  (ii) the Heathrow Express rail link, which was opened after the Heathrow employment survey was conducted – for which estimates have been provided by BAA.
  (iii) airline ticketing and enquiry call centres not serving specific airports – for this we used estimates provided by British Airways and grossed these up for other airlines on the basis of relative scheduled passenger numbers.

The resulting estimates of total direct employment in the UK aviation industry are shown in Table I.1. **In 1998 the UK aviation industry directly employed 180,000 full-time equivalent workers.** This represents 0.8% of total UK employment (measured on a comparable basis), and is on a par with the number of jobs in, for example, motor manufacturing, hotels or telecommunication services. The fact that aviation accounts for a smaller share of UK employment than output reflects the high labour productivity of the sector - a point to which we return below (section I(iv)).

Table I.1: Direct Employment in the Aviation Industry, 1998

Airport	Total Terminal Passengers (millions)	Direct Employment
Aberdeen	2.65	2,700
Belfast City	1.31	720
Birmingham	6.61	5,280
Bristol	1.81	2,050
Cardiff	1.23	1,740
East Midlands	2.14	4,040
Edinburgh	4.55	2,400
Gatwick	29.03	33,410
Glasgow	6.48	5,000
Heathrow	60.36	70,650
Luton	4.12	7,610
Manchester	17.21	16,410
Newcastle	2.92	2,730
Stansted	6.83	7,990
Other Airports*	11.76	11,950
Employment not allocated to a specific airport**		4,874
Total	**159.0**	**179,554**

Source: Airport Studies, OEF calculations

***ie airports for which we do not have employment studies*

**Includes call centres and some air trafffic control*

Table I.2: Structure of Direct UK Employment at Airports

Category	% Breakdown	Total Employment
Airport Operator	11	19,215
Airlines/Handling Agents	60	104,808
Freight/Cargo	4	6,987
Concessions	9	15,721
Control Agencies	6	10,481
Other	10	17,468
Total		**174,680**

Source: BAA, Manchester Airport plc and OEF calculations

Table I.2 shows the structure of the direct employment associated with UK airports. Around 60% of employees work for airlines or handling agents (eg as flight crew, check-in staff, maintenance crews etc). Another 10% or so work directly for the airport operator (eg in airport management, maintenance, security etc). Almost another 10% work in concessions (retail outlets, restaurants etc), with 4% in freight/cargo businesses and 6% in control agencies (eg HM Customs and Excise, immigration). The remainder work in a variety of organisations, including on-site ancillary activities such as hotels. The industry therefore provides a wide range of different types of jobs.

The direct employment estimates presented in Table I.1 do not represent the total employment generated by the UK aviation industry. There are also substantial numbers of jobs that are supported by the purchases of the aviation industry, typically referred to in previous studies as **indirect employment**.

Indirect employment is defined as employment in firms outside aviation generated because they supply goods and services to the aviation industry. Examples include the jobs in the energy sector generated because of airline purchases of aircraft fuels, or in the aerospace sector by airline purchases of aircraft equipment; the employment in the IT sector providing computer systems for airport and airline operators; construction workers building additional facilities at airports; and the workers required to manufacture the goods sold in airport retail outlets.

In practice, the distinction between direct and indirect jobs is somewhat arbitrary. Industries which are very vertically-integrated will tend to generate relatively little indirect employment relative to their number of direct employees since they supply a large proportion of their own intermediate inputs. In contrast, industries which outsource a relatively large proportion of their activities will generate a relatively large number of indirect jobs per direct employee. Equally, the classification of jobs into direct and indirect depends on which industry's perspective one is looking from. Business spending on aviation is an intermediate purchase in the production of other goods and services. So, direct employment in aviation related to business travel could equally be classified as indirect employment supported by the industry of the company buying the travel.

Most previous studies of the indirect employment generated by airports have looked only at the employment generated at a regional level, whereas our focus is on effects for the UK as a whole. But there are two exceptions to this - estimates of national indirect employment effects are available for Heathrow and Manchester Airports. Moreover, the methodology adopted for these studies is consistent in the sense that any indirect employment that is generated by the activities of Manchester Airport in firms based at Heathrow is explicitly excluded from estimates of direct employment in the Heathrow study. We can therefore use these estimates to provide indirect employment for these two airports.

To estimate the national indirect employment generated by airports other than Heathrow and Manchester, we adopted the following procedure:

- First, we identified what proportion on average of their employees work for airlines/handling agents (ie the closest equivalent we could get from the employment studies to SIC 62 in the National Accounts) as opposed to in concessions or in other activities.

- We were then able to calculate the indirect employment associated with the employees in airlines using the official UK input-output tables, which identify the supply chain for air transport separately[5].

- Similarly, for employees in concessions, we estimated the indirect employment multiplier from the UK input-output tables on the assumption that retailing at airports supports the same number of indirect jobs per direct employee as retailing nationally.

- Finally, for the indirect employment generated by airport jobs outside airlines and concessions (which represent around 30% of total direct employment), we used for simplicity multipliers calculated for these activities by the Manchester employment survey since analysis of the estimates in conjunction with York Consulting and PIEDA Consulting supported the view that these were likely to be representative of the majority of other airports.

On this basis, we calculate that **the 180,000 direct jobs in aviation generate an additional 200,000 indirect jobs in the UK through the supply chain - that is, the aviation industry generates, directly and indirectly, about 380,000 jobs in the UK.**

There are several other routes by which the aviation industry helps to support jobs in the UK economy:

- Employees in the aviation sector (whether directly or indirectly) use their income to purchase goods and services for their own consumption, and this spending then helps to support the jobs in the industries that supply these purchases. Estimates based on simulations conducted on Oxford Economic Forecasting's Macroeconomic Model of the UK economy suggest that this so-called **induced employment** may be around 100,000 (ie about 25% of direct and indirect employment in aviation). This does not mean that these additional jobs would not exist in the long run without the aviation sector, but they are likely to do so only at somewhat lower real wages and living standards for those workers.

- Around 80% of the work of employees in travel agents is associated with the arrangement of air travel or selling package holidays that include air travel. Since there are around 94,000 employees (full-time equivalents) in travel agencies and tour operators, this implies that the equivalent of 75,000 of those jobs are supported by the aviation sector. This is a two-way process, of course - it is equally valid to regard jobs in aviation as supported by travel agency.

Table I.3: Jobs supported by aviation, 1998

	(thousands)
Direct employment	180
Indirect employment	200
Induced employment	94
Travel agents	75
Total	549

Source: OEF calculations

[5] The figures were adjusted to avoid double counting of jobs in other transport services and distribution which should already be picked up in the estimates we are using for direct employment.

Putting these different elements together implies that the aviation industry helps to support 550,000 jobs in the UK (Table I.3). In addition:

- Employment in the UK **tourism** industry is clearly dependent on the aviation industry since two-thirds of foreign visitors arrive by air. We discuss the links between the aviation and tourism industries below.

- **The aviation sector also helps to generate employment elsewhere in the economy by, for example, facilitating foreign direct investment in the UK and improving the efficiency and competitiveness of UK industry.** This is one of the key points we discuss in detail in Chapter II of this report.

The estimates of employment effects presented here, although built on work carried out in studies of the employment impact of individual airports, are not directly comparable with estimates in those reports for a number of reasons:

- We are interested in overall employment generated by the industry, not just that which can be allocated to individual airports.

- We are interested in the impact on jobs in the economy as a whole, rather than in the vicinity of each airport. When looking at the gross impact on jobs, the national impact will often be larger than local or regional impacts since a significant proportion of indirect and induced spending can take place outside the local area. But the net impact on jobs may be smaller at the national level if local jobs partly displace jobs in other parts of the country.

- Our estimate of the induced employment multiplier is smaller than that typically used in studies of the impact of individual airports. In our estimates, we have assumed that if workers currently in the aviation industry were no longer employed in that sector then they would still receive some income (eg unemployment benefits) which they could spend and therefore would continue to support some employment elsewhere in the economy. In contrast, most airport studies have assumed that if workers currently in the aviation sector were no longer employed in that sector then they would no longer support any employment in the wider economy. Our estimates are therefore based on the income employees in aviation receive over and above the benefits they would receive if they were otherwise unemployed, whereas the other studies have typically looked at induced employment effects on the basis of the total income received by employees in aviation.

In either case, though, estimates are on a gross basis, ie no attempt is made to net out any crowding out of jobs elsewhere in the economy from upward pressure on wages[6]. These effects are allowed for, however, in the model used at the end of the study to put all the different elements of the analysis together.

(ii) Aviation and tourism

> *"Tourism is of enormous importance to the economy of England and makes an impact on all our lives. It is a modern industry that needs a modern structure to help it succeed."*
>
> **Tomorrow's Tourism, DCMS**

Tourism makes a large and growing contribution to the UK's economy. According to "Tomorrow's Tourism" (the Department for Culture, Media and Sports strategy document on the future of the industry):

- It directly employs 1.75 million people in 125,000 businesses (7% of all jobs)[7].

[6] We have, however, deliberately not included our estimate of the number of jobs supported in the UK tourism industry in the total quoted, since there is an offsetting effect from UK residents travelling overseas (see below).
[7] This estimate does not include any jobs in aviation that depend on tourism.

Table I.4: Overseas Visitors to the UK, 1997

	Air	Sea	Channel Tunnel	**All modes**
Visits:				
Millions	16.9	5.7	2.9	**25.5**
% of total	66.1	22.5	11.5	100
Spending:				
£ billion	9.9	1.4	1.0	**12.4**
% of total	80.1	11.1	8.0	100
£ per trip	587	237	340	**480**

Source: International Passenger Survey 1997, ONS

- It has accounted for 1 in 6 of all new jobs created in the last 10 years.
- Tourism expenditure in the UK is estimated at £53 billion.
- Tourism accounts for 4-5% of GDP.
- It is our largest invisible export.
- It brought 25.5 million overseas visitors to the UK in 1997 and is expected to attract 27.5 million in 2000.

Travel and tourism are inextricably linked. Tourism depends on the travel industry to bring visitors. But equally the travel industry depends on tourism to generate demand for its output. We look here at how many jobs in UK tourism are supported by visitors who arrive by air.

It is worth bearing in mind that tourists do not include just those who come to the UK simply for a holiday. Many people coming to the UK on business become tourists once their meetings have finished, and visit the same sort of places and spend money on the same types of things as those just coming for a holiday. Statistics on overseas tourists therefore include all types of visitors.

Table I.5: Employment in tourism-related industries in the UK ('000s)

	1998
Hotels & other tourist accommodation	284
Restaurants, cafes,etc	359
Bars, pubs & nightclubs	428
Travel agencies/tour operators	105
Libraries/museums & other cultural activities	82
Sports & other recreation activities	323
Total tourism employees	1581
Self employment	176
Total	**1757**

Source:ONS

Table I.6: UK Employment Generated by Air Visitors from Overseas

	Retail sales	Hotels & catering (1)	Land travel	Enter-tainment	All identifed categories
Proportion of tourist spending (%)	25	58	8	2	93
Spending by air tourists (£bn)	2.4	5.8	0.8	0.2	9.2
Total UK spending (£bn)	186.7	55.8	7.7	6.6	256.8
Air tourists' share of UK spending (%)	1.3	10.3	10.3	3.0	3.6
UK Employment (000's)	2416	1062	464	405	4347
Employment due to spending by air tourists (000's)	31.4	109.5	47.7	13.7	202.4

(1) Hotel & Catering = accommodation, catering, bars, pubs, & nightclubs

Source: OEF calculations

As table I.4 shows, 66% of these overseas visitors arrive by air. And since visitors flying to the UK spend more on average while they are here than visitors arriving by sea or the Channel Tunnel, visitors arriving by air accounted for 81% of total spending by overseas visitors to the UK in 1997. The aviation industry is therefore critical to the Government's tourism strategy, which aims to make the UK tourism industry a world leader. There is no point, for example, in spending "more money for a more focused and aggressive overseas promotion programme to bring more overseas visitors" (Tomorrow's Tourism action point 3), if the aviation industry does not have the capacity to handle the increase in passengers this would entail. While a limited number might still want to travel to the UK by other means, many would probably be put off by the additional travelling time and congestion that would result and choose other destinations - especially those from outside Europe, who make up 55% of visitors arriving by air.

Tourism does not fit neatly into the classification of industries used to collect and present most economic statistics in the UK. Rather, jobs in a wide range of different sectors can be supported by tourism. Table I.5 shows the scale of employment in the more obviously tourism-related industries, such as accommodation, restaurants & bars, and recreational activities. But jobs in these areas may also depend heavily on local spending, while tourism can be an important factor behind jobs in other sectors too, such as retailing in many heavily-visited areas.

We have therefore produced our own estimate of the numbers of jobs in the UK directly attributable to overseas tourists (Table I.6). This involves:

- Looking at the main items on which overseas visitors spend their money, such as accommodation, food and shopping (a few smaller categories of spending are excluded from the calculation). Surveys record both the total spending in the UK by visitors arriving by air from overseas, and what proportion of it is spent on different items.

- We then calculate this spending as a share of total spending in the UK on comparable items.

- Finally, we assume that the same proportion of relevant employment is attributable to the spending of foreign visitors.

This approach implies that spending in the UK by visitors arriving by air from overseas generates 200,000 jobs (in addition to the jobs generated by their demand for air services themselves).[8]

[8] The same type of calculation shows that the output of these sectors that can be attributed to spending by overseas visitors arriving by air amounted to some £3.5 billion in 1998 (in 1995 prices), equivalent to 0.5% of GDP.

Having said that, there is, of course, an offsetting impact from the amount UK visitors spend abroad. Indeed, for passengers who travel by air this spending outweighs the spending of foreign visitors to the UK by around 35% - UK air travellers abroad spent £13.4 billion in 1997, compared with the corresponding £9.9 billion spent in the UK by overseas travellers by air. If the alternative to travelling overseas by air for these people was to spend the same amount on visits within the UK then they would arguably support more economic activity in the UK than overseas visitors travelling by air to the UK currently do, although it is not clear in practice what people would choose to spend their money on instead.

(iii) The financial contribution of aviation

Table I.7 provides summary information for the profit and loss account of the major UK airlines and airports. Airline operating revenues on this basis were nearly £12 billion in 1997, compared with operating income of a little over £1.9 billion for airports in 1997/98. Total operating profits were around £720 million for airlines and almost £600 million for airports. It should be emphasised, however, that these accounts do not cover the total aviation industry. For example, they do not cover the activities of, amongst others, separate airport retailers and caterers, freight- and baggage-handlers.

Table I.7: Profit and Loss Account Summary, Airports and Airlines, 1997
(£ million)

	Major UK Airlines 1997	Major UK Airports 1997/98
Traffic	11987	850
Commercial	-	1065
Total Operating Income	*11987*	*1915*
Total Operating Expenditures	*11266*	*1322*
Total Operating Profit	**721**	**594**
Interest Payable (net)	171	67
Other expenses, etc	-253	83
Profit on Ordinary Activities Before Taxation	**803**	**444**
Taxation	200	110
Profit on Ordinary Activities After Taxation	**603**	**334**
Dividends	326	128
Retained Profit for the Year	**277**	**206**

Sources: CAA Airline Statistics, Annual Operating, Traffic and Financial Statistics, tables 2.03, 2.04 and 2.05
CRI, University of Bath, 'The UK Airports Industry - Airport Statistics 1997-98

The financial contribution of the UK aviation industry includes a sizeable contribution to the government's revenues, as shown in Table I.8:

- **Income tax** revenues from employees in aviation are estimated to have been £830 million in 1998-99[10].

[10] Figures from the New Earnings Survey for 1998 show average wages in air transport services (SIC 62) 49% higher than the UK average, supporting transport activities (SIC 63.2) 18% higher than the UK average and

Table I.8: Contribution of aviation to UK public finances, 1998-99

	(£ million)
Income tax from aviation	829
National Insurance Contributions from aviation	495
Corporation tax revenue from airlines	209
Corporation tax revenue from airports	125
Air passenger duty	837
Total	2495

Sources: ONS; CRI; OEF calculations

- **National Insurance Contributions** (both employees' and employers') are estimated to have been £500 million in 1998-99.

- **Corporation tax** revenues from airlines and airports totalled over £330 million in 1998-99. This understates total corporation tax revenues from the industry, since it excludes equivalent figures for other companies in the aviation sector (eg on profits from operating concessions at airports), which are not readily available.

- **Air passenger duty** receipts were almost £840 million in 1998-99.

Taken together, these figures imply that the aviation industry contributed directly £2.5 billion to the Exchequer in 1998-99 (equivalent to around 1p on the basic rate of income tax). However, they understate the total contribution to the Exchequer since we have not been able to include all taxes in the calculation, such as business rates, insurance premium tax on flights and VAT on either sales at airport shops or spending elsewhere in the economy by households employed in the aviation industry. And we have not taken account of tax paid by workers in the aviation supply chain (ie indirect workers).

Table 1.9 shows the direct contribution of the aviation industry to the UK's trade in services[11]. UK airlines sold £4.4 billion of tickets overseas in 1998 and earned £400 million in freight charges, while UK airports and other members of the industry generated £1.8 billion of exports, including costs incurred by overseas airlines in using UK airports. **Total aviation exports therefore totalled £6.6 billion in 1998, which accounted for 11% of the UK's overall exports of services and 3% of all exports**, similar in value to exports of food, oil, pharmaceuticals or financial services**.**

UK airlines produced a net export surplus of £1.5 billion, after allowing for £3.4 billion of spending overseas on services such as airport charges, accommodation for flight crews, advertising and commission. But because of the high level of demand for air transport in the UK, overseas airlines are also significant export earners in their dealings with the UK, with the net result that the UK had a balance of payments deficit in air transport services of around £1.4 billion in 1998.

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distribution, hotels & catering (SIC 50-55) 23% lower. Combining these figures using the proportions in Table 1.2 implies that average earnings in aviation could be around 25% higher than in the economy as a whole. Estimates of income tax and NICs from aviation therefore represent a 25% higher share of total receipts from these taxes than aviation's share of total employment.

[11] These figures do not include any indirect effects from the UK's balance of trade in tourism or from the value of goods exported or imported by air. Neither do they include any impact of aviation activities on the balance of trade in goods - for example the fuel taken on by UK aircraft at overseas airports and vice versa - which is not separately recorded.

Table I.9: Air Transport Contribution to Balance of Payments, 1998
(£ million)

Exports	**6631**
of which:	
Passenger revenue	4422
Freight	408
Disbursements	1505
Other revenue	296
Imports	**8069**
of which:	
Passenger revenue	4114
Freight	583
Disbursements	3372
Balance	**-1438**
of which:	
Net exports by UK airlines (1)	1458
Exports by UK airports, etc (2)	1801
Imports by air users (3)	-4697

Note (1): Exports of passenger services and freight, less imports of disbursements
Note (2): Exports of disbursements and other revenue
Note (3): Purchases of passenger services and freight from overseas airlines by UK residents
Source: ONS

(iv) Productivity and investment

Productivity is a key engine of economic growth - over time, countries grow and wealth is created when resources are diverted from areas where they are used least efficiently to those where they are most productive. Indeed, raising the level of productivity in the economy is one of the key aims of the government's economic policies. We return to the impact of aviation on productivity in the rest of the economy in Chapter II, but even without such effects, the expansion of a high-productivity sector should raise the overall productivity of the economy.

Table I.10 shows that **value-added per employee in airlines (SIC 62) in 1998 was nearly £70,000 at 1995 prices, with productivity in the air transport supporting activities (ie SIC 6323) almost £80,000. These figures compare with the national average of £28,000** and are exceeded only in the extraction and utilities industries (a very capital-intensive range of activities) and in the real estate and renting sector (obviously dominated by investment in commercial property). Productivity in the aviation sector is, for example, around 25% higher than in the chemicals industry, over 50% higher than in the post and telecommunications sector, and double that in both the motor manufacturing and electrical engineering sectors. Constraining the growth of aviation would therefore be likely to hit the average level of productivity in the economy and reduce the living standards the economy could sustain.

High productivity per employee is often a reflection of the capital stock available per worker, and the aviation industry is heavily capital-intensive. This reflects not only the investment required in runways, airport terminals and aircraft, but also in associated computer systems, maintenance facilities and offices.

National Accounts data published by the Office for National Statistics on investment broken down by industry only provide estimates for the air transport sector up to 1995. However, after discussing the position with them and presenting them with some estimates based on reported capital spending from

Table I.10: Relative Productivity in the UK Aviation Industry, 1998	
	Value-added per employee (£ '000s)
Air transport (SIC 62)	68.0
Air transport supporting activities (SIC 6323)	78.5
Extraction	278.9
Manufacturing	32.2
of which	
Chemicals	60.8
Motor Vehicles	33.5
Mechanical Engineering	23.9
Electrical Engineering	35.0
Electricity, gas and water	102.6
Construction	15.9
Post and communications	47.7
Distribution	14.9
Real estate and renting	103.0
Total	28.0
Source: ONS, OEF calculations	

UK airlines, the ONS have now provided us with provisional estimates for airlines' capital spending up to 1998. Figures for capital spending by airports are published by CRI.

Table I.11 shows that **over the last five years UK airlines have invested £9½ billion at 1995 prices, while airports have invested over £3 billion over the same period. Together these figures are equivalent to 3% of total UK business investment.**

Adding in purchases of computer software - which are now scored as investment in the National Accounts, but are not included in these figures - would push the total higher. Moreover, we have not included investment by firms in the industry outside airlines and airports, for which no reliable estimates are available. As for many industries, a substantial part of the capital spending undertaken

Table I.11: Investment in Airlines and Airports, 1994-1998 (£ millions)

	1994	1995	1996	1997	1998	1994-98 (Average)
Airlines						
Total Airlines (Current Prices)	1,540	429	1,339	3,084	3,189	1,916
Total (1995 Prices)	1,621	429	1,300	3,000	3,100	1,890
Airports						
Total Airports (Current Prices)	669	572	506	787	637	634
Total (1995 Prices)	704	572	491	766	619	630
Total Airlines and Airports						
Total (Current Prices)	2,209	1,001	1,845	3,871	3,826	2,550
Total (1995 Prices)	2,325	1,001	1,791	3,766	3,719	2,520

Source: CRI - The UK Airports Industry: Airport Statistics, updated from company reports; ONS

by the aviation industry is used to purchase foreign-made investment goods - though this is probably less the case for airports undertaking construction work than for airlines buying aircraft, and Boeing aircraft that have been bought with Rolls Royce engines still have a significant UK content even though they are imports.

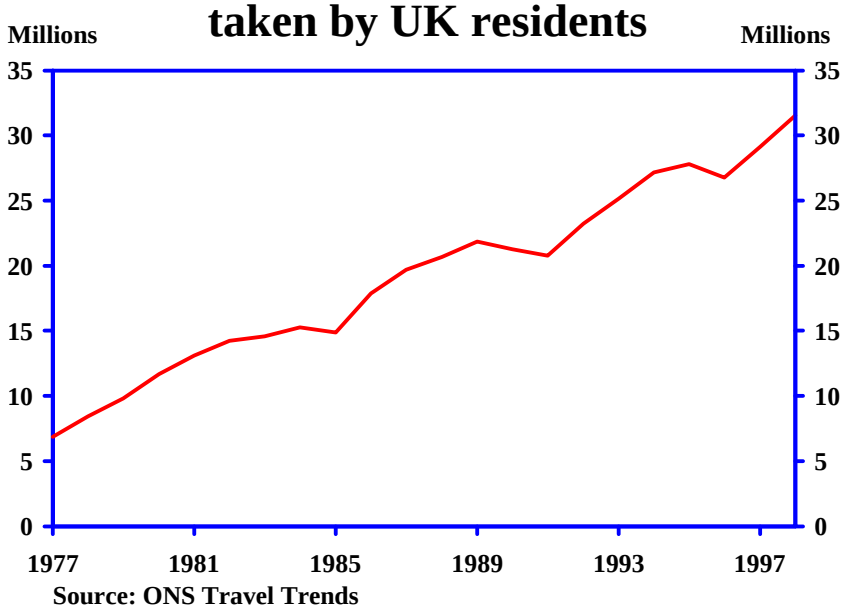
(v) Wider welfare benefits

The indicators of the significance of the UK aviation industry presented have been based on standard economic measures of its *market* contribution. However, such estimates do not capture the full contribution of the aviation industry because, like most industries, it also generates significant additional *non-market* benefits for its customers and because there are significant indirect welfare benefits to non-customers[12]. For example:

- *The availability of affordable and frequent flights from the UK to most of the world has brought foreign travel and holidays within reach of the majority of the population.* In 1998 UK residents took 31½ million foreign holidays, compared to just under 7 million in 1977, with over two-thirds, (22 million) travelling by air. As a result, much of the population were able to enjoy visiting other countries and experience a wide range of new cultures. The rapid growth in the availability of air travel has made a foreign holiday the norm for much of the UK population rather than an elite activity from which most people were excluded simply by price. It has led to a huge increase in foreign travel which has arguably helped deepen our understanding of our European neighbours and reinforce ties with other countries. And it has helped to maintain international family ties and friendships which might otherwise have withered. The broadening of the availability of foreign travel to less well off socio-economic groups can be seen as a contribution to enhancing social inclusion in the UK.

- *The aviation industry has expanded the range of choices available to the consumer*. For example, seasonal fruit and vegetables are now available all the year round at reasonable prices thanks to the speed and low cost of the UK's air-freight services; the range of potential holiday destinations has increased enormously due to the availability of affordable and frequent flights from UK

Chart I.1: Number of holidays abroad taken by UK residents



Source: ONS Travel Trends

[12] This is not to deny that aviation also generates welfare *disbenefits* to non-users. However, as explained in the introduction, the environmental impact of aviation is outside the scope of this study.

Table I.12: Visits abroad by UK residents in 1998 (Million)

Mode of travel	Air	Sea & Tunnel	All modes	Air travel share (%)
Purpose of visit				
Holiday	22.2	9.4	31.6	70.3
Visiting friends or relatives	4.5	2.1	6.5	68.4
Business	6.2	2.0	8.1	75.9
Miscellaneous	0.8	3.3	4.1	19.8
All Visits	33.6	16.7	50.3	66.9

airports; and the large number of overseas visitors has helped widen range of leisure and cultural activities available in the UK - according to the Society of London Theatres, overseas visitors typically make up one-third of their audience, and they would be unable to support the range of productions currently put on without overseas tourists. Sponsorship can also widen consumer choice - Manchester Airport, for example, is the biggest corporate sponsor of arts in the region, helping to support a wider diversity of cultural activity than would be possible without this help.

- *Excellent air transport links have helped Britain beat stiff competition to host major international sporting events* - including this year's Rugby world cup, the 2002 Commonwealth Games and the 2005 world athletic championships. The UK's bid to host the 2006 football World Cup would be a non-starter without good air transport links.

It is also possible to look at the value of the industry's output in terms of the benefits customers derive from it. The value of aviation to customers in the UK is to a large extent reflected in the £12.4 billion we estimate was spent on it by UK residents and UK-based businesses in 1998. But there are additional, *non-market*, benefits arising when some customers would be prepared to pay more than they actually have to, to secure a seat on a particular flight (a concept known to economists as 'consumer surplus')[13] - an example might be parents travelling to their daughter's wedding in Australia who value the opportunity to be present very highly.

This value of this consumer surplus is not straightforward to calculate, since we cannot observe in practice how much each person would be willing to pay if they had to. But using plausible estimates of the responsiveness of demand to changes in price, we calculate it could be as much as £6 billion for

Table I.13: Overseas residents visits to UK in 1998 (Million)

Mode of travel	Air	Sea & Tunnel	All modes	Air travel share (%)
Purpose of visit				
Holiday	6.0	4.5	10.5	57.1
Visiting friends or relatives	3.9	1.5	5.4	72.7
Business	5.6	1.3	7.0	81.0
Miscellaneous	2.1	0.9	3.0	68.7
All Visits	17.7	8.3	25.9	68.1

[13] Annex C gives more details on definition and calculation of consumer surplus.

UK passengers and businesses (£2.3 billion for leisure travellers, £3.4 billion from business travel, and £0.4 billion from the use of air freight services). Of course, airlines devote more effort than most industries to reflecting the value customers put on a service in the price they have to pay for it. To the extent they are successful in this, the value of consumer surplus will be correspondingly reduced.

Conclusion

This Chapter has looked at a number of indicators of the size and contribution of the aviation industry to the UK economy, some easier to measure than others. In 1998, aviation:

- Contributed £10.2 billion to GDP, 1.4% of the total.
- Directly employed 180,000 people in the UK, 0.8% of the total.
- Supported up to three times as many additional jobs through the supply chain, induced effects and jobs depending on inbound and outbound travellers.
- Exported £6.6 billion of services, 11% of UK exports of services and 3% of total UK exports.
- Contributed £2.5 billion to the Exchequer, on a conservative estimate.
- Produced around two and half times as much value-added per head as the average across all UK industries, helping to support the government's vision of a high-productivity economy.
- Invested £2.5 billion a year over the past 5 years, 3% of total UK business investment.
- And there are wider welfare benefits from aviation on top of any estimates of the contribution to GDP.

But the industry also has a role to play in facilitating growth in other parts of the economy which are dependent on aviation to allow them to be competitive in an increasingly globalised economy. It is to this more diffuse role than we turn in the next chapter.

II. The importance of the aviation industry to economic growth in the UK

This Chapter describes the importance of the aviation industry to economic growth in the UK. There are several reasons for thinking aviation has an important role to play in helping the UK economy prosper in the future:

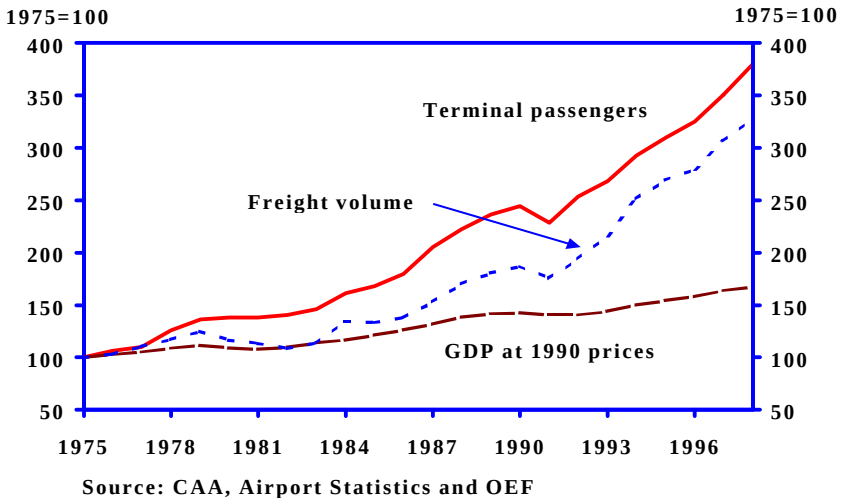
- First, it makes a direct contribution as a source of output and productivity growth in its own right.
- Second, we show that those sectors which are likely to be the main sources of economic growth over the next 10-15 years are typically among the most dependent on aviation. Restricting their access to air travel is therefore likely to be a serious constraint on their ability to grow.
- Third, we illustrate the importance of good air transport links to encouraging inward investment into the UK and to encouraging firms already located here to base new projects in this country.
- Fourth, and more fundamentally, the aviation industry is part of the transport infrastructure on which many other parts of the economy depend, and one strand of economic theory highlights that improvements in transport infrastructure can boost productivity growth across the rest of the economy.

A. The direct contribution of aviation to growth

The UK economy will only achieve its economic potential if we are able to compete in the industries of the future. We need to be strong in the areas with the potential to grow rapidly. And this includes the aviation industry itself.

The demand for air transport has risen strongly over the last 25 years, driven by falling real prices and rising incomes. For example, the number of passengers travelling via UK airports has increased by 280% since 1975, while the volume of freight handled by UK airports has risen by over 210%[14]. This

Chart II.1: Air traffic and GDP



Source: CAA, Airport Statistics and OEF

[14] Interestingly, the volume of freight transported by air has grown more rapidly than passenger numbers since 1991, having grown less rapidly in the preceding period.

compares with an increase in UK gross domestic product (GDP) of around 60% over the same period. The result is that aviation directly contributed around 2½% of the real growth of the economy over the last 25 years or so - four times as much as if it had remained at around 0.6% of GDP as it was in 1975[15].

And the demand for air travel is expected to continue to expand rapidly. For example, taking the mid-point of the DETR's 1997 Air Traffic Forecasts for the UK (the last published official projections), total passenger numbers are expected to reach 310 million by 2015. This is almost twice the number in 1998, and would mean air travel growing on average by 4% a year over the next 15 or so years, close to double the Government's estimate of the overall economy's potential rate of growth.

On this basis, the aviation industry is set to make a rapidly expanding contribution to the UK economy, with value-added in aviation expected to reach £18 billion by 2015 (in 1995 prices) - 90% up on its level in 1998 and equivalent to 2.1% of GDP.

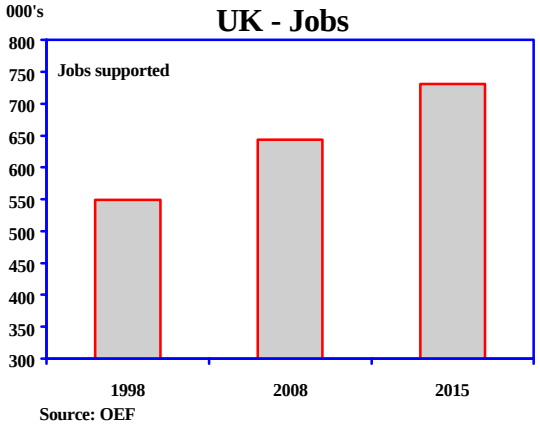
Projections of the employment associated with this output depend on assumptions about productivity. We have assumed for simplicity that past trends continue over the forecast period. This probably gives a very conservative estimate of employment in aviation, where the number of passengers handled per employee has been rising by around 3% a year, since it could become increasingly difficult to sustain this rate of productivity growth. But, offsetting this, it may overstate associated employment at travel agents, where developments such as increasing use of the internet could change the nature of the business over the coming years. Our assumptions mean that:

- Direct employment in aviation is projected to increase by 30,000 by 2015, to 210,000. On this basis, the aviation industry is set to employ, for example, a third more people than motor manufacturing and become a bigger employer than the chemicals industry.

- Aviation is expected to generate another 290,000 jobs indirectly through the supply chain by 2015 - 90,000 higher than now.

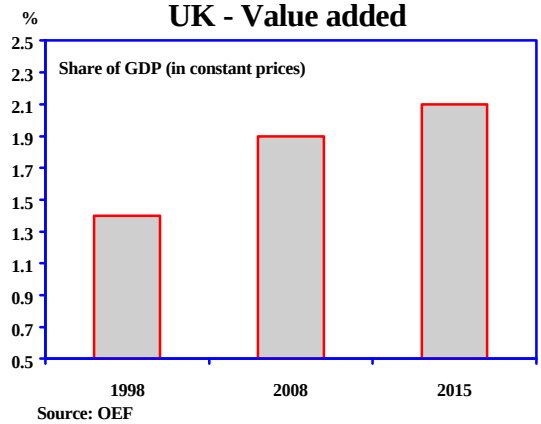
- And the number of jobs in travel agents that depend on aviation-related products might rise from 75,000 now to 110,000 by 2015.

Chart II.2: The growth of aviation in the UK - Jobs



Source: OEF

Chart II.3: The growth of aviation in the UK - Value added



Source: OEF

[15] This does not include the indirect contribution of aviation to growth, to which we return below.

Table II.1: Share of Aviation in the UK Economy

	1998	2008	2015
Direct employment (000s)	180	196	210
Direct employment (% of UK)	0.8	0.9	0.9
Indirect employment (000s)	200	243	287
Induced employment (000s)	94	110	124
Value-added (£1995 billion)	9.4	13.9	18.3
Value-added (% of UK)	1.4	1.9	2.1

Source: OEF forecasts

B. The contribution of the aviation industry to the success of the UK growth sectors

(i) Growth sectors in the UK

As the Government recognised in the DTI's White Paper on Competitiveness, growth depends on building the so-called 'knowledge-driven economy' - that is, sectors in which "the generation and exploitation of knowledge has come to play the predominant part in the creation of wealth" (DTI(1998), p 2). Looking back over the past ten years, the UK economy as a whole grew on average by 1.9% a year between 1988 and 1998. Within this, sectors which have grown particularly rapidly include pharmaceuticals (average growth 5.5% a year over the last decade); computers and office equipment (13.5% a year); electronic equipment (5.1% a year); communication services (6.6% a year); insurance (3.4% a year); computer services (7% a year); and other business activities such as consultancy (4.6% a year).

And with many of these industries still in a relatively early stage of development, it is for the most part these sectors which are expected to continue to grow rapidly over the next 10 years[16]. UK competitiveness depends on continuing to exploit the opportunities for growth in these sort of areas.

(ii) The relationship between the aviation industry and the UK growth sectors

How important is the aviation industry to the success of the growth sectors in the UK? To shed light on this question, we have compared the relative growth of the various industrial sectors with their relative dependence on aviation. Since no definitive index of a sector's reliance on aviation exists, we have used a number of indicative measures (see Annex E for more details of the results):

- An industry's spending on air transport, both as a proportion of the sector's total inputs of transport services and per employee.

- The degree of 'internationalisation' for manufacturing industries - exports as a proportion of output and the degree of foreign ownership - on the basis that the more international a business, the more reliant it is likely to be on air transport services.

- The proportion of exports transported by air by different manufacturing industries.

While not necessarily confirming a causal relationship, these indicators do suggest that the fastest growing sectors tend to be relatively significant users of aviation services:

- Calculations of rank correlation coefficients between sectoral output growth and spending on aviation (either the share of air transport as a proportion of a sector's total inputs of transport services, or the spend on air transport services per employee) are statistically significant at the 5% level. Sectors such as communication services and insurance are among the most dependent on aviation on these definitions.

- The rank correlation between sectoral output growth and spend per employee on aviation is also significant if we look just at the service sector - this indicator is arguably a better measure of the importance of aviation for business travel in services than it is in manufacturing, where it will also be affected by the use of aviation for freight. With trade in services likely to grow at a faster rate than overall trade and global consolidation within service sectors - especially financial services - the dependence of these sectors on air transport is likely to increase.

[16] See Annex E for more details on how rapidly different industrial sectors in the UK have grown over the last decade and how fast OEF predicts that they are likely to grow over the next 10 years.

- There is also a statistically strong rank correlation within the manufacturing industry between sectoral output growth and our indicators of the degree of internationalisation of business. For example, the pharmaceuticals, computers/office equipment and electronic equipment sectors are among the most export dependent within manufacturing and also sectors where foreign ownership is very high. This finding is supported by surveys such as the 'Locationally Sensitive Businesses' Study (Gordon and Cheshire, 1993), which indicates that airport access is of prime importance for multinational companies.

- The computers/office equipment and electrical engineering sectors are also relatively large users of air for international freight.

Aviation is important to growth sectors for a variety of reasons:

- Air freight matters most for producers of high value/low weight products - typified by the 'knowledge-intensive' industries of the future - and for those running just-in-time inventory systems where rapid delivery times are needed to keep production going.

- In sectors such as computers and electronics, the speed at which components are developing and improving means that companies cannot hold large stocks without the risk of being left with obsolete and unusable products. Quick and effective distribution of components and products in response to client demand is therefore essential.

- However, business travel is probably more important than freight to rapidly growing sectors, and is becoming even more important as the economy becomes more globalised. This is true, for example, for sectors with a lot of research activity like pharmaceuticals, where R&D staff need to travel frequently to discuss findings and keep up with latest developments. Similarly, it is critical to the financial services sector, with banks based in the City of London investing more capital abroad than those of any other country (equivalent to 19% of external lending globally and 40% of lending by European countries).

- Business travel matters for growth sectors producing goods, too - there is a clear link between the number of business trips to another country from the UK and the size of our exports to that country. The importance of aviation for the development of world trade is explored further in the box.

(iii) The high-tech alternative to air transport

Some commentators argue that the development of alternative technologies such as video-conferencing will reduce the importance of aviation for international business. However, this is not the expectation of several companies. ICI, for example, expects that the depth of business travel within its operations will fall - ie less employees will find it necessary to travel - but that those that do travel will need to do so increasingly. And Glaxo told us that "communications technology will not obviate significantly the need for face-to-face contacts."

This is more consistent with the experience of recent years. Communications technology has advanced rapidly over the last decade, with conference calls, the Internet and video conferencing. Nevertheless, business travel has actually increased in most sectors of the economy over this period. While some trips are made unnecessary by alternative technologies, these also foster the demand for air travel by leading to an expansion in the types of business which require face-to-face contact or products to be transported across countries.

Aviation is an engine of international trade

Increasing international trade is a major driver of world economic growth. It expands the potential market in which companies can operate; it enhances competition between international companies; it encourages countries to specialise in activities in which they have a comparative advantage, leading to increased productivity; it increases the incentives for companies to undertake research and development since, by expanding the potential market, it also increases the potential return on such investment; and it facilitates the spread of knowledge from one economy to another. As the Government's White Paper on competitiveness puts it, "the combination of greater competition, the more rapid spread of ideas and the faster pace of innovation all help to advance the transition to the knowledge driven economy" (DTI 1998).

Air transport has clearly contributed to the rapid growth in international trade in recent decades by making it cheaper and quicker to move products and personnel across long distances. Maintaining a world class aviation industry is vital if the UK economy is to take full advantage of the benefits of the future growth in international trade:

- Over a fifth of UK exports of goods by value are now transported by air. So, the easier and cheaper it is to get these products to market and to get salesmen to their customers, the more competitive is UK industry. This is particularly important for more distant markets, such as the so-called 'emerging' economies in Asia, Latin America and Eastern Europe, which are likely to see the most rapid growth over the next 10-15 years.

- The ability of managers to travel quickly is one of the factors supporting both inward and outward foreign direct investment which facilitates many of the potential gains from trade (see Section II.C).

- UK businessmen need to keep up with new ideas being developed overseas and best international practice. As the Competitiveness White Paper points out: "The ease of international travel, through lower transport and transactions costs, makes events such as conferences and activities like management consultancy much easier" (DTI 1998).

(iv) Conclusions

This Section has illustrated that the high growth sectors in the UK economy are typically among the more dependent on aviation services. The very fact that these sectors are growing fast means that they represent an ever larger proportion of national output. The implication of this is that the future health of the UK economy as a whole is likely to become more dependent on aviation. Conversely, it implies that restrictions on the expansion of aviation could constrain overall economic growth.

The Competitiveness White Paper recognises the importance of globalisation in committing the government to "maintain the UK's position as one of the world's most open economies" and to "make the removal of remaining barriers to trade a priority in future international trade negotiations" (DTI 1998). But if the UK is to compete successfully in the modern knowledge-based industries of the future, they will need to be able to make growing use of aviation. Sectors that depend on rapid delivery times of components or products, which depend on business travel to generate overseas sales or where keeping up with worldwide developments in technology is important, all depend on the availability of aviation to develop their full potential.

Apart from being typically among the more dependent sectors on aviation, the high growth sectors in the UK are also likely to be among the more internationally mobile sectors which can locate future expansion wherever local conditions meet their requirements best. The next Section looks in more detail at the specific issue of the impact of aviation on location decisions.

C. The contribution of the aviation industry to global investment in the UK

(i) Introduction

The growth of both inward and outward foreign direct investment has been an integral part of the globalisation of the world economy - leading to greater international specialisation across the world and providing the opportunity to raise living standards. Inward investment brings with it important benefits to the recipient, most obviously in terms of increased employment and output, but also in the transfer of technology and new management techniques from overseas. According to the Office of National Statistics, foreign-owned manufacturing firms in the UK employed 815,000 people in 1996, some 19% of total employment in the sector, and these firms produced 28% of the net output of the manufacturing sector.

The UK has been very successful in attracting foreign direct investment(FDI). As shown in Table II.2, the UK received an average of $22 billion of inward investment a year between 1993 and 1997, more than any other country apart from the United States and China, and bigger in relation to the size of the economy than in any other G7 economy. Almost 8% of the world's stock of FDI is located in the UK.

Table II.2: Foreign Direct Investment

	Average inflow 1993-97		**Inward stock end 1997**		**Inward stock**
	$ billion	Share of world total	$ billion	Share of world total	% GDP
US	62.9	20.6	720.8	20.9	8.3
UK	22.0	7.2	274.4	7.9	20.5
France	20.1	6.6	174.2	5.0	10.1
Canada	7.7	2.5	137.1	4.0	22.0
Italy	3.7	1.2	78.5	2.3	7.4
Germany	2.8	0.9	137.7	4.0	5.9
Japan	0.9	0.3	33.2	1.0	0.7

Source: UNCTAD: World Investment Report 1998

Most inward investment takes the form of mergers and acquisitions rather than high profile investments in 'greenfield' sites, such as the Nissan car plant in Sunderland or the LG electronics plant in South Wales. However, research by the National Institute of Economic and Social Research (1997) highlights that the benefits arising from inward investment do not depend simply on the extent to which it creates new capacity, "but also the extent to which it acts as a channel through which new ideas, technologies and working practices can be established in the host economy" (p 70). A good example of this is the renaissance of the car industry in the UK in the late 1980s, which was due in significant measure to the management and production techniques introduced by Japanese inward investors.

In this section, we consider the importance of the aviation industry to encouraging FDI into the UK. Many of the same arguments apply to the value of the aviation industry in retaining domestic investment within the UK. Equally, however, some aspects of aviation will have the opposite effect: for example, the UK's good air links have also encouraged UK firms to invest abroad by making it easier to manage overseas subsidiaries - between 1993 and 1997 UK investment overseas averaged $39 billion.

Table II.3: Top 10 countries for international scheduled passengers, 1997			
	Passengers (millions)	Population (millions)	Passengers / Population
United States	113.4	267.6	0.4
United Kingdom	78.6	59.0	1.3
Germany	69.0	82.1	0.8
Japan	45.4	126.1	0.4
France	45.1	58.6	0.8
Spain	32.3	39.3	0.8
Hong Kong	27.7	6.5	4.3
Italy	26.5	57.5	0.5
Canada	26.3	30.3	0.9
Netherlands	25.7	15.6	1.7

Note: Germany includes charter traffic
Sources: IATA, Passenger Forecast 1998-2002; World Bank, World Development Indicators

(ii) Aviation and inward investment

A wide range of factors play a part in determining the scale and distribution of foreign direct investment. These include unit labour costs in the recipient country compared with other potential locations; the degree of market access; language; political stability; tax and other incentives; and trade policy. But the trend towards globalisation is making good international communications and transport links an increasingly important component of firms' investment decisions.

The UK has very good air transport links in comparison with other countries, coming out top on almost every measure. UK airports are able to provide the flight frequency and choice of destination which are crucial to overseas investors, handling the second highest number of international scheduled passengers in the world, behind only the US (Table II.3). Moreover, the links with the key sources of FDI, like the United States and Asia, are particularly good. As Table II.4 shows, the UK has better air transport links with the US than any other European country: in 1997 14.3 million passengers flew between the UK and the US, whereas just 6.5 million passengers flew between Germany, the runner-up, and the US. The same pattern applies to business passengers alone. Similarly, the UK is the busiest European route to Japan, Singapore and Hong Kong, among other destinations.

Independent surveys of business locations confirm the comparative advantage of the UK's air transport industry. For example, London was ranked first out of 30 European cities for its "transport

Table II.4: Links With Key Markets, 1997							
Busiest routes between Asia-Pacific and Europe				**Busiest routes between North America and Europe**			
Rank	Country pair		Passengers million	Rank	Country pair		Passengers million
1	Japan	United Kingdom	1.4	1	United Kingdom	United States	14.3
2	Japan	France	1.0	2	Germany	United States	6.5
3	Hong Kong	United Kingdom	1.0	3	France	United States	4.4
4	Singapore	United Kingdom	0.9	4	Netherlands	United States	3.9
5	Japan	Germany	0.8	5	United Kingdom	Canada	2.0
6	India	United Kingdom	0.8	6	Italy	United States	1.9
7	Thailand	Germany	0.7	7	Scandinavia	United States	1.7
8	India	Germany	0.6	8	Switzerland	United States	1.5
9	Australia	United Kingdom	0.6	9	Spain	United States	1.3
10	Japan	Italy	0.5	10	Ireland	United States	0.9

Source: IATA Passenger Forecast 1998-2002

Table II.5: Best European Cities For External Transport Links

City	Best external transport links 1999		Best city to locate a business 1999
London	1	London	1
Paris	2	Paris	2
Frankfurt	3	Frankfurt	3
Amsterdam	4	Amsterdam	4
Brussels	5	Brussels	5
Zurich	6	Barcelona	6
Munich	7	Madrid	7
Berlin	8	Zurich	8
Madrid	9	Milan	9
Manchester	10=	Munich	10
Dusseldorf	10=	Berlin	11
Milan	10=	Dublin	12
Copenhagen	13	Lisbon	13
Barcelona	14	Manchester	14
Glasgow	15	Geneva	15
Geneva	16	Dusseldorf	16
Rome	17=	Glasgow	17
Lyon	17=	Stockholm	18
Hamburg	17=	Hamburg	19
Athens	20=	Lyon	20
Stockholm	20=		

Source: Healey & Baker European cities monitor 1999

links with other cities and internationally" in Healey and Baker's annual survey (1999, p 5) - see Table II.5. Given that 57% of the companies surveyed reported that good "transport links with other cities and internationally" were "absolutely essential", it is hardly surprising that London was also rated the best city in which to locate a business. But it is not only London that is attractive in this respect - both Manchester and Glasgow also feature highly. (International transport links include road, rail and sea but the fact that the UK is an island means that air links are inevitably the most important.) This finding is supported by the latest edition of Ernst and Young's annual survey of European business locations (1998), which reports that "Germany and the UK provide the best choice of air services, with many regional airports offering inter-continental and European flights".

The fact that the top 5 cities in the Healey and Baker survey for external transport links are also ranked as the top 5 cities in which to locate a business suggests a clear link between the attractions of a location for investment and its transport links. And a number of other surveys confirm that good international air transport links are an important consideration in the choice of a new business location. The Henley Centre (1994) surveyed multinational companies and urban planners across Europe for their EC City Futures study, asking them to rank a range of factors in terms of their influence on corporate location. Their answers showed that international air transport links were one of the most important factors, coming equal top out of 19 factors. Similarly, the Swiss economic research group BAK surveyed 100 multinationals for their 1998 report on the significance and quality of location factors for investment decisions, finding that international transport connections ranked 14th equal out of 42, ahead of factors such as the cost of capital and proximity to the firm's market (BAK, 1998).

The results of these European surveys are supported by local surveys of actual inward investors. For example, Chesterton International (1994) surveyed 77 companies which had moved into the North West in the previous four years and found that 9 of the 34 companies which replied indicated that

Manchester Airport was a major reason for their location decision. And Nathaniel Lichfield and Partners surveyed 54 overseas firms in the North and found that "Newcastle International Airport was a very important or important factor for over half of the overseas firms in the decision to locate in the North", but more importantly "almost a quarter of all responding firms would not have moved to the region if it did not have an international airport" (1994, p 12).

A number of these responses may indicate that aviation services tipped the balance in favour of one part of the UK over another, rather than part of the UK over a non-UK location. But reports from individual inward investors tend to back up the conclusion that in at least some cases the alternative would have been to locate in a different European country. For example, the senior vice-president of Computer Associates International told London First that "London outranked every other city when it came to choosing the site for our European Headquarters. The overriding factors were accessibility and the proximity of Heathrow airport, the highly-skilled workforce…" (1999, p 3).

For some firms locating near to a good airport is clearly essential. According to the South East England Development Agency (SEEDA 1999, p 2) "the airlink is a vital component for those exact industries we are trying to attract … the knowledge-based, high value-added industries, such as biotech/pharmaceuticals, ICT, high tech engineering, business and financial services. As well as being global companies, the high-value goods produced in these industries tend to be exported by air rather than by road." An example is NetGenics UK Ltd, a life sciences company whose managing director, Andrew Payne, told London First (1999 p3) that "London was the optimal choice for us since the road, rail and air transport systems around London provide us with the shortest journey times to potential customer sites in both the UK and Europe. London is probably the most internationally accessible city in the world for business travel."

Aviation is not only often vital for reaching customers but also for the supply chain. Many industries are making increasing use of air freight to cut delivery times as part of their just-in-time delivery systems, enabling them to cut inventory holdings. The car industry, for example, makes extensive use of air freight to deliver spare parts.

But good international air transport links are not just a key requirement for particular industries. They are also critical for particular functions. According to a 1992 survey by Ernst and Young, cited by Christodoulou (1996, p 28), good international transport and communication links are a key requirement for regional headquarters and for R&D centres. Air links seem to be particularly important for 'strategic businesses' which are characterised by the mix of headquarters, R&D and production functions, and a high level of autonomy. An example is Procter and Gamble, who told the British Chambers of Commerce (1994) that without an effective air link to London the headquarters in Cincinatti could be forced to move the Newcastle R&D centre to another site with better transport links, probably on mainland Europe. Another is Omega Engineering, a US based manufacturer and distributor of instrumentation, who were quoted by York Consulting in the Manchester Airport Second Runway economic impact study as saying: "The excellent freight and passenger transport service provided by Manchester Airport was one of the most important factors in our decision to locate our new European headquarters in Irlam" (1994, p 76-77).

(iii) Conclusion

In this Section, we have reviewed the survey evidence illustrating the factors firms consider important when deciding where to locate foreign investment decisions. It should be stressed, however, that these considerations influence not only potential inward investors but also the decisions of firms indigenous to the UK who are deciding where to locate new activities. To summarise, the evidence suggests that **good air transport links are essential if the UK is to attract inward investment in a number of high technology sectors such as electronics and life sciences, as well as in many long-established industries such as the car industry, which depend increasingly on just-in-time deliveries. They are also essential to attracting investment in a number of key functions, such as head office and R&D. For other sectors, air transport access plays a significant part in firms' international location decisions, although it is probably not an over-riding consideration.**

D. The contribution of the aviation industry to productivity and output growth elsewhere in the economy

(i) Introduction

The previous section has looked at the role that aviation can play in attracting and retaining investment. But transport can play a more general role in boosting the productivity of other sectors for any given level of investment. Annex F provides a more detailed explanation of some of the existing economic literature in this area and the estimation work we have carried out to pinpoint the scale of these effects. Here we focus on a general discussion of the ways in which transport can boost productivity in other sectors, and on the implications of our results.

(ii) How does aviation contribute to productivity growth?

The services provided by the aviation industry represent intermediate inputs to the production process of other sectors of the economy. In this respect they are similar to the services provided by a number of other industries (for example, the gas and electricity utilities), and improvements in the efficiency of aviation are beneficial for the rest of the economy, reducing firms' costs and improving their competitiveness.

But economic growth theory highlights that improvements in the transport infrastructure, of which aviation is an important part, can have more dynamic impacts on productivity in the rest of the economy and hence on potential GDP growth[17]. This reflects important spillover effects - known to economists as 'externalities' - that may be generated because business travel and freight shipments are cheaper and/or faster.

There are a number of mechanisms through which these spillovers might operate:

- An improved transport infrastructure may lead to a more efficient allocation of resources because of the larger market it creates. This allows greater scope for economies of scale, increased specialisation in areas of comparative advantage, and stiffer competitive pressures on companies, encouraging them to become more efficient. Air transport takes this a stage further than most other forms of transport through its role in facilitating world trade. This in turn means aviation supports foreign direct investment both into and out of the UK, which is often accompanied by improved technology.

- Similarly, aviation may improve innovation as a result of encouraging better collaboration between companies in the UK and other countries by allowing more effective networking, or through spin-offs from innovations within aviation itself (see box).

- An improved transport infrastructure may improve the profitability of investment in other sectors, and so encourage greater innovation by companies - increasing the size of potential markets could allow the fixed costs of innovation to be spread over larger sales, for example.

[17] See, for example, Barro and Sala-I-Martin (1995) for an introduction to the literature on economic growth, and Aschauer (1989) for an early empirical study of this type of effect.

Innovations within aviation - benefits to the UK

The aviation industry has sometimes contributed to developments in the rest of the economy by introducing innovations in the way business is done which have then been adopted by other companies. Examples where airlines have been among the first to introduce new practices include:

Electronic ticketing

British Airways introduced its revolutionary electronic ticketing system on all domestic routes in March 1997. After a highly successful launch, with BA research showing that a quarter of travellers on UK flights were utilising the system, the E-ticket was made available on a number of international routes as well. The installation of self-service check-in machines at numerous airports has reduced check-in times to less than one minute in some cases. Passengers with hand luggage can check-in using a credit card or an Executive Club card, and then allocate their seat and print off a boarding pass.

This system clearly offers the customer greater flexibility, it saves time, and by avoiding the queues and stress involved in check-in, could make for a more pleasant travel experience, perhaps encouraging more frequent usage in the future. The kiosks allow the customer to bypass the check-in desk, while still obtaining a proof of purchase receipt for personal and company records. The supplier also benefits from the cost savings and administrative efficiency of such a system in terms of a virtually paperless transaction, reduced staffing needs, and the potential to gain more information about its customers via databases, allowing for targeted marketing in the future.

Such developments can be adapted to suit a number of UK industries, allowing them to offer a more competitive, higher standard of service to their customers. The concept of a smart card has since been adopted within the hotel industry, with the Hilton hotel group providing the cards to a select group of frequent travellers, and numerous hotels providing network-accessible hotel rooms. Such advances allow for enhanced hotel check-in, specification of room preferences, and access to loyalty schemes and other travel-related services in the future. The benefits of such loyalty schemes are discussed below.

Customer loyalty schemes

British Airways' frequent flyer programme (FFP) began as a loyalty programme in 1981, with the award of Air Miles credits as a travel incentive commencing in 1991.

Since then, several retailers, for example, have adopted smart card schemes, including supermarkets. Financial incentives such as coupons, and discounts do generate sales, but they do not necessarily generate repeat sales. Observing the success of the frequent flyer schemes, more and more companies are recognising the fact that it costs far less to keep an existing customer than it does to find new customers. There has been, and will be, a growing trend to adopt a more long-term approach to consumer marketing in today's increasingly transparent and competitive global market. The role of technology and technological advances in service provision within such a market will therefore become extremely important.

Managing large-scale construction projects

Over the last five years, BAA has set into action a change management programme which has sought to refine their processes and reduce the unacceptably high amount of waste that is often found in construction projects throughout the economy. Indeed their Chief Executive, Sir John Egan headed work on a DETR document "Rethinking Construction" last summer for the Government which has been instrumental to change throughout the whole construction industry, not just at BAA.

Rethinking Construction has spearheaded a major shift in construction towards a more cost effective and predictable industry. Together with other major industry clients, BAA is participating in a DETR initiative to bring together a programme of construction projects to demonstrate improvement within the industry. The lessons learned are applicable to other sectors of the economy which generate large capital projects.

(iii) Results

Estimating the contribution of the aviation industry, and the transport infrastructure generally, to productivity growth is complicated. Previous research (see Annex F for more details and references) has looked at a number of different countries, at varying levels of disaggregation. And researchers have adopted a variety of different approaches to trying to pinpoint the relevant effects. Some studies have been unable to identify any effects, while disaggregated studies have typically yielded lower estimates than aggregate ones. In some cases, doubts have been raised subsequently about the direction of causation of relationships that have been identified. But to the extent that there is a consensus, it suggests that a 10% increase in transport services might be expected to increase aggregate productivity[18] by 0.5-4%.

Our own econometric analysis (again, see Annex F for details), based on disaggregated industry-level data for the UK, is towards the conservative end of this range. We estimate that a 10% increase in the provision of transport services increases overall UK productivity by 1.3%. This implies that **the average impact of transport growth on the increase in total output in the whole economy is of the order of £800 million a year.**

We have been unable to identify in the data a separate effect for aviation from that caused by the transport infrastructure as a whole. This is probably due to the relatively modest proportion of the transport sector accounted for directly by air travel, and to the volatility of the data. But there are several reasons for believing that the boost to productivity across the rest of the economy from growth in transport that we have identified is not all caused by other modes of transport:

- The mechanisms by which transport infrastructure can boost growth set out above clearly apply as much to aviation as other transport.

- Regional analysis also points to a link between growth and access to air transport. For example, counties in the hinterland of airports have typically experienced employment growth above the regional average. The M4 and M40 corridors, including Berkshire and Buckinghamshire, have benefited from easy access to Heathrow: the 'Western Sunrise' Study (University of Reading, 1987) showed for a sample of companies in Berkshire that the most important factor in their location decision was access to Heathrow. Growth was facilitated by Heathrow attracting firms that operate in high growth sectors. Similarly, Tyne and Wear has experienced employment growth above the regional average. Of the 36,000 jobs in the Northern region attracted or safeguarded through inward investment over the period 1985-92, 90% went to the three counties nearest Newcastle International Airport, one of which is Tyne and Wear. These jobs reflect both the expansion of established firms and investment by overseas firms such as Nissan[19]. And Cheshire - ie close to Manchester Airport - has experienced noticeably higher employment growth over the last decade than the North West as a whole.

- The econometric results are rather better determined when aviation is included in the measure of transport output used than when it is left out. This suggests that aviation is part of the reason for the relationship between transport and productivity growth.

If we therefore assume that aviation has contributed as much to productivity growth as other modes of transport for the same growth in output, the fact that the majority of the growth in transport output that has occurred in the UK in the last 10 years has actually been growth in aviation means that we estimate **the average impact of aviation growth on the increase in total output in the whole economy is of the order of £550 million a year**.

To put it another way, growth in aviation contributes approaching 3% of the trend increase in GDP of around £17½ billion a year. It should be emphasised that this is over-and-above the direct

[18] Productivity is measured here after netting off the impact of changes in both the stock of capital equipment and the number of people employed - a concept known to economists as 'total factor productivity'.

[19] Nathaniel Lichfield & Partners (1994)

contribution of aviation to UK GDP, and is the average effect each year. This means that by the end of a 10-year period in which the contribution to growth amounted to an average of an extra £550 million a year, the total contribution to the level of GDP would amount to around £5.5 billion.

(iv) Conclusions

This Section has highlighted the ways in which the transport infrastructure, and aviation in particular, can contribute to productivity growth elsewhere in the economy. This is a contribution recognised in the economic growth literature, and on our estimates is worth of the order of £550 million a year from the impact of growth in aviation.

But this is not the total impact of the aviation industry on growth in the rest of the economy. The increase in overall productivity encouraged by an increase in the aviation infrastructure is likely to encourage additional investment in other sectors of the economy. The resulting increase in the capital stock supports faster growth in output over-and-above the effects we have estimated here, which are based on the growth in productivity after adjusting for the levels of capital and employment. These different effects on the supply-side performance of the economy are brought together in the modelling and scenarios presented below.

III. Measuring the Overall Contribution: the Implications of Constraining the Growth of Aviation

Introduction

Chapter II has highlighted the importance of aviation for a successful modern economy, and identified several ways in which aviation contributes to the growth of the UK economy. Not all of these are easy to quantify, and many of them are inter-related - for example, improvements in productivity arising from the greater efficiency with which it is possible to use materials and staff when the transport infrastructure is improved, will themselves be one of the factors encouraging higher investment, including attracting greater foreign direct investment into the UK. So it is only really possible to estimate the combined impact of the different forces at work in the context of a detailed model of the economy, which can be used to simulate alternative scenarios for aviation and the implications for the rest of the economy.

The approach we have adopted is to build an expanded version of Oxford Economic Forecasting's well-established UK Industry Model. The main version of the model is used as an analytical tool to examine the implications of changes in the overall macroeconomic environment for different industrial sectors of the economy and the linkages that exist between the different sectors. As such it already incorporates an input-output framework of links between different parts of the economy. The version of the model for this study has been expanded to include the aviation sector of the economy explicitly rather than simply as part of the transport services sector, and to incorporate detailed linkages between aviation and other sectors reflecting the relationships identified in the rest of the study.

The rest of this chapter is organised as follows:

- First, we look at the structure of the model, emphasising the different ways in which aviation impacts on the rest of the economy.

- Second, we describe the forecast for the growth of aviation included in the baseline scenario used for the analysis. This includes projections of the direct and indirect employment, and value-added, expected to be generated by the aviation industry over the next 15 years or so if supply is able to meet projected demand.

- Third, we discuss the implications of alternative assumptions about the future of aviation for the performance of the UK economy.

More details of the results of alternative scenarios are given in Annex G, together with a summary listing of the equations in the model.

(i) The structure of the model

The version of OEF's UK Industry Model used here provides annual forecasts of output, employment, investment, prices and so on for the UK economy, disaggregated into around 30 sectors. It incorporates a series of dynamic relationships between different parts of the model, which are solved simultaneously to generate the forecasts. The simultaneous nature of the relationships means that any one part of the forecast typically depends on all the other parts of it, but it is nevertheless possible to pinpoint certain key causalities within the model.

Output for each sector is estimated using a production function, which relates the level of output of the sector to the inputs used in the production process. This has three key elements:

- Employment in the sector. This is determined partly by the level of real wages (the higher the real wage an employer has to pay, the fewer people he will take on), and partly by the level of demand for the sector's output. Demand, in turn, depends partly on the output of other industries which use the sector's output as an input to their own output, and partly on final demand from consumers, exports, etc.

- The amount of capital equipment available, which depends on the industry's investment record.

- And the sector's productivity after taking into account the amount of labour and capital used.

But in the long run the overall level of employment is not determined so much by the level of demand from particular industries as by the supply of workers looking for a job. If an expanding industry increases the demand for labour sufficiently, this will, over time, put upward pressure on wages as firms compete for the available pool of workers, until the increase in wages, and any increases in interest rates as the Bank of England tries to curtail their inflationary impact, are sufficient to choke off the extra demand for labour. Conversely, if the demand for labour is below the available supply, over time there will be downward pressure on real wages and interest rates until the falling cost of employing people is sufficient to attract additional demand for labour. So in the long run, it is investment and productivity which are the key to the economy's output.

There are four routes through which aviation enters into these relationships and affects other sectors in the economy, illustrated in Figure III.1:

a) Intermediate demand generates indirect effects on supply chain

As discussed in sections I (i) and (ii), output and employment in aviation will automatically generate demand in sectors supplying aviation companies. This will in turn affect the level of employment in those industries, and the additional wages they pay will generate demand and jobs elsewhere in the economy.

But while the numbers of jobs generated are useful in assessing the contribution of an industry to a local area, or to the overall economy in the short run, as noted above in the long run the level of overall employment is not determined so much by the level of demand from particular industries as by the supply of workers looking for a job. So in the long run, employment does not give a reliable indication of the contribution aviation makes to the UK economy. Its significance lies more in the types of jobs and industries we will have in the future and the living standards they can support, rather than in the overall level of employment we are likely to see.

b) Changes in supply affect aviation prices which affect intermediate costs

The impact of changes in the supply of aviation services on their prices is discussed in more detail below. The principle, however, is that restrictions in the supply of air services put up costs for businesses, whether through directly higher fares, longer journey times as a result of lower frequency of service, or the need to find alternative ways to travel or transport freight. This in turn leads to a loss of competitiveness for those UK industries which make significant use of aviation, reflected in lower demand for British goods and services.

c) Aviation output facilitates productivity growth elsewhere

Section II D discussed the relationship between aviation output and productivity growth elsewhere in the economy. Our estimation work shows an identifiable impact of changes in aviation output on productivity growth, which is incorporated into the model through the level of output each industry produces for given inputs. This is critical for the estimates of the long-run impact of aviation, given the way employment effects tend to be offset elsewhere in the economy.

d) Productivity also affects returns to capital and hence the level of investment

Section II C looked at the impact aviation can have on the attractions of the UK as a destination for foreign direct investment. This is reflected in the model through the impact of changes in productivity back onto investment and hence the amount of capital equipment available for production.

Figure III.1: Impact of aviation industry on other sectors

Price of air transport

Availability of air transport

Indirect/induced effects

Competitiveness **Productivity** **Investment** **Intermediate/ final demand**

The model identifies 6 separate components of air traffic which have potentially different effects on the economy: leisure (terminating) passengers, split into UK resident and non-UK resident; business (terminating) passengers, also split into UK resident and non-UK resident; transfer passengers; and freight carried. It also identifies 3 separate aviation prices: leisure fares; business fares; and freight charges. The traffic variables are not determined within the model - they are given by the nature of the scenario being studied.

But the price of different aviation services is allowed to vary within the model. The focus of the analysis is on the impact of restrictions in the growth of aviation services below baseline projections. The baseline is designed to represent the most plausible level of demand if the supply capacity of the industry does not impose constraints. Conversely, the alternative cases assume that restrictions on the capacity of the aviation industry to meet projected demand mean that demand has to be reduced, either by price increases or by rationing, or perhaps by increased congestion costs. This means that the price equations in the model are based on demand relationships rather than supply relationships[20]. Prices for different types of aviation (business/leisure/freight) are therefore assumed to be negatively related to the corresponding traffic variables - a rise in price would mean that fewer passengers would want to travel and businesses would want to move less freight by air. In principle, each price could be affected by all the different traffic variables since the numbers of one type of passenger affect the amount of space available on aircraft for other types of passengers, and some relatively minor effects from the volume of one type of traffic on the price of another type are included in the model - but these have only a modest impact on the results.

Clearly, not all types of traffic or prices will have the same effect on the economy. It is business travel and freight which affect other industrial sectors' costs and competitiveness, and their ability to sustain

[20] More technically, we are analysing the impact of a *shift* in the 'supply curve' of aviation, which will result in a move *along* the 'demand curve'.

growth. But leisure travel also affects tourist spending, which will itself impact elsewhere in the economy, and also has a significant impact on wider welfare benefits.

(ii) Baseline projections of air travel

Section II.A discussed the direct contribution of aviation to growth as a result of the expected increase in air travel over the next fifteen years or so. The projections for air traffic are based on DETR's 1997 Air Traffic Forecasts for the UK, the last published official traffic forecasts. These present low and high forecasts for terminal passengers at UK airports up to 2015, with the mid-point used here as the baseline. This implies a forecast of 310 million passengers by 2015, an increase of 95% over 1998 levels.

Table III.1: Summary of 2015 Air Traffic Forecasts
(million passenger movements)

Domestic	58.4
International	251.7
of which:	
UK business	28.4
UK leisure	103.2
Foreign business	31.7
Foreign leisure	53.2
Transfers (inc. misc.)	35.1

Source: DETR 1997 forecasts, mid-point, after allocating channel tunnel diversion estimates across the categories of traffic

These DETR projections do not split domestic traffic down in the same way as the international traffic forecasts, but there is no reason why domestic air services should not, for example, facilitate productivity growth elsewhere in the economy in a similar way to international services. We have therefore included domestic flights in the appropriate traffic variables for the model, using proportions derived from recent CAA passenger reports (CAP 677, 678 and 690). These imply domestic passengers are made up of 54.5% UK business passengers, 4.9% foreign business passengers, 34.6% UK leisure passengers and 6.0% foreign leisure passengers. The resulting passenger projections are shown in Table III.2. We assume at the same time that freight volumes grow by around 1% a year more than passenger numbers, in line with the experience over the past 10 years.

Table III.2: Summary of Air Passenger Forecasts
(million passenger movements)

	1998	2008	2015
Domestic and international passengers	159.0	234.8	310.0
UK business	30.5	45.4	61.9
UK leisure	65.8	95.2	127.4
Foreign business	13.0	23.0	36.6
Foreign leisure	27.2	42.1	58.7
Transfers (inc. misc.)	22.2	29.1	35.1

Sources: DETR 1997 forecasts, mid-point; OEF estimates

Section II.A describes the implications of these projections for the future employment and value-added of the aviation industry - to recap, it is expected to account for 2.1% of GDP by 2015 compared with 1.4% in 1998. But these projections make no allowance for the additional role the industry is playing in facilitating growth elsewhere in the economy, and this is what the alternative scenarios are designed to illustrate.

(iii) Alternative scenarios - the implications of restricting the supply of aviation

One of the difficulties in analysing the different ways aviation facilitates growth elsewhere in the economy is that it is impossible in today's world to envisage a complete absence of air transport services. Aviation is such an integral part of the modern world that it is hard to see how some parts of the economy could be expected to operate at all in its absence. It is therefore more fruitful to model the implications of a reduction in the available supply of aviation rather than its complete abolition. We have therefore looked in the first instance at what the impact on the economy as a whole could be expected to be if overall passenger numbers were restricted to 25 million fewer than the 310 million envisaged in the mid-point of DETR's published projections (with the same proportionate reduction in freight tonnage carried). This represents an 8% reduction in the overall number of passengers in 2015.

There are a number of reasons why passenger numbers might be lower. For example:

- GDP growth might be lower, and hence the demand for travel from both business and leisure passengers might be lower.

- A tax increase, perhaps for environmental reasons, might lead to higher prices and therefore lower demand.

- Lower investment in airport capacity might mean that it is impossible to carry the baseline level of passengers assumed.

These different causes are likely to have different implications for which types of passengers are most affected, depending partly on whether pricing behaviour crowds out some types of passengers more than others. And clearly, the impact on the economy will depend on which types of passengers are affected. Here, we have a limitation of capacity particularly in mind as the reason why passenger numbers are assumed to be lower in the alternative scenarios (although there is no reason not to expect the results to be similar in the case of a tax increase). One of the consequences we might expect in this case would be that airlines would aim to concentrate the loss of passengers on those who yield the least revenue - transfer passengers, followed by some leisure passengers. But we cannot entirely predict how different types of passengers would be affected, and there are risks that more valuable passengers would be lost as well. Within different types of passengers, there may also be different effects. In-bound tourists may be more affected than outbound ones since they have more alternatives available. And business passengers from small and medium-sized enterprises may be more affected than those from large companies since they are less likely to travel on full business-class terms. Rather than attempt to predict the resulting allocation of reductions in passenger numbers, therefore, we have made alternative illustrative assumptions, starting with the 'neutral' assumption that reductions in passengers are spread proportionately across all types of passengers.

The most obvious impact on passengers from inadequate capacity would be an increase in the cost of air travel. This might be reflected in an increase in the price of air tickets (if companies were allowed to put prices up). Alternatively, it might be reflected in greater congestion and longer travel times as infrastructure becomes overloaded and more passengers have to wait for alternative flights. This is analogous to some of the effects already being seen for road and rail passengers where for many people the travel experience has worsened as congestion has increased. If demand is held down by price increases, much of the loss to passengers is offset by gains to the airlines or airports But if higher congestion costs and waiting times are the main ways in which demand is limited, the entire increased user cost for UK travellers represents a loss to economic welfare in the UK.

Looking at the impact of 25 million fewer passengers, spread across all types of passengers, in terms of economic activity rather than welfare, the estimated effect on the economy by 2015 would be:

- 17,000 fewer people directly employed in aviation, with the output directly lost in aviation equivalent to around 0.17% of GDP.

- A further 19,000 fewer jobs in the supply chain.

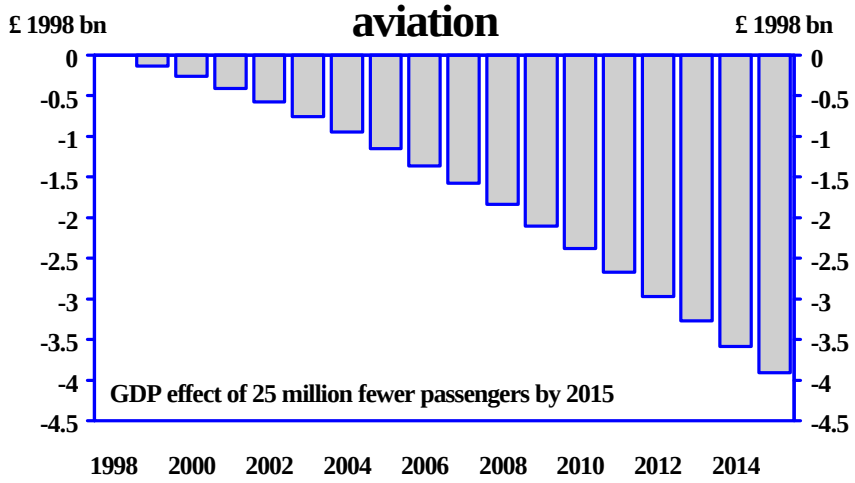
- Little change in overall employment since most of the jobs lost are, over time, replaced by other jobs elsewhere in the economy, albeit at lower average levels of productivity and living standards.

- Critically for living standards, investment might be around 0.6% a year lower as a result of less FDI being attracted and weaker incentives for domestic investment, reducing the capital stock and hitting potential output by a bit less than 0.1% a year.

- And output per worker from a given amount of capital equipment would be a bit more than 0.2% lower, through the loss of competitiveness of key sectors and the poorer infrastructure supporting the rest of the economy.

- Overall, GDP would be some 0.3% lower a year than would otherwise be the case. This is equivalent to nearly £4 billion (in 1998 prices) - equivalent to around three times the annual net capital spending by the Department of Health and the NHS Trusts, for example.

Chart III.1: Economic impact of restricting aviation



Assuming the reduction in passengers below the central projection happened gradually between now and 2015, the cumulative loss of output would be worth £20 billion in today's money.

The main impact on the economic performance of the economy comes from business passengers and freight. To illustrate the importance of business use of aviation for economic growth, it is interesting to look at the impact on productivity and output if all the reduction in passengers is assumed to come from business (although this is not a realistic outcome given the importance of business passengers to the airlines in terms of revenue yield per head as well as to the economy). In that case, we estimate:

- The impact on employment would be similar to the previous scenario.

- But investment could be 1½% lower a year as the impact on business costs and productivity is higher. The resulting fall in the capital stock reduces GDP by 0.2% by 2015.

- Overall, productivity and output could be between 0.8% and 0.9% lower, amounting to £10 billion lost output a year in 1998 prices.

On the other hand, if the reduction in passengers came entirely from leisure or transfer passengers, there would be a more limited impact on GDP. But there would still be important welfare consequences - reductions in leisure passengers, for example, would still have a significant impact on some of the wider benefits of the availability of air travel discussed in Section I (v). We estimated

there that 'consumer surplus' might be worth as much as £6 billion a year in 1998. By 2015 the increase in air travel in our base case means that the corresponding estimate rises to nearly £15 billion (in 1998 prices). We estimate that a 25 million reduction in passengers spread proportionately across all types of passengers would reduce this total by £2.3 billion. Some of this reduction reflects the consumer surplus of business passengers - if the reduction in passengers were entirely amongst business passengers, the loss of consumer surplus could be as high as £3.7 billion. In the case of business passengers, however, some of the effects of the benefit they derive from travelling will be reflected in the estimates we have made for the impact on GDP of restrictions in passenger numbers. For leisure passengers, the effect is distinct from any impact on GDP - we estimate that if there were a 25 million a year reduction in leisure passengers by 2015, the loss of consumer surplus could amount to £1.7 billion.

Finally, it is worth pointing out that our estimates of the loss of economic welfare from less air travel and higher prices or congestion costs only reflect the loss to UK residents or UK businesses, since UK policy makers may not be directly concerned with welfare losses to non-UK residents. But our traffic assumptions assume that reductions in passenger numbers affect both UK and non-UK users proportionately. If a 25 million reduction in the number of passengers were spread proportionately just across UK business and leisure passengers, we estimate the loss of consumer surplus could amount to £3.6 billion.

25 million passengers represents a fairly modest reduction in the total number of passengers envisaged by 2015. It is the equivalent, for example, of seeing 3½% a year growth in passengers rather than the 4% growth that underlies our base case. Supply restrictions leading to 50 million fewer passengers by 2015 would have broadly double the effect. If the reduction were spread proportionately across all types of passengers, we estimate that by 2015 there would be:

- 34,000 fewer people directly employed in aviation.
- A further 37,000 fewer jobs in the supply chain.
- Investment around 1.2% a year lower.
- Overall GDP some 0.6% lower a year than would otherwise be the case, equivalent to nearly £8 billion (in 1998 prices).

But the greater the restrictions, the more likely the impact is to be greater than simply multiplying up the basic results. If the number of passengers were not allowed to grow at all over 1998 levels, the estimated effect would be to reduce the level of GDP by 2015 by around 2½% - more than £30 billion (in 1998 prices), or the equivalent of around four-fifths of the total UK education budget, for instance. In other words, no growth at all in aviation might mean losing the equivalent of a full year's growth in the economy every fifteen years or so. Indeed, the increasingly severe difficulties in travelling that such a scenario would probably entail highlight the risk that the UK could lose its reputation as a good place for international business. If this were to happen in an increasingly globalised world economy, there is a risk that the impact of lost investment could spiral beyond the level allowed for in our scenarios, with potentially more damaging long-term effects on the competitiveness of the UK economy.

Conclusions

This Chapter has focused on modelling the overall impact on the UK economy of restricting the availability of the supply of aviation in the UK. We estimate that a 25 million a year reduction in the number of passengers, spread proportionately across all types of passengers would mean that GDP would be nearly £4 billion a year (in 1998 prices) lower by 2015 than if supply were sufficient to meet the levels of demand projected in our central case.

In terms of investment, the costs of existing airport construction projects suggest that the capacity to service 25 million passengers might cost around £1½ billion on average. £4 billion worth of GDP a

year therefore looks like a very good return to the economy as a whole from any such investment needed to meet the projected demand for aviation services.

This estimate implies that the overall impact on GDP is nearly twice the direct output loss in the aviation industry (around 0.17% of GDP). This is in marked contrast to the majority of industries, where the overall impact would be much *less* than the direct effect. The normal result stems from taking into account the automatic stabilisers in the economy: as explained above, the model is constructed to allow for the impact of changes in one industry on the overall level of demand for labour in the economy and hence on macroeconomic conditions which will feed back onto all the industries in the model. So an expansion in one industry will tend to lead to lower employment elsewhere in the economy, and vice versa. This has the effect of dampening any effects on overall output. The fact that overall effects are significantly greater than direct effects for aviation reflects the additional effects we have discussed on investment, productivity, etc in the rest of the economy.

IV. Conclusions

This report has looked at many facets of the aviation industry's contribution to GDP. It is a significant employer in its own right - in the UK it directly employs 180,000 people, and supports at least 550,000 jobs when the impact on the supply chain and the spending of its employees are taken into account. It is a growing industry - by 2015 it is likely to support at least 700,000 jobs. Air transport contributes to the quality of life in the UK in many ways that are not reflected in conventional, market-based, measures for example, by widening the leisure and cultural options for UK residents. And critically, growth in other parts of the economy depends on an efficient and successful aviation industry:

- Typically, sectors of the UK economy which we are likely to depend on for future growth make relatively heavy use of aviation.

- Good air transport links are one of the key considerations affecting where international companies choose to invest.

- Technological innovations within the sector have spin-offs for other parts of the economy.

- Most importantly, the industry is part of the transport infrastructure on which many other parts of the economy depend. Evidence suggests that improvements in that infrastructure boost productivity growth across the rest of the economy.

Not all of these effects are unique to aviation, by any means. But the industry is perhaps unusual in contributing to activity and growth in so many different ways. And it is unusual in that our estimates of the overall impact on the economy of lower aviation output are significantly greater than the direct effects, rather than smaller as we would expect for most sectors. This means there are dangers to the UK economy from restricting the supply of aviation - we estimate that a 25 million a year reduction in the number of passengers, spread proportionately across all types of passengers, would mean that GDP would be expected to be nearly £4 billion a year (in 1998 prices) lower by 2015.

Indeed, the increasing globalisation of the world economy means there is a danger the impact could be greater than this. If growing difficulties in meeting the demand for aviation mean that the UK were to lose its reputation as a good place for international business, the impact of lost investment could spiral beyond the level allowed for in our scenarios, with potentially damaging long-term effects on the competitiveness of the UK economy.

Of course, aviation is not only unusual in the number of ways it contributes to economic activity in the UK. It is also unusual in the degree to which it sparks debate over the sustainability of growth and the environmental impact of its activities. This is outside the terms of reference of this report. What we have demonstrated, though, is that there would be significant economic implications of restricting the growth of aviation which need to be taken into account alongside environmental considerations in considering future policy towards aviation.

Annex A: Organisations sponsoring the study of The Contribution of the Aviation Industry to the UK Economy

Air 2000
Airport Operators Association
Airtours
BAA plc
Belfast International Airport/Cardiff International Airport (TBI Group)
Belfast City Airport
Birmingham International Airport Ltd
Britannia Airways
British Air Transport Association
British Airways
British Midland
Caledonian Airways
Department of Environment, Transport and Regions
East Midlands Airport/Bournemouth International Airport (National Express Group)
Jersey Airport
JMC
KLM UK
Leeds Bradford International Airport
London City Airport
London Luton Airport
Manchester Airport plc
Monarch Airlines
Newcastle Airport Ltd
Scottish Airports Ltd
Virgin Atlantic

Annex B: Consultation

As part of the study, we sent the following letter inviting comments and views to potentially interested organisations identified by sponsors of the study, who were also invited to pass the consultation letter on themselves to regional organisations they thought might have something additional to contribute.

Dear interested party

Contribution of the Aviation Industry to the Economy of the United Kingdom

On 20th July 1998 the Integrated Transport White Paper was published. This paper stated that *As recommended by the Transport Select Committee in May 1996, we will prepare a UK airports policy looking some 30 years ahead. This will develop the application to the UK airports of the policies set out in this White Paper - of sustainable development, integrated surface transport and contribution to regional growth.*

It was also announced that in preparing the National Airports Policy *the policy will draw upon new studies of the role of airports in economic development to gain a better understanding of the underlying relationships. These studies will focus on aviation opportunities and the link between air services, economic growth and regeneration in specific local circumstances.*

To complement studies referred to in the Integrated Transport White Paper, Oxford Economic Forecasting Ltd has been commissioned by a consortium of airport operators, airlines and DETR to analyse the contribution the aviation industry makes to the economy of the United Kingdom, both at present and in future years. A summary of the scope of the study is attached for information.

As part of this study we are writing to a wide range of organisations seeking written responses to the following key questions:-

1. Aviation provides global accessibility to the UK and its regions. What are the economic implications of this accessibility in terms of the attractiveness of the UK as a place to do business?

2. It is widely assumed that the aviation industry facilitates the economic activity in other sectors of the economy. What are your views on this hypothesis? Can you provide specific examples of how the aviation industry facilitates economic activity in other sectors?

3. How important do you consider the aviation industry to be in sustaining and improving the Untied Kingdom s globally competitive position?

4. The UK attracts more inward investment than any other country in Europe - how important are good world wide air links to attracting inward investment? What other factors drive inward investment decisions?

5. Aviation has traditionally been a source of technological innovation. Does aviation play a role in introducing new technologies to other parts of the economy? If so can you provide examples?

6. Aviation supports both inbound and outbound tourism. How important are both sectors of the tourism industry to the economic and social welfare of the UK?

7. Can you provide any reports which your organisation has commissioned which you consider may be helpful input to the study?

8. Do you have any comments regarding the scope of the study?

I would be very grateful if you could consider the attached and return any comments by 30th June.

A Study of the Contribution of the Aviation Industry to the Economy of the United Kingdom.

Summary of Project's Scope

It is proposed that the study is divided into two parts, the first covering the current contribution of the industry, the second looking to the future.

Part 1 - Current Contribution

The study will **quantify measures** of economic activity of the aviation industry, such as GDP, employment, investment, profits and turnover generated, taxes and revenues paid to the treasury etc. This is essentially an accounting exercise, but avoiding for instance double counting of economic activity. It is envisaged that this part of the study will form a relatively small proportion of the overall value of the commission.

The majority of the study will provide an assessment of the "value" of the industry to the United Kingdom, the economic welfare derived from it and the contribution that will be made to future growth and prosperity.

In this context, the GDP measures defined will not necessarily be confined to the "direct" activities of the aviation industry. Consideration will be necessary of the quantification (in GDP measures) of indirect and induced contribution which can be robustly quantified e.g. value of inbound tourism arriving by air, value of imports and exports transported by air.

Economic Welfare

The study will be expected to use a well-recognised approach to valuing economic welfare, allowing for externalities as well as measuring the private benefits which accrue from air travel. However, it will not extend to environmental benefits and/or costs, which are outside the scope of this study. The DETR will be taking forward separately the development of policy on the Environmental impacts of aviation. The study will show how the measurement of the contribution of aviation to economic welfare relates to the measures of its contribution to economic activity

Examples could include the value of time saved by having an aviation sector, the consumer surplus created by the industry, the value of generating high quality skilled employment, the "quality of life" derived from being able to travel world wide say on holiday, to visit relations, cultural exchange and so on. This is obviously distinct from an accounting based approach, but is of fundamental value to the UK.

Effect Aviation has on the growth and structure of the economy

This part of the study will examine the effect the aviation industry has on the growth and structure of the economy, as a key ingredient of the transport infrastructure of the UK - this will seek to demonstrate the role aviation has in facilitating other industries (such as tourism, exports of goods and services, inward investment etc.). In particular, it will highlight the contribution to industries which are likely to be major contributors to the growth of the economy in the future, either because of their size or because of their major growth potential (eg financial services, information technology).

The study will develop its analysis of the impact of aviation on economic growth within a recognised framework, which allows the analysis of:-

- the contribution of air transport to productivity growth, as a key element of the transport infrastructure;
- the contribution of good air links to the efficient allocation of resources: and

- the importance of air transport in attracting investment to the UK, which could otherwise flow to other European locations.

The overall objective of this part of the study will be to demonstrate the contribution of aviation to the competitiveness of the UK economy. It will also include some assessment of whether air transportation links are likely to be more important to the growth in the UK than in other European countries, reflecting the fact that Britain is an island on the edge of Europe and therefore cannot rely on road and rail links for trade with neighbouring countries.

Part 1 Output

The output will be a "base line" of the ***current*** economic contribution of the aviation industry. Although this study seeks to address national issues, it is envisaged that future studies will address regional scenarios.

Part 2 Future Contribution

The second part of the study will seek to quantify the future contribution of the industry, and the economic activity that will be foregone if growth is constrained. The consultant will advise on the economic benefits which are derived from different types of traffic, the interdependencies between the various types of traffic, and the relationship of certain types of traffic to other areas of the economy, so that policy makers understand the full implications of restrictions to these sectors of the market.

The analysis of future contribution will draw upon the analysis undertaken during the first part of the study. Consideration of future growth will take into account all sectors of the market (business, leisure, transfer etc.) recognising the interdependencies between the different types of traffic, rather than focusing on just one or two market sectors.

When considering future contribution, the assumptions used will relate to varying levels of demand (both passenger and cargo) - it will be assumed that there are no supply "shocks", the objective being to indicate economic benefits relative to the scale of future demand. In addition for the purpose of this study it is assumed that demand will be met where it arises

When considering future contribution, consideration of how structural changes in the economy (e.g. globalisation, likely sectoral shifts etc.) affects the relative position of the aviation sector will be undertaken. In addition there will be consideration of how air transportation supports the Government's "vision" of a competitive economy, as set out in the recent HMG Competitiveness White Paper and last year's Mckinsey's Report on Competitiveness.

Part 2 Output

The output of the second stage of study will enable an assessment to made of the economic benefits of meeting demand nationally (assuming that demand is met where it arises) but in a form that lends itself to future analysis at a regional level. In addition the study will provide an assessment of the economic benefits foregone in the event of demand not being met where it arises.

Letters were sent by OEF to the following organisations:

Economic Policy and Regulation
World Travel and Tourism Council
Scottish Enterprise
Board of Airline Representatives in the UK
Air Transport Users Council
Association of European Airlines
British Air Freight Associations
Consumer Association
Scottish Tourism Forum
The British Chamber of Commerce
ABTA
Chartered Institute of Transport
Trades Union Congress
Institute of Directors
Society of British Aerospace Companies
British Tourist Board
Confederation of British Industry
IATA
Friends of the Earth
Transport 2000
Aviation Environment Federation
Airports Policy Consortium
Council for Protection of Rural England
North East RDA
North West RDA
Yorks and the Humber RDA
East Midlands RDA
West Midlands RDA
South East RDA
South West RDA
Eastern RDA
Local Government Association
TEC National Council

Replies were received from the following organisations, whose comments are gratefully acknowledged:

Air Transport Users Council
Aviation Environment Federation
BARUK
British Air Line Pilots' Association
British Chambers of Commerce
British International Freight Association
Doncaster Chamber of Commerce
Ealing Aircraft Noise Action Group
East Midlands Development Agency
Friends of the Earth
Institute of Directors
Local Government Association - Strategic Aviation SIG
London First
London Tourist Board
ONE North East (NE Development Agency)
North West Development Agency
Solihull Metropolitan Borough Council
Society of British Aerospace Companies
South East England Development Agency

Annex C: Supporting Material for Chapter 1 - General Aviation; Aerospace; Consumer Surplus

(i) General aviation

The use of aircraft for purposes other than the transport of passengers or cargo on commercial terms is known as General Aviation. Although commercial aviation is the primary focus of this study, the contribution of non-commercial aviation is still significant - approximately 45% of total movements at reporting UK airports in 1998 were of a non-commercial nature.

The bulk of commercial flights in the UK operate out of a relatively small number of airports, but there are a total of 140 licensed aerodromes in the UK as well as unlicensed aerodromes and private strips at which aircraft may be based. The general aviation industry employed around 16,450 people in 1997 according to estimates from the General Aviation Manufacturers and Traders Association, though clearly some of these workers will have been based at a commercial airport, in which case they have been included in our estimates of direct employment in the aviation industry already. Though corporate travel accounts for only 4% of total hours flown per annum within general aviation (with the rest accounted for by private and professional training, air taxis, aerial work, and so on), it is the business travel element which is of greatest relevance to UK economic performance. General aviation is also seen as important, though, in training a pool of pilots who can take up commercial work later.

Business aviation has seen strong growth over the last 20 years or so, with the world fleet almost tripling in size. The European Business Aviation Association (EBAA) estimates that in the UK 85% of FTSE 100 companies make use of private aircraft which they either own or lease. The use of business aircraft enables company staff to access locations which may not be serviced by scheduled aircraft, and raises overall efficiency within the firm by saving time, allowing schedules to be tailored to the needs of individuals, offering security and privacy, the opportunity to hold business meetings on board, and in instances where large groups are travelling together it can also save money.

(ii) Aerospace

The aerospace industry is not included in the aviation industry as defined in this report. But clearly UK airlines are major customers of the aerospace manufacturers, and a successful domestic aviation industry provides a strong base from which the UK aerospace industry can compete in international markets.

The aerospace industry employed 100,000 people in 1998, with its value-added around £3.7 billion, equivalent to 0.5% of GDP. Of its sales, about 10% are typically to UK airlines, and the associated jobs (about 10,000) are included within our estimates of indirect employment generated by aviation. (The bulk of sales reflect exports, military sales, and intermediate sales within the industry.)

The aerospace industry invests over 6% of its turnover (almost £1 billion a year) in R&D. As well as ensuring the competitiveness of UK manufacturers in the sector, many of the new technologies developed have important applications elsewhere. For example:

- *The health sector* - Computerised lens design led to varifocal spectacles, and technology used for measuring vibrations in gas turbines was applied to control heart pacemakers to match body activity rates.

- *Crime and security* - Aircraft windscreens were the inspiration behind toughened security glass.

- *Transport* - High quality welding techniques for difficult materials have been adopted within the automotive industry, and disc brakes and automatic braking systems have been applied to cars and trains.

(iii) Calculating the value of consumer surplus: an overview

We can attempt to quantify the non-market benefits generated by UK air transport services by estimating the value of the consumer surplus. A simple diagram helps illustrate what we are trying to measure. Figure C.1 shows a market for air tickets in which the demand curve (D) is linear and the supply curve (S) is horizontal. The number of passengers flying from UK airports is given by Q and the air fare by P. All passengers in the same category of travel pay the same fare because the market is assumed to be a single perfectly competitive market which prevents any price discrimination. The total amount that the passengers would be prepared to pay for Q air tickets is given by the triangle labelled A plus the rectangle labelled B. However, the total amount the passengers actually have to pay is given by the rectangle B. The triangle A therefore represents the value of consumer surplus enjoyed by the passengers.

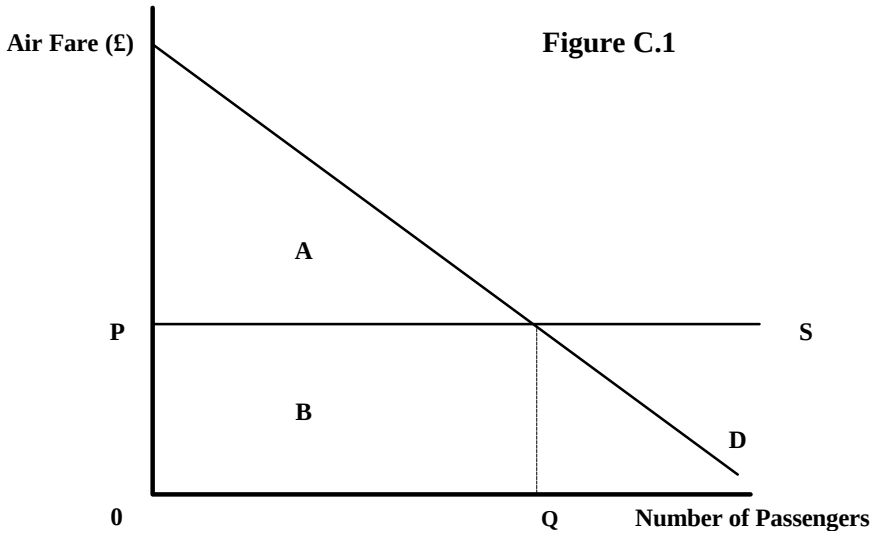


Figure C.1

To estimate the consumer surplus generated by air passenger services we need to know the shape and slope of the demand curve, the number of passengers and the average fare:

- We estimate that total expenditure on UK air transport services by UK residents and UK-based businesses was £12.4 billion in 1998.

- There are many different views on how responsive demand is to changes in price - ie the slope of the demand curve, usually expressed by economists as the 'elasticity of demand' (with respect to price). Our calculations are based on plausible estimates towards the lower end of the range of elasticities cited by existing studies.

- There is also uncertainty over the overall shape of the demand curve. This is intrinsically difficult to know about since it is unobservable - we can never be sure about the highest price one person would be prepared to pay for a ticket if it were the only flight ever provided, since this situation does not and has not ever existed. Our assumption of a straight line demand curve gives more conservative estimates of consumer surplus than other alternatives sometimes used.

On these assumptions, we calculate that the total value of consumer surplus enjoyed by UK residents and UK-based businesses was £6.1 billion in 1998. Leisure travellers enjoyed consumer surplus worth £2.3 billion, while business travel by UK residents generated £3.4 billion. UK-based businesses also enjoyed £0.4 billion worth of consumer surplus from their use of air freight services.

It is worth emphasising one further complication in interpreting these estimates - they assume that customers in each of the groups identified pay the same fare. This is clearly unrealistic, as airlines devote considerable effort to yield management by charging different prices to different customers. At the extreme, if they were able to match the price charged to each customer perfectly to the amount they were willing to pay then there would be no consumer surplus left. In practice, of course, yield management cannot be as effective as this, and the main segmentation is probably between business and leisure passengers and between scheduled and charter passengers. The above calculations are likely to have captured the bulk of the price discrimination that takes place because each of these segments is treated separately. Nevertheless, they are still likely to overstate consumer surplus to some degree.

In order to estimate the value of consumer surplus arising from consumption of any good or service we need to know the shape and slope of the whole demand curve. The shape and slope of the whole demand curve for air passenger and air freight services is inevitably very uncertain. However, there is an extensive literature on the elasticity of demand for these services in response to relatively small price changes (see, for example, OECD 1997). These estimates provide us with a guide to the slope of the demand curve close to the prevailing level of demand. If we assume that the slope of the demand curve is constant (i.e. the demand curve is a straight line) and that there is no price discrimination then we only need to know the elasticity of demand and the level of expenditure in order to estimate the value of consumers' surplus.

(iv) Calculating the value of consumer surplus: details and assumptions

Price discrimination

The market for air travel is divided into several distinct segments allowing airlines to charge passengers different fares for the same journey. For example, business passengers tend to pay significantly more than leisure passengers, while scheduled fares are significantly higher than standby or charter fares. If the air passenger market were treated as a single market in which everyone paid the same fares then it would lead the value of consumer surplus to be overestimated by a significant margin. However, we have calculated consumer surplus separately for each of the main market segments, thus reducing this problem.

Price elasticity of demand

There is considerable uncertainty surrounding estimates of the elasticity of demand. In an OECD study on the impact of a carbon tax (OECD, 1997), Oum reports the following "most likely" estimates:

- vacation travel -1.1 to -2.7
- business travel -0.4 to -2.1
- freight etc -0.8 to -1.6

The range of estimates is very wide, which may reflect differences between the elasticity of airport-specific, or airline-specific demand for air services, and the elasticity of aggregate demand for air services overall. Nevertheless, it is clear that the demand for business travel is significantly less price elastic than the demand for leisure travel. Oum et al. (1992) conclude that "the demand elasticity of business travel is less than unity while that of holiday travel is greater than unity" (p 149). Following discussions with the aviation industry, we have used median estimates for the price elasticities which fall towards the bottom of the range quoted by Oum (OECD, 1997) in order to calculate the value of consumer surplus.

Expenditure on air transport services

The purpose of this study is to measure the contribution of the UK aviation industry to the UK economy, so we need only estimate the value of consumer surplus enjoyed by UK residents and UK-based business when using UK aviation services. In principle we could have used the ONS's estimate for consumers' expenditure on air travel for the level of expenditure on leisure air travel by UK

residents. However, the ONS figure for 1998, some £7.8 billion, implies an average fare for package holidays of around £270, which seems implausibly high for the air fare component of such a holiday. Based on figures for passengers numbers and air fares[21], we estimate that expenditure on leisure travel by UK residents in 1998 was actually about £7 billion (Table C.1).

Table C.1: Expenditure on leisure air travel by UK residents in 1998

	Number of return trips million	Average fare per return trip £	Total expenditure £ million
International package tours	13.354	170	2270
Other international leisure travel	13.305	298	3965
Domestic air travel by UK residents	2.957	188	556
Total			**6791**

Using the same methodology we estimate the expenditure on business travel by UK residents in 1998 was £4.8 billion (Table C.2). We estimate that expenditure by UK-based businesses on air freight was £0.8 billion (Table C.3).

Table C.2: Business expenditure on air travel by UK residents in 1998

	Number of return trips million	Average fare per return trip £	Total expenditure £ million
Domestic air travel	4.436	222	985
International travel	6.169	621	3831
Total			**4816**

Table C.3: Expenditure on air freight by UK businesses in 1998

	Freight tonnes 000s	Price per tonne £	Total spending £ million
Total freight handled by UK airports	1903		
of which UK business	951	839	798

(v) Calculating the value of consumer surplus: results

The calculation of the value of consumer surplus is straightforward if we assume that the demand curve is a straight line (-0.5 times total expenditure divided by the elasticity). This is a conservative assumption: a constant elasticity of substitution (CES) demand curve or semi-log demand curve would produce substantially higher estimates for the value of consumer surplus. On the basis of these assumptions we estimate that the total value of consumer surplus enjoyed by UK residents and businesses using UK air transport services was £6.1 billion.

[21] The average fare paid by passengers travelling on package tours was estimated from the 1996 operating results of UK airlines (CAP 687) UK airlines: Average scheduled international fares were calculated as a weighted average of the fares reported in "The economic impact of new air services" (CAP 638). Average domestic fares were taken from "The impact of the increasing tax burden on civil aviation", a presentation by the CAA at the 5th Winter Service Workshop and exhibition of the Airports Council International. Freight rates were estimated from the operating results of UK airlines (CAP687). Leisure airfares were uprated to 1998 prices in line with the deflator for consumers' expenditure on air travel, while business fares and freight charges were uprated in line with the GDP deflator.

Table C.4: Consumers' surplus arising from use of UK air transport services in 1998

	Total expenditure £ million	Own price elasticity of demand	Total consumer surplus £ million
Leisure air travel by UK residents	6791	-1.5	2264
Business air travel by UK residents	4816	-0.7	3440
UK freight	798	-1.0	399
Total			**6103**

The margin of error surrounding this estimate is inevitably wide given the uncertainty surrounding the shape of the whole demand curve. Estimates using the extreme points in the range presented by Oum are shown in Table C.5.

Table C.5: Consumer surplus arising from use of UK air transport services in 1998

	Expenditure	Price elasticity of demand		Consumers' surplus	
		High	Low	High price elasticity	Low price elasticity
	£ million			£ million	£ million
Leisure air travel by UK residents	6791	-2.7	-1.1	1258	3087
Business air travel by UK residents	4816	-1.2	-0.4	2007	6020
UK freight	798	-1.6	-0.8	249	499

There are additional uncertainties in estimating the value of consumer surplus associated with estimating the impact of price discrimination. In the extreme, if airlines were able to match the price charged to each customer perfectly to the amount they were willing to pay then there would be no consumer surplus left. The details of the calculations set out above show that we have allowed for the big differences in prices sometimes paid by business and leisure passengers, and this is likely to have captured the bulk of the impact of the price discrimination that takes place. Nevertheless, they are still likely to overstate consumer surplus to some degree.

Annex D: The Growth and Composition of Air Traffic

Table D.1 breaks down the growth of UK terminal passenger movements over the last decade into three components:

- *International terminating passengers* - ie the number of journeys either starting at UK airports and finishing abroad, or starting at foreign airports and finishing in the UK.
- *International transfer passengers* - ie those transferring from one international flight to another at a UK airport.[22]
- *Domestic terminal passengers* - ie those journeys starting at a UK airport which either end at another UK airport or involve the passenger transferring to an international flight at another UK airport.

The number of international terminating passengers and the number of domestic terminal passengers have both risen by about 60% since 1988, while the number of international transfer passengers has trebled over the same period. International terminating passengers now account for 65% of total terminal passengers, with international transfers accounting for a further 14% and domestic passengers for the remaining 21% (on the basis usually adopted for recording total terminal passenger

Table D.1: Air Passengers, 1988-98

	(millions)		% change
	1988	1998	1988-98
International Terminal Passengers			
Terminating Passengers			
UK Passengers	42.1	70.7*	69.7
Foreign Passengers	21.9	39.3*	79.5
Total Terminating	64.0	110.0*	71.9
Connecting (intnl-intnl) Passengers **	7.4	15.4*	108.1
Total International Passengers	71.4	125.4	75.6
Domestic Terminal Passengers ***	21.8	33.6	53.9
Total Terminal Passengers ***	**93.2**	**159.0**	70.7

*Note: * Data for these components are estimates, based on proportions from the previous year.*

*** Data only refer to Heathrow, Gatwick and Manchester airports*

**** Domestic passengers are conventionally counted twice in figures on terminal passengers, once at each end of their journey*

Sources: DETR, from International Passenger Survey data, CAA Airports Statistics, table 3.02 and Transport Statistics Great Britain 1998

[22] The data presented here for terminal passengers exclude transit passengers - ie those who remain on aircraft that stop over temporarily at UK airports before continuing their journey.

Table D.2: UK International Passenger Movements: Business and Leisure, 1965-97

	Business Passengers			Leisure Passengers			**Total Terminating Traffic**
	UK Passengers %	Foreign Passengers %	Total Business %	UK Passengers %	Foreign Passengers %	Total leisure %	
1965	12.5	11.0	23.5	50.3	26.1	76.5	**9,373**
1970	12.1	11.9	24.0	42.2	33.8	76.0	**18,026**
1975	11.1	11.6	22.7	44.7	32.6	77.3	**25,845**
1980	11.4	11.7	23.1	48.1	28.9	76.9	**36,141**
1985	10.9	10.8	21.7	48.4	29.9	78.3	**46,289**
1990	10.9	11.2	22.1	51.7	26.1	77.9	**68,239**
1995	11.0	12.3	23.2	52.9	23.8	76.8	**89,566**
1997	11.8	11.0	22.8	52.5	24.7	77.2	**94,398**

Note: Data refer to Terminating Passengers only.

Sources: DETR, from International Passenger Survey data, CAA Airports Statistics, table 3.02 and Transport Statistics Great-Britain 1998

numbers in which they are counted at both ends of their journey). Scheduled flights typically represent around three-quarters of all terminal passengers (77% in 1998), with charter flights accounting for the remaining quarter (23% in 1998).

Around 23% of international terminating passengers to and from UK airports are accounted for by people travelling primarily for business purposes - a proportion that has remained remarkably stable since the 1960s, as shown in Table D.2. (By way of comparison, business travel passengers are typically fairly equally split between UK residents travelling overseas to conduct business and foreign residents travelling to the UK.

Leisure travel accounts for the remaining 77% of international terminating passengers. Around two-thirds of leisure travellers have typically been UK residents travelling abroad for holidays, to visit relatives etc, more than twice the number of leisure visitors to the UK from overseas.

Table D.3 shows where international passengers departing the UK are travelling to and where international arrivals at UK airports are coming from. Not surprisingly, the majority of international passengers are travelling between the UK and Western Europe - though some of these will be travelling further afield but transferring flights at Amsterdam, for example. The proportion of passengers travelling to Western Europe has fallen over the past decade, reflecting a general trend towards long-haul destinations, with the US, Latin America and Asia all seeing increases in the proportion of passengers they account for.

The rapid growth in international transfers through UK airports in recent years has a number of advantages for British travellers. While those transferring from one international flight to another are nearly all foreign residents, the revenues associated with their journeys - estimated at £2-2.5 billion a year for UK airlines - support flights from UK airports to a wider range of destinations and at a greater frequency than would otherwise be available. In particular, regular services to destinations for which there is relatively little demand from UK residents are very dependent on transfer passengers for their continued viability (eg to Bridgetown, St Petersburg). Similarly, since transfers are less heavily peaked than local traffic, they allow airlines to offer a better spread of flight times through the day than would otherwise be justifiable (see CAA (1999)). The increased choice of destinations and flight times is particularly valuable to business travellers.

Table D.3: Destinations / Points of Origin for UK International Passengers

	1987		1997		% Increase
	000's	% of total	000's	% of total	1987-97
Benelux	3,895	5.8	8,302	7.2	113.1
France	4,236	6.4	6,443	5.6	52.1
Germany	4,347	6.5	7,125	6.2	63.9
Greece	3,980	6.0	3,774	3.3	-5.2
Irish Republic	2,721	4.1	7,786	6.8	186.1
Italy	3,065	4.6	5,234	4.6	70.8
Spain and Canary Islands	14,800	22.2	19,558	17.1	32.1
Scandinavian Countries	2,339	3.5	5,364	4.7	129.3
Switzerland	2,325	3.5	3,101	2.7	33.4
Total Western Europe:	*48,054*	72.2	*76,524*	66.7	59.2
Eastern Europe (incl. USSR)	629	0.9	2,204	1.9	250.4
USA	7,734	11.6	15,652	13.6	102.4
Canada	1,684	2.5	2,868	2.5	70.3
Rest of America	768	1.2	2,539	2.2	230.6
Japan	460	0.7	1,462	1.3	217.8
Hong Kong	612	0.9	1,006	0.9	64.4
Rest of Asia	904	1.4	2,515	2.2	178.2
Africa	2,055	3.1	3,373	2.9	64.1
Total Rest of the World	*17,678*	26.5	*37,575*	32.8	112.6
Unidentified	*867*	*1.3*	*601*	*0.5*	
Total International Air Passenger Traffic	**66,600**	100	**114,700**	100	72.2

Note: Scandinavian Countries include Denmark, Finland, Sweden and Norway

Rest of America includes South America, Central America and Caribbean

Source: DETR, Transport Statistics Great-Britain 1998, from CAA, UK Airports, table 12

Table D.4 shows the breakdown of terminal passengers in the UK by airport. Heathrow is by far the largest, accounting for 38% of total UK passengers in 1998. This compares with 18.3% for Gatwick, 10.8% for Manchester and just over 4% each for Stansted, Birmingham and Glasgow. London area airports together accounted for 64% of total passengers in 1998.

Table D.4: Terminal Passengers by Airport, 1988 and 1998

	1988		1998		% change
	000's	% of total	000's	% of total	1988-98
Heathrow	37,510	40.3	60,360	38.0	60.9
Gatwick	20,744	22.3	29,033	18.3	40.0
Manchester	9,504	10.2	17,206	10.8	81.0
Stansted	1,047	1.1	6,830	4.3	552.4
Birmingham	2,786	3.0	6,608	4.2	137.2
Glasgow	3,634	3.9	6,481	4.1	78.3
Edinburgh	2,074	2.2	4,545	2.9	119.1
Luton	2,797	3.0	4,116	2.6	47.2
Newcastle	1,395	1.5	2,920	1.8	109.3
Aberdeen	1,612	1.7	2,652	1.7	64.5
Belfast International	2,176	2.3	2,627	1.7	20.7
East Midlands	1,130	1.2	2,136	1.3	89.0
Bristol	705	0.8	1,814	1.1	157.3
Jersey	1,846	2.0	1,694	1.1	-8.2
Leeds Bradford	683	0.7	1,398	0.9	104.7
London City	133	0.1	1,360	0.9	922.7
Belfast City	400	0.4	1,314	0.8	228.6
Cardiff Wales	619	0.7	1,230	0.8	98.7
Guernsey	825	0.9	890	0.6	7.9
Liverpool	352	0.4	869	0.5	146.8
Total London Area Airports	*62,326*	*66.9*	*101,704*	*64.0*	63.2
Total All Reporting UK Airports	**93,162**	**100**	**158,996**	**100**	70.7

Note: The 20 airports with the most passengers in 1998 are included in the table.

Source: CAA Airport Statistics, Annual Operating, Traffic and Financial Statistics, table 10.3

Table D.5: Distribution of Terminal Passengers by Region and by Airport, 1998/99

% of Traffic	Domestic	Europe	North Atlantic	Other long haul	Total international
Heathrow	11.8	48.1	19.9	20.2	88.2
Gatwick	9.4	50.9	19.3	20.4	90.6
Manchester	15.3	69.7	9.3	5.8	84.7
Stansted	17.5	77.3	1.0	4.1	82.5
Glasgow	52.8	32.5	6.5	8.2	47.2
Edinburgh	73.4	25.2	0.3	1.1	26.6
Aberdeen	82.8	16.0	0.2	1.1	17.2

Note: Passengers are allocated to region according to the final destination of the flight boarded at the UK airport, or the firs origin of the flight disembarked at the UK airport

Sources: BAA, Traffic Statistics, 1998/99 and Manchester Airport, Traffic Statistics Report 1998

Table D.6: Terminal passenger movements by Airport: Business and Leisure, 1998

	Business Passengers		Leisure Passengers		**Total International Traffic 1998**
	Business 000's	% of International Traffic	Leisure 000's	% of International Traffic	
London Area Airports:					
Gatwick	4,208	16.0	22,092	84.0	**26,300**
Heathrow	19,790	37.2	33,410	62.8	**53,200**
London City	740	61.7	460	38.3	**1,200**
Luton	294	8.9	3,006	91.1	**3,300**
Stansted	1,204	21.5	4,396	78.5	**5,600**
Total London Area Airports	26,790	29.9	62,810	70.1	**89,600**
Other UK Airports:					
Aberdeen	364	39.6	555	60.4	**919**
Birmingham	1,577	29.2	3,823	70.8	**5,400**
Edinburgh	251	25.1	749	74.9	**1,000**
Glasgow	282	9.4	2,718	90.6	**3,000**
Manchester	2,115	14.1	12,885	85.9	**15,000**

Note: The data refer to International Passengers only.

Sources: Total traffic from CAA Airport Stats1998, Annual Operating, Traffic and Financial Statistics, table 10.1

Business and leisure figures estimated by their respective share in 1997 for Gatwick, Heathrow and Manchester (CAP 690 table 7) and in 1996 for the other airports (CAP 677 table 5, CAP 678 table 48)

The principal destinations served differ greatly from airport to airport, as shown in Table D.5. For example, a much larger proportion of passengers flying from Heathrow and Gatwick travel either on the North Atlantic or other long haul routes, with relatively few travelling within the UK. In contrast, passengers from Scottish airports are mainly travelling to another UK airport, although this may be in order to transfer on to an international flight.

Similarly, the split between business, leisure and transfer traffic differs significantly across UK airports (Table D.6). For example, over 60% of passengers using London City are doing so for business purposes, with the equivalent figure almost 40% for Heathrow and Aberdeen. In contrast, less than 10% of passengers at Luton and Glasgow are business-related. Over a third of passengers using Heathrow, and a fifth at Gatwick, are transfer passengers, reflecting their role as important hubs for airlines (Table D.7).

Table D.8 shows the increase in the value of exports carried by airfreight between 1992 and 1996 (the latest available figures), together with a breakdown by destination/origin. £35.5 billion of UK exports were transported by air in 1996, up from £21 billion in 1992, with almost 34% of these goods being sent to the EU, compared with nearly 22% to the US and 18% to the Far East. £40.1 billion of UK imports in 1996 were brought in by air, up from £22.3 billion in 1992. In this case, less than 18% of the goods entered from the EU, compared with 35% from the US and nearly 27% from the Far East. Not surprisingly, it is typically high value/low weight and perishable goods that are transported by air, such as pharmaceuticals, spare parts for cars and ships, hi-tech products, fresh fruit, flowers etc.

Table D.7: Transfers and Terminating Traffic, 1996

	Total passengers (000's)	Number of Transfers within an airport (000's)	Number of Transfers between airports (000's)	**Total Transfers (000's)**	**Total Transfers (%)**
London airports:					
Gatwick	23,980	4,149	534	**4,683**	**19.5**
Heathrow	55,492	18,187	494	**18,681**	**33.7**
Stansted	4,678	176	8	**184**	**3.9**
Luton	2,325	39	3	**42**	**1.8**
London City	722	7	-	**7**	**1.0**
Total London airports	*87,197*	*22,558*	*1,039*	***23,597***	***27.1***
Birmingham	5,380	174	-	**174**	**3.2**
Edinburgh	3,775	30	-	**30**	**0.8**
Glasgow	5,405	114	-	**114**	**2.1**
Manchester	14,369	335	-	**335**	**2.3**
Total	**116,126**	**23,211**	**1,039**	**24,250**	**20.9**

Notes: Transfers do not include transit passengers. They are defined as passengers whose sole business is to transfer from one flight to another, within 24 hours of arrival at the airport.
This table refers to both scheduled and charter flights.

Source: DETR, 'Connecting Traffic at UK Airports', from CAA surveys: CAP 677 and CAP 678

Since the bulk of air freight is carried in the holds of passenger aircraft, it is not surprising that London airports account for over 80% of all UK airfreight tonnage, as shown in Table D.9. Both Stansted and East Midlands have seen particularly rapid growth in freight movements over the last decade.

Table D.8: Value of Trade Carried by Airfreight, 1996

	1992		1996		% change
	£ billion	% of Total	£ billion	% of Total	1992-96
EXPORTS:					
Total EC	6.6	31.2	12.0	33.8	83.0
Total non-EC countries	14.5	68.8	23.5	66.2	62.2
of which:					
Rest of Western Europe	0.9	4.4	1.8	5.0	93.5
Arab Gulf & Red Sea	1.5	7.3	1.7	4.8	10.7
Far East	3.2	15.1	6.3	17.7	97.7
USA	5.3	25.3	7.7	21.7	44.5
Total all countries	**21.1**	**100**	**35.5**	**100**	68.7
IMPORTS:					
Total EC	*4.6*	20.5	*7.0*	17.5	53.5
Total non-EC countries	*17.7*	79.5	*33.1*	82.5	86.6
of which:					
Rest of Western Europe	2.4	10.8	3.5	8.8	45.8
Arab Gulf & Red Sea	0.7	3.1	1.1	2.7	53.7
Far East	5.0	22.2	10.6	26.5	114.4
USA	7.5	33.4	14.0	34.9	87.8
Total all countries	**22.3**	**100**	**40.1**	100	79.8

Source: Transport Statistics Great-Britain 1998, from HM Customs and Excise

Table D.9: Airfreight Handled by Airports

	1988		1998		% Change
	000's tonnes	% of UK total	000's tonnes	% of UK total	1988-98
Heathrow	642	59.0	1209	57.8	88.3
Gatwick	192	17.6	275	13.1	43.2
Stansted	24	2.2	180	8.6	650.0
Total London airports	*885*	*81.3*	*1694*	*80.9*	91.4
East Midlands	20	1.8	123	5.9	515.0
Manchester	69	6.3	101	4.8	46.4
Total UK airports	**1088**	**100**	**2093**	**100**	92.4

Note: Freight does not include mail, excess baggage and diplomatic bags.

Source: CAA Airport Statistics, Annual Operating, Traffic and Financial Statistics, table 13.2

Annex E: Supporting material for Chapter II.B - Growth Sectors

Table E.1 shows how rapidly different industrial sectors in the UK have grown over the last decade and how fast OEF predicts that they are likely to grow over the next 10 years. The implication is that the industrial mix of the UK economy will have changed dramatically in the 20 years from 1988 to 2008. For example:

- The share of manufacturing industry in overall GDP is likely to have fallen from 22% in 1988 to only 18% in 2008.

- This fall would have been even more dramatic were it not for the expansion in pharmaceuticals - up from ½% of GDP in 1988 to 1% in 2008 - and in the manufacture of computers/office equipment and electronic equipment - up from 0.4% and 0.8% of GDP respectively in 1988 to 2.2% and 1.3% in 2008.

- The marketed services sector overall is set to move from 36% of GDP in 1988 to 45% of GDP by 2008.

Table E.1: UK sectoral growth

	Average annual value-added growth				
	1988-98	1998-08	Share of total output (%)		
	% year	% year	1988	1998	2008
Agriculture, forestry & fishing	0.8	-0.2	1.7	1.5	1.2
Extraction	1.9	0.6	2.8	2.7	2.3
Basic metals	-1.1	0.9	1.2	0.8	0.7
Pharmaceuticals	5.5	6.0	0.5	0.7	1.0
Other chemicals	1.6	2.2	1.7	1.7	1.6
Computers & office equipment	13.5	8.7	0.4	1.3	2.2
Electrical engineering	1.0	2.8	1.0	0.8	0.8
Electronic equipment	5.1	4.4	0.8	1.1	1.3
Food, beverages & tobacco	0.7	1.0	3.0	2.6	2.3
Coke, petroleum & nuclear fuel	1.3	0.4	0.6	0.6	0.5
Mechanical engineering	-1.1	1.2	2.0	1.5	1.3
Metal products n.e.c	-0.8	0.3	1.5	1.1	0.9
Non-mineral extraction	-1.7	-0.9	0.9	0.6	0.4
Motor vehicles, parts & accessories	1.5	2.6	1.3	1.3	1.3
Other manufacturing	0.3	1.8	0.6	0.5	0.5
Other means of transport	1.3	2.4	1.1	1.1	1.1
Paper & pulp	0.2	0.4	0.7	0.6	0.4
Printing & publishing	1.1	2.3	1.7	1.6	1.6
Precision & optical instruments	-0.5	1.0	0.3	0.2	0.2
Rubber & plastics	2.1	1.7	1.0	1.0	0.9
Textiles, leather & clothing	-2.7	-0.7	1.5	0.9	0.7
Wood & wood products	-1.9	1.3	0.4	0.2	0.2
Electricity, gas & water	2.5	2.4	2.1	2.2	2.3
Construction	0.4	1.7	6.6	5.6	5.3
Distribution	2.4	2.7	10.7	11.1	11.5
Hotels & catering	0.0	1.1	2.6	2.1	1.8
Transport	2.8	4.0	5.3	5.7	6.6
Communication	6.6	4.6	2.6	4.0	4.9
Insurance	3.4	0.9	1.2	1.4	1.2
Banking & finance	2.3	1.9	4.0	4.1	3.9
Real estate & renting	3.8	3.1	2.6	3.1	3.4
Computer activities	7.0	7.7	0.9	1.4	2.4
R & D	-4.6	4.3	0.6	0.3	0.4
Other business activities	4.6	4.7	5.7	7.4	9.2
Non-market services	1.6	0.9	28.5	27.2	23.6

Sources: ONS, OEF Forecasts

- Within this, communication services are expected to rise from 2.6% of GDP in 1988 to 4.9% by 2008, with computer service up from 0.9% of GDP to 2.4% over the same period.

Table E.2 shows the share of air transport as a proportion of the sector's total inputs of transport services[23].

Table E.2: Sectoral growth and use of air transport

	1988-98 average growth		Share of air transport	
	Rank	% year	Rank	in total transport demand (%)
Agriculture, forestry & fishing	**22**	0.8	**27**	5.7
Extraction	**14**	1.9	**13**	13.4
Basic metals	**31**	-1.1	**14**	13.1
Pharmaceuticals	**4**	5.5	**23**	7.0
Other chemicals	**15**	1.6	**28**	4.9
Computers & office equipment	**1**	13.5	**17**	11.4
Electrical engineering	**21**	1.0	**18**	11.1
Electronic equipment	**5**	5.1	**19**	11.1
Food, beverages & tobacco	**23**	0.7	**31**	3.9
Coke, petroleum & nuclear fuel	**19**	1.3	**9**	22.9
Mechanical engineering	**30**	-1.1	**24**	6.7
Metal products n.e.c	**29**	-0.8	**25**	6.6
Non-mineral extraction	**32**	-1.7	**30**	4.7
Motor vehicles, parts & accessories	**17**	1.5	**15**	12.8
Other manufacturing	**25**	0.3	**26**	6.5
Other means of transport	**18**	1.3	**1**	63.8
Paper & pulp	**26**	0.2	**34**	3.2
Printing & publishing	**20**	1.1	**4**	34.5
Precision & optical instruments	**28**	-0.5	**10**	20.3
Rubber & plastics	**13**	2.1	**32**	3.7
Textiles, leather & clothing	**34**	-2.7	**21**	7.6
Wood & wood products	**33**	-1.9	**35**	0.3
Electricity, gas & water	**10**	2.5	**22**	7.4
Construction	**24**	0.4	**29**	4.8
Distribution	**11**	2.4	**33**	3.4
Hotels & catering	**27**	0.0	**16**	12.4
Transport	**9**	2.8	**11**	19.4
Communication	**3**	6.6	**8**	23.0
Insurance	**8**	3.4	**3**	36.0
Banking & finance	**12**	2.3	**2**	49.6
Real estate & renting	**7**	3.8	**12**	14.7
Computer activities	**2**	7.0	**6**	24.2
R & D	**35**	-4.6	**7**	23.8
Other business activities	**6**	4.6	**5**	30.4
Non-market services	**16**	1.6	**20**	11.1
Spearman's Rank Correlation				0.33

Source: OEF calculations based on ONS input-output supply and use balances, 1996

[23] The main analysis presented here is based on input-output (I/O) tables. The last full I/O table for the UK was published in 1995 for 1990 and the next one is not expected until 2000. However, for years up to 1996 there are input-output supply and user balance tables which cover the full range of sectors but do not separate domestic and import activity and do not adjust for distribution costs. Nevertheless, they provide us with the most up-to-date indication of the relative importance of aviation in the production process and allow us to get a handle on the aviation sector's contribution to sectoral growth. The input-output tables do not split air transport purchases into air freight and business passenger travel. Data from the I/O tables have therefore been supplemented by HM Customs and Excise data on export volumes and CAA data on passenger numbers.

Table E.3 shows the spend on air transport services per employee.

Table E.3: Sectoral growth and air transport spend per employee

	1988-98 average growth			
	Rank	% year	Rank	Spend per employee (£, 1996)
Agriculture, forestry & fishing	**22**	0.8	**34**	14
Extraction	**14**	1.9	**2**	1,152
Basic metals	**31**	-1.1	**7**	537
Pharmaceuticals	**4**	5.5	**21**	90
Other chemicals	**15**	1.6	**10**	239
Computers & office equipment	**1**	13.5	**11**	220
Electrical engineering	**21**	1.0	**19**	100
Electronic equipment	**5**	5.1	**22**	85
Food, beverages & tobacco	**23**	0.7	**18**	106
Coke, petroleum & nuclear fuel	**19**	1.3	**3**	1,044
Mechanical engineering	**30**	-1.1	**26**	62
Metal products n.e.c	**29**	-0.8	**27**	60
Non-mineral extraction	**32**	-1.7	**12**	216
Motor vehicles, parts & accessories	**17**	1.5	**13**	207
Other manufacturing	**25**	0.3	**20**	97
Other means of transport	**18**	1.3	**6**	565
Paper & pulp	**26**	0.2	**29**	49
Printing & publishing	**20**	1.1	**9**	454
Precision & optical instruments	**28**	-0.5	**16**	140
Rubber & plastics	**13**	2.1	**28**	60
Textiles, leather & clothing	**34**	-2.7	**24**	68
Wood & wood products	**33**	-1.9	**35**	8
Electricity, gas & water	**10**	2.5	**33**	19
Construction	**24**	0.4	**32**	19
Distribution	**11**	2.4	**23**	68
Hotels & catering	**27**	0.0	**30**	48
Transport	**9**	2.8	**5**	796
Communication	**3**	6.6	**8**	478
Insurance	**8**	3.4	**1**	1,528
Banking & finance	**12**	2.3	**4**	970
Real estate & renting	**7**	3.8	**14**	185
Computer activities	**2**	7.0	**17**	114
R & D	**35**	-4.6	**25**	66
Other business activities	**6**	4.6	**15**	183
Non-market services	**16**	1.6	**31**	39
Spearman's Rank Correlation				0.35
Spearman's Rank Correlation for Service Sectors Only				0.45

Source: OEF calculations based on ONS input-output supply and use balances, 1996

Table E.4 shows indicators of the degree of 'internationalisation' for manufacturing industries - exports as a proportion of output and the degree of foreign ownership. The more international a business, the more reliant it is likely to be on air transport services.

Table E.4: Sectoral growth and internationalisation of manufacturing

	1988-98 average growth		Exports (as a % of output,1996)		Share of output produced by foreign firms	
	Rank	% year	Rank	%	Rank	%
Basic metals	**17**	-1.1	**10**	24.9	**12**	19.3
Pharmaceuticals	**2**	5.5	**3**	37.9	-	-
Other chemicals	**5**	1.6	**7**	31.2	**4**	41.9
Computers & office equipment	**1**	13.5	**2**	40.8	**1**	72.0
Electrical engineering	**10**	1.0	**8**	29.3	**8**	25.9
Electronic equipment	**3**	5.1	**4**	36.6	**3**	48.0
Food, beverages & tobacco	**11**	0.7	**18**	8.7	**11**	21.1
Coke, petroleum & nuclear fuel	**8**	1.3	**15**	12.2	**5**	35.1
Mechanical engineering	**16**	-1.1	**5**	33.7	**7**	27.8
Metal products n.e.c	**15**	-0.8	**16**	12.0	**16**	11.4
Non-mineral extraction	**18**	-1.7	**13**	13.7	**14**	13.6
Motor vehicles, parts & accessories	**6**	1.5	**9**	25.8	**2**	67.3
Other manufacturing	**12**	0.3	**14**	12.8	**17**	9.3
Other means of transport	**7**	1.3	**1**	42.4	**13**	15.9
Paper & pulp	**13**	0.2	**17**	11.6	**6**	33.3
Printing & publishing	**9**	1.1	**19**	8.7	**15**	11.7
Precision & optical instruments	**14**	-0.5	**6**	33.0	**10**	23.9
Rubber & plastics	**4**	2.1	**11**	17.9	**9**	24.7
Textiles, leather & clothing	**20**	-2.7	**12**	16.4	**18**	8.3
Wood & wood products	**19**	-1.9	**20**	3.7	**19**	4.2
Spearman's Rank Correlation				0.51		0.72

Source: OEF calculations based on ONS input-output supply and use balances, 1996, and census of production

Chart E.1: Internationalisation of manufacturing and output growth

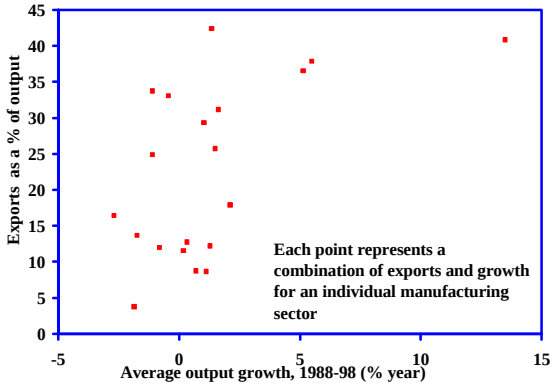


Chart E.2:Manufacturing output and foreign ownership of production

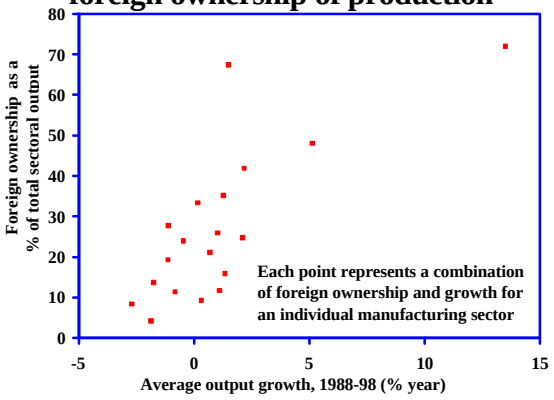


Table E.5, for manufacturing, shows the proportion of exports transported by air.

Table E.5: Air freight usage by sector (by volume)

	Share of freight - EU exports (1992)		Share of freight - non-EU exports (1998)	
	Rank	as % of total freight	Rank	as % of total freight
Basic metals	**16**	0.1	**15**	0.4
Chemicals & man-made	**12**	0.1	**12**	1.9
Computers & office equipment	**2**	3.4	**1**	24.2
Electrical engineering	**5**	2.8	**4**	14.5
Food, beverages & tobacco	**15**	0.1	**16**	0.3
Coke, petroleum & nuclear fuel	**17**	0.0	**17**	0.0
Mechanical engineering	**7**	0.9	**6**	12.1
Metal products n.e.c	**14**	0.1	**8**	7.4
Non-mineral extraction	**11**	0.3	**7**	10.2
Motor vehicles, parts & accessories	**9**	0.4	**10**	4.2
Other manufacturing	**3**	3.1	**5**	12.5
Other means of transport	**1**	6.4	**3**	16.5
Paper, printing & publishing	**13**	0.1	**14**	1.2
Precision & optical instruments	**4**	2.8	**2**	20.6
Rubber & plastics	**8**	0.4	**13**	1.7
Textiles, leather &clothing	**6**	0.9	**9**	7.2
Wood & wood products	**10**	0.3	**11**	2.1
Total		0.1		1.8

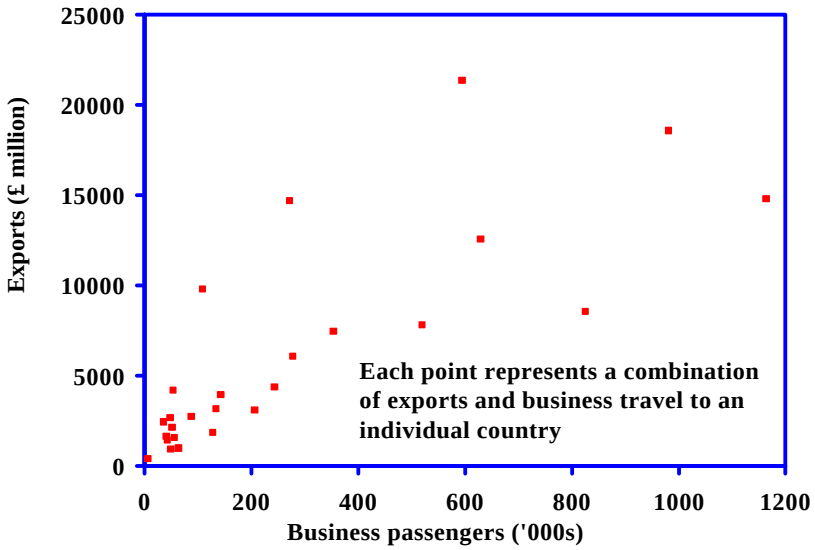
Source: OEF calculations based on data supplied by MDS Transmodal

Table E.6 illustrates the link between value of exports and the number of business trips to different destinations. The bilateral trade elasticities shown in the last column are the rate of growth of trade to different areas as a proportion of the rate of growth of business trips. These elasticities tend to be greater the further the destination is from the UK.

Table E.6: Destination of UK exports and business travel					
Destination	**UK business travel '97 ('000)**	**UK exports 1997 (£m)**	**UK business travel average annual growth '87-'97**	**UK exports average annual growth '88-'97**	**Elasticity**
US	594	21,371	6.0	9.0	1.5
Canada	51	2,157	7.3	0.7	0.1
N. AMERICA	645	23,527	6.1	7.9	1.3
Belgium/Luxembourg	519	7,826	9.4	7.9	0.8
France	1,163	14,792	6.9	7.6	1.1
Germany	981	18,573	7.8	8.7	1.1
Italy	353	7,467	6.1	7.8	1.3
Netherlands	629	12,557	7.4	10.7	1.4
Denmark	127	1,867	8.9	6.0	0.7
Irish Republic	825	8,557	12.7	9.8	0.8
Greece	49	938	7.8	9.1	1.2
Spain	277	6,082	4.2	10.3	2.4
Portugal	55	1,580	2.3	8.7	3.9
Austria	63	1,000	6.4	8.8	1.4
Finland	42	1,429	8.0	7.1	0.9
Sweden	142	3,942	7.4	7.6	1.0
Switzerland	206	3,122	3.7	6.7	1.8
Norway	87	2,762	6.8	12.8	1.9
W.EUROPE	5,618	93,132	7.6	8.7	1.1
Middle East	108	9,820	11.4	60.1	5.3
S. Africa	40	1,645	11.5	44.5	3.9
AFRICA	133	3,177	6.7	1.7	0.3
E. Europe	243	4,389	23.3	29.1	1.3
Japan	53	4,199	5.8	11.6	2.0
Asia (exc Japan)	271	14,686	8.1	12.8	1.6
Australia	35	2,454	8.4	7.5	0.9
New Zealand	6	409	4.6	4.0	0.9
L. America	48	2,685	9.1	15.5	1.7
All countries	7,166	172,022	7.8	9.7	1.2

Source: International Passenger Survey and IMF's Direction of Trade Statistics

Chart E.3: Exports and business travel



Annex F: Supporting material for Chapter II.D - Endogenous Growth

Section II.D summarises the ways in which the transport infrastructure, and aviation in particular, can contribute to the growth of productivity elsewhere in the economy. This annex sets out in more detail previous work that has been carried out into estimating the scale of such effects; and the results of our own econometric estimation work.

(i) Results from previous studies

The notion that transport infrastructure, or public sector capital infrastructure more generally, can contribute to productivity growth *via* spillovers has spawned considerable research. Existing empirical studies fall into two broad categories: those looking at cross-country variations in growth, and those looking at the contribution to output, usually for a single country. We report some typical figures from various studies below. First, we look at the main issues.

(a) Growth

The growth approach relates changes in (typically) output per head to investment (the change in the capital stock). It is closely related to the growth accounting approach, where factor shares are used to construct growth in total factor productivity; we use this in our own work only for individual sectors.

Results here have been mixed. Easterly and Rebello (1993) follow the approach pioneered by Barro, and run regressions explaining the rate of growth for many (about 100) countries, with government spending as an explanatory variable. They are able to break down expenditures into different categories. Among their findings, they report (p 431) that "[t]ransport and communication investment seem to be consistently positively correlated with growth with a very high coefficient". Note that this is new investment, and does not necessarily imply anything about the total (rather than marginal) contribution to output. There might also be a confusion of causality, which is a recurrent theme in the literature. Essentially, it may be that growth and infrastructure investment are correlated because economies demand more infrastructure as they grow richer: thus fast-growing countries choose to invest more. There is an obvious identification problem, an issue we return to later. This is sometimes referred to as 'reverse causality'. However, they get even stronger results using instrumental variables techniques, which are intended to control for this. They also report "that *only* transport and communication investment and general government investment are robustly correlated with growth" (their emphasis). The conclusion seems to be that transport, and by implication aviation, *is* important for growth. However, the problem with their results is arguably not that there are no effects, but that the coefficient is implausibly large. The consensus is that these studies raise more questions than they answer, at least partly because of the causality issue, which is acute at this level of aggregation.

(b) Output

Other evidence comes from analysis of the level of output and related variables. From one point of view, these are preferable since, when we look at growth rates, we are effectively ignoring information contained in the levels of the data. There are two types of analysis that have been undertaken here.

1. Production functions

The initial estimates were derived from estimates of production functions. The empirical literature was started by Aschauer. In his 1989 paper, he essentially estimates a production function for the US private business sector. He breaks down public capital spending into different types - education, hospitals, and so on. The very clear result is that what he calls "a 'core' infrastructure of streets, highways, *airports*, mass transit sewers, water systems, etc, has most explanatory power for

productivity" (our emphasis), offering support for the case that aviation is important.[24] If we assume, as is implicit, that aviation is a perfect substitute for the other parts of this aggregate, we can easily work out aviation's impact. Similarly, we can calculate the contribution to growth. In other papers, Aschauer has produced similar results for G7 countries. However, these results were criticised for giving excessively large effects. The extra output from an extra dollar of infrastructure capital works out at over one dollar - thought to be a very high marginal product.[25]

And, on the other hand, others have found no effects. For instance, Holtz-Eakin (1994) finds that there are no public sector capital productivity effects using US state-level panel data. He argues that once allowance is made for differences in the level of productivity between different states, there is essentially no effect from changes in public sector capital. As he points out, this does not imply public capital is unproductive, simply that it does not contribute to productivity growth. However, this striking result seems somewhat odd; an implication is that roads, for example, have no effects on firms' costs.

So why this disparity of results, some rather implausible? We have to recognise that there are potential problems which were not fully recognised in early work. These stem from two main sources:

- First, *non-stationarity and spurious regression* - If data are non-stationary (loosely speaking, strongly trended) then there is a severe danger of 'spurious regression'. This occurs when we get apparently excellent statistical results that are, in fact, entirely meaningless. The basic insight comes from the fact that trended variables all have one thing in common: they grow. More technically, the variance of any non-stationary variable increases with time. It follows from this that even variables that in reality have absolutely no connection whatsoever will often *appear* to be closely related. Possibly, this is what happened with Aschauer. The big coefficient on infrastructure could be spurious. The solution is to take proper account of this by undertaking cointegration analysis. If two or more trended variables have a genuine relationship then over time they will tend to move in line with each other. What cointegration techniques do is to look for this common trend. Differencing the data removes the trend and avoids the spurious regression problem. However, it may also remove information about the long run. We discuss this more below.

- Second, *causality* - There may be the problem of causality referred to above. One way of avoiding this is to work, as we do, with individual industries.

2. Cost functions

Production functions look directly at technological relationships. Another approach is to look at the decisions of firms, using the so-called cost function approach. These have been used in a variety of studies. In essence, cost functions use information about factor prices, and treat factor inputs as endogenous variables in estimation. This offers a richer menu of information about the cost, production and demand structure. However, it should be clear that this approach is not inconsistent with estimating production functions. Typically, this approach provides smaller figures for the estimated impact of infrastructure than the Aschauer type of study. Lynde and Richmond (1993) produced one of the very few studies for the UK using this methodology (as well as in other papers for the US). Perhaps the best example is Nadiri and Mamuneas (1996) (and Nadiri and Mamuneas (1994)).

(c) The lessons from existing studies

What conclusions can be drawn from existing work in the literature? The most common approach has been to use a log-linear (Cobb Douglas) production function. Table F.1 briefly summarises some results, which have tended to vary somewhat. Aggregation seems to be an important issue;

[24] One result imposing constant returns to scale is y-k = -2.33 +.001 t +.41(n-k)+.40(g-k)+.38 cu where everything is in logs so that (eg) y = log(Y), K is capital, N is employment and G is the government capital stock, excluding the military. He also adds a capacity utilisation term, cu, to control for cyclical effects.

[25] The marginal product of a factor input is the extra output from an extra unit of the factor.

disaggregated studies tend to deliver lower estimates, as do cost functions. The elasticity of output with respect to the public capital figure for the UK from Lynde and Richmond (1993) is about 20%, compared to Aschauer's ball-park figure of 40% for the US. The best evidence probably comes from disaggregated cost function approaches. Although still subject to potential criticism, the most reliable estimate is likely to be from Nadiri and Mamuneas (1996), who look purely at highway capital. As the table reports, they find an elasticity of around 5% (just for roads).

Table F.1: Selected results from previous studies

Study	Description	Output elasticity
Aschauer (1989)	Cobb Douglas; US time series; levels	approx 0.4
Hulten and Schwab (1992)	Cobb Douglas; US time series; differenced	0.4
Ford and Poret (1992)	TFP levels and differences for OECD	mixed results; UK insignificant
Holtz-Eakin (1994)	Cobb Douglas; US regional panel	no effects
Lynde and Richmond (1993)	UK manufacturing; cost function	approx 0.2
Nadiri and Mamuneas	US industries; cost function; highway capital	approx 0.05

We conclude that there is no consensus in the literature, but early aggregate estimates are thought to be too high. So, we might expect to find estimates lying between Lynde and Richmond, on the one hand, and Nadiri and Mamuneas, on the other. That is, in the range 5% to 20%.

(ii) Levels versus growth equations

We need to spend a little more time on the appropriate modelling of our data. One practical issue is whether to look at the installed capital stock or the output of the relevant sector. For our purposes, while recognising that capacity utilisation can vary, these are very nearly the same. A given capital stock provides a flow of services. If we can measure output, as we can with aviation, then that is perfectly acceptable, and even preferable. If we had measures of the flow of private capital services, we would be happy to include them in a production function, just as we are happy to use employment-hours. Indeed, given the existence of congestion, it is arguably preferable to use output.

A second issue is the choice between examining the *level* of the data, or *growth rates*. Loosely, the first explains the long-run relationships and the second short-term changes. Ideally, we would be able to explain the level. This raises technical issues.[26] If we find a plausible relationship in the levels, we are pleased. But what if we do not? Clearly, there must be a long-run process generating output. Inputs of employment and capital certainly affect output - there must be some relationship. So, one conclusion to draw from failure to find such a relationship is that there are other variables in the system that we have not considered. A possible approach would be to look for those missing variables. However, this may prove difficult. One important missing variable is human capital or 'knowledge' - notoriously difficult to proxy.

Should we give up if we fail to find a relationship in levels? The answer is no. We can return to the earlier growth accounting methodology of first-differencing. What this is intended to do is to transform trended variables to stationary ones. As we observed above, this leaves us open to the charge of ignoring long-run information. And the method is certainly invalid if a long-run relationship *does* exist, as a key part of the dynamics of the process is driven by the deviation of the levels from their long-run values. But if we have not identified such a relationship, this criticism does not apply. It is then statistically valid to look for evidence of relationships in the growth rates.

[26] Technically, we are talking about 'cointegration' here.

Chart F.1: Air passenger miles

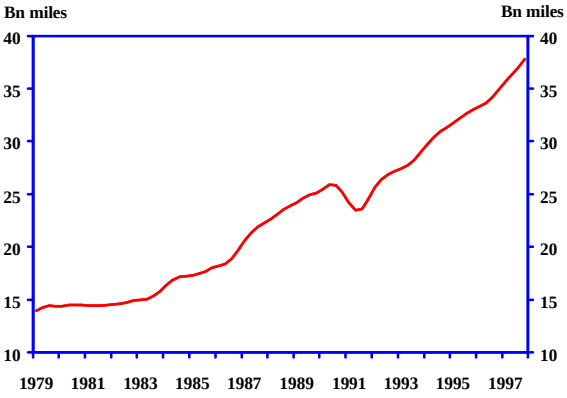


Chart F.2: Air transport output

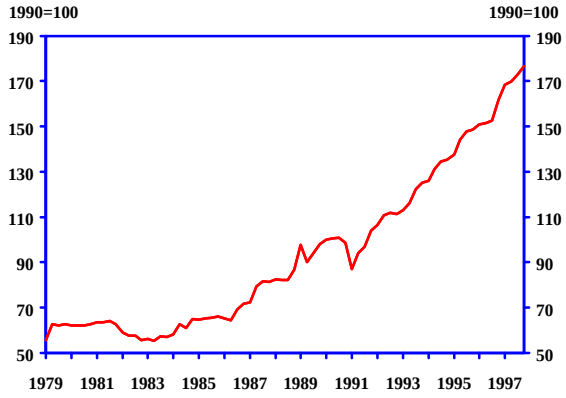


Chart F.3: Total transport output*

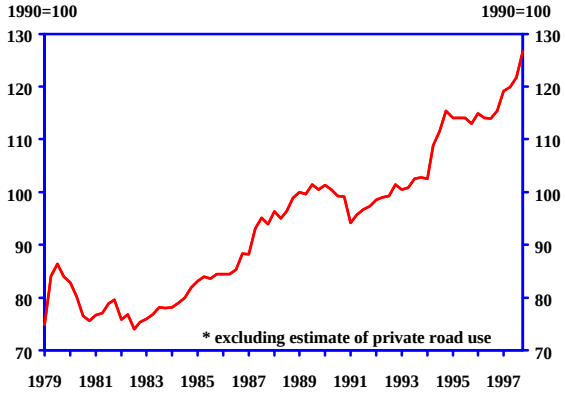
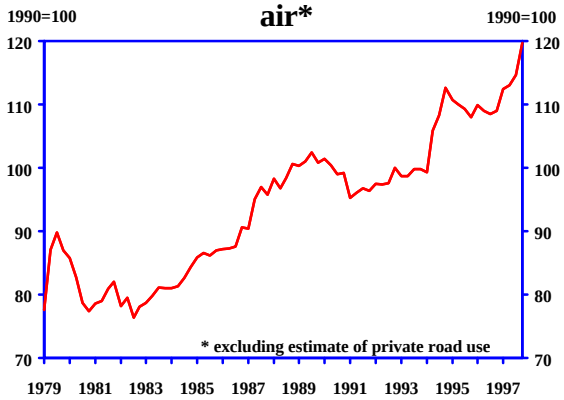


Chart F.4: Total transport output less air*



(iii) Transport proxies

We had a range of proxy variables available for the transport sector. These are illustrated in charts F.1 to F.8. Chart F.1 shows a basic indicator of air transport volume - passenger miles flown from UK airports. This measure does not distinguish business and leisure travel, but we know that the two categories move in a remarkably similar manner. Chart F.2 gives the output series for the sector. It tells the same story as passenger miles: the correlation coefficient between the two is 0.97. For transport as a whole, there are several possibilities. The basic transport sector output figures, with the total sector worth 5.4% of GDP, are given in Chart F.3; Chart F.4 excludes air. Arguably, land and air transport are the most important categories for our purposes: Chart F.5 shows the two aggregated together. But an excluded category is private road use. This is hard to measure, but we have figures for passenger road miles, and these could be translated into an 'output' series if we knew the 'price' of a passenger mile. To construct this, we took an average inter-city rail fare per mile on 20 routes into London in 1995, and then used the rail and total RPI to construct a real series (illustrated in Chart F.7). The aggregate of land, air and private road use is given in Chart F.6; the shares are 25.1 (out of 1000) for land, 6.6 for air and 6.8 for road use. Finally, Chart F.8 puts several of these aggregates together. It is clear that air travel has grown by noticeably more than the other sectors. In some parts of our work we also used the output from the communications industry as a similar infrastructural industry. The final results simply use the output of the transport sector, as conventionally defined.

Chart F.5: Land and air transport

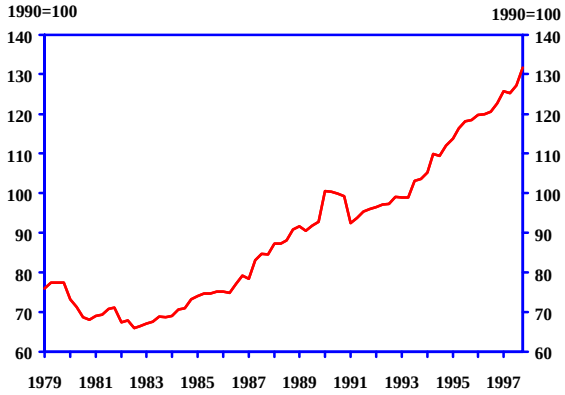


Chart F.6: Land, air and private road use proxy transport

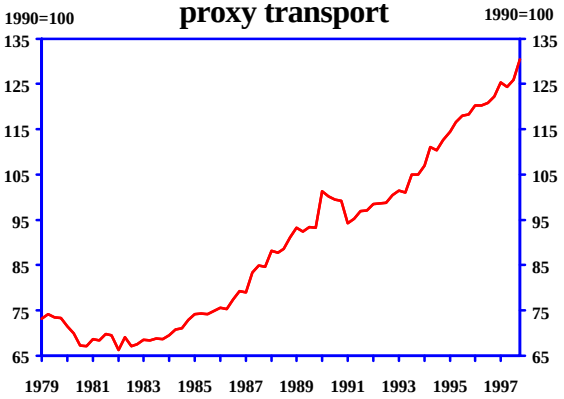


Chart F.7: Inferred private road use 'output'

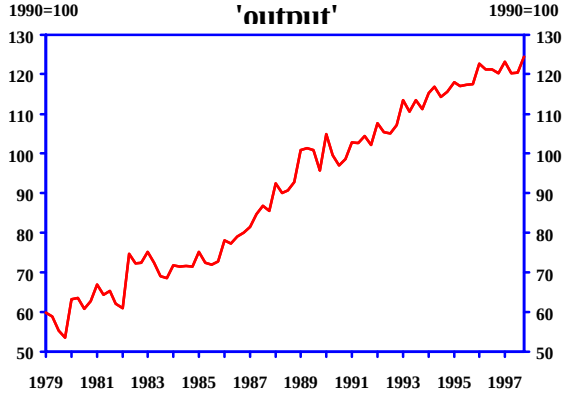
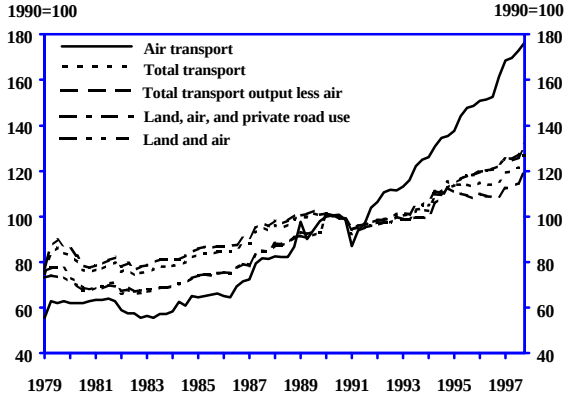


Chart F.8: Measures of transport output



(iv) Results

We believe that the best way to estimate the effects that we are looking for is to use as detailed data as possible. This avoids aggregation problems, and also side-steps the causality issue. We have separately identified 27 industrial sectors, with data for output, employment and the capital stock, and estimated single-equation Cobb-Douglas production functions with a simple, common lag structure. We have the adopted a 'dynamic panel' methodology, which delivers individual sectoral estimates, but is likely to be best at providing an accurate picture of the average impact. In a nutshell, this specification allows us to separate short-run dynamics from long-run effects. We have estimated an equation for each industry, and then taken averages. This gives a consistent estimate of the average effect even if each industry has a different parameter. It is often the case in such data sets that individual coefficients are widely dispersed, often with implausible coefficients; but with a much more plausible average.

Our results are based on growth rates,[27] using a simple dynamic structure to take account of slow adjustment and cyclical effects.[28] The main results are given in Table F.2.[29] Only the transport

[27] Technically, we examined growth in total factor productivity. The growth in total factor productivity is the growth of output that cannot be accounted for by rising inputs. For this calculation we assume constant returns to scale and perfect competition. We needed estimates of the shares of labour and capital in output; these came from the input-output tables and were not estimated econometrically.

Table F.2: Effect of transport growth in disaggregated factor growth equations

Sector	Coefficient	Standard error	t-ratio
Agriculture, forestry and fishing	0.075	0.251	0.30
Basic metals	0.334	0.281	*1.19*
Other marketed services	0.101	0.188	0.54
Construction	0.200	0.162	1.23
Chemicals and man made fibres	0.215	0.164	1.31
Communications	0.191	0.119	1.60
Computers and office equipment	0.746	0.381	*1.96*
Distribution	0.096	0.105	0.91
Extraction	-0.243	0.409	-0.59
Electrical engineering	0.231	0.168	*1.38*
Finance	-0.136	0.149	-0.91
Food, beverages and tobacco	0.018	0.060	0.29
Coke, petroleum and nuclear	0.227	0.357	0.64
Mechanical engineering	0.630	0.151	*4.16*
Metal products	0.392	0.143	2.73
Non-metallic minerals	0.163	0.159	1.02
Motor vehicles and parts	0.777	0.249	3.12
Non-market services	-0.141	0.074	-1.89
Other manufacturing	-0.035	0.174	-0.20
Other means of transport	-0.315	0.284	-1.11
Paper, printing and publishing	0.304	0.112	2.71
Precision and optical instruments	-0.062	0.235	*-0.26*
Rubber and plastics	0.082	0.187	0.44
Textiles, leather and clothing	0.046	0.147	0.32
Transport	-0.636	0.842	-0.76
Electricity, gas and water	0.257	0.454	0.57
Wood and wood products	0.125	0.252	0.50

Estimation method: SUR.
Sample: quarterly data, 1979 to 1997.
Average effect: 0.135 (t-ratio 2.31)

effects are reported here; the other parameters are not of any particular interest. What the numbers tell us is the impact on industry growth of growth in transport, of which aviation is a part.[30]

The t-ratio is a measure of statistical importance; the larger, the better. Not many among the 27 are statistically significant,[31] and the estimates vary widely (although only one of the estimates is significantly negative, and that only at a low (10%) level of significance). But despite appearances, this does not present an econometric problem. Widely-varying individual estimates are common in these kinds of data; the aim of the dynamic panel methodology is to try to use these estimates to get a good fix on the average effect. The average value of the effect of transport on growth for the full 27 is sensible, at 0.135. There are two ways of working out the t-ratio; the more robust of these is 2.31.

[28] Despite the fact that we did not experiment with the dynamic specification, there was not much evidence for autocorrelation (by LM(4) tests on the OLS results) in many of these equations. 4 out of 27 equations fail at the 5% level. The industry average calculation will be robust to some misspecification, so this is not a problem.
[29] Estimation was by the method of seemingly unrelated regression, or SUR. The less efficient OLS results are very close, although not so well determined.
[30] We included transport itself in the analysis, as there may still be identifiable effects from aggregate activity in the component sectors.
[31] That is, with a t-ratio above 2.

This implies that we have a significant average effect from transport.[32] In other words, we can be confident there is some effect from transport in the way we have been trying to identify. The t-ratio also indicates the degree of uncertainty over the size of the effect - we can be 95% sure it lies somewhere between about 0.02 and 0.25, with the estimated effect of 0.135 representing the best guess within this range. The results using the other transport proxies are very similar. If we take out aviation, the estimated long-run effect is slightly smaller but similar: it is 0.111, t-ratio 1.46. What we find then is that the aggregate including aviation is rather better determined. This strongly suggests that aviation is doing some work here. The fact that we cannot identify a separate effect is probably due to the relatively modest proportion of the sector due directly to air travel and the volatility of the data.[33]

All the reported results are based on lagged transport proxies, as growth spillover effects are unlikely to feed through contemporaneously. It is also arguable that contemporaneous transport output and factor productivity are procyclical, which might induce a spurious correlation, although the lag structure is intended to control for this. For the record, contemporaneous transport generally enters with a larger, indeed arguably implausibly larger, coefficient. To further control for the cycle, we introduced a series measuring demand,[34] and also growth in GDP. Neither of these made any difference to the results.

(v) Conclusions

So we have an estimate for the effect of transport on private output (or, equivalently, total factor productivity) in the region of 0.13. Is this number plausible? In a production function context, we would interpret the estimate as the elasticity of output with respect to aviation.[35] The average marginal product of transport is roughly 7.45%. Aviation is contained within this: an extra £1 of aviation output raises the output of a typical industry by 7.4p.[36]

As we are not identifying level effects, it may be better to interpret the figures as marginal contributions to growth. Taking this line, as the transport sector has grown on average at a rate of about 0.7% per quarter, the contribution of transport to growth at the margin has been 0.095%. Aviation is only a part of this sector, but it has grown at a significantly faster rate than the total. This means that over recent years, aviation has accounted for a much larger share of the growth in the rest of the economy facilitated by transport, than one might expect given its share in overall transport output - the contribution of aviation to growth works out at 0.07% per quarter. While this might appear small, it is not trivial. GDP in 1998 was £844 billion. At the average contribution over the period we are examining (1979 to 1997), growth in aviation output adds about £550 million every year to whole economy output growth; transport generally contributes around £800 million. This is, of course, over-and-above the direct contribution of the aviation industry to GDP. By comparison, trend growth would be expected to raise GDP by perhaps £19 billion in a normal year. This implies that aviation has contributed approaching 3% of the trend increase in GDP a year.

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[32] A Wald test of the 'poolability' restriction strongly rejects (χ^2_{26} is 76.3, well above the critical value; the OLS results also reject, at a lower level of significance), but this is not a problem, as we are happy to assume divergent elasticities, even if we cannot estimate them precisely. For the record, though, when we do pool this parameter, it takes the value of 0.045 with a low t-ratio of 1.3. Interestingly, though, the OLS estimate is 0.163 with a t-ratio of 3.30, similar to the un-pooled average.

[33] The technical problem is that the effect is less than the coefficient's standard error.

[34] The deviations from the Hodrick Prescott filter trend of log GDP.

[35] The marginal product of aviation output can be calculated as 0.13 Q_i/Z where Q_i is the level of output of the ith industry and Z aviation output. There are 27 industries, and as government is about 20% of GDP, the average share of each is roughly 3%.

[36] We can now see why it is so difficult to identify a separate effect from air, as the margin of error in our estimate exceeds this. As air transport (narrowly defined) is 0.7% of GDP, the coefficient on aviation we would expect to observe would be 0.016. If this were estimated with the same precision as for the whole sector, it would be swamped by the standard error, which is 0.05 on average.

Annex G: Supporting material for Chapter III - Model and Scenarios

Chapter III describes the structure of the model and the main linkages between the aviation industry and the rest of the economy. And it summarises the results of the different scenarios we have run on the model. This Annex provides more detail on the scenario results. At the end of the Annex we have provided a summary listing of the equations in the model. A technical guide to the model is available for those requiring a full understanding of how it operates.

(i) Scenario results

The alternative scenarios were run by inputting different assumptions about passenger numbers of different types and freight movements into the model, and looking at the impact on the rest of the economy via the mechanisms outlined in Chapter III. The first five scenarios shown all look at the impact of a 25 million a year reduction in the number of passengers, but with different assumptions about which types of passengers are affected. The last scenario in the tables looks at a 50 million a year reduction in the number of passengers, spread proportionately across the different types of passengers.

The tables summarise the impact on the economy by 2015 - Table G.1 looks at the percentage impact on a number of key variables, Table G.2 the absolute impact. So, for example, a 25 million reduction in passengers spread across all passenger types would be expected to reduce the level of GDP in 2015 by 0.3% (Table G.1) or £3.9 billion in 1998 prices (Table G.2).

We also looked at an extreme case of no growth at all in the numbers of the different types of passenger numbers over those travelling in 1998. This is clearly not intended to be a realistic scenario - passenger numbers so far in 1999 are already higher than 1998 levels - but simply to illustrate the possible overall impact of growth in aviation over the next fifteen years or so. The results of assuming passengers fixed at 1998 levels are shown below.

Table G.3: Impact of passenger levels restricted to 1998 levels
(differences from base in 2015)

Direct employment (‘000s)	-100
Indirect employment (‘000s)	-135
Induced employment (‘000s)	-60
Investment	-3.6%
Capital stock	-1.4%
Productivity	-2.7%
GDP (£1998 billion)	-33

Table G.1: Summary of Simulation Results (1)

	All Passengers	25m reduction in Business Passengers	Leisure Passengers	Transfer Passengers	UK Passengers	50m reduction in all Passengers
% differences from base in 2015:						
Aviation traffic variables						
Leisure, UK residents	-8.1	0	-13.9	0	-13.6	-16.1
Leisure, non-UK residents	-8.1	0	-13.9	0	0	-16.1
Business, UK residents	-8.1	-26.4	0	0	-13.6	-16.1
Business, non-UK residents	-8.1	-26.4	0	0	0	-16.2
Transfer passengers	-8.1	0	0	-71.2	0	-16.1
Freight	-8.1	-8.1	-8.1	-8.1	-8.1	-16.3
Aviation price variables						
Business fares	13.2	58.7	0	0	14.3	30.1
Leisure fares	7.1	5.6	10.6	0	8.2	15.9
Freight fares	9.3	11.5	8.9	8.9	9.3	20.9
Other aviation variables						
Output for total aviation	-8.1	-10.4	-7.1	-7.1	-8.1	-16.1
Business related aviation	-8.1	-23.8	-1.2	-1.2	-8.6	-16.2
Direct employment	-8.1	-10.4	-7.1	-7.1	-8.1	-16.1
Indirect employment	-7.8	-9.5	-7.0	-7.0	-7.9	-15.7
Induced employment	-8.0	-10.0	-7.1	-7.1	-8.0	-15.9
Macro variables						
GDP	-0.3	-0.8	-0.1	-0.1	-0.3	-0.6
Consumption	-0.2	-0.4	0	0	-0.3	-0.4
Investment	-0.6	-1.6	-0.1	-0.1	-0.6	-1.2
Exports	0	0.4	-0.1	-0.1	0	0.2
Imports	0.1	1.1	0	0	0.2	0.5
Capital stock	-0.2	-0.6	0	0	-0.2	-0.4
Total Employment	0	0.1	0	0	-0.1	0
Productivity	-0.3	-0.9	0	0	-0.3	-0.6
Price	0.2	1.8	0	0	0.2	0.9
Wages	0	0.8	0	0	0	0.3
Consumer surplus	-16	-25	-12	-1	-25	-29

Table G.2: Summary of Simulation Results (2)

	All Passengers	25m reduction in Business Passengers	Leisure Passengers	Transfer Passengers	UK Passengers	50m reduction in all Passengers
Absolute differences from base in 2015:						
Aviation traffic variables						
Leisure, UK residents ('000s)	-9950	0	-17130	0	-16800	-19900
Leisure, non-UK residents ('000s)	-4575	0	-7870	0	0	-9150
Business, UK residents ('000s)	-4850	-15880	0	0	-8200	-9700
Business, non-UK residents (000's)	-2800	-9120	0	0	0	-5600
Transfer passengers (000's)	-2825	0	0	-25000	0	-5650
Freight (tonnes)	-282	-282	-282	-282	-282	-564
Other aviation variables						
Direct employment (000's)	-17	-22	-15	-15	-17	-34
Indirect employment (000's)	-19	-23	-17	-17	-19	-37
Induced employment (000's)	-9	-11	-8	-8	-9	-18
Macro variables						
GDP (£bn, 1998 prices)	-3.9	-10.3	-0.6	-0.8	-4.2	-7.6
Consumption (£bn, 1998 prices)	-1.3	-3.8	0.0	0.0	-2.5	-3.8
Investment (£bn, 1998 prices)	-1.3	-3.8	0.0	0.0	-1.3	-2.5
Exports (£bn, 1998 prices)	0.0	2.5	0.0	0.0	0.0	1.3
Imports (£bn, 1998 prices)	1.3	6.3	0.0	0.0	1.3	3.8
Total Employment (000's)	-11	25	-3	-4	-12	-8
Consumer surplus (£bn, 1998 prices)	-2.3	-3.7	-1.7	-0.1	-3.6	-4.3

(ii) Model equations

The model is designed to take the base scenario and interactions with the macro-economy as given by the OEF macro and sectoral models. The equations here, therefore, are intended to reflect the impact of changes in the structure of the economy that result from changes in the aviation projections, rather than the full determinants of the forecast.

For each sector:

Final Demand	$\ln(FD) = f(C, IF, GC, X) - 0.58*\ln(P/PGDP)$
Intermediate Demand	$ID = \sum w_i*Q_i$ (ie Q by sector, including QAV)
Total Demand	$TD = FD + ID$
Output	$\ln(Q) = \nu_i*\ln(E) + (1-\nu_i)*\ln(K_{-1}) + \ln(TFP)$
Intermediate Costs	$IC = \sum w_i*P_i$ (ie P by sector - including PAV)
Labour Costs	$LC = W*E/Q$
Total Costs	$TC = IC + LC$

Prices	ln(P) = ln(TC) + constant
Wages	Δln(W) = Δln(PGDP) + 0.55*Δln(Q/E) + 0.28*Δ(ln(ΔE)-ln(ESTAR))
	-0.31*(ln(W_{-1})-ln($PGDP_{-1}$*Q_{-1}/E_{-1})-1.1*(ln(ΔE_{-1})-ln($ESTAR_{-1}$)))
Employment	Δln(E) = 0.22*Δln(TD) - 0.42*Δln(W/P)
	-0.36*(ln(E_{-1})-ln(TD_{-1})+ln(W_{-1}/P_{-1}))
Total factor productivity	Δln(TFP) = 0.04*🚲Δln(QAV)
Investment	Δln(I) = 0.1*Δln(TFP) + 2.1*Δln(Q_{-1}) -0.1*ln(I_{-1}/K_{-2})
Capital stock	K = (1-♥)*K_{-1} + I
Depreciation	♥

Aggregate variables:

Expenditure	ZGDPE = ZC + IF + ZGC + IS + ZX - M
Output	GDPO = ΔQ
Consumption	Δln(ZC) = Δln(W*E/P)
	C = ZC + 0.6 * (GDPO-ZGDPE)
Investment	ΔIF =ΔΔI
Exports	Δln(ZX) = -0.4*Δln(PGDP/WORLDP)
	X = ZX + 0.2 * (GDPO-ZGDPE)
Imports	Δln(M) = 0.6*Δln(PGDP/WORLDP)
Government Consumption	GC = ZGC + 0.2 * (GDPO-ZGDPE)
Price level	PGDP = ΔP
'Natural' level of employment	ESTAR

The Aviation Sector of the Model:

(Traffic variables are treated as exogenous for purposes of scenarios.)

Leisure (terminating) passengers, UK resident ('000s)	PASLUK
Leisure (terminating) passengers, non-UK resident ('000s)	PASLOV
Business (terminating) passengers, UK resident ('000s)	PASBUK
Business (terminating) passengers, non-UK resident ('000s)	PASBOV
Transfer passengers ('000s) (not split UK and non-UK)	PASTR
Total (non-transit) passengers ('000s)	PASTOT = PASLUK + PASLOV + PASBUK + PASBOV + PASTR
Freight carried (tonnes)	FREIGHT
Business fares	Δln(PPASB) = Δln(PTRA) - 1.43*Δln(PASBUK+PASBOV) -0.1*Δln(PASTR)
Freight charges	Δln(PFRT) = Δln(PTRA) - 1.0*Δln(FREIGHT)
Leisure fares	Δln(PPASL) = Δln(PTRA) - 0.67*Δln(PASLUK+PASLOV) + 0.1*Δln(PASBUK+PASBOV)

Aviation output	QAV = f(PASTOT, FREIGHT)
Direct employment	ln(EAV) = ln(QAV) - 0.03*TREND
Indirect employment	 ln(EAVINDI) =  ln(QAV) - ln(GDP/  E)
Induced employment	EAVINDU = 0.25 * (EAV+EAVINDI)

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