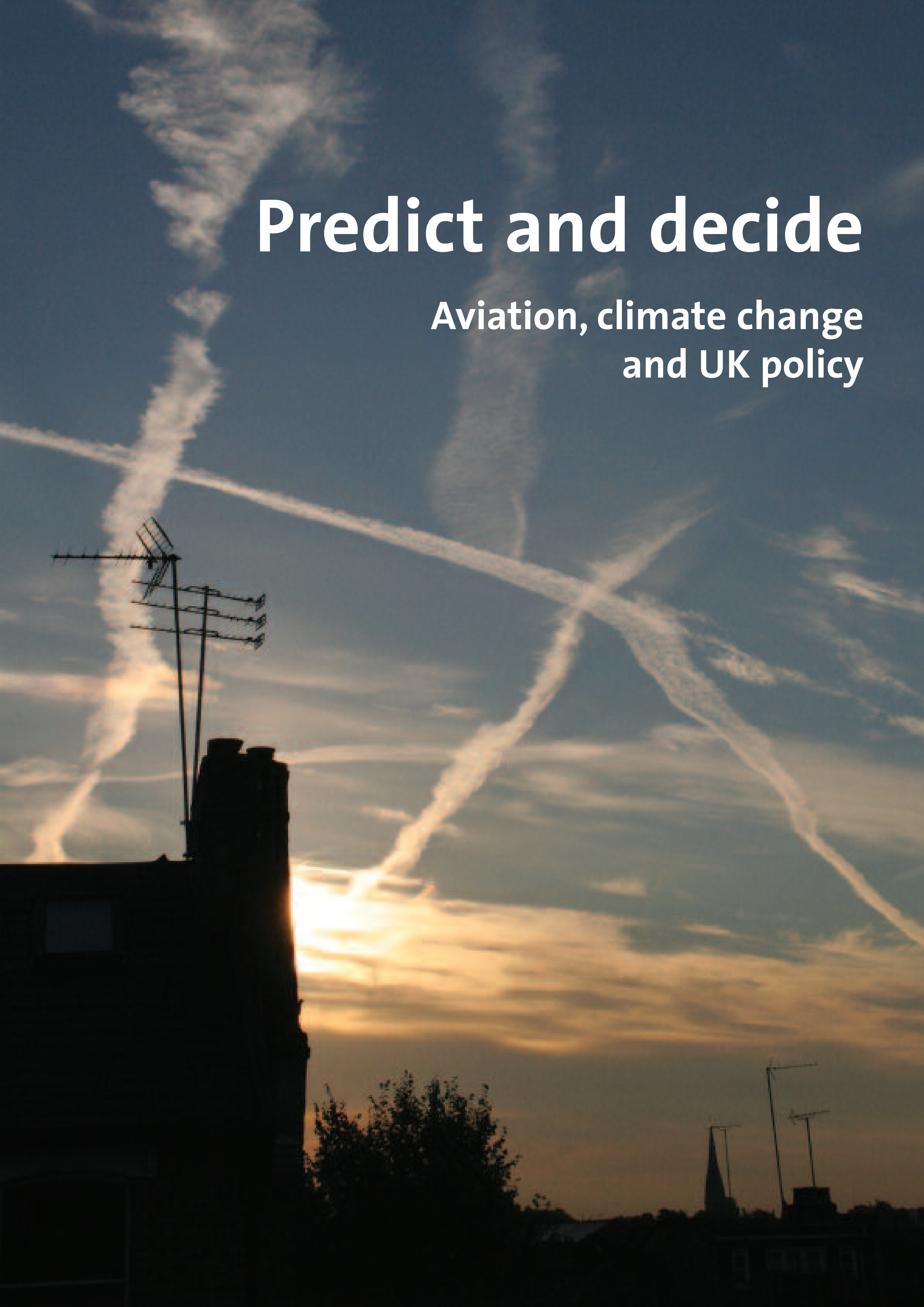
Predict and decide

Aviation, climate change and UK policy



In November 2005, the Environmental Change Institute of the University of Oxford commissioned Sally Cairns and Carey Newson to undertake a review of the evidence about the significance of aviation to climate change and potential policy measures for mitigating its impacts. This report represents the final output of that work. It builds on an interim paper (also called 'Predict and Decide') produced in December 2005 for the Stern Review[1], and a subsequent consultation draft of this report (called Predict and Decide II). The consultation draft was completed in June 2006, and circulated for comments to about 90 people, including those working in national Government and the EU; representatives of both the aviation and tourism industries; environmental pressure groups; academics; and others active in the debate. The report has been significantly revised following the receipt of comments.

The research has been funded through the UK Energy Research Centre, as part of a grant to the Demand Reduction theme, from the joint Research Councils. Dr Brenda Boardman leads this theme, at the Environmental Change Institute, University of Oxford and Dr Jillian Anable co-ordinates the research on transport, from The Centre for Transport Policy, The Robert Gordon University, Aberdeen.

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Cover photo: Sally Cairns

Related research

The ECI published *40% house* in March 2005, as an investigation into the policy required to achieve a 60% cut in carbon dioxide emissions from the energy used in the residential sector by 2050. This work was funded by the Tyndall Centre. http://www.eci.ox.ac.uk/lowercf/40house.html

Carbon Visions Buildings is a research project, due to be completed in September 2008, funded by the Carbon Trust and the Engineering and Physical Sciences Research Council. The three consortia are examining the opportunities for a 50% cut in carbon dioxide emissions by 2030, from all energy in all buildings (except industrial processes). *Building Market Transformation* is the consortia led by the ECI, with Bath, Cardiff, Strathclyde and Surrey Universities. BMT is focusing on the scenarios that would achieve this reduction. http://www.eci.ox.ac.uk/lowercf/bmt.htm

The *Interactive Manual of Policies to Abate Carbon from Transport* (IMPACT) database is a main tenet of the UKERC Demand Reduction transport effort. This is an inventory of surface, air and water passenger and freight transport policies which records current best practice, potential impact, implementation timescales, policy synergies and rebound effects. The IMPACT database will be a searchable resource available on-line at the beginning of 2007 and will include an interactive element whereby practitioners and other experts can offer their experience and results. The database is expected to contain around 70 policies in surface, air and water transport.

Quick Hits are a series of short briefing notes which examine the potential of policies that could be implemented in the short term to have rapid and significant effects on UK carbon reduction targets. The Demand Reduction team of the UKERC has focussed initially on the transport sector and have so far investigated speed limit enforcement and reduction, the eco-driving test and LED street lighting. Other policy measures will follow. http://www.ukerc.ac.uk/

Smarter Choices and Carbon Emissions was undertaken for the Department for Transport by Anable et al (forthcoming) to assess the potential for 'soft' transport measures to reduce carbon emissions from personal surface transport. This was a follow up study to *Smarter Choices – Changing the Way We Travel* (Cairns et al 2004) which used case study evidence of local policies such as workplace and school travel plans, individualised marketing, car clubs and tele-initiatives to show that an intensive programme of such measures could reduce national traffic by 11% nationally. Summary and main reports are available at: http://www.dft.gov.uk/stellent/groups/dft_susttravel/documents/divisionhomepage/031340.hcsp

The Department for Transport recently commissioned Jillian Anable to lead an *Evidence Base Review of Attitudes to Climate Change and Transport*.
The objectives were to improve the evidence base for policy decisions concerning (i) How climate change knowledge and awareness relates to transport decision-making, attitudes and behaviours amongst the public; (ii) The nature and impact of interventions aimed at altering attitudes and behaviours in relation to climate change issues; (iii) The identification of research methods (including measures and data sources) pertinent to these issues. (iv) The identification of evidence gaps worthy of further research. Summary and main reports are available at: http://www.dft.gov.uk/stellent/groups/dft_control/documents/contentservertemplate/dft_index.hcst?n=16906&l=1

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Final report

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The majority of these people were included in the consultation phase of this research.

Contents

Executive Summary

The UK Government is committed to a 60% reduction in carbon dioxide emissions from UK activities between 1990 and 2050. Many climate scientists now believe that even tougher targets are needed, but in all cases swift action is required to reduce climate impacts. Yet the UK's Aviation White Paper sets a policy framework that supports a major expansion in aviation activity, which would enable air passenger movements to increase from about 200 million in 2003 to about 470 million in 2030.

This report assesses the implications of aviation growth in the UK, while recognising that there would be some positive benefits. Available evidence about the scale, nature and impacts of the projected rise in air travel is used to weigh up the arguments for and against restraining aviation, particularly passenger air travel.

In the light of this evidence and the UK's environmental goals, the report concludes that the Government will need to explore a policy of managing demand for air travel. This is likely to include:

- A change in strategic policy to give a presumption against the expansion of UK airport capacity;
- A fiscal package to make flying less attractively priced;
- A communication strategy that builds on existing public support for addressing aviation's environmental impacts and ensures that the contribution of flying to climate change is understood and recognised.

Why is demand for air travel a challenge?

In just ten years, between 1990 and 2000, carbon dioxide emissions from UK aviation have doubled. During the same period, the combined emissions of carbon dioxide from all other UK activities fell by around 9%. A review of various forecasts of UK air travel growth indicates that aviation emissions are set to more than double again between 2000 and 2030 and could increase to between 4 and 10 times their 1990 level by 2050.

Aviation is excluded from international inventories of greenhouse gases for the Kyoto Protocol. If it is assumed that the impacts will be included in the UK's aspirations to stabilise climate change, several factors have to be considered:

- First, aviation's potential impact is even bigger than the forecasts of carbon dioxide emissions suggest. Quantifying the effect of the other emissions is scientifically problematic and not undertaken in this report. Hence, the figures quoted for the climate change impact of aviation are conservative and only refer to the minimum contribution.
- Second, the UK generates more flights than any other European country: a fifth of all international air passengers worldwide are on flights that arrive or leave from UK airports. Hence, aviation makes a proportionally greater contribution to climate change for the UK than for most other countries.
- Third, even at the lower end of the forecast range, carbon dioxide emissions from aviation are set to reach 17 million tonnes of carbon (MtC) by 2050. The higher end of the range is 44 MtC. Meanwhile, the UK is attempting to limit the carbon emissions of all its activities to 65 MtC by this date. This means that, in order to offset aviation's emissions, all other sectors of the UK economy would need to reduce their emissions by 71%–87% instead of the currently planned 60% from 1990 levels. There is no sign that this can or will happen: the existing 60% target is already extremely challenging.
- Fourth, these growth forecasts already allow for improvements that may be achieved through changes in air traffic management, other operational procedures and technological development. If these do not occur, emissions could be even higher.

The implication is that the UK will be unable to meet its targets for reducing climate change impacts without action to curb the demand for air travel. It is a political decision as to whether the aim should be to restrict the anticipated growth in aviation emissions, stabilise them at current levels or reduce them in absolute terms.

Who flies?

Passenger traffic at UK airports has grown at an average annual rate of about 6% since the mid-1970s, with an increase of 12.5 million new passenger movements in the last year. Much of the recent expansion in flying has occurred because better off people are flying more often. There is little evidence that those on low incomes are flying more; flying cannot be regarded as a socially inclusive activity.

UK residents make 67% of all trips affecting UK airports. The greatest growth has been in international leisure flights – there are now five overseas holiday flights to every business flight made overseas by a UK resident. Between 1994 and 2004, 70% of the additional international trips that occurred were UK residents going abroad for leisure. The largest category of future trips from UK airports is likely to be more of the same - UK residents travelling abroad for leisure purposes.

The UK is increasingly developing an air dependent culture. If action to tackle flying is postponed, we will enter an era in which frequent flying is increasingly the norm for better-off households, with lifestyles adapted to this expectation, including far greater ownership of second homes abroad, and more geographically-distant networks of friends and family.

Aviation's contribution to UK tourism and the economy

The case for supporting the predicted growth in flying has been made partly on economic grounds. Aviation does bring economic benefits (such as employment) which would be impacted if the future growth in aviation were curbed. However, this would be offset by public revenue from a more appropriate fiscal package for aviation and the potential effect of higher air fares on the growing tourism deficit. The balance between the costs and benefits needs to be carefully assessed.

The Government recognises there is a £17 billion tourism deficit resulting from UK residents spending more money abroad than overseas visitors bring in: for every £1 an overseas visitor spends in the UK, a UK resident spends £2.32 abroad. In 2003, spending by domestic tourists accounted for four-fifths of the UK's £74 billion tourism earnings. New analysis for this report shows that in the six months after the 2001 terrorist attacks, people's reluctance to fly meant that the money lost from overseas tourism was outweighed by an increase in domestic spending by UK residents. Together, this evidence indicates:

- The majority of spending at UK tourist destinations is not reliant on international aviation, since it is actually coming from UK residents;
- If air travel becomes less desirable, there could be a significant increase in expenditure in the UK by UK residents, to the benefit of the wider economy.

What does the public think?

Public opinion surveys dating from 2002-6 suggest that support for making flying more expensive on environmental grounds has grown over time. The most recent public opinion survey, conducted by Ipsos MORI, found that:

- Support for a policy to constrain the growth in air travel outweighed opposition, with less than 22% of respondents opposed to such a policy;
- There was majority support (about 60%) for airlines to pay higher taxes to reflect environmental damage, even if this meant higher air fares.

The main effect of increasing air prices would be to avert new growth in demand for journeys that has not yet taken place. The UK has the opportunity to choose a more sustainable trajectory, in which we do not continue to build our society around increasingly high levels of flying or encourage an expanding 'air culture'. This path could offer significant benefits in terms of public revenue and the regeneration of UK domestic tourism and, most importantly, in setting a credible course towards fulfilling the UK's commitments on climate change.

How could the demand for air travel be restrained quickly?

Air Passenger Duty (APD) is a duty levied by the Government on passenger trips from UK airports. Raising the level of APD is the most obvious measure for affecting demand quickly, because:

- UK fares for both leisure and business flights have fallen dramatically in real terms over the last 15 years. Estimates suggest that at least 40% of the recent growth in air travel has been generated by fare reductions. Raising APD would help to counter that trend;
- The Government's preferred solution - to include aviation in the EU Emissions Trading Scheme - is likely to take a number of years to achieve and its impacts will depend on the detailed design of the scheme;
- Increases in fuel prices, as a result of market volatility, cannot be expected to have a consistent, long term effect on fares;
- Raising APD is legally straightforward and does not require international agreement, unlike other measures such as aviation fuel taxation.

Another policy that deserves serious consideration is the addition of VAT to domestic air tickets. The Government could also pursue other options, including encouraging the EU to abolish duty free on extra-EU flights and gaining international agreement to implement an aviation fuel tax or a charge on en-route emissions from flights.

Making flying more expensive, by introducing new taxes or charges, offers one of the quickest ways to address the demand for air travel. New charges are likely to be socially progressive since the profile of aviation use means that they are primarily likely to deter richer members of society from flying more. An appropriate fiscal package for flying would also raise significant public revenue, which could be spent on more socially inclusive opportunities or reducing other taxes. One estimate suggests that aviation's tax advantages amount to £9 billion p.a. of lost revenue for the UK Treasury.

For the longer term, more radical solutions such as personal carbon allowances could be appropriate.

Introduction

1.1 Purpose of the study

Policy about, and understanding of, aviation are evolving remarkably swiftly. The primary aim of this report is to assess the contribution of aviation to climate change, and to review existing policy in this context, including the potential role for economic policy measures to mitigate its impacts. In particular, this report focuses on the issues raised by aviation emissions for the UK, including the potential for, and implications of, taking unilateral action on the issue. The UK Government's main policy statement on aviation is an Aviation White Paper entitled 'The future of air transport', which was released in 2003 (DfT, 2003b). This paper is supported by a range of documentation both leading up to its release and subsequent to its publication. The Department for Transport intends to issue a 'progress report' on the Aviation White Paper by the end of 2006.

Aviation policy is clearly an issue of international concern, being addressed by both the European Commission, and the International Civil Aviation Organisation (ICAO), a specialised agency of the United Nations[2]. However, it is a particular concern for the UK because the UK accounts for a significant proportion of the world's total aviation activity. According to the Aviation White Paper, a fifth of all international air passengers are on flights to or from a UK airport (DfT, 2003b, para. 2.6)[3].

As well as undertaking some new data collection and analysis, this study aimed to draw on the substantial evidence base that has been generated by a range of other bodies, including work by national and international government organisations, think tanks and pressure groups, industry and academia. The main research for the report was undertaken between November 2005 and May 2006.

In the majority of this report, the term 'UK aviation' is used to broadly mean aviation activity which affects the UK. However, when considering emissions and climate change impacts (in Chapter 2), more specific definitions are used. In evaluating the Aviation White Paper emissions forecasts, the Government's own definition is used, as given in one of the daughter documents to the White Paper entitled 'Aviation and Global Warming' (DfT, 2004a). This identifies the emissions from 'UK aviation' as being those arising from all domestic passengers within the UK plus all international passenger departures from UK airports and air freight activities.

In undertaking this study, many of the justifications for supporting aviation growth are subject to critical assessment. Clearly, air travel has many positive aspects, such as the increase in personal well-being generated by a holiday abroad. Moreover, there is no intention to suggest that the industry itself is deserving of any particular criticism. However, the benefits brought by aviation need to be weighed against the potential detrimental consequences of climate change. Hence national justifications for supporting the industry have been subjected to close scrutiny on that basis.

1.2 Context

There is widespread acceptance that climate change represents a major threat to world well-being. The UK Government's Chief Scientist Professor David King, has stated: *'climate change is the most severe problem that we are facing today – more serious even than the threat of terrorism'*, (King, 2004). The Pentagon has advised George Bush that *'because of the potentially dire consequences, the risk of abrupt climate change ... should be elevated beyond a scientific debate to a US national security concern'* (Schwartz and Randall, 2004).

The UK Government's response is being formulated within the United Nations Framework Convention on Climate Change and its Kyoto Protocol. In 2003, the Government produced an Energy White Paper, in which it reiterated its Kyoto Protocol commitment to reduce greenhouse gas emissions by 12.5% below 1990 levels by 2008–12, and its own national goal to move towards a 20% reduction in carbon dioxide emissions below 1990 levels by 2010. In addition, it accepted a recommendation from the Royal Commission on Environmental Pollution (RCEP) that *"the UK should put itself on a path to a reduction in carbon dioxide emissions of some 60% from current levels by about 2050"*, with an interim target for 2020 (DTI, 2003, paras 2.14 and 2.12).

The RCEP target was based on a calculation undertaken by the RCEP secretariat, in response to the Second Assessment Report of the Intergovernmental Panel on Climate Change (IPCC). The IPCC report gave an estimate of the annual global emissions of carbon dioxide that would be needed by 2050 to stabilise the atmospheric concentration of carbon dioxide at 550 parts per million (ppm). The RCEP secretariat divided this estimate by the predicted world population for

2050, and then multiplied it by the predicted UK population, to conclude that, in total, the UK should be aiming to emit only about 65 million tonnes of carbon (MtC) by 2050[4], which would mean a reduction from current levels of emissions of about 60% (RCEP, 2000, RCEP Secretariat, 2006).

In general, meeting this target is seen as being extremely challenging. However, at the same time, there is concern that it does not go far enough. Hillman and Fawcett (2004, p24) state: *"A limit of 550ppm for carbon dioxide emissions has been suggested by several bodies ... However, it has not been universally accepted: 550ppm is twice the level [of carbon dioxide] that was in the atmosphere prior to the Industrial Revolution, and current understanding of the way in which the climate and natural systems work may not be reliable enough to guarantee that the degree of change under these conditions would be safe and acceptable... A lower limit of 450ppm would be a more risk-adverse maximum." (*Current atmospheric concentration of carbon dioxide is about 380ppm.)

Various commentators also emphasise the importance of swift action. For example, in January 2005, the Chairman of the Intergovernmental Panel on Climate Change Dr Rajendra Pachauri and ex-Transport Minister Stephen Byers together launched a report from the International Climate Change Taskforce which argued that action *within the next 10 years* is critical. In particular, the report highlighted the importance of avoiding a temperature rise of more than 2°C above pre-industrial levels, stating: *"Above the 2°C level, the risks of abrupt, accelerated or runaway climate change also increase. The possibilities include reaching climatic tipping points leading, for example, to the loss of the West Antarctic and Greenland ice sheets (which, between them, could raise sea levels more than 10m over the space of a few centuries), the shutdown of the thermohaline ocean circulation (and with it, the Gulf Stream), and the transformation of the planet's forests and soils from a net sink of carbon to a net source of carbon*" (ICCT, 2005, pp3–4).

Partly due to political difficulties in agreeing responsibilities, the emissions from international aviation (together with those from international shipping) were excluded from the Kyoto Protocol and all associated target setting, (although the emissions from domestic aviation were included). This is a clear anomaly, and has led to discussion about how international aviation emissions can be included in future succession agreements to Kyoto[5].

Meanwhile, the UK 65MtC target, which was derived from a calculation of the maximum amount of carbon dioxide that the UK could fairly emit by 2050, should, by implication, be taken to include the emissions from international aviation attributable to the UK (although it is not clear that this is currently the official position).

The UK Government's general approach to tackling climate change is to achieve reductions in emissions in the most cost-effective way across the whole of the economy rather than having particular targets for particular sectors. In relation to aviation, this has led to particular interest in including aviation within the EU Emissions Trading Scheme, which would be expected to bring about reductions in emissions both by encouraging technological efficiency in aviation and by enabling the aviation industry to buy emission credits which stimulate cuts in emissions elsewhere. According to the Aviation White Paper, including aviation within EU ETS, together with changes in working practices and air traffic management, research and development into aeroplane technology, and voluntary action by the industry, will *"provide a solid foundation for action in tackling aviation's global impacts"* (DfT, 2003b, paras 3.41–3.42). At the same time, the Aviation White Paper envisages a dramatic increase in flying, aiming to enable the number of passenger movements at UK airports to increase to about 470million by 2030, from about 200million in 2003.

The Aviation White Paper clarifies this approach as follows: *"Reduction in greenhouse gas emissions across the economy does not, however, mean that every sector is expected to follow the same path. The Government is committed to a comprehensive approach, using economic instruments to ensure that growing industries are catered for within a reducing total. The use of emissions trading allows coverage of environmental costs through a mixture of emissions reduction within the sector and purchase of reductions that can be produced more cheaply by other sectors"* (DfT, 2003b, para 3.37).

However, critics argue that this approach is flawed, both because the technological and efficiency gains possible in the aviation sector are seen as limited, and because there is not necessarily sufficient scope for other sectors to absorb growing emissions from the aviation sector. Achieving a 60% cut in emissions is already seen as extremely challenging in most parts of the UK economy. According to Boardman (2006): *"A 60% carbon dioxide reduction in the domestic sector is seen as tough but achievable. The '40% house' project (Boardman et al, 2005) demonstrated that a wide gamut of policies are required, whose implementation should start as soon as possible. A much greater reduction is almost impossible to conceive, even though residential energy use is thought to be one of the easiest areas to tackle".*

As further context, it should be noted that the recent debate about the need for a major expansion in nuclear power is based on the premise that (only) 30% of the UK's current electricity generating capacity will need replacement by 2025. Achieving this is also seen as extremely challenging (DTI, 2006). Specifically commenting on the UK Government's approach to aviation, the House of Commons Environmental Audit Committee states: *"Power companies, manufacturers, retailers, households, motorists and hauliers are already going to have to make significant efforts to decarbonise their lives and livelihoods. If the Government continues in its policy of allowing just this one industry to grow, it will either cause severe pain to all other sectors or provoke so much opposition as to fatally undermine its 2050 target" (*HoCEAC, 2006, p61).

An alternative to reducing its own emissions would be for the UK to buy 'emissions credits' from abroad, via various mechanisms (including the EU Emissions Trading Scheme). However, the RCEP target was based on the model of 'contraction and convergence', whose underlying philosophy is that each developed country should aim for an absolute reduction in its own emissions. This can be justified first, on the grounds of social equity, and second, because relying on offsetting emissions abroad cannot be a permanent solution given that, as other countries develop, they may not offer sufficient spare 'emissions capacity' to offset UK activities in the future. Specifically, the Royal Commission on Environmental Pollution states: *"If it [trading] became merely a means of enabling wealthy nations to buy up the emission entitlements of poorer countries on the cheap, thereby evading taking any action at home, trading would not serve the cause of climate protection."* In brief, then, there is a belief that, overall, the UK needs to cut its own emissions substantially in absolute terms.

Hence, it is important to understand the scale and nature of aviation's impacts on climate and to consider whether the EU Emissions Trading Scheme, together with industry action, will be enough to mitigate its impacts in this context. If these will be insufficient, this implies either that more direct policies will be needed to address the impacts from aviation, or that there needs to be an informed debate about future choices. For example, would people rather heat their homes or fly? Would they choose an even greater expansion of nuclear power than that already proposed if it enabled aviation to grow unchecked? If these are the choices to be made, it is important to have a full and frank debate about them.

1.3 Scope of the study

Various issues were defined as being beyond the scope of this study, either because they were seen as being tangential or subsidiary to the main issue under consideration, or simply because the timeframe meant that they could not be addressed. These issues were as follows.

- *Air freight:* Whilst the emissions from all aviation activities are considered, the study primarily examines the issues associated with supporting or restraining *passenger* air travel. It does not include a detailed consideration of the issues associated with air freight, and this topic requires further research.
- *More radical restraint measures:* The study is primarily focused on the potential to reduce passenger demand for flying through economic mechanisms. An alternative approach would be to introduce a personal carbon allocation scheme, such as personal carbon allowances. Such mechanisms are not considered here, partly because they are the subject of other work by the UK Energy Research Centre, and partly because they could not be introduced as quickly as some of the other mechanisms discussed here. Specifically, this report argues that measures which could make a difference to the demand for flying should be introduced as rapidly as possible. In the longer term, a mixture of pricing and rationing mechanisms is likely to provide the most equitable solution. A more direct approach would simply be to limit flight numbers from all UK airports. Again, examining this approach was beyond scope of this report.
- *Noise and local air pollution:* In this report, the noise and air quality impacts of aviation have not been considered specifically. In general, these issues strengthen the case for restricting aviation on environmental grounds and are also recognised as

being problems by the public. However, some of the technological measures which might reduce the climate change impacts of aviation could increase noise or air quality problems, and vice versa, meaning that there are some important trade-offs to be considered.

- *The relative credentials of different airlines or trip types:* There is a significant debate about the relative environmental credentials of different airlines, depending, for example, on the age of their fleet, their investment in research and development activities, typical loading factors etc. The issue of how emissions credits should be allocated to different airlines in the EU Emissions Trading Scheme is particularly controversial. However, here, this is taken to be a secondary issue, since the literature does not suggest that an alteration in the balance of power between the airlines would significantly alter the conclusions reached. Equally, the report does not comment on the appropriate balance between short-haul and long-haul flying, although it should be noted that longer journeys are almost always more environmentally damaging (even if they are less so per kilometre travelled).
- *Benefits to domestic tourism due to climate change:* Some commentators argue that the demand for flying may naturally reduce with climate change, as the UK may enjoy better weather in the summer, whilst some traditional holiday destinations may become undesirably hot. This *may* be true. However, it would be complacent to believe that the problem will 'solve itself'. Moreover, although there may be some positive aspects from climate change, the current consensus is that, overall, these will be substantially outweighed by negative impacts.
- *Carbon offsets:* There are an increasing number of schemes where individuals can pay a fee to compensate for the environmental impacts of their journey. In general terms, the effect is to increase the price of air travel, and is therefore not materially different to one of the key recommendations in this report, namely that air travel should be made more expensive. However, there are concerns that the offsets which individuals pay do not adequately address the issue of lag between the time that the carbon is emitted and the point at which it has been offset; and that some offset schemes may have led to unintended negative consequences (Hartzell, 2006, New Internationalist, 2006). In addition, there is a more fundamental problem with such offsets, if they encourage the development of a culture of flying, given that flying will probably need to be limited at some point. Some of these points have also been raised by the House of Commons Environmental Audit Committee, which is in favour of offsets, but states that it is important that their use: *"is accompanied by rigorous auditing of the projects funded as a result. Moreover, the public should not be encouraged to think that offsetting implied that growth in aviation emissions was environmentally tenable" (*HoCEAC, 2006, p61). The issue of developing an 'air dependent culture' is discussed further in Chapter 4.
- *Knock-on effects from restricting aviation:* This report does not consider how the aviation industry might react if aviation in the UK is discouraged – for example, would there be a significant sale of planes to other countries at a lower cost which would stimulate flying elsewhere? Equally, if second home ownership abroad became less attractive, there would probably be increasing demand for second homes in the UK. These issues have not been addressed, partly because of the timeframe of the study, and partly because they do not seem to pose insuperable problems. However, if a strategy of aviation restraint were introduced, a strategic approach would also need to be developed to address follow-on issues of this nature.
- *Terrorism and related security issues:* The terror attacks on September 11th 2001, and the events and procedures following the August 2006 security concerns, have had, and will have, a significant effect on the demand for air travel. In section 5.7, the events in 2001 are considered, in relation to their impacts on tourist income. However, consideration of the overall effects of these events on aviation demand was beyond the scope of this report. As with increases in the price of fuel (discussed further in section 6.7), such happenings do not alter the need for a potential change in the strategic direction of UK aviation policy to meet climate change objectives, although the impacts of such events would need to be factored into implementing any strategy. As discussed in section 3.7, prior to the recent security alerts, passenger growth was thought to be back to pre-2001 levels, and a recent paper by Njegovan (2006b) argues that the effect of such shocks is usually short-term.

1.4 Structure of the report

The specific topics addressed in this report are:

- Collation and assessment of available evidence about the current and future significance of aviation emissions to climate change, and the potential for improvements in technology, company operations and air traffic management to offset aviation growth – see Chapter 2.
- A consideration of the characteristics of current and forecast air travel, including consideration of who flies, why they travel and where they go, and a brief discussion of air freight – see Chapter 3.
- A discussion about whether the UK should cater for growing demand for air travel, or whether, instead, it should adopt a strategy of demand restraint, including arguments about why trips are unlikely to readily migrate to other parts of Europe, the difficulties of trying to build 'enough' capacity to avoid congestion and the benefits of immediate action for avoiding the development of 'air dependent' lifestyles – see Chapter 4.
- A discussion about whether aviation growth should be supported for the sake of the economy, including consideration of the relationship between aviation and GDP, the fairness of current taxation policy, the cost benefit analyses undertaken by the Department for Transport to support the Aviation White Paper, the significance of aviation jobs, the importance of flying to business, the impacts of flying on UK tourism and the impacts of aviation on other travel industries – see Chapter 5.
- A consideration of whether economic mechanisms, that increase the cost of air travel, have the potential to affect passenger demand, and the scale of price rises that might be needed to achieve behavioural change – see Chapter 6.
- A summary of existing public opinion surveys that give some indications about whether the public would support a rise in the cost of flying on environmental grounds – see Chapter 7.
- A summary of the plans for including aviation in the European Union's Emissions Trading Scheme, the anticipated impacts, and the apparent consequent need for additional measures – see Chapter 8.
- A brief assessment of some of the other economic policy options for addressing aviation, including taxation of aviation fuel, emissions charging, VAT on air tickets, air passenger duty, ending duty free, introducing airport slot auctions and raising airport landing charges – see Chapter 9.
- Recommendations for future research – see Chapter 10.
- Summary and conclusions – see Chapter 11.

What is Aviation's Contribution to Climate Change?

2.1 Introduction

There is increasing recognition that aviation is a cause for concern in terms of its impact on climate. Yet, due to political difficulties in agreeing responsibilities, the emissions from international aviation (together with international shipping) were excluded from the Kyoto Protocol, and all related assessments. There is also a lack of clarity about how 'bad' aviation is. This is because, in addition to emitting carbon dioxide, aviation emits a range of other substances which add significantly to its climate impacts, but whose significance is difficult to quantify. Moreover, *global* estimates for aviation's impacts significantly underestimate the scale of the problem for the UK, given that a disproportionate share of international flights arrive or leave from UK airports.

This chapter provides a brief review of existing estimates of the scale of aviation's impacts. It considers the relative contribution of aviation to the UK's emissions of carbon dioxide, and a number of forecasts which suggest that aviation will increasingly dominate the UK's carbon dioxide emissions unless there are significant steps to curb its impacts. It discusses the impacts of aviation's other emissions. It examines the likely scale of emission reductions possible through improvements in technology and operations, including changes in air traffic management. Finally, it summarises the overall implications of the existing evidence base.

2.2 Existing statistics about the scale of aviation's contribution to climate change

There are various existing statistics about the scale of aviation's impacts. There are two widely quoted figures, which suggest its contribution is relatively small, as outlined below.

- First, in a special report on 'Aviation and the Global Atmosphere' published in 1999, the Intergovernmental Panel on Climate Change calculated: *"the best estimate of the radiative forcing in 1992 by aircraft is ... about 3.5% of the total radiative forcing by all anthropogenic activities"* (IPCC, 1999, p8). This implies that aviation is responsible for a relatively small percentage of climate change. However, it should be noted that this figure was a global average. As outlined in Chapter 1, the UK accounts for a much bigger share of aviation than its population would imply, meaning that this figure is an under-estimate of the contribution of aviation to the *UK's* impacts on climate.
- Second, in 2003, the UK Government produced a new Energy White Paper, which looked at carbon emissions in considerable detail. This concluded: *"The transport sector, including aviation, produces about one quarter of the UK's total carbon emissions. Road transport contributes 85% of this, with passenger cars accounting for around half of all carbon emitted by the transport sector"* (DTI, 2003, p63). By implication, therefore, this analysis suggests that rail, aviation and shipping together account for less than 4% of the UK's total carbon emissions; that they are far less important than road transport; and that they are only a small part of the problem. However, although not explicitly stated in the White Paper, the emissions from international aviation were excluded from these calculations because they are not covered by Kyoto requirements. This lack of clarity has resulted in aviation often being dismissed as an insignificant contributor to the UK's climate impacts.

In contrast, there have been several recent estimates which include the impacts of international flights and which suggest that aviation's impacts are much more important than these previous estimates imply. Although the method of calculating these estimates is controversial, they indicate that aviation needs serious consideration as a potentially major part of the UK's climate change problem.

- The latest White Paper on 'The Future of Transport' (DfT, 2004b) states: *"If UK aviation is defined as all domestic services plus all international departures from the UK, then the aviation sector currently contributes about 5.5 per cent of the UK's* CO_2 *emissions but, because of radiative forcing, 11 per cent of total UK climate change impact."*
- A recent book by Hillman and Fawcett (2004, p148) suggests that, for the average UK household, air travel currently accounts for approximately 34% of the climate change caused by *direct* household

energy use (defined as being use of gas, electricity, heating oil and transport). Their calculations also suggest that, for the UK, air travel is now causing greater climate damage than car travel.

2.3 Carbon dioxide emissions from aviation and how they relate to UK targets

2.3.1 Introduction

Unlike the other emissions from aviation, the effects of carbon dioxide are independent of the location or conditions in which emissions take place, meaning that carbon dioxide from aviation can be relatively readily compared with carbon dioxide emissions from other activities. In addition, carbon dioxide is a relatively long-lived gas, making it particularly important when considering the impacts that aviation will have in the long term.

This section examines current and forecast emissions of carbon dioxide from aviation, and how these compare with the Government's targets for CO_2 reduction, as given in the 2003 Energy White Paper. As highlighted in Chapter 1, the overall aim is for the UK to achieve a 60% reduction in carbon emissions from 1990 levels by 2050, such that it emits only 65MtC p.a. by 2050 from all activities[6], with an aim of making '*real progress*' by 2020. The latest Energy Review clarifies that this is a target for 110–120MtC by 2020, (DTI, 2006). As expressed in the 2003 Energy White Paper, the 65MtC goal excludes consideration of international aviation emissions. However, given its derivation, these emissions should be included in the total. (As outlined in Chapter 1, the figure of 65MtC is derived from the per capita emissions needed to stabilise emissions at 550ppm). Emissions from domestic aviation are already officially included within the 65MtC figure.

2.3.2 Department for Transport forecasts of aviation emissions

There are various sources of emissions data for aviation. Initially, the data used in relation to the 2003 Aviation White Paper is examined (since the primary purpose of this report is to explore how Government policy on aviation relates to Government policy on climate change). These data were published in a supporting document to the Aviation White Paper called 'Aviation and global warming' (DfT, 2004a). There are some discrepancies in this paper, and these have been clarified through correspondence with the Department for Transport (DfT, 2006b)[7]. The data given in Table 2.1 are for emissions from domestic flights, international passenger departures and air freight traffic movements but exclude the emissions from surface access transport.

Table 2.1 Carbon emissions from aviation, current and future (MtC)

	Emissions from aviation (mid-range forecast)
1990	4.6
2000	8.8
2010	10.8
2020	14.9
2030	17.7
2040	18.2
2050	17.4

Source: Data given in DfT 2004a, in support of the Aviation White Paper[8]

This four-fold increase is the Department's mid-range emissions forecast, which allows for significant improvements in aircraft efficiency and air traffic management. Their high-range forecast (which excludes improvements in aircraft efficiency) suggests that aviation emissions would grow to 29.1 MtC by 2050, which would represent a more than six-fold increase from 1990 emissions levels. (There is also a low-range forecast, which incorporates the effects of 'economic instruments'. However, that is not considered here, since the potential role of economic instruments is considered in later parts of this report.)

If the mid-range forecast of 17.4MtC were realised, aviation would then constitute about 27% of the UK's target emissions of 65MtC for 2050.

Meanwhile, DTI (2004) provides information about the emissions from all other sectors. Excluding the emissions from domestic aviation implies that, in 1990, total emissions from all other UK activities were about 164.8MtC, reducing to 152.2 MtC in 2000.[9]

The conclusions from the analysis described above are as follows:

- The emissions from aviation approximately doubled between 1990 and 2000 (whilst emissions from other activities fell by about 9%). Aviation currently accounts for about 5.5% of the UK's total emissions of carbon dioxide.

- Without the application of 'economic instruments', the emissions from aviation are forecast to at least double again between 2000 and 2050, meaning that they will quadruple during a period in which overall UK emissions are aiming to reduce by 60%.
- By 2050, other sectors would have to reduce their emissions by even more than forecast – specifically, by about 71% – in order to compensate for the growth in aviation.

Since the Aviation White Paper estimates were published, there have been two further studies which have estimated the future scale of carbon dioxide emissions from aviation.

2.3.3 Work by Owen and Lee

The most recent study has been undertaken for the UK Department for Environment, Food and Rural Affairs (DEFRA) by Owen and Lee (2006a) from the Centre for Air Transport and the Environment, Manchester Metropolitan University. Their work uses an extremely detailed model of air fleet characteristics (the FAST model) to examine the impacts of different aviation growth scenarios. Up to 2020, they used a forecast of revenue passenger kilometres produced by the International Civil Aviation Organisation's Forecasting and Economic Support Group for the sixth quadrennial meeting of ICAO's Committee on Aviation Environmental Protection. From 2020 onwards, two different forecasts were developed, based on updated versions of scenarios used by the Intergovernmental Panel on Climate Change. The study involved converting these forecasts of passenger demand into global emissions, using the FAST model, and then using different methods for allocating emissions to different countries. Data were adjusted to include emissions caused by airfreight traffic. Owen and Lee highlight that non-scheduled traffic is excluded from their forecasts, meaning that the figures are *underestimates* of total emissions. (The Green Skies Alliance, 2006, suggests that the exclusion of charter flights means that the emissions estimates are underestimating the true amount of CO_2 by 25–30%. Other estimates suggest that the exclusion of charter flights could be resulting in an underestimation of 10–20%[10]).

For the UK, Owen and Lee's results are shown in table 2.2.

Table 2.2 Carbon emissions from aviation, current and future – scheduled traffic only (MtC)

	Domestic aviation	*International aviation*	*Total*
2010	0.85	7.8	8.7
2020	1.23	12.1	13.3
2030	1.5–1.8	16.9–20.5	18.4–22.3
2040	2.1–2.5	24.8–28.9	26.9–31.4
2050	2.3–3.4	27.5–41.0	29.8–44.4

Note: Data have been converted from $GgCO_2$ to MtC, and are taken from Table 13, p30, Owen and Lee, 2006a. Data are from the calculations relating to allocation option 6, where emissions are allocated according to the country of departure or destination of passengers or cargo – since this is the most directly comparable allocation method to that considered in the Aviation White Paper. Owen and Lee highlight that most of the different allocation methodologies under consideration by the UNFCCC would produce remarkably similar results for the UK[11].

The differences between these figures and the DfT forecasts are discussed in section 2.6.

On the basis of these figures, Owen and Lee conclude: *"In terms of the UK CO_2 budget in 2050, the contribution of aviation emissions represented approximately 43% of the UK's targeted emissions according to FAST-B2 and 65% according to FAST-A1, if international aviation emissions are included."* (FAST-B2 and FAST-A1 are the names for the two scenarios considered)[12].

If, in 2050, between 29.8MtC and 44.4MtC of the target 65MtC came from aviation, this means that other activities would need to reduce their emissions by between 79% and 87% rather than 60% (assuming 1990 emissions of 164.8MtC from non-aviation UK activities, as reported in section 2.3.2). The 44.4MtC represents nearly a ten-fold increase over the 4.6MtC emissions in 1990 (Table 2.1).

2.3.4 Work by the Tyndall Centre for Climate Change Research

The third relevant report is by the Tyndall Centre for Climate Change Research (2005)[13]. This research involved exploring how the UK could meet its target of a 60% reduction in carbon emissions by 2050. In relation to aviation, the scenario was based on assumptions about future passenger growth rates and fuel efficiency improvements. It suggested that aviation could generate the emissions of carbon set out in Table 2.3.

Table 2.3 Future carbon emissions from aviation (MtC)

	Emissions from aviation
2010	12.1
2020	17.3
2030	21.3
2040	26.2
2050	32.3

Source: Data provided by Bows (2006)

The researchers therefore concluded that permitting aviation growth in the context of the UK's objective to limit carbon emissions to try to stabilise at an atmospheric concentration of 550ppm CO_2 could mean 50% of UK emissions were caused by aviation by 2050. Their result is a similar order of magnitude to the lower estimation by Owen and Lee, and the high range forecast of the Department for Transport.

Moreover, the Tyndall Centre report concluded that *"if the UK Government follows the scientific consensus that a 450ppm stabilisation level is required, then the aviation sector would exceed the carbon target for all sectors by 2050"*.

2.3.5 Summary

In brief, then, a summary of the three sets of data is shown in Table 2.4.

Table 2.4 Future emissions of CO_2 from aviation(MtC)

Emissions from aviation	*Aviation White Paper (mid range forecast)*	*Owen and Lee (scheduled traffic only)**	*Tyndall Centre scenario*
2010	10.8	8.7	12.1
2020	14.9	13.3	17.3
2030	17.7	18.4–22.3	21.3
2040	18.2	26.9–31.4	26.3
2050	17.4	29.4–44.4	32.3

* Figures are therefore under-estimates.

These data suggest the following:

- By 2020, aviation CO_2 emissions will increase to between 13.3MtC and 17.3MtC. An increase of about 15MtC (the Department for Transport's forecast) would mean that, if other sectors meet their targets, aviation emissions would constitute 11–12% of all emissions from UK activities by 2020[14], which would be approximately double their relative contribution in 2000. By 2030, all forecasts suggest that the emissions from aviation will more than double in absolute terms, compared with the 2000 level of 8.8MtC reported by the Department for Transport. Since other sectors are aiming for a further reduction in emissions over that period, the relative contribution of aviation emissions would also increase.
- By 2050, estimates of aviation's CO_2 emissions range from 17.4MtC to more than 44MtC. This would mean that aviation emissions increased by between 4 and 10 times by 2050 compared to the 1990 level of 4.6MtC reported by the Department for Transport. Moreover, the Government target is that all UK emissions should equal 65MtC. Hence, aviation could account for between 27% and 67% of all UK target emissions by that point, requiring other sectors to cut their emissions by between about 71% and 87% of 1990 levels.

There are clearly some significant differences in these estimates, which partly derive from their assumptions about future aviation growth rates, improvements in technological efficiency and improvements in air traffic management. Section 2.5 explores the potential for fuel efficiency gains and improvements in air traffic management in more detail, whilst section 2.6 explores how far the forecasts described above take these issues into account. Notably, all estimates have been chosen for consideration *because* they assume that improvements in technology, operations and air traffic management will occur – and yet they all imply that carbon dioxide from aviation will grow significantly in absolute terms; that it is likely to become an increasingly significant part of the overall carbon dioxide emitted by UK activities; and that compensatory reductions in other sectors will be needed, over and above those already envisaged, in order to meet Government targets.

Moreover, these are just the estimates of aviation's CO_2 impacts. As already mentioned, aviation emits a range of other substances whose impacts on the climate are potentially very powerful. These are discussed in the next section.

2.4 Non-CO_2 emissions from aviation

As well as carbon dioxide, the combustion of kerosene also emits:

- Nitric oxide and nitrogen dioxide, together termed NOx (which form ozone, a greenhouse gas, at altitude);
- Particulates (soot and sulphate particles);
- Water vapour (which leads to the formation of contrails and cirrus clouds at altitude); and
- Other compounds including sulphur oxides, carbon monoxide, hydrocarbons and radicals such as hydroxyl.

The combined effect of these other emissions is to add significantly to the climate change impacts of aviation, over and above those caused by its CO_2 emissions alone. The fact that aviation's climate impacts are 'significantly worse' than those caused by its carbon dioxide emissions is scientifically *uncontroversial*. However, putting a precise value on 'significantly worse' is problematic for various reasons, as follows:

- Unlike the situation for CO_2, the effect of some emissions from aviation varies at different altitudes, and in different climatic conditions. (This is particularly true for the impacts of NOx and water vapour). The role of aviation in the formation of cirrus clouds is particularly difficult to predict and model.
- Some emissions play a complex role in atmospheric chemistry. For example, the NOx emissions from aircraft can indirectly result in the destruction of ambient methane (a greenhouse gas present from other sources), although NOx also forms ozone, a different greenhouse gas, and the balance between these two processes changes over time[15].
- The impacts of different emissions last, in the atmosphere, for different lengths of time. Whilst CO_2 has a lifetime in the atmosphere in the order of 100 years or more, contrails and cirrus clouds have a much shorter lifetime in the atmosphere, such that their direct radiative forcing effect is removed more quickly, although their impacts on temperature may dissipate less quickly because of the complexity of the coupled ocean-atmosphere system.

As a way of assessing the overall impacts of aviation, the Intergovernmental Panel on Climate Change's Special Report on 'Aviation and the Global Atmosphere' (IPCC, 1999) used the climate metric 'radiative forcing of climate', which is a globally averaged measure of the imbalance in radiation caused by the addition of an activity or emission.

Radiative forcing is seen as a useful measure since models have shown that it is approximately proportional to the change in globally averaged surface temperatures (RCEP, 2002, p14).

For 1992, the IPCC estimated the change in radiative forcing caused by the build-up of CO_2 in the atmosphere from aviation since the start of the aviation era to 1992[16], and, in addition, the change in radiative forcing caused by the other outputs from aviation emitted in 1992.

The IPCC calculated that, by 1992, the total radiative forcing caused by aviation was approximately 2.7 times that of the forcing caused by its CO_2 emissions alone (IPCC, 1999, p188). 2.7 was defined as being the 'radiative forcing index' (RFI) for aviation CO_2[17].

In addition to their calculation for 1992, the IPCC looked at a range of scenarios for aviation up to the year 2050. Their overall conclusion (p8) was that: *"over the period from 1992 to 2050, the overall radiative forcing by aircraft (excluding that from changes in cirrus clouds) for all scenarios in this report is a factor of 2 to 4 larger than the forcing by aircraft carbon dioxide alone. The overall radiative forcing for the sum of all human activities is estimated to be at most a factor of 1.5 larger than that of carbon dioxide alone."*

Since their report, there have been a number of other studies examining the radiative forcing caused by aviation, of which the most significant is the EU TRADEOFF project (Sausen et al, 2005). This has broadly endorsed the 2–4 multiplier suggested by the IPCC findings, although specific calculations for 2000, based on improved understanding of the impacts of aviation emissions, suggest that, in 2000, the radiative forcing index may have been as low as 1.9. However, the effects of cirrus clouds were again excluded, and these are now thought to have a bigger impact on the climate than previously. The EU QUANTIFY project will aim to provide better understanding about the effects of aviation-induced contrail and cirrus cloud formation and its significance for climate change.

More details of the IPCC and TRADEOFF calculations are given in Appendix A.

Although the IPCC's calculations are accepted as robust, there are growing concerns about the way that other people are now applying the RFI multiplier and its use as a means of estimating the future impact of non- CO_2 emissions from aviation. This is partly because it was developed as a means of assessing the impacts to date from historic emissions, rather than as a way of assessing future impacts. More details of these concerns are given in Appendix A. Consequently, there is increasing interest in developing an alternative metric, based on global warming potential (GWP) or global temperature change potential (GTP). However, neither of these measures is considered sufficiently fully developed or, in the case of GTP, tested in relation to non-CO_2 aviation emissions to be used reliably at present.

Moreover, any such metric would have to be used in relation to a specific time frame, as highlighted by Forster et al (2006). As an illustrative example of this, Forster et al have estimated how the CO_2, NOx and contrails generated by aviation activity in 2000 will affect the climate over time. For the year 2000 *alone*, the calculations suggest that the overall effect of those emissions is 36 times greater than those of the CO_2 emissions. However, because of their different lifespans, over a 20 year time frame, the effects of all emissions would only be 3.7 times greater than the CO_2 emissions, whilst over a 100 year time frame, the effects would be 1.7 times greater[18].

This raises the question of the most appropriate time frame to be considered. It also highlights the importance of the policy question under consideration. For example, the use of a GWP-based multiplier might be used to answer the question – what is the relative benefit of removing a tonne of CO_2 from aviation as compared with a tonne of CO_2 from a power station? If interested in a different question – e.g. how much warming will aviation cause between now and 2050 if emissions are allowed to grow unchecked – a considerably greater multiplier might be appropriate, since the effects of non-CO_2 emissions in any one year will be topped up by fresh emissions in subsequent years, and it would be important to take this 'combined' effect into account.

In brief, then, studies of the emissions from aviation all indicate that its climate impacts are considerably worse than the effects of its CO_2 emissions alone. Moreover, the non-CO_2 emissions have a powerful short-term impact on climate. This could be particularly important, given the urgent imperative to address climate change in the short-term to avoid runaway climate change, as outlined in Chapter 1. However, using a specific multiplier to assess the combined effects of all aviation emissions is currently problematic.

2.5 Reducing aviation emissions without demand restraint

2.5.1 Introduction

There are three ways in which emissions from aircraft could be reduced without affecting the number of flights taken. These are:

- Improvements in air traffic management
- Other improvements in operational efficiency, and
- Improvements in technological efficiency.

Improvements in air traffic management are discussed in section 2.5.2.

Other improvements in operational procedures are often included within discussions about improving technological efficiency. Hence, these are discussed together in section 2.5.3. The IPCC (1999, p11) clarifies that these operational measures include increasing load factors (carrying more passengers per aircraft), eliminating non-essential weight, optimising aircraft speed, limiting the use of auxilliary power (e.g. for heating and ventilation) and reducing taxiing. Notably, the IPCC dealt with these 'operational procedures' as a self-contained topic and estimated that the potential scale of emissions reductions from such measures was relatively small (2–6%). Technology options are defined as improvements in airframe and engine design, and the possible use of alternative fuels.

Meanwhile, the International Civil Aviation Organisation has produced guidance entitled 'Operational Opportunities to Minimise Fuel Use and Reduce Emissions' which looks at the possibilities for reducing emissions from existing aircraft via both air traffic management and other improvements in operational efficiency (ICAO, Feb 2004). This guidance takes the IPCC estimates as an appropriate guide to the scale of potential savings.

The potential emissions reductions outlined in sections 2.5.2 and 2.5.3 are then followed by a discussion in section 2.6 that considers how far these improvements could offset the growing emissions from aviation envisaged in section 2.3.

2.5.2 Air traffic management

There are two ways in which air traffic management could help to ameliorate the climate impacts of aviation. The first is to reduce inefficiency in current flight patterns. The second is to encourage flight patterns which take account of prevailing atmospheric conditions in order to minimise the impacts of the non-CO_2 emissions from aviation.

Inefficiencies in flight patterns occur due to airspace structures and current management practices as well as the more local phenomenon of planes being 'held' above airports due to airport congestion. The volume of carbon dioxide emitted by planes is directly related to fuel used, and therefore reduces as flight patterns become more efficient. According to Williams et al (2006), in Europe, Air Traffic Control sectors have boundaries aligned according to national borders, with each nation taking sovereign responsibility for its airspace. As a result, flight routing is often complex and inefficient. Since 1990, the European Organisation for the Safety of Air Navigation (EUROCONTROL) has been attempting to address these issues. Rationalisation of airspace structural difficulties is also one of the aims of the Single European Sky initiative of the European Commission, which came into force on the 20 April 2004. This is supported by the Single European Sky Air Traffic Management Research Programme (SESAR) which seeks to address the issues for Europe's air traffic system.

Since work in this area began, there have been some reductions in vehicle delays and improvements in efficiency via the introduction of RVSM (reduced vertical separation minima) – i.e. reducing the vertical distances required between planes (ICAO, 2006). Efficiency gains from initiatives at individual centres are also possible in the near future. However, the main deployment phase for SESAR will not begin until 2014[19].

Overall, the IPCC Special Report on Aviation and the Global Atmosphere (1999) estimated that enhanced air traffic management had the potential to lead to a global saving of 6–12% of total fuel consumption, and this is consistent with the scale of savings expected from the EC Single European Sky initiative.

The second way in which aviation impacts could be offset by changes in air traffic management practices is by encouraging more 'environmentally friendly' routing and scheduling of planes. For example, a recent paper by Stuber et al (2006) highlights that the contrail effect from aircraft is significantly worse at night. (This is because, during the day, whilst contrails reflect radiation back to earth, increasing warming, they also reflect radiation from the sun back into space, reducing warming. At night, only the former effect takes place). Hence, Stuber et al recommend rescheduling air traffic from nighttime to daytime, to help minimise the climate impacts of aviation.

There is also a body of work exploring the potential to mitigate the effects of aviation based on similar principles (i.e. that flying in particular conditions can have a significant effect on the overall impacts of the flight), but based on considerably more sophisticated techniques. For example, for contrail mitigation, Williams et al (2006) have examined a range of scenarios for ensuring that aircraft avoid atmospheric regions in which contrails form. These could include defining a set of fixed monthly altitude restrictions; developing altitude restrictions which would apply every six hours; or incorporating real-time information on local atmospheric conditions to provide a much more targeted approach to adjustments in cruise altitude.

Whilst such techniques may form part of a long-term solution to the environmental impacts of aviation, it is clear that they could increase the amount of carbon dioxide used, since routes avoiding regions of contrail formation could be longer. More sophisticated scenarios, which enable aircraft to minimise diversions based on immediate data, create increasingly complex problems for airspace management.

In short, then, changes in air traffic management could lead to some increases in efficiency, estimated to be in the order of 6% to 12%. Moreover, over time, better understanding of the relative importance of the different emissions from aviation, combined with more sophisticated air traffic management techniques, could help to ensure that an appropriate balance is struck between minimising carbon dioxide emissions, and minimising the impacts of other aviation emissions. Such measures are all likely to be important in minimising the climate impacts of aviation emissions. However, they are also all likely to be relatively long term solutions, and the scale of potential savings is limited. These issues are discussed further in section 2.6.

2.5.3 Improvements in technological and operational efficiency

In June 2005, the UK aviation industry produced a document called 'Sustainable Aviation' (AOA, BATA, SBAC and NATS, 2005). This made a commitment to: *"improve fuel efficiency by 50% per seat kilometre including up to 10% from air traffic management efficiencies and reduce NOx emissions by 80% by 2020 based on new aircraft of 2020 relative to equivalent new aircraft in 2000."* The targets were adopted from targets set by ACARE, the Advisory Council for Aeronautics Research in Europe.

Prior to this strategy document, 'Greener by Design' had been formed, a coalition of industry and Government. Its work has included reviewing the possibilities for mitigating the effects of aviation via improvements in technology and operations. In terms of potential fuel efficiency improvements, the Greener by Design website gives less optimistic projections, stating: *"Fuel efficiency improved by 70% between 1960 and 2000... Improvements of an additional 20% are projected by 2015, and 40–50% by 2050 relative to today's aircraft"*[20]. This is consistent with the estimate of the Intergovernment Panel on Climate Change in 1999 for the improvements possible through technological development[21].

Greener By Design also highlights a debate as to whether significant reductions in non-CO_2 emissions are possible at the same time as a reduction in CO_2. In a recent report from Greener by Design's Science and Technology Sub-Group, the group states that, in the short term, improvements in engine design could substantially reduce emissions of NOx, and, further, combined reductions of both CO_2 and NOx emissions could be achieved by advances in airframe and propulsion (although these would currently result in increases in noise). However, the same report notes that the obvious routes for further reductions of non-CO_2 emissions are, unfortunately, likely to increase CO_2. Specifically, for example, it states: *"NOx emissions can be reduced by reducing engine pressure ratio, and ozone generation by NOx might be reduced by optimising designs to cruise at lower altitudes. [However] in both cases, the result is likely to be an increase in fuel burn, CO_2 emissions and operating cost. Contrail and cirrus cloud formation and ozone creation might also be reduced by operational measures, but at the expense of an increase in fuel burn"* (Greener by Design, 2005).

In a special report on aviation in 2002, the Royal Commission on Environmental Pollution (RCEP) reviewed both the ACARE and IPCC estimates for reductions in aircraft emissions through improvements in fuel efficiency. It argued that all industry forecasts of technological improvement were not necessarily realistic in the timescales envisaged, concluding: *"the ambitious targets for technological improvement in some industry announcements are clearly aspirations rather than projections."*

It argued that, while there are considerable opportunities for *incremental* improvements in the environmental performance of individual aircraft, these will not offset the effects of the growth in aviation. Moreover, whilst a non-incremental change could result from radically new airframe designs, these were not expected to affect the industry for decades and even then, would only apply to large long-haul aircraft.

The prospects for changing to hydrogen, as an alternative aircraft fuel, were considered poor, and the benefits unclear. This is partly because the fuel would require larger aircraft design, and would produce additional water vapour at high altitudes with the consequence of increased climate impact. The IPCC has also highlighted that the introduction of hydrogen as a fuel source is not a short-term option, stating: *"there would not appear to be any practical alternatives to kerosene-based fuels for commercial jet aircraft for the next several decades"* (IPCC, 1999, p10).

In addition to the RCEP's concerns about the reliability of future forecasts for fuel efficiency improvements in the aviation industry, some critics have questioned claims about past improvements. Specifically, in December 2005, the European Federation for Transport and Environment reported on research undertaken by the Dutch National Aerospace Laboratory, which suggests that efficiency claims made by the aviation industry have been "*at best exaggerated, and at worse, have not happened at all*" (T&E, 2005). This study, by Peeters et al (2005), argued:

- The claim for a 70% improvement in fuel efficiency between 1960 and 2000 ignored the previous generation of piston-powered aircraft, which were as efficient, per seat kilometre, as an average modern jet aircraft. In addition, the reference jet aircraft used for 1960 (the DH Comet 4) was a little used model, with atypically poor energy efficiency, meaning that even claims about the improvements in the efficiency of jet aircraft are overstated.
- The rate of efficiency gains made in jet aircraft performance is slowing considerably, meaning *"many studies on predicted future gains are rather optimistic".*

In brief, then, industry aims to improve the efficiency of aircraft are clearly laudable and are likely to bring benefits. There is a general estimate for a 40–50% improvement in fuel efficiency by 2050. However, this may be a significant over-estimate of what is possible and may mean an increase in non-CO_2 emissions.

2.6 Comparing future forecasts of carbon dioxide emissions from aviation

Section 2.5 highlights that the carbon dioxide emissions from aviation can be reduced, to an extent, by better air traffic management and improvements in aircraft operations and efficiency. In particular, if all potential gains are realised, the largest achievable reductions are likely to be that better air traffic management could reduce emissions by 6–12% and that aircraft could be 40–50% more fuel efficient than existing aircraft by 2050. As already highlighted, there are concerns that such aspirations are over-optimistic. However, if they are achieved, a key issue is whether such improvements will be sufficient to offset the forecast growth in aviation.

Table 2.5 Changes in efficiency assumed in the studies described in section 2.3

Department for Transport (2004a)	A fuel efficiency improvement of 50% was envisaged between 2000 and 2050, taken to comprise a 15% fuel efficiency improvement between 2000 and 2030, with a further 25% savings occurring between 2030 and 2050, and the remaining 10% savings arising from the assumption that all aircraft fly the shortest routes (i.e. that air traffic management is optimised).
Owen and Lee (2006a)	Between 2005 and 2050, an overall fuel efficiency improvement of 15% was assumed to occur, derived from detailed assumptions about changes in air fleet mix, passenger loading and improvements in air traffic management, drawn from a number of different studies[22].
Tyndall Centre for Climate Change Research (2005)	An incremental improvement in overall fuel burn for a typical journey of 1.2% a year was assumed, which equates to an improvement in fuel efficiency of about 43% over the scenario period (2002 to 2050).[23]

Table 2.6 Predicted growth rates for aviation used in the studies described in section 2.3

Department for Transport (2004a)	As outlined in para 3.55 (DfT, 2004a), the Department for Transport central emissions forecasts are based on a rise in passenger movements from 180 million in 2000, to 379 million in 2020, 480 million in 2030 and 670 million by 2050. This would equate to a growth of 272% between 2000 and 2050[24].
Owen and Lee (2006a)	Growth rates were taken from forecasts developed by ICAO and the IPCC. The study implies UK growth from 170.7billion revenue passenger kilometres in 2005 to between 901.4 and 1,341.1 billion revenue passenger kilometres in 2050, representing a growth of between 428% and 686%[25].
Tyndall Centre for Climate Change Research (2005)	The scenario examined the effects if passenger kilometres by air grew by 6.4% p.a. between 2002 and 2015, and by 3.3% between 2015 and 2050[26]. This would mean an index of passenger kilometres increasing from 100 to 697, a growth of 597% between 2002 and 2050.

Section 2.3 outlined three different forecasts of future aviation emissions. However, all three of these estimates already include assumptions about improvements in technology, air traffic management and other operational procedures. The assumptions used are set out in Table 2.5. A further issue is the expected growth in future air travel, since overall emissions will also be determined by the volume of air travel. The assumptions used by the forecasts for future aviation growth are set out in Table 2.6.

Comparing these forecasts highlights that the Department for Transport mid-range forecasts use assumptions about gains in fuel efficiency and improvements in air traffic management which are in line with the most optimistic industry targets. In addition, they use remarkably modest growth rates compared to those of the other two studies. This is a major cause for concern since it suggests that the mid-range emissions forecasts given in the Aviation White Paper are likely to be underestimates of the potential scale of the climate change impacts from aviation in the future. However, even using these assumptions, these forecasts are still suggesting that the CO_2 emissions from aviation will quadruple from 1990 levels by 2050. Meanwhile, even though the other studies do incorporate assumptions about improvements in fuel efficiency and air traffic management – and have aimed to include realistic assumptions – they are suggesting that a considerably greater increase in emissions is possible.

2.7 Summary

The evidence reviewed in this chapter suggests the following:

- The carbon dioxide from UK aviation approximately doubled between 1990 and 2000. In contrast, the carbon dioxide emissions from other UK activities reduced by about 9% over the same period. Aviation already accounts for about 6% of the UK's carbon dioxide emissions and a significantly greater proportion of its overall climate change impacts.
- Between 2000 and 2030, aviation CO_2 emissions are forecast to more than double again, in both absolute and relative terms, if other sectors meet their targets. Other sectors are aiming for a substantial reduction in emissions over the same period
- By 2050, the most conservative estimate of aviation's future significance, which uses optimistic forecasts of improvements in fuel efficiency and air traffic management and relatively modest growth rates, suggests that, between 1990 and 2050, the carbon dioxide emissions from aviation will approximately quadruple. Other forecasts suggest that the carbon dioxide from aviation could grow by more than 10 times over that period. Meanwhile, other UK activities are aiming to reduce their carbon dioxide emissions by 60%. To offset the carbon dioxide emitted by aviation, other sectors would need to reduce their emissions by 71%–87% instead of 60% by 2050 from 1990 levels.
- In addition to carbon dioxide, aviation emits other substances which have a range of additional climate impacts. One estimate suggests that, *in a period of 12 months*, the damage caused by CO_2, contrails and NOx emissions from aviation is 36 times as bad as that caused by the CO_2 alone. Finding a robust way of allowing for the damage caused by different emissions is problematic, given that the impacts last for different time periods, are of different strengths and are determined by prevailing atmospheric conditions. However, there is no doubt that the non-CO_2 emissions from aviation add significantly to the climate impacts of aviation, and have a particularly powerful short-term effect.
- Air traffic management offers some potential for reducing aviation emissions, although significant improvements to the management of European airspace are not expected to begin until 2014, and the range of likely impacts would only be to reduce carbon dioxide emissions by 6–12% relative to their current level. Whilst some of the other effects of aviation (such as contrail formation) could be mitigated by alternative air traffic management practices, such gains could be at the expense of an increase in carbon dioxide emissions.

- Improvements in fuel efficiency are expected to be incremental, and there is no significant alternative to kerosene envisaged for the foreseeable future. Many believe that industry estimates of potential improvements in fuel efficiency are over-optimistic.

In brief, the carbon dioxide emissions from aviation are forecast to reach between 17.4 million and 44.4 million tonnes of carbon, at a time when the UK is attempting to limit the carbon emissions of all its activities to only 65 million tonnes of carbon. In addition, the impacts of aviation will be significantly worse than those of its carbon dioxide emissions alone. Hence, the implication is that a significant reduction in the projected growth of aviation is required and it will be impossible to reduce the UK's climate change impacts to the extent needed to meet international aspirations unless action is taken to curb aviation growth.

Who Flies and What is Driving Aviation Growth?

3.1 Introduction

Chapter 2 has examined the contribution of aviation to the climate change impacts of UK activities. It highlights that all forecasts of future aviation emissions indicate that, if flying continues to grow unchecked, these will play an increasingly major role in the UK's climate impacts, and significantly offset gains made in other sectors. Hence, one of the central tenets of this paper is that demand restraint in the aviation sector is essential, if aspirations to stabilise the UK's contribution to climate change are to be met. In considering the role for demand restraint, it is important to understand the nature of air travel and air travel growth. This chapter provides a brief review of the available data. In particular, it indicates:

- Most of the current passenger demand for air travel is for leisure purposes, and the majority of growth has come from UK residents making increasing numbers of leisure trips abroad on no-frills carriers.
- The majority of passenger trips are to and from mainland Europe.
- Air travel is not a socially inclusive activity and most of the growth that is occurring is due to existing air travellers flying more.
- Future forecasts of air travel presume that UK leisure passengers will still constitute the largest share of air passengers.
- Future forecasts of air travel may be substantially under-estimating the scope for the sector to grow, unless there is some kind of intervention.
- Air freight has different characteristics to air passenger travel and requires separate consideration.

3.2 The composition of passenger travel

The Department for Transport produces a variety of analyses of passenger air travel, based on data from the Civil Aviation Authority[27], and the International Passenger Survey[28]. For the purposes of this project, a full breakdown of passenger travel has been sought, and kindly supplied by DfT and its contractors (DfT 2006a). The full data are given in Table 3.1.

Table 3.1 Composition of passenger trips at UK airports in 2004

	Passenger trips (in millions)	*Implied % of all passenger trips*
UK residents making an international trip for leisure purposes starting/finishing at a UK airport	89.3	46.4
UK residents making an international trip for business purposes starting/finishing at a UK airport	17.0	8.9
UK residents making a domestic journey in order to connect with an international flight (for leisure purposes)	3.0	1.6
UK residents making a domestic journey in order to connect with an international flight (for business purposes)	0.8	0.4
Foreign residents making an international trip for leisure purposes starting/finishing at a UK airport	24.7	12.9
Foreign residents making an international trip for business purposes starting/finishing at a UK airport	13.5	7.0
Foreign residents making a domestic journey in order to connect with an international flight (for leisure purposes)	1.1	0.6
Foreign residents making a domestic journey in order to connect with an international flight (for business purposes)	0.5	0.3
International passengers using a UK airport to transfer to another international flight	22.4	11.7
UK residents making a domestic air trip for business purposes	10.3	5.4
UK residents making a domestic air trip for leisure purposes	8.9	4.6
Total	191.5	100%

Note: Information supplied by DfT (2006a). It relates to inputs for the 2006 national air passenger forecasts. Figures refer to individual passenger trips – hence passengers taking a return flight are counted as two passenger trips. Return domestic flights are typically counted as four passenger movements in DfT forecasting, since each one-way trip involves a landing and take-off in the UK. In this table, figures for domestic passenger movements have therefore been halved, to give the number of one-way passenger trips. In 2004, there were about 216 million passenger movements in total, allowing for 4 domestic passenger movements per return flight. The terms 'foreign' resident and 'overseas' resident appear to be used interchangeably in the data sources.

These data can be amalgamated in various different ways. For example, Figure 3.1 shows that, in 2004, just over half of all air trips arriving or departing from UK airports were UK residents travelling for leisure purposes. 14% were overseas residents visiting for leisure purposes; 22% were for business purposes (with about a quarter of those – 5.4% – being business trips made by UK residents within the UK); and 12% were international passengers simply using the UK to connect with another international flight.

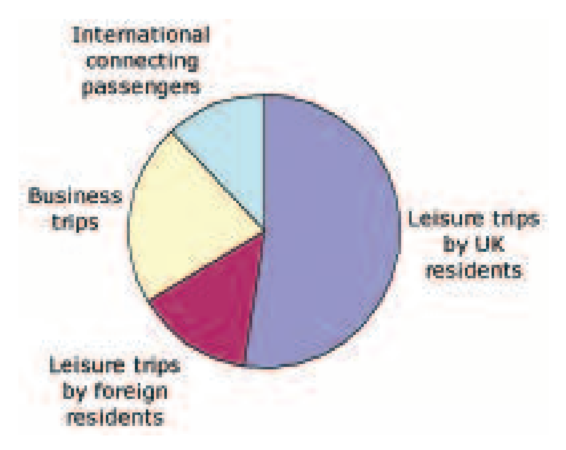


Figure 3.1 Breakdown of passenger trips through UK airports

Note: For the purposes of this graphic, passengers making a connecting flight have been classified by the journey purpose of their eventual flight. The exception is international passengers, connecting with another international flight, who have been categorised as 'international connecting passengers'.

Looking at alternative breakdowns of all passenger trips through UK airports:

- 67% are made by UK residents;
- 13% are made on flights within the UK;
- 75% of trips terminating in the UK are for leisure purposes;
- 15% of trips are connecting trips (of which 3% are made on domestic flights)

Interestingly, the categories of air travel which are commonly seen as the most economically valuable, namely international business flights and foreign leisure visitors, contitute only 29% of air trips. The economic contribution of aviation is discussed in detail in Chapter 5.

3.3 Growth in passenger travel by type of carrier and fares paid

As well as understanding the current composition of passenger air travel, it is also useful to understand where the growth in air travel has occurred. In Annex A of the 2003 Aviation White Paper, the Department for Transport provides a specific breakdown of where the growth in passenger travel has occurred, based on the type of carrier. This information is shown in Table 3.2.

Table 3.2 Changes in the number of passenger movements through UK airports (in millions)

	1998	*1999*	*2000*	*2001*	*2002*	*% change*
Domestic no-frills carriers	2.0	4.0	5.8	8.6	13.0	+550%
Other domestic	31.6	31.1	30.4	28.7	28.1	–11%
International no-frills carriers	5.7	8.7	12.4	15.8	22.4	+292%
Other international	118.2	123.4	129.9	126.6	124.2	+5.1%
Total*	159.1	168.5	180.1	181.3	189.1	+18.9%

*Total includes 'other' trips such as those by air taxi which are not included in the preceding rows. Figures are for passenger movements.
Source: DfT, 2003b, Annex A.

As shown in the table above, by far the majority of growth in air travel is occurring in the 'no-frills' sector[29], with 92% of the 30 million additional passenger movements occurring between 1998 and 2002 being new trips taking place on no-frills services.

In relation to a freedom of information request, on 24/4/06, the Department for Transport also released data on the average fares paid by UK passengers travelling from UK airports to overseas destinations (in constant 2004 prices), as shown in Figure 3.2.

Fares have fallen dramatically for all types of travel since the 1970s. For example, until 1986, the average fare paid by a UK passenger making a short haul leisure journey was over £150. In 2004, it was only £63. The fall in the cost of long-haul leisure trips has been even more dramatic, from approximately £600 in the

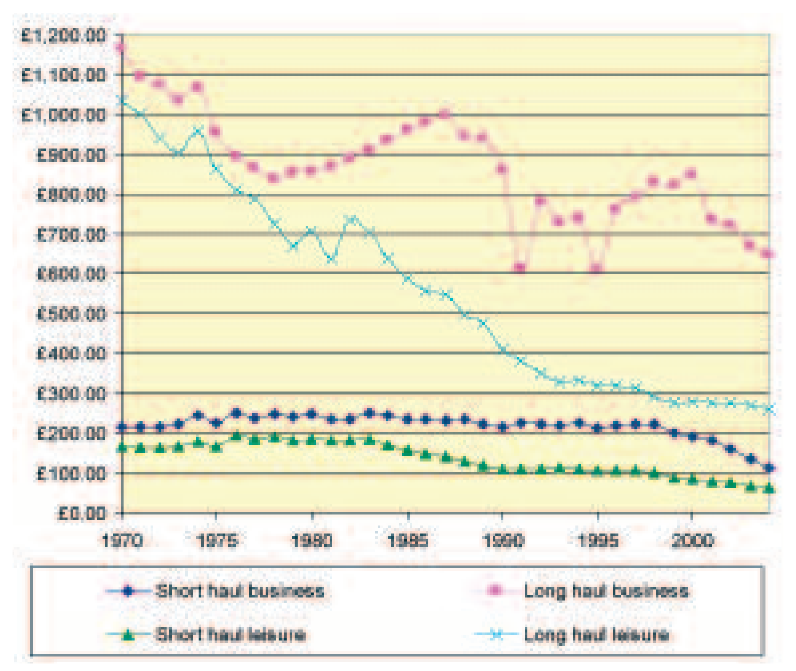


Figure 3.2 Fares paid by UK residents making international trips

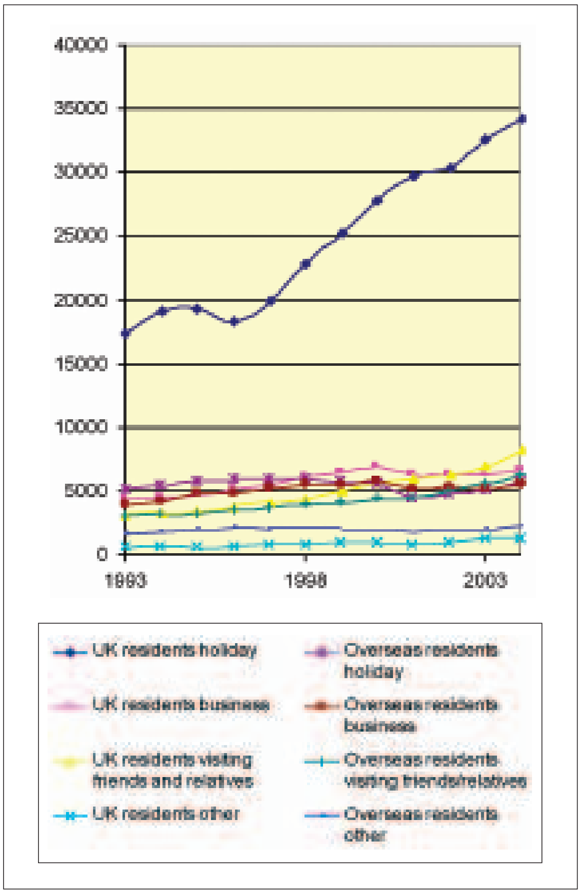
Data are in present value year 2004 prices, and are taken from http://www.dft.gov.uk/stellent/groups/dft_foi/documents/ divisionhomepage/611569.hcsp DfT (2006d) advises that fares paid for charter flights are excluded.

Table 3.3 Changes in international air trip purpose over time

Passenger trips (in '000s)	*1994*	*2004*
UK residents holiday	19,261	34,363
UK residents business	4,487	6,604
UK residents visiting friends and relatives	3,271	8,179
UK residents other	606	1,289
Overseas residents holiday	5,374	5,835
Overseas residents business	4,211	5,536
Overseas residents visiting friends/relatives	3,140	6,290
Overseas residents other	1,740	2,341
Total	42,090	70,437

Source: ONS (2006)

Figure 3.3 International passenger trips from UK airports, by trip purpose (in '000s)



Source: ONS (2006)

mid 1980s to £260 now. Moreover, a significant proportion of these reductions has occurred in the last few years. For example, in the five years between 1999 and 2004, short-haul leisure fares fell by over 25%. Fares paid for business travel have also fallen significantly.

These data provide corroboration of the previous finding – namely, that most of the growth in UK air travel has been on relatively cheap services, likely to have included both cheap flights on no-frills airlines, and cheaper tickets from more established operators. The implications of these fare reductions are discussed further in Chapter 6.

3.4 Growth in international passenger travel by journey purpose

Data from the International Passenger Survey makes it possible to examine changes in international passenger journey purposes over time. Data are given in Table 3.3 and Figure 3.3[30].

These data highlight that the biggest component of the growth in international passenger trips has come from a growth in leisure trips, primarily made by UK residents. By 2004, 84% of international air trips made by UK residents were for holidays or to visit friends and relatives and 88% of the new international trips by UK residents between 1994 and 2004 were of this nature. In contrast, the number of international business air trips by UK residents appears to have been relatively stable since 2000. Hence, by 2004, UK residents were making 5 international holiday flights to every international business flight. Meanwhile, the growth in trips by overseas residents visiting the UK has been much more modest, and, whilst there has been some increase in leisure trips (mainly to visit friends and relatives), again, business trip numbers seem to have been relatively static since the late 1990s. In total, by 2004, about 60% of all international trips from UK airports were UK residents going abroad for leisure purposes, and 70% of the additional international air trips that occurred between 1994 and 2004 were of this nature. The growth in trips to visit friends and relatives is also interesting, indicating more geographically dispersed networks of friends and family.

3.5 Air travel origin and destinations

The International Passenger Survey also provides some insight as to the destinations of UK residents travelling abroad, and the origins of overseas visitors visiting the UK[31]. These data demonstrate that the majority of international air passenger trips take place to or from other European countries.

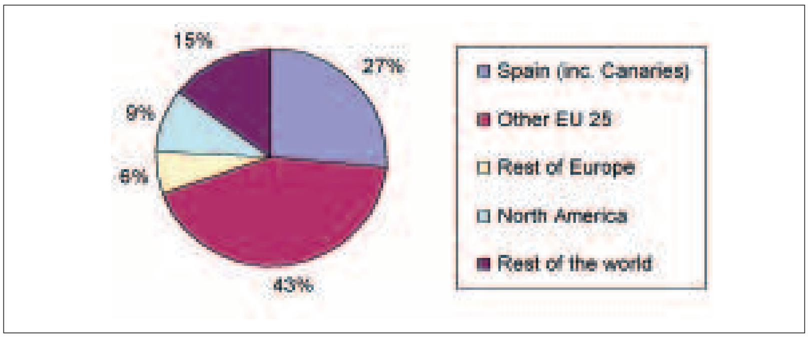


Figure 3.4 Destinations of UK residents' air trips abroad in 2004

Data taken from Table 5.08 of Travel Trends (NS, 2004).

As shown in Figure 3.4, for UK residents travelling overseas, over three-quarters of all air trips are made to other European countries, with more than a quarter made to Spain (including the Balearic and the Canary Islands). Over half of all air trips (about 53%) are made to only 5 countries, namely Spain, France, Italy, Greece and the USA. Just over 80% of all air trips made by UK residents are made to only 18 countries[32].

The profile of incoming air travellers is somewhat different, with a larger proportion of trips – 19% – coming from North America. However, mainland Europe still dominates and, in 2004, 63% of all overseas visitor trips were made from mainland Europe. Hence, in total, about 72% of all international air trips being made in 2004 were to or from mainland Europe, with 66% being made to or from the other member states of the European Union.

This is relevant when considering the geographical scope of economic policy solutions. Specifically, these data highlight that altering air travel within the EU would affect the majority of trips (albeit a smaller proportion of emissions).

A key concern about policy solutions which are initially only applied to Europe is that they could simply encourage people to travel elsewhere. However, air travel to more distant locations is likely to be more expensive, and the low-fares airlines might face difficulties in setting extensive equivalent services. The nature of the policy solutions adopted is also likely to affect the relative attractiveness of simply travelling elsewhere. Clearly, these are not definitive arguments on the issue. Nevertheless, the current patterns of travel do provide some justification for prioritising solutions that would affect air travel within Europe in the short term (partly as a way of building acceptance for more widespread international action at a later stage). This view has also been expressed by some respondents to an EU survey, as discussed in section 7.2.4.

Finally, the geographical pattern of trips has implications for arguments about how air travel (and economic policy measures designed to constrain air travel) might affect the economies of the developing world. For example, T&E/CAN-Europe (2006, p23) argues that, since only a small proportion of flights from Europe are to developing countries, if ticket taxes are introduced which raise revenue for international aid, the net effect for developing countries is that the benefits are likely to outweigh any negative effects.

3.6 Socio-demographic characteristics of air passengers

3.6.1 Introduction

One of the greatest concerns about using economic measures to make flying more expensive is that this will simply involve ‘pricing off’ poorer passengers. For example, in the Integrated Policy Appraisal in Annex E of the Aviation White Paper, the Department for Transport states: “*policies to encourage growth are likely to make air travel relatively more affordable, accessible and socially inclusive. By contrast, policies not to expand capacity would price-off lower income travellers and ‘favour’ higher income groups*” (DfT, 2003b, p172).

There must be some legitimacy in this argument, in that price rises are always likely to have a greater effect on more price sensitive customers. This also provides a strong justification for progressing some kind of personal carbon allocation system, in parallel with economic measures to make flying more expensive. However, there are also strong counterarguments. First, if revenue gained from new taxes or charges on aviation is redistributed to other sectors of the economy, this can be targeted to provide greater benefit to those who are less well-off than keeping flight prices low. Second, the data analysis outlined below indicates that the vast majority of the growth in flying is not coming from people in the the lowest income bands and that the cost of an overseas holiday is still too high for many of these people. Hence, the majority of the travel affected by price increases is likely to be discretionary travel currently being undertaken by the richer members of society.

3.6.2 Current profile of passengers

According to the Aviation White Paper, in 2001, only 50% of the UK population had flown at least once in that year (DfT, 2003b, ‘Key facts’). Available data show that air travel is still primarily undertaken by richer sections of society, and that aviation is not a socially inclusive activity.

Data on average incomes of air passengers from the Civil Aviation Authority’s 2003 survey showed that the average household income for UK leisure passengers making international trips, passing through UK airports, ranged from £33,531 at Birmingham airport, through to £54,488 at Heathrow, and £61,995 at London City Airport (CAA, 2003d)[33]. In contrast, for the UK as a whole, in 2002/3, the average household income was about £28,704[34].

Data from the Civil Aviation Authority’s 2004 survey also showed that, of 62,849 leisure passenger trips terminating at Gatwick, Heathrow, Luton, Manchester and Stansted, 76% of passengers were from socio-economic groups A, B and C1, and only 24% were from groups C2, D and E (DfT, 2005a).

Similar findings have emerged in data from the British Social Attitudes survey (DfT, 2005a). This shows that, for example, in 2003, over half of those in semi-routine or routine occupations had not flown in the previous year, whereas nearly half of those in higher managerial and professional occupations had flown three or more times (see Table 3.4).

Meanwhile, data from the 2004 Social Inequalities report (Haezewindt and Christian, 2004) indicates that over a fifth of two-parent families and nearly three-fifths of lone-parent families are unable to afford a week’s holiday that does not involve staying with relatives, highlighting, perhaps, the differences in leisure opportunities open to different sections of society. By implication, then, making leisure and tourism more socially inclusive could probably be most effectively achieved by widening UK-based leisure opportunities rather than through an expansion in flying.

Table 3.4 Frequency of flying by socio-economic group

How many air trips in the last year?	*None*	*One*	*Two*	*Three +*	*Base Number*
Higher managerial and professional occupations	21%	17%	17%	46%	106
Lower managerial and professional occupations	36%	20%	19%	26%	311
Intermediate occupations	41%	20%	24%	14%	126
Small employers and own account workers	49%	21%	11%	19%	86
Lower supervisory and technical occupations	41%	29%	16%	14%	140
Semi routine occupations	55%	23%	8%	15%	183
Routine occupations	56%	25%	11%	6%	168
Never worked and long term unemployed	74%	11%	15%	0%	33

Source: 2003 British Social Attitudes Survey (DfT, 2005a)

3.6.2 Changes in the profile of passengers

As well as looking at the profile of current travellers, it is also relevant to consider how the profile of travellers is changing over time, since it is often claimed that cheaper air fares are making air travel available to a wider constituency of people.

To assess this issue, further information about international leisure trips by UK residents was obtained from the Civil Aviation Authority's passenger surveys completed annually at Manchester, Gatwick, Heathrow, Stansted and Luton, (DfT, 2006a). These data give the proportion of trips by passengers in different household income bands[35], and the total number of passenger trips at each airport. The data were analysed, to calculate the total figures for passenger trips at the five airports by people from the different household income bands, and the relative proportions that these represent. The results are shown in Table 3.5 and Figure 3.5.

Contrary to expectation, the data show that, at the five airports, in both absolute and relative terms, the number of international leisure trips by UK residents in the lower two household income bands has fallen. This is a general trend, and has also occurred at four of the five individual airports. For the total of all five airports, between 2000 and 2004, the proportion of

Table 3.5 Proportion of international leisure trips made by UK residents in different household income bands at Manchester, Gatwick, Heathrow, Stansted and Luton

	Total passenger trips ('000s)	*Income bands*					
		Up to £14,374	*£14,374 to £28,749*	*£28,750 to £40,249*	*£40,250 to £57,499*	*£57,500 to £114,999*	*£115,000+*
Manchester 2000	10996	21.5	33.9	19.8	14.2	9.5	1.1
Manchester 2004	12748	13.0	30.4	25.7	18.1	11.1	2.0
Gatwick 2000	16501	12.1	27.3	22.3	19.2	14.1	5.1
Gatwick 2004	17090	10.2	23.1	20.9	21.6	18.3	5.9
Heathrow 2000	14965	17.9	25.5	18.5	15.5	15.6	7.0
Heathrow 2004	14787	13.3	21.9	18.2	17.1	20.6	8.7
Stansted 2000	5906	15.1	26.2	18.7	18.6	15.4	6.0
Stansted 2004	8885	14.4	19.9	21.1	17.6	20.2	6.8
Luton 2000	2980	10.8	23.0	24.3	20.0	14.9	6.9
Luton 2004	3533	14.5	17.3	21.1	18.7	21.4	7.0
5 airports 2000	51362	16.1	27.8	20.4	17.0	13.7	5.0
5 airports 2004	57052	12.5	23.6	21.3	18.8	17.8	6.0

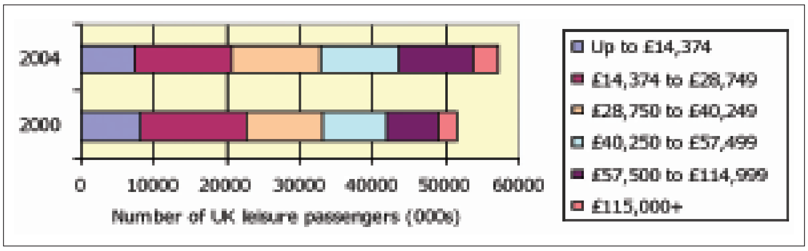


Figure 3.5 Number of international leisure trips made by UK residents in different household income bands at Manchester, Gatwick, Heathrow, Stansted and Luton

international leisure air trips made by UK residents in households with an income of less than £28,749 fell from 44% to 36%, representing an absolute fall of approximately 2 million one-way trips per year. Meanwhile, the total number of international leisure trips made by UK residents in households with an income of £28,750 or more has increased by a total of more than 7 million one-way trips per year. The only exception to this general trend is at Luton, where there has been an increase of 190,000 one-way trips being made by people in households with an income of less than £14,374. However, this has been coupled with a decline of 74,000 trips by people with a household income of between £14,375 and £28,749. Overall then, the data suggest that, in recent years, flying has become less accessible to those on lower incomes.

There are various possible explanations for these results. Since household income data relates to the year of the survey, there may be a small effect which is due to salary rises and inflation. It may also be the case that passengers with lower household incomes are more likely to have started using regional airports, because of their use by no-frills carriers (although if this is a dominant trend, it should have been more evident at both Luton and Stansted). In general though, these data suggest that the presumption which is often made – namely that the growth in flying is primarily due to more people from lower incomes enjoying the benefits of international travel – may be inaccurate. Instead, the indication is that the majority of the growth in aviation has occurred because richer people are flying more often.

This conclusion has also been reached by other commentators. Specifically, Graham (2006) reports on an analysis of leisure travel at the four London airports by socio-economic group. She states:

"between 1996 and 2003, the share of traffic from the A/B groups increased at all airports including both Luton and Stansted which experienced a huge growth in the amount of low cost carrier traffic. Likewise at these two airports, the proportion of trips taken by the next wealthiest group C1 also increased while the share for the other less affluent groups decreased. Therefore, this does not provide strong evidence to suggest that the low cost carriers are appealing to the less wealthy parts of the population that have not travelled much by air before. Instead, they seem to be encouraging more frequent flying – perhaps, in some instances, influenced by the existence of a second home."

In a recent report (CAA, 2005c), the Civil Aviation Authority notes that class structures change over time, quoting data which suggest that, between 1999 and 2003, the proportion of the UK adult population classed as A, B or C1 has increased from 49% of the population to 54% of the population. However, this upward social mobility is not sufficient to account for the lack of representation of lower socio-economic groups amongst air passengers, who took only 24% of leisure air trips (according to the data given in the preceding section).

Evidence from surveys commissioned by the Department for Transport also provide some relevant data. More details of these surveys are given in section 7.3. Specifically, in 2002, the DfT included some questions on air travel in the Office for National Statistics Omnibus survey (DfT, 2002). In their responses, 51% of respondents stated that they had not flown during 2001, whilst 25% had flown more than once in that year. In 2004, responses to a similar question in the British Social Attitudes Survey indicated that 48% of respondents had not flown in the preceding 12 months – suggesting a potential small increase in first time flyers. However, 37% of respondents now reported that they had flown more than once, (DfT, 2006c). Although the two surveys may not be strictly comparable, these data do suggest that the biggest change over time has been in the proportion of people flying more frequently.

In brief, then, available evidence suggests that flying is largely undertaken by those in richer households, and that most of the growth in flying is coming from people in such households flying more often.

3.7 Forecasts of future air passengers

3.7.1 Overview

Chapter 2 has already alluded to the Aviation White Paper forecasts of future air passengers. More details of this forecasting process are given in Appendix B. In brief, these forecasts are based on assumptions that the growth in air travel will be driven by several factors, including future growth in UK and world GDP, increased world trade, changes in air fares, exchange rates and the onset of increasing market maturity.

The central Government forecast for demand at UK airports, assuming that airport capacity is unconstrained, is for about 400 million passenger movements by 2020, rising to 500 million passenger movements by 2030. In reality, the Government expects that there will be some airport capacity limits, and, in the favoured scenario outlined in the White Paper, this is expected to limit passenger movements to 466 million by 2030 (DfT 2006a). (This is described as 'around 470 million' passenger movements in the main part of the White Paper).

In this scenario, the Aviation White Paper supports a substantial addition to existing capacity including new runways at Stansted, either Heathrow or Gatwick, Birmingham, Edinburgh and possibly Glasgow, together with an expansion of many airports across the UK[36]. There are specific proposals for a new runway at Stansted in 2011/12 and, probably, a new runway at Heathrow in 2020.

The forecasts used in the Aviation White Paper have been critiqued in various ways (see, for example, Riddington 2006). Here, they are assessed in terms of what they suggest about the magnitude of passenger growth, and the likely composition of future air travellers.

3.7.2 The future volume of air passenger demand

It is important to assess whether the forecasts are indicating the right order of magnitude of future air travel, since a core theme of the Aviation White Paper is that failure to provide appropriate airport capacity could have detrimental economic consequences. Consequently, it supports a substantial addition to existing capacity, which would go most of the way to meeting its mid-point forecast for unconstrained demand of 500 million passenger movements by 2030.

However, if its passenger forecasts are too low, then the planned expansion will be inadequate, and any detrimental consequences would then be experienced anyway[37]. Moreover, if demand for air travel is currently accelerating, there are clear reasons why it may be easier to stem it now, rather than at a later point. The issue of demand becoming self-perpetuating is discussed in detail in Chapter 4.

The Department for Transport's mid-range forecasts equate to a growth of approximately 4.3% p.a. to 2020, followed by growth of approximately 2.3% p.a. to 2030. These mid-range forecasts are in line with some other forecasts for the growth of aviation in Europe. However, there is some evidence that air travel may be growing faster in the UK than elsewhere, and may even have started accelerating.

For example, in a press release (CAA, 2005b), the Civil Aviation Authority reports: *"Passenger traffic at UK airports has grown at an average annual rate of about 6% since the mid-1970s. This is more than twice the rate of economic growth in the UK and considerably faster than traffic growth in most other developed aviation markets during the same period."*

Verification of this statement is provided by data from Transport Statistics Great Britain, as shown in Figure 3.6. In particular, these data show that, between 2003 and 2004, passenger movements at UK airports rose by 8%. Moreover, prior to the September 11th attacks, the pace of growth generally seemed to be increasing, following the liberalisation of the airline market in the early 1990s (with growth of 6% between 1998 and 1999, and 7% between 1999 and 2000). Latest data from the CAA suggest that for 2004/05 the growth rate was 6% – an additional 12.5m passenger movements.

The issue of whether the UK air travel market is maturing is also discussed by Graham (2006). She highlights that there are various ways in which market maturity can be identified, largely based on economic measures. Her analysis indicates that, whilst the growth in spending on international air holidays seems to be slowing, this may be partly due to decreases in travel and holiday costs, and, in contrast, spending on international air holidays as a proportion of consumer expenditure is increasing. She identifies a number of factors which indicate that aviation growth will not necessarily slow down, including lower cost fares, the tendency for people to take an increasing number of shorter holidays, people having smaller families later in life, more single travellers, and, whilst

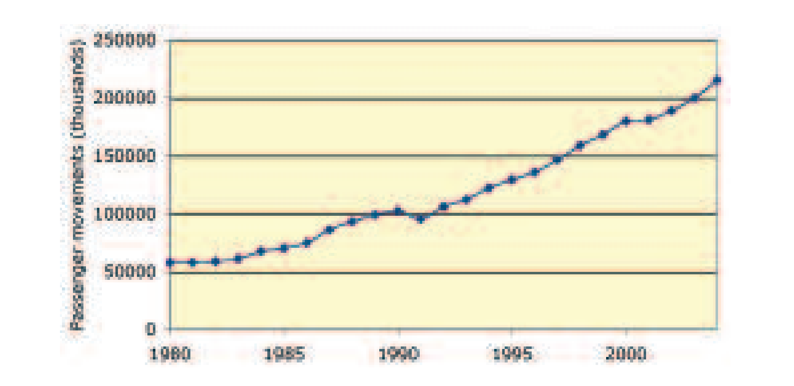


Figure 3.6 Increase in passenger movements at UK airports

Data taken from Transport Statistics Great Britain (DfT et al, 2005, Table 2.1).

pension availability permits, the growth of a healthier, wealthier, better travelled over-55s market.

The evidence cited above has significant implications, since it suggests that the Department for Transport's forecasts may represent a serious underestimate of the potential demand for air travel. For example, suppose that passenger movements were to continue to grow at 8% p.a. – given that there were 216 million passenger movements in 2004, this would mean that there would be 500 million passenger movements by 2015 – i.e. less than 10 years away – at which point all the capacity expansion proposed in the Aviation White Paper would become inadequate. Moreover, reporting on their projections for 2030, DfT (2003c) reported that, with 500 million passenger movements in total, the average UK resident would be making just under two return air trips a year, compared with 0.8 return trips in 2000[38]. It is not at all obvious that this represents an inevitable ceiling to the number of flights that people will come to take (although other factors, like oil supplies and airport capacity may act as limits to growth).

3.7.3 The future nature of air passengers

The Department for Transport's forecast breakdown of aviation demand in 2030 is given in Tables 3.6 and 3.7.

If the Department for Transport's forecasts are accepted, these indicate that, by 2030, more than half of all future air passenger movements will still be made by UK residents, and about two-thirds of international trips will be for leisure purposes.

However, there are various assumptions feeding into these tables that are questionable. In particular, as outlined in Appendix B, there are assumptions that business travel will grow faster than leisure travel, and that incoming leisure visits by overseas residents will increase faster than trips by UK residents travelling abroad for leisure purposes. As highlighted in section 3.4, in reality, in the last 10 years, the opposite has been true. Specifically, according to the International Passenger Survey data given in Table 3.3, between 1994 and 2004, international air trips for leisure purposes grew by 76% (+23.6 million) whilst

Table 3.6 DfT forecasts for passenger types in 2030

Passenger movements p.a.	*Total*	*International – UK residents*	*International – foreign residents*	*Domestic*	*Connecting*
Million	466	201	149	68	48
%	100%	43%	32%	15%	10%

Source: DfT 2006a, based on some update of the data used in DfT, 2003c. Figures given are for individual passenger movements – hence an international return journey would be counted twice in these figures, whilst a domestic return journey is counted four times. 'International – UK passengers' and 'international – foreign residents' include flights made within the UK to connect to an international flight. 'Domestic' refers to flights made by UK residents which start and end in the UK. 'Connecting' only refers to passengers arriving on an international flight and connecting with another international flight.

Table 3.7 Purpose of international passenger movements in 2030

Passenger movements p.a.	*Total*	*Foreign residents Business*	*UK residents Business*	*Foreign residents Leisure*	*UK residents Leisure*
Million	350	61	57	88	144
%	100%	17%	16%	25%	41%

This table excludes the 68 million domestic and 48 million connecting passenger movements given in Table 3.6. Source: DfT, 2003c, p51.

international trips for business purposes grew by only 40% (+3.4 million). Similarly, international leisure air trips by UK residents grew by 89% (+20.0 million) compared to a growth of only 39% (+3.6 million) in leisure trips by incoming overseas residents. The nature of future passengers has important implications for the economic value of air traffic growth, as discussed in Chapter 5, and an economic strategy based on the current Department for Transport forecasts – which assume that all existing trends alter – is therefore potentially unwise.

3.8 Air freight

So far, this chapter has not dealt with air freight, because, as explained in Chapter 1, air freight was deemed to be beyond the scope of this study. However, because of its relevance to some of the wider arguments, a brief review of readily available information about the characteristics of air freight is included here.

According to statistics from the Civil Aviation Authority (2005a), in 2005, freight aircraft movements represented only 3% of the total aircraft movements at all UK airports. (They are probably responsible for a slightly greater proportion of emissions because freight aircraft are typically older and heavier than average and therefore use more fuel). However, whilst dedicated freight aircraft are only a tiny fraction of aircraft movements, according to the same CAA statistics, approximately two-thirds of air freight (64%), in tonnes, is carried in the cargo space of passenger aircraft. According to Bishop and Grayling (2003), 80% of air freight movements are handled by Heathrow, Stansted and Gatwick – with 72% of all air freight being dealt with at Heathrow.

The movement of air freight goods is complex. Air freight was the subject of a specific report for the Department for Transport by MDS Transmodal, in 2000, and the following table summarises the data that they produced about air freight movements.

Table 3.8 Air freight movements through the UK

Freight travelling...	*Weight in million tonnes*	*%*
From the UK market to the EU	0.13	6.6
From the UK market to non-EU countries	0.6	30.6
From the EU to the UK market	0.09	4.6
From non-EU countries to the UK market	0.7	35.7
Through the UK from the EU	0.13	6.6
Through the UK to the EU	0.09	4.6
Through the UK from non-EU countries	0.09	4.6
Through the UK to non-EU countries	0.13	6.6
Total	1.96	100

Source: Data from the diagram on p35 of the MDS Transmodal (2000) study.

These figures excluded mail and domestic air freight which, together, MDS Transmodal estimated to account for approximately 360,000 tonnes of air freight.

Examining these data highlights that:

- 11% of all international air freight movements (by weight) are between the UK market and the European Union.
- 66% of all international air freight movements (by weight) are between the UK market and non EU countries.
- 22% of all international air freight movements (by weight) are goods in transit.
- The UK market imports slightly more goods (0.79 million tonnes) than it exports (0.73 million tonnes).

Available data about the nature of air freight are sparse, although it is clear that goods imported are not the same as goods exported. According to the MDS Transmodal study (p43), in weight terms:

- The largest export commodity categories are miscellaneous manufactures (15%) and other electrical machinery (15%).
- The largest import commodity categories are fruit and vegetables (13%), photographic equipment (11%), general industrial machinery (10%), telecommunications and audio equipment (9%), travel goods (8%), office machinery (5%), and metalworking machinery (5%).

In terms of air freight's contribution to the economy, in 1998, air freight represented only 0.4% of all goods carried by volume, but 32% of all goods carried by value (of which about a third was 'diamonds and coin' whilst about two-thirds was other items), (MDS Transmodal, 2000, p38).

The main sectors using air freight were identified on the basis of £million spent on air freight purchases in 1996, (MDS Transmodal, 2000, pp74–79). This analysis showed that the banking and finance sector accounted for nearly 16%; purchases from within the air transport sector itself were close to 12%; whilst insurance and pension funds accounted for just over 11%. Two other service sectors – transport services and other business services – were the only other sectors to account for between 5% and 10% of total purchases, and together, these five sectors accounted for 50% of all air freight services purchased. The manufacturing sectors together accounted for no more than about 15% of purchases. It is unclear whether users by value and users by volume of air freight services are the same – although it seems unlikely.

In terms of growth, the use of air freight has increased dramatically over time, although the rate of growth has considerably slowed down recently. According to the CAA (2005a), between 1996 and 2005, the total volume of air freight transported (in tonnes) increased by 33%. However, this growth rate has declined, from 10% between 1996 and 1997, to 6% between 1999 and 2000, 2% between 2001 and 2002, and 0% between 2004 and 2005, possibly representing an increasing maturity of the market.

In terms of other comments on the underlying trends in the carriage of air freight, Bishop and Grayling from the Institute of Public Policy Research (2003) state: *"air freight was once mainly the preserve of high-value, lightweight commodities, yet increases in capacity and declining shipment rates have meant the range of goods carried by air has widened... This helps explain why the value to weight ratio of air freight imports has declined in recent years."* They therefore argue that: *"Charging for the environmental costs of air transport will merely ensure that it continues to be used by high-value lightweight produce and is not an excuse for bad supply chain management."*

In this study, it has not been possible to assess the arguments for and against increasing the environmental costs paid by air freight in any detail. However, a brief discussion of the economic importance of air freight is given in section 5.9.

3.9 Summary

Overall, these statistics indicate both the potential and the importance of demand restraint. For passenger trips, demand restraint would primarily involve deterring increasing numbers of leisure trips by richer UK residents abroad. This can be viewed as one of the more socially-equitable forms of regulation that may be required to meet climate change objectives, and could even have some economic benefits, as discussed further in Chapter 5. The fact that a significant proportion of trips are to Europe means that action at European level, or with other European member states, has the potential to address a large proportion of air trips.

Meanwhile, an assessment of the Department for Transport's forecasts of future air travel demand provides no obvious reason to question this conclusion. In the future, according to their forecasts, the most significant proportion of air passenger movements is still likely to be by UK residents making leisure trips abroad. Moreover, the fact that the forecasts may significantly underestimate the future growth in air travel makes the objective of the current strategy – namely, to cater for the majority of future demand – potentially unrealistic. Instead, as discussed in the next chapter, demand restraint constitutes a more rational response for a number of reasons.

Should We Cater for the Growing Demand for Air Travel?

4.1 Introduction

As outlined in section 3.7, the Government's latest White Paper on *The Future of Air Transport* (DfT, 2003b) is widely interpreted as being in favour of aviation growth, and in facilitating the provision of additional airport capacity to accommodate it. Some commentators also argue that air travel to and from the UK receives considerable support in the form of a net tax subsidy from the Treasury, as discussed further in section 5.3.

The main justifications for supporting aviation, and expanding airport capacity, are that this is necessary to avoid future additional air trips simply migrating abroad, to avoid airports becoming overly congested and to retain the economic benefits that air travel brings.

The economic benefits and disbenefits of air travel are explored in detail in Chapter 5. Meanwhile, this chapter examines the issues of growth migration (arguing that it is highly unlikely that the majority of growth could migrate abroad), and the issue of avoiding airport congestion (where lessons from car travel policy suggest that trying to 'build our way out of trouble' will not necessarily be successful). This chapter also looks at reasons why demand restraint could be particularly important now – before 'air dependence' becomes more widespread.

4.2 The justification for encouraging growth

One of the key ways in which the Government facilitates or restricts flying is in its stance on airport capacity – i.e. whether it permits new airport capacity or not. An assessment of the importance of providing airport capacity in determining the volume of flying is perhaps most clearly set out in the South East consultation document produced ahead of the White Paper (DfT, 2003a). This argues that if no new runways were built, then, by 2030, UK airports would have a throughput of 428 million passengers with around 73 million [potential] passengers no longer travelling by air in the UK. These passengers are described in the consultation paper, somewhat emotively, as being "*lost to the UK system*". The paper also estimates that not providing capacity would lead to a rise in airfares, with an estimated fare premium of £100 per person in today's prices at Heathrow, Gatwick or Stansted by 2030.

While some commentators see capacity constraints as going some way towards heading off the expected expansion in demand for flying and reducing the impact on climate, the Government takes the line that if the UK doesn't cater for this continued increase in flying, someone else will. 'The Future of Air Transport' comments that, if additional capacity were not provided *"Airports would become more congested; air fares would rise as slots became increasingly sought-after; and much of the future growth in air travel – along with the associated economic growth – could in due course migrate elsewhere. In the case of international traffic, this would often mean to other European countries"* (DfT, 2003b, para 2.13).

One important implication is that the environmental benefits of fewer people travelling by air would be largely written off since these journeys would simply be made from other international airports. These claims need further critical analysis.

4.3 Will growth migrate elsewhere?

The expectation that demand would migrate elsewhere can be questioned on several grounds.

First, as shown in Table 3.6, much of the future demand for air travel – 58% of the passenger traffic predicted for 2030 – will be journeys made by people living in the UK. These cannot readily be transferred elsewhere to be made from non-UK origins.

Second, the expectation takes no account of the potential for European co-operation on a policy of demand restraint, despite the fact that the functioning of the air transport market is generally subject to EU rules and that other EU countries are also concerned about averting climate change. The point is taken up in a report by Bishop and Grayling (2003) for the Institute for Public Policy Research, who argue that, in their environmental concerns, our European neighbours are no more relaxed about airport development than UK citizens, and that they have often been prepared to apply tighter controls. For example, according to Gazzard (2006), *"Paris has currently abandoned plans for a third airport, plans for a new runway at Frankfurt are being legally challenged and a study on expanding Schipol has received highly unfavourable public reaction as this would mean* *overturning current legal noise capacity limits"*. Gazzard further comments that the 5 airports around London constitute an *"unparalleled airport system that no other European region comes close to matching"*. Moreover, the fact that a fifth of international passengers arrive or depart at UK airports (DfT, 2003b), the majority of them UK residents, means that the UK is responsible for more aircraft emissions than other European countries, and can be expected to take the lead in tackling aviation's contribution to climate change.

Third, some of the future demand for air travel, if constrained by demand management, could be expected to migrate to alternative modes such as rail, which might be no bad thing in either environmental or economic terms. (The issue of rail substitution is discussed further in section 5.8).

Fourth, those journeys that might most readily be expected to migrate elsewhere are passengers in transit, whose value to the UK economy is relatively low. As outlined in section 3.2, 12% of passengers at UK airports are simply transferring between international flights. At Heathrow Airport, the 2004 Civil Aviation Authority survey suggested that 35% of passengers were connecting with other flights (CAA, 2004).

The value of transit passengers is a subject of debate within the airline industry. For example, Luton airport has *"questioned the value of transfer passengers from the perspective of an airport operator"*, viewing airport capacity as a scarce resource, best used by UK residents or incoming tourists, and commenting *"Transfer passengers provide little or no revenue to the airport (e.g. no car parking fees) but transfer infrastructure such as a new baggage system is required to cope with their needs"* (CAA, 2003c).

DfT (2003c, p73) argues that this allows UK passengers to benefit from direct flights to more destinations, stating: *"The UK punches above its weight currently in global connections, which increases services and frequencies for all passengers through UK hubs. Hub airports allow for a greater variety of destinations for passengers than a smaller airport could offer, which is more favourable to leisure passengers and also increases the benefits to business, particularly from direct foreign investment"*.

However, Bishop and Grayling (2003) point out that Manchester Airport serves a similar number of destinations to Heathrow, despite the fact that only a very small percentage of passengers change planes there. Stansted meanwhile, with twice as many international to international transfers as Manchester, serves 70 fewer destinations.

DfT's own forecasts of demand show that constraining airport capacity is likely to impinge on transfer passengers more than other travellers. Table 4.1 gives summary details of the 7 different scenarios for airport expansion given in the White Paper, including the anticipated composition of 'lost passengers'. It indicates that, in all scenarios, at least half of the lost passengers would be those in transit – i.e. those that are arguably of least value to the UK economy.

Figure 4.1 Different airport capacity scenarios for 2030*

	2 Max Use of Existing Runways	*7 STN +1*	*12s1 STN+1, LHR+1 (2020, 550/600)*	*12s2 STN+1,LHR +1 (2016, 550–690)*	*12s3 STN+1, LHR +1 (2020, 655/700)*	*13 STN+1, LGW+1 (w–s)*	*15s1 STN+1, LHR+1 (2020), LGW(ws)*	*Unconstrained*
Total passenger movements (millions)	431	448	466	476	478	474	484	501
Lost interchanging passengers	–35	–27	–20	–16	–15	–17	–13	
Lost terminal passengers	–35	–25	–15	–9	–7	–10	–4	
% lost passengers interchanging	50%	52%	56%	64%	68%	61%	75%	

Source: Data received from DfT, 2006, based on an updated version of Annex B6 from DfT (2003c).

* Table headings refer to different scenarios considered in the Aviation White Paper. 12s1 is the favoured scenario, as defined in section 3.7.

4.4 The limitations of 'predict and provide'

Another rationale of the current aviation strategy is that it is necessary to increase airport capacity in order to avoid congestion at the airports. The implication is that there is some fixed level of demand which, once catered for, will then stay constant, permitting efficient operations for ever more.

In advocating this rationale, a key criticism of the Aviation White Paper is that it repeats the mistakes of the 1980s, when a 'predict and provide' policy set out to accommodate an expansion in road traffic through an extensive programme of road building. Predict and provide has been discredited both by the irrevocable impact of new motorways on well loved areas of British countryside, and by the realisation that new road space can generate additional traffic, as explained in the 1994 landmark study by the Standing Advisory Committee for Trunk Road Assessment. The finding is linked to the argument that building new roads is likely to become a cyclical and self-perpetuating process, in which each new generation is committed to higher levels of car dependence and lower levels of physical activity than the one before. Such changes are likely to be harnessed to the ongoing erosion of the landscape and an inexorable rise in traffic. In the 1998 Transport White Paper (DETR, 1998), the Government recognised that the 'predict and provide' approach was fundamentally unsustainable, and that it was necessary to manage demand for road space rather than attempt to build a way out of the problem. In 2001, work for the Commission for Integrated Transport highlighted that the UK had some of the most congested roads in Europe (WS Atkins, 2001), indicating that the previous adoption of a 'predict and provide' approach had not provided a solution to congestion.

Moreover, the potential of demand management is reinforced by the empirical finding that constraining road capacity can reduce traffic levels. Specifically, it has been shown that, just as expanding highway capacity induces traffic, so reducing highway capacity leads to a proportion of traffic 'evaporating' as journeys are made by other means or not made at all, either because the activity is not undertaken, or because it is undertaken in other ways (Cairns et al, 2002).

These findings are particularly pertinent in relation to the discussion in section 3.7.2, which suggests that, if flying remains cheap, the current Department for Transport forecasts of passenger traffic in 2030 may represent a serious underestimate of future demand.

In theory, demand management, as a way of reducing congestion, is considerably more straightforward for air travel than for car travel, since access to the air is already, of necessity, tightly controlled. One of the difficulties in reducing congestion via demand restraint for car travel is that, unless road space is physically reallocated to other modes, there are no actual constraints to prevent it filling up with traffic. In contrast, access to the air is controlled by airport slots and people rarely arrive at airports unless they already have a ticket on a pre-booked flight.

Moreover, most drivers have already invested up front in car ownership, and this commitment skews their travel decisions towards car use. This problem does not apply in the same way to air travel, where travel decisions are still generally made on a pay-as-you-go basis (although the various frequent flyer schemes undermine this to some degree).

Finally, air travel is particularly well suited for demand restraint because 'air dependence' is considerably less developed than 'car dependence'.

4.5 The benefits of immediate action – avoiding air dependence

Action taken now to reduce demand is likely to be easier, because 'air dependence' is still at a relatively early stage. The greatest threat to the UK's successful mitigation of climate change is contained in a growth in demand that *has not yet happened*. This means that, whilst aviation may be a poor candidate for emissions reduction through technological efficiency, it is a very good candidate for demand restraint.

Many of the challenges encountered in applying demand restraint in other areas of transport arise from the fact that unsustainable travel behaviour has become embedded in our way of life. The UK has what is often described as 'a car culture', in which people have become increasingly dependent on car use for routine journeys. Life choices such as where to live, where to work and where children will go to school are often predicated on high levels of car use. The situation has reached the point where households without access to a car experience social exclusion because of poor access to facilities and services (SEU, 2003).

This is not, at present, the position for air travel. As outlined in section 3.2, the majority of UK air travel is for leisure purposes and demand for leisure travel is known to be more elastic in response to price than demand for other types of travel. For example, the Government's National Transport Model indicates that, for every 10% rise in the cost of motoring, day trips and holiday travel by car can be expected to fall by 9%, whereas car travel generally will only fall by 3%[39]. In demand management terms, therefore, air travel is likely to be 'a good buy'. (Price elasticities for air travel are discussed in more detail in section 6.4).

Air travel is still, largely, regarded as a luxury rather than a necessity. Raising the price of air tickets does not require a complex range of strategies to mitigate adverse social effects. It does not, for example, require us to redesign our cities to make them less air reliant or to fund alternative transport for large numbers of people who may otherwise have to change employment because of commuting problems. Demand restraint in transport is *generally* considered to be good value in reducing emissions, as highlighted, for example, in recent work on 'Smarter choices and carbon emissions' (Anable et al, forthcoming). In the case of air transport, it is likely to be particularly good value.

Common sense suggests that people find it easier to forgo a benefit that they are not yet accustomed to, rather than one that is already part of their lives. This is illustrated empirically by research into individual patterns of car use over time, which shows that the relationship between rising and falling income and car travel is not a symmetrical one (Dargay, 2004). An increase in income leads to a higher level of car travel, but when income falls, car travel is not reduced correspondingly. The study concludes that there is no unique car-use – income relationship, rather a pattern described as a hysteresis loop. Households become accustomed to the convenience of car travel and shape their lives around it. The result is that car dependency is not easily reversed, so there is a tendency to maintain car use in spite of falling income. Specifically, based on Family Expenditure Survey data, Dargay showed that, on average, in the long run (5–10 years), as household income increased by 10%, car distance travelled increased by 10.9%, but a 10% fall in income only resulted in an 8.6% reduction in the car distance travelled.

If a parallel effect holds for air travel, then, as people become more accustomed to higher levels of flying, they will become less responsive to price. Consequently, to achieve the same reduction in the overall volume of air travel at a later date through price constraint, ticket prices would have to rise further than they would now.

There are plenty of examples where the current availability of cheap flights is already leading to other societal changes that will encourage more flying in future. Concerns that existing policies are fostering the growth of an 'air culture' have been eloquently expressed by Blake Lee-Harwood (2005), the Campaigns Director of Greenpeace, who highlights the risk of delayed action: "*in the same way that we've locked ourselves into a great car economy, we're going to lock ourselves into the great aviation economy, where people are getting so used to flying. Look at the growth in second homes in Europe now. Why are tens of thousands of English people buying second homes in Bulgaria? Because they can afford to do so, because it only costs a small amount of money to fly there three or four times a year. This, ultimately, is impossible to reconcile with sustainable development. Yet we're building a huge constituency of people who will make their voice heard through the democratic process to prevent any action to roll back the aviation economy.*"

The economist Brendan Sewill has also focused on this issue. Quoting from The Times (12/8/02), he calculates, for example, that with 50,000 second homes purchased abroad by British people each year and second home owners making an average of six trips a year, then on present growth rates, owners of second homes will soon be taking 12 million flights a year (Sewill, 2005, p18).

Second homes are only one aspect of 'air dependence'. Sewill points to several ways in which people alter the way they live as flying becomes cheaper. Tourists take more short breaks abroad, instead of one long holiday; friends and relatives become more inclined to attend weddings or funerals on the other side of the world; migrant workers move to look for employment in other countries, and fly home to see their relatives on a regular basis; commuting to work by air becomes a practical option. In evidence of this last trend, Sewill points to reports that house prices near regional airports have soared with the arrival of low cost flights. Meanwhile, a report by the Thomson Future Forum suggests that, based on emerging trends, by 2020, there could be 1.5 million people working in the UK, but living overseas, using Heathrow, Gatwick, Luton, Stansted and other airports as commuter terminals (Thomson, 2006). Increasing numbers of international marriages are likely to be another outcome of growing air travel, leading to many more trips to see friends and relatives.

All of these trends may, of course, have personal benefits for those involved. However, if climate change is likely to require reductions in aviation travel at some point in the future, overall, the net benefits for personal wellbeing are likely to be greater if people are discouraged from making decisions now which may lead to a significant reduction in their wellbeing once the current availability of flights is curtailed. For example, a commitment to live and work abroad may seem attractive whilst flights 'home' are cheap and readily available, but considerably less so, if this is not the situation.

4.6 Summary

This chapter has examined some of the reasons given in 'The Future of Transport' White Paper for expanding airport capacity, and thereby facilitating a growth in the amount of flying. It highlights that the expectation that the predicted growth in flying will otherwise migrate to mainland Europe is questionable (not least since much of the future demand for flying is expected to be additional trips by UK residents). Moreover, if the deterred trips are most likely to be transit passengers, the benefits of catering for such trips are questionable anyway.

The idea that airport congestion can be avoided by building enough capacity seems unrealistic, based on the experience of trying to cater for car traffic by building roads, which has manifestly failed to provide an adequate solution to road congestion. Instead, economic instruments such as road pricing are now being put forward as part of a package of measures designed to manage demand for road use. In progressing towards a low carbon society, it therefore seems logical to employ similar demand management strategies in relation to air travel, whether through price mechanisms such as taxation, or ultimately, through less conventional mechanisms designed to maximise the choice exercised by individual consumers in allocating their own carbon use, such as the introduction of personal carbon allowances.

Given that access to airports and aeroplanes is reasonably well controlled, demand restraint through price potentially represents a relatively simple mechanism for addressing the issue as things currently stand. In addition, there are likely to be particular benefits from taking immediate action, before a culture of 'air dependence' becomes more entrenched, and increasing numbers of people build the availability of cheap flights into the way they plan and organise their lives.

Meanwhile, perhaps the single other most significant reason given in the White Paper for facilitating air travel is that doing so could result in a range of economic benefits. These are considered in the next chapter.

Some Economic Aspects of Aviation Growth

5.1 Introduction

The Government's Aviation White Paper emphasises the value of aviation for the British economy, both in providing transport links to enhance tourism, business and exports and in directly generating jobs. It also highlights the role of air services in the economic vitality of Scotland, Wales, Northern Ireland and the English regions.

The scale and nature of economic impacts that would result from an expansion in flying have been questioned on a number of grounds. Whilst there would clearly be economic gains, there would also be detrimental economic consequences that need to be taken into account. This chapter identifies:

- The general relationship between aviation and economic growth
- Aviation and taxation
- The specific cost-benefit analyses conducted in support of the Aviation White Paper.
- The value of aviation in terms of job creation
- The benefits of aviation in supporting business development
- The value of aviation to the UK tourist industry
- The impacts of aviation on other travel industries
- The economic importance of air freight.

The analysis presented here is not exhaustive. Instead, it is intended to highlight that many of the Aviation White Paper assertions can be challenged and that the balance of costs and benefits that would arise from curbing the predicted growth in flying needs detailed consideration.

5.2 General relationship between aviation and economic wellbeing

Within transport, there is a general debate about the value of improved transport links. In 1999, the Government's Special Advisory Committee on Trunk Road Assessment was commissioned to assess the links between transport and the economy (SACTRA, 1999). It found that, where circumstances are right, it is possible to reduce the rate of road traffic growth without harming the economy. In particular, SACTRA concluded that in some conditions, measures to control traffic would raise transport prices while still having a favourable local or national impact. A key observation in the report was that: *"there is no guarantee that transport improvements will benefit the local or regional economy at only one end of the route – roads operate in two directions, and in some circumstances the benefits will accrue to other, competing, regions."*

It seems plausible that SACTRA's 'two-way road' argument could also prove to be relevant for an expansion of UK air capacity. For example, Whitelegg and Cambridge (2004) have argued that it would be unwise to claim automatic economic benefits from inward investment in the UK resulting from better international accessibility, since the total of UK investment in the rest of the world is greater than that of the rest of the world in the UK.

One underlying theme in the aviation debate is that growth in air travel is 'inevitable' since it is seen as being an inexorable consequence of GDP growth. Clearly, income and GDP growth are important drivers of aviation demand. However, this cannot be taken to mean that, conversely, aviation is a critical driver of income and GDP growth, or that policy measures – which seek to alter the amount of air travel – will be ineffective. Instead, as outlined below, the relationship between air travel and wealth is not straightforward and is therefore presumably susceptible to policy intervention.

First, as context, it is worth noting that, for a long time, overall energy consumption was seen as being inevitably linked to GDP – i.e. it was believed that any increase in GDP would inevitably result in an increase in energy use. However, the UK Energy White Paper highlights that the two have been successfully decoupled (DTI, 2003, p26), since overall energy consumption in the UK has risen by only about 15% since 1970, whilst the economy has doubled. It seems plausible that the amount of air travel is no more inextricably linked to GDP than energy consumption overall.

Graham (2006) explicitly explores the link between GDP and air travel, commenting: *"The traditional 'rule of thumb' measure for general air transport markets is that the GDP multiplier is around 2 – this assumes that demand will grow or decline twice as fast as any change in GDP"*. However, her analysis shows, first, that this 'multiplier' has changed over time, and

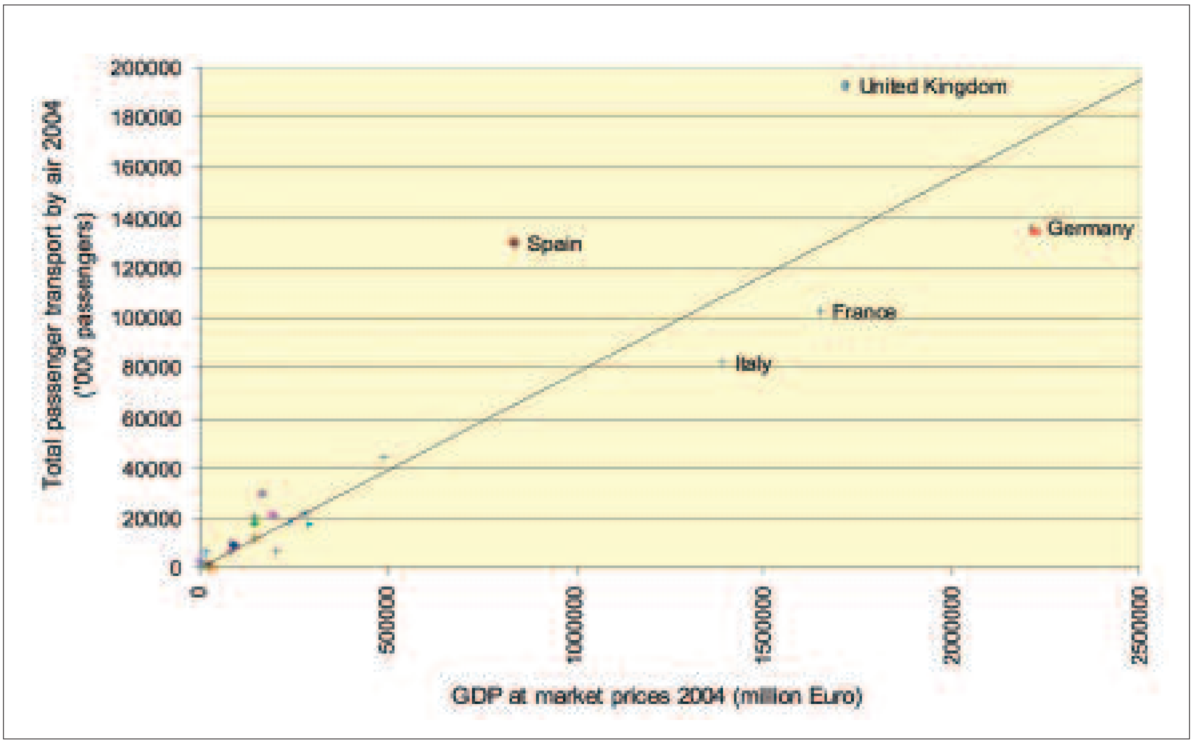


Figure 5.1 Relationship between GDP and flight numbers for the EU 25 countries

Source: Data on passenger numbers taken from De La Fuente Layos (2006). Data on GDP downloaded from the Eurostat website, epp.eurostat.cec.eu.int, on 22/3/06.

second, that the multiplier for world air travel is different from the multiplier for UK air travel. Specifically, between 1990 and 2000, she estimates that, worldwide, international tourist arrivals rose by 4.2% p.a., whilst real-world GDP rose by 3.3% p.a., implying a multiplier of 1.3. In contrast, for UK residents, international air holidays rose by 6.7% p.a., whilst real consumer expenditure (which she identifies as being a better measure of personal income than GDP) rose by 2.6% p.a., implying a multiplier of 2.6. Hence, the relationship between GDP and air travel is not straightforward.

Eurostat data also makes it possible to compare the relationship between GDP and passenger numbers for the EU 25 countries (see Figure 5.1).

The graph indicates that, at a broad level, as GDP increases, the number of passengers travelling by air increases. However, this is only an approximate relationship, as indicated by the relative position of the five largest EU economies. For example, Germany has nearly three times the GDP of Spain, but about the same number of flights. Meanwhile, France and the UK have approximately the same GDP, but the UK has nearly double the number of flights. Indeed, it is notable that the UK has more flights than any of the other EU25 countries, and drawing a trend-line through the results suggests that the UK has considerably more flights than any simple relationship between GDP and flying would imply.

Expanding on the lower section of the graph confirms that the relationship between GDP and flying is not direct (Figure 5.2)[40]. Whilst there is a broad trend, there are many examples of countries with lower levels of flying than others, but higher GDPs, or, alternatively, higher levels of flying than others, but lower GDPs.

Hence, the argument that a particular level of flying is an inevitable consequence or determinant of a given level of GDP – and is impervious to policy intervention – cannot be sustained.

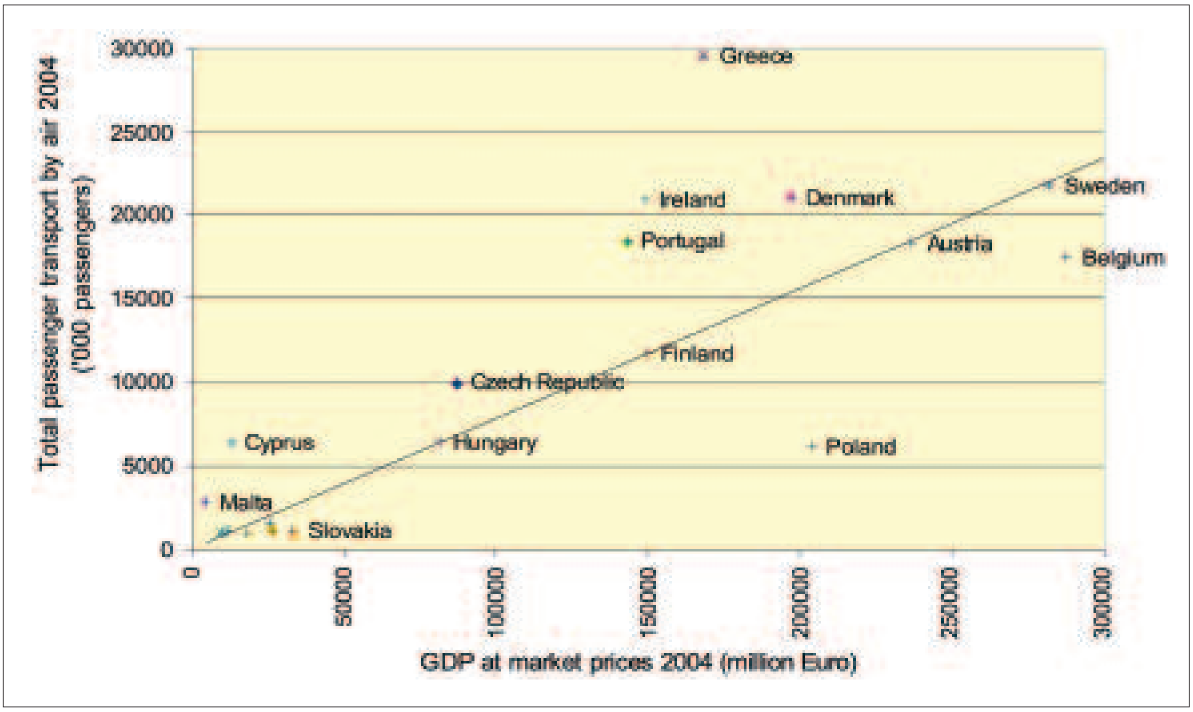


Figure 5.2 Relationship between GDP and flying for EU countries with a GDP of up to 300billion Euros in 2004

Source: Data on passenger numbers taken from De La Fuente Layos (2006). Data on GDP downloaded from the Eurostat website, epp.eurostat.cec.eu.int, on 22/3/06

5.3 Does aviation's tax status distort assessments of its value?

There is a debate about whether aviation is receiving appropriate tax treatment, since it is exempt from fuel duty, VAT is not charged on air tickets and some goods sold enjoy duty free status. Currently, the only tax paid on air tickets is Air Passenger Duty, which is £5–£40 depending on the class of travel and the destination[41]. Air Passenger Duty is discussed further in section 9.6.

Those in support of the current regime argue that aviation's tax status is similar to the tax treatment of bus and rail services and can be justified on the grounds that air travel is a form of public transport. Bus operators on registered services are reimbursed for a major part of fuel duty and railways pay a low red diesel rate, while VAT is not charged on public transport. The counter-argument is that such treatment is motivated by both social and environmental objectives: it reduces the cost of public transport to the benefit of those who depend on it for daily journeys, including those who do not have access to a car. It also encourages more people to use public transport in preference to driving, thereby reducing emissions. Air travel, which caters primarily for richer sections of society making leisure journeys, and which is an especially environmentally damaging mode of travel, cannot be regarded in the same light. Hence, it is unclear why it should merit the same kind of tax treatment.

Instead, it is argued that air travel has more in common with car travel, and should therefore also be subject to VAT and fuel duty.

A further argument sometimes made against this is that the aviation industry covers the cost of its infrastructure through landing charges. However, car drivers also pay vehicle licence tax, but are nevertheless subject to both fuel duty and VAT on petrol.

If it is accepted that aviation should be taxed at similar levels to motoring, then it can be argued that the industry currently benefits from a public subsidy, through tax exemptions, and that this needs to be taken into account in assessing its economic benefits. Conversely, the public revenue that could be gained from such taxation must be regarded as a potential benefit that would arise from a policy of demand restraint that includes fiscal measures. A further implication is that the current expansion in air travel is partly artificially driven by the fact that aviation is under-taxed.

It has been calculated that the revenue lost to the Treasury as a result of aviation's tax treatment in relation to fuel duty, VAT and duty free, is considerable, amounting to £10.1 billion a year, or £9.2 billion net, if revenue from Air Passenger Duty is deducted (Sewill, 2003). Interestingly, this equates fairly well with an estimate made by Sewill (2003) for the cost of the environmental damage caused by aviation, as discussed in 5.4.

5.4 Official cost benefit calculations

In determining its position for the Aviation White Paper, the Government undertook specific cost benefit analysis. In supporting documentation (DfT, 2003c, Annex C), the Government clarifies that this cost benefit analysis considers five categories of direct economic benefits, namely:

- The reduction in costs to passengers who, in the absence of additional airport capacity, would transfer to less preferred airports or not travel by air at all.
- Benefits to existing passengers from additional air frequencies enabled by higher airport capacity.
- Producer benefits to airport operators from additional capacity[42].
- Additional Air Passenger Duty (APD) to Government from the use of additional airport capacity.
- Benefits to air freight movements.

It also clarifies that by far the largest benefit in this calculation is the reduction in costs to passengers who, in the absence of additional airport capacity, would transfer to less preferred airports or not travel at all. The appraisal compares the capital costs of airport development with the user benefits and producer benefits generated by the investment[43].

Specific figures for the costs and benefits are then contained in *Aviation and Global Warming* (DfT, 2004a), which finds that the net benefits of a new runway at Stansted in 2011 and another at Heathrow in 2015, considered over the period 2003–2060 are worth £17.08 billion while, even without assuming any fuel efficiency savings from technological development, the cost of the global emissions is calculated as being only £5.17 billion, meaning that the benefits of this expansion outweigh the costs by £11.91 billion.

Perhaps the first point to note about this approach is that many people might find it counter-intuitive. If told that an expansion in aviation would bring large economic benefits to the economy, they might expect this to mean that it was important to growth in GDP or perhaps to the overall level of jobs, rather than that the main measure of this importance was derived by attaching a value to the benefits enjoyed by the passengers themselves. There are therefore some concerns about the narrow basis on which the calculations have been undertaken.

In addition, the analysis of benefits has been criticised for placing too high an emphasis and value on passenger time in the future, with estimates that suggest an ever more frenetic pace of life. Sewill (2005) reports that the Department for Transport's SPASM computer model assumed that business travellers valued their time at £42 an hour, rising to £87 in 2030, whilst leisure travellers' time, now valued at £6.60 an hour would double to £12.80 (at present prices – the increases are not the result of inflation, but of higher incomes). Sewill questions whether everyone will actually value their time twice as highly in 2030 as they do now, and whether society would really welcome this. He reports that a re-run of the SPASM model, assuming that time will be valued in future as it is now, led to the economic benefits of new runways being roughly halved. Sewill's view on the future value of travel time is supported by a finding of the National Travel Survey (DfT, 2005c), namely, that in the last ten years, while distance travelled has increased, the average time spent travelling by all means has remained roughly the same (about an hour a day). This suggests that people are still allocating the same kind of time budget to travel in terms of the amount of the day that they are prepared to spend on it.

Another issue is that, where time is so highly valued, then for business travellers particularly, stepping onto an aeroplane rather than into a video conferencing suite could be prohibitively expensive. If the Government were to adopt policies to constrain flying and encourage the development of more sophisticated facilities for video conferencing, the economic benefits (valued in terms of time savings) could be extremely high. The point has been picked up by Whitelegg and Cambridge (2004) who argue that, for business purposes, while some physical face-to-face meetings will always be necessary, many journeys can be replaced by the use of communications technology with immediate financial benefits. They cite a study by REGUS (1998), which showed that if ten people were to conduct a two-hour video conference between London and Chicago, the cost would be €3,439 whereas air travel expenses for the same meeting would be €65,755.

None of this is to suggest that business people do not value flying abroad for a business trip or that tourists do not value flying to the sun. However, it is not obvious that time is the most appropriate 'currency' in which to measure that value. Moreover, quantifying the benefits of these activities is not helpful for policy unless the potential benefits of pursuing alternative policies are considered alongside. For example, if, for argument's sake, aviation were taxed as a means of restraining demand and the generated revenue was spent on education, what would be the economic benefit of such an investment by 2030? Or if, as a result of a rise in airfares over time, UK residents were inclined not to take increasing numbers of holidays abroad (as the Government's current predictions suggest they will) what would be the value in monetary terms of the resulting investment in UK tourist areas, and the subsequent benefits to both residents and visitors from this regeneration? The tourism issue is addressed in more detail in section 5.7.

A final criticism of the Government's assessment is that it has not only overvalued the economic benefits of flying, but has undervalued the environmental cost. Specifically, Sewill (2005) argues that the analysis outlined in DfT and HM Treasury (2003) is flawed because of the multiplier it uses to allow for the non-CO_2 impacts of aviation, the value it assigns to a tonne of carbon and the exclusion of the upstream and downstream costs related to the manufacture and disposal of aircraft. Using what he considers to be more realistic figures, Sewill estimates the external cost of passenger aviation to be somewhere in the range of £6–12.5 billion a year.

It should be noted here, that the values attributed to environmental damage generally are an important area of debate, and that many issues have yet to be resolved. DEFRA has recently pointed out, in a policy statement (DEFRA website, 2006), that recent estimates of the social cost of carbon refer to those impacts of climate change that can currently be measured in monetary terms. It adds that there are areas of uncertain but potentially major impacts that the current models are not capturing, and that estimates of costs are likely to increase over time more rapidly than previously assumed. DEFRA's statement concludes that, while for the time being, its guidance on these costs remains unchanged, they intend to reconsider the position once the Stern Review has reported in Autumn 2006.

5.5 Aviation jobs

According to Transport Statistics Great Britain, the Civil Aviation Authority reports that, in 2004, 83,572 people were employed by UK airlines worldwide (DfT et al, 2005). Using a wider definition of aviation employment, the Aviation White Paper states: *"The aviation industry... directly supports around 200,000 jobs, and indirectly up to three times as many"* (DfT, 2003b, para. 2.6).

However, the 'job creation' value of aviation has been questioned again by Sewill (2005). In particular, he argues that such claims of economic benefit fail to take into account the tax subsidy that the industry receives through the exemptions from fuel duty, VAT and tax on duty free goods discussed in 5.3. As a result, he calculates that every aviation job is currently subsidised to the tune of £45,000 a year.

Sewill argues that, in terms of its contribution to GDP, (2% according to the White Paper), aviation is only a medium sized UK industry, similar to mechanical engineering, hotels or restaurants, and deserves no special treatment to justify its privileged tax status. Moreover, he points out that the additional revenue that would be raised by a fair level of tax could generate 200,000 new jobs – the same number as are otherwise forecast for aviation by 2030 (given that aviation employment is forecast to double by then) – but in other sectors. He also comments that while the Government has highlighted the benefits of indirect employment generated by aviation, such claims could equally be made for the indirect employment generated by an expansion of employment in health or education – for example, through the generation of new jobs in the supply industries that serve these sectors. Alternatively, if the additional revenue were used to finance cuts in income tax, then this would also be expected to benefit the economy as a whole.

Assumptions about the additional jobs that would be generated by new air capacity are also questioned in a report commissioned by both the aviation industry and the Government. In its 1999 assessment of the contribution of aviation to the UK economy, Oxford Economic Forecasting considers the impact on the economy as a whole that would result from a restriction in passengers to 25 million fewer than projections by 2015. If this were to happen, OEF estimate, it would result in 17,000 fewer people directly employed by aviation. But the report goes on to say that there would be: "*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*". (In practice, levels of productivity and living standards would depend on the nature of the replacement jobs involved.)

The point about overall employment is also taken up by Berkeley Hanover Consulting (BHC, 2000) who highlight that passengers constrained from flying will have more disposable income to spend on other goods and services, such as a holiday in the UK or buying consumer items, with potential job creation benefits. BHC also argues that the expansion of airports in South East England could have adverse consequences for the local labour market, by crowding out other businesses and significantly raising local housing prices.

5.6 Business costs and foreign direct investment

In 2004, around 22% of all trips made to or from UK airports were for business purposes, with 15% by UK residents (Table 3.1). The Government's South East consultation document says failing to build new runway capacity would result in increased business costs and some reduction in attractiveness to foreign direct investment (DfT, 2003a).

In its assessment of the economic benefits from aviation, OEF (1999) comments: "*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.*" OEF also argues that the sectors of the economy on which the UK is likely to depend for future growth make comparatively heavy use of air travel. The report comments that spend on flying is relatively high in insurance, communication services and the banking and finance sectors, which it identifies as some of the rapidly growing industries that contribute to the knowledge economy. OEF concludes that a rise in the cost of flying, as a result of constraints on capacity, could have an impact on the competitiveness of such industries.

A central argument against this is that, in general, business travellers are less price responsive than leisure travellers (see section 6.4), and are therefore less likely than leisure passengers to be deterred from flying by higher prices. Moreover, where businesses are price responsive, it may be that a rise in the cost of flying will simply lead them to become more discriminating about the trips they choose to make by air. BHC (2000) suggests this, arguing that a business faced with additional costs in air travel will respond by dropping those journeys that have marginal business benefits. They find it far-fetched to believe that, "*for the want of a couple of hundred pounds on the air budget, millions of pounds of profitable trade will be lost*". A corollary of this is that businesses obliged to review their travel policies may well make overall savings in the process – as discussed in 5.4. The experience of workplace travel plans and fleet management initiatives indicates that businesses are often unaware of the costs attached to business travel or the amount of working time that staff sacrifice in the process of travelling. It would therefore be a mistake to assume that current practice, based on the availability of relatively cheap air travel, is necessarily optimal from a business perspective. Indeed, some companies are already reviewing their current air travel on this basis. For example, Credit Suisse is strongly promoting teleconferencing and has messages on the home page and travel pages of its website encouraging employees to consider whether their air travel is really necessary. It reports that, in 2005, its worldwide use of videoconferencing rose 14%, whilst the growth in air mileage was zero (Cohen, 2006).

Fast growing companies are likely to be quick to adapt in a changing cost environment, and this is particularly the case for those closely involved in the knowledge economy, who will have a head start in their ability to replace less essential face-to-face meetings with electronic forms of communication. Indeed, the development of increasingly user-friendly virtual conferencing facilities for business purposes could represent a good UK business opportunity in its own right.

BHC is also sceptical of the suggestion (again made by OEF) that there is a clear relationship between air capacity and foreign direct investment. They point out that detailed reports on inward investment show that investment decisions depend on a range of factors, including land prices, labour costs, market size and political stability. As discussed in 5.2, the relationship between transport links and economic prosperity is not a straightforward one.

In its South East consultation document (DfT, 2003a), the Government comments that, while restrictions to airport capacity would generally tend to reduce leisure rather than business passengers, on domestic routes both types of passenger would be particularly hard hit. However, one reason why domestic business passengers might be more responsive to a rise in the price of flying than international ones is the availability of competing high speed rail links, potentially offering an acceptable alternative to flying (see section 5.8).

5.7 Tourism impacts

5.7.1 A growing tourism deficit

Another critical part of the economic case for aviation is that it helps to boost tourism income for the UK. Specifically, the Aviation White Paper states: *"Britain's economy is in turn increasingly dependent on air travel... Around 25 million foreign visitors a year contribute to a tourism industry that directly supports more than two million jobs; two thirds of these visitors come by air"* (DfT, 2003b, para. 2.5).

Later picking up on this statement, it again raises "*The importance of in-bound tourism to the UK economy*" commenting that *"It accounts for an estimated 4.4% of GDP in 2002, and more than two million direct jobs"* (DfT, 2003b, para 4.22).

This is incorrect – based on an apparent misappropriation of domestic tourists as inbound ones[44]. Figures from Visit Britain and National Statistics show that *all* UK tourism, including spending by both overseas *and* domestic tourists, contributed around 4% of total GDP[45] in 2002, with UK residents contributing the majority of this.

Meanwhile, spending by UK residents travelling abroad by air is greater – and has increased faster than spending by overseas residents visiting the UK by air (Figure 5.3). Overall, this suggests that the growth in air travel is contributing to a growing 'tourism deficit'.

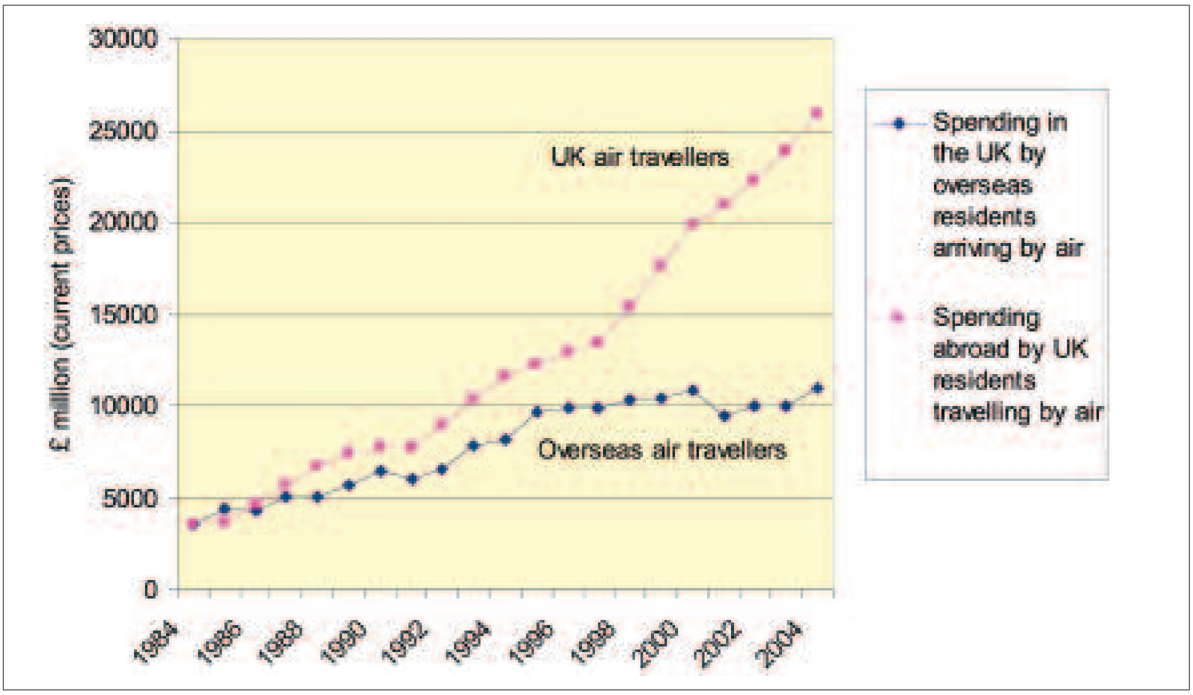


Figure 5.3 Spending by UK air travellers and overseas visitors, current prices

Source: Data taken from table 1.07 and 1.08 of the International Passenger Survey (National Statistics, 2004b, pp22–23), and refers specifically to spending by air travellers.

This is not an original observation. The loss of income from UK tourists travelling abroad and the resulting impact on the health of the tourism industry, is a focus of concern in the Government's prospectus for tourism, *Tomorrow's Tourism Today* (Department for Culture, Media and Sport, 2004). Specifically, it states: *"the UK's tourism 'balance of payments' was £15 billion in the red in 2002"*, based on a comparison of incoming visitor expenditure versus outgoing spending by UK residents. In 2005, the UK tourism deficit is reported to have hit £17 billion (Press Association, 2006) despite record numbers of overseas visitors.

A House of Commons research paper on tourism (HoC, 2003) also comments that UK tourism abroad has grown steadily and rapidly in recent years, in contrast to domestic tourism (i.e. tourism activities undertaken in the UK by UK residents). It reports that, from 1995 to 2002 overseas tourism by UK residents, in terms of trips made, increased by 44% while domestic tourism rose by only 13%.

The paper looks at the contribution of all tourism to GDP[46] and shows how much this is eroded by the loss of earnings abroad. It finds that, in 2002, tourism revenue – comprised of UK residents' spending in the UK (£26.7 billion) and overseas residents' spending in the UK including fares paid to UK carriers (£14.9 billion) came to £41.6 billion in total, representing a gross contribution to GDP of 4.0%.[47] Meanwhile, according to the International Passenger Survey, UK residents in turn spent nearly £27.0 billion *overseas* in the same year, which, the paper argues, can be thought of as an effective import of goods and services. Subtracting the £27.0 billion spent abroad from all other tourism revenue in the UK, the paper argues that the *net* contribution of tourism to GDP was therefore 1.4% in 2002. This is without taking fare payments by UK residents to overseas carriers into account. If these were included, the true net contribution would be even lower[48].

In 'Britain Inbound' (2006a), Visit Britain's latest market and trade profile, the balance of payments deficit is raised again, with the authors commenting: *"For every £1 spent by an overseas resident in the UK, a UK resident visiting overseas spends £2.32. Typical air fares paid in Britain have risen by around 5% in the last eight years, compared to those paid in other EU nations, which have risen by around 20% – so far it has been the British outbound traveller who has benefited the most from the low-cost airline boom".*

In brief, then, there is strong evidence that the growth in aviation has, overall, had a net negative effect on the UK tourism industry, since there is more money leaving the country than is being attracted in, and that this problem is increasing. Hence, an expansion in air travel cannot be justified on the grounds of economic benefits for tourism.

This conclusion can be challenged if it is assumed that all recent trends reverse in the future – i.e. that overseas air traveller numbers and spending will increase dramatically whilst the growth in travelling and spending by UK residents becomes significantly moderated. However, whilst this is a feature of existing Department for Transport forecasts, as highlighted in section 3.7, given that current trends are suggesting an entirely different scenario, it would seem unwise to base an entire economic strategy on this assumption.

Meanwhile, the analysis outlined above also indicates that the majority of spending at UK tourist destinations is not reliant on international aviation, since it is actually coming from UK residents. For example, figures from Visit Britain show that in 2003 spending by UK residents accounted for four fifths of the UK's £74 billion tourism earnings[49].

If air travel by UK residents were deterred by an increase in the price of flying, it could not be assumed that this would all convert into domestic tourism, as people forgoing an overseas holiday might choose to spend the time and money saved in a number of ways. However, there is some evidence that there is likely to be some gain, as discussed further in section 5.7.3.

5.7.2 A tendency to focus on overseas visitors

The Department for Culture, Media and Sport is aware of the crucial importance of the domestic market. In recent years, it has given it increased weight in both funding and policy terms, and says that this trend will be continued in its forthcoming Tourism 2012 Strategy (DCMS, 2006).

Table 5.1 Breakdown of tourism spending in the UK in 2004

	Trips (in millions)	*Nights (in millions)*	*Spend (in millions)*	*Spend per trip*	*Spend per night*
UK residents	126.6	408.9	£24,357	£192	£60
Visitors from North America	4.356	39.476	£2,877	£660	£73
Visitors from Europe	19.424	121.391	£6,623	£341	£55
Visitors from other countries	3.975	66.539	£3,546	£892	£53

Source: Data from the 2004 UK Travel Survey about tourism trips by UK residents involving an overnight stay (Visit Britain, 2006b), and data from the 2004 International Passenger Survey about trips made by inbound visitors (National Statistics, 2004b).

Nevertheless, the Government has historically been inclined to focus on the benefits of attracting overseas visitors rather than the potential for recapturing a share of the outbound UK tourist market, and so drawing back some of the large amounts of tourist spend currently haemorrhaging overseas. The Aviation White Paper reflects this tendency, with the Government focusing particularly on the benefits of its policies to the inbound tourist market, whilst neglecting the impact of those same policies in eroding the important domestic market.

The tendency to over-concentrate on overseas visitors is also shown by the reaction to the events of 2001 (namely, the foot and mouth outbreak, and the terrorist attacks of September 11th). For example, as reported in the House of Commons research paper, in commenting on September 11th, the Secretary of State for Culture, Media and Sport (Tessa Jowell) is quoted as saying: *"The impact on the British tourism market is severe, because transatlantic tourists typically spend £6 for every £1 spent by a domestic tourist"* (HoC, 2003).

This is in spite of the fact that, as already observed, domestic tourism spending overall represents a much greater share of tourism earnings than tourist earnings from overseas visitors. Moreover, whilst spending *per trip* is higher for overseas visitors, spending *per night* is similar, as shown in Table 5.1. This is particularly important given that one of the growth markets for tourism generally is in short break trips (rather than longer holidays).

5.7.3 Spending in the aftermath of foot and mouth and the terror attacks of September 11th

There is some interesting evidence from the events of 2001, which perhaps gives some insight into the issue of whether, if air fares were increased, some of the potential loss of income from overseas tourists could be counterbalanced by an increase in revenue from domestic tourism.

The House of Commons Research Paper on Tourism looked at the impact of both Foot and Mouth Disease in spring 2001, and the terror attacks of September 11th 2001. Both appear to have been devastating for the industry. The (then) British Tourist Authority (BTA) reported that the outbreak of foot and mouth disease and the way it was depicted in overseas media meant that visitor expenditure was down 16% against pre-foot and mouth disease forecasts by April 2001. The attacks of September 11th hit Britain's inbound tourism industry again, with spending in October 2001 down 27% on original forecasts. Total losses over the whole of 2001 were estimated at £2bn (15%).

Whilst the overall losses in 2001 were clearly severe, the pattern of tourism spend in the aftermath of September 11th may have implications for aviation policy. The BTA reports that rural areas that had suffered from Foot and Mouth Disease subsequently benefited from UK residents staying at home. Specifically, a survey by the English Tourism Council indicated that around 900,000 UK holidaymakers changed their plans between October 2001 and the end of December 2001 and decided to holiday at home, instead of abroad. Analysis of spending data for that period indicates that this offsetting increase in spending by domestic tourists may have been very substantial.

Data on domestic spending are available via the UK Tourism Survey[50], which reports on spending by UK residents making an overnight stay, and excludes day trip tourism.

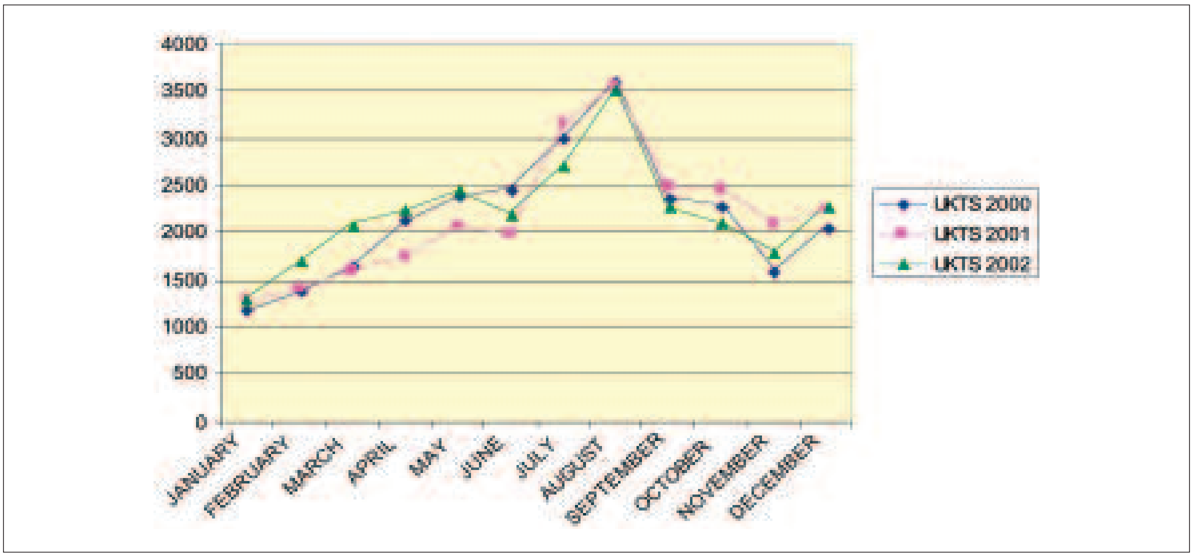


Figure 5.4 Spending by UK residents making overnight stays in the UK (£million)

Data supplied by Visit Britain (2006b) and sourced from www.staruk.org.uk

Figure 5.4 illustrates spending in 2000, 2001 and 2002. If the 2000 data are taken to show a typical annual trend line, then the graph shows, first, that spending was lower than expected in the early part of 2001 (as would be expected from the spring outbreak of foot and mouth), but appears to be higher than average for the end of 2001 and the beginning of 2002. Analysis of the post September 11th impacts is given in Table 5.2.

Table 5.2 Spending by UK residents making overnight stays in the UK (in £million)

	Before Sept 11th (2000 data)	*After Sept 11th (i.e. Q4 2001 and Q1 2002)*	*Change*	*% change*
Oct-Dec	5940	6782	+842	+14%
Jan-Mar	4202*	5096	+894	+21%

*Note that 2001 data for Jan-Mar are not used due to foot and mouth

There is an issue about whether some increase in spending (due to annual increases in spending on tourism) should have been expected anyway. In 2003, total tourism spend by UK residents in the UK was reported to be £26,482 million, compared with £26,132 million in 2000 – an increase of 1.3%. It is clear that the increases recorded after September 11th are significantly greater than this. Adjusting the recorded increase in spending after September 11th downwards, to allow for this increase of 1.3% over three years, suggests that the total increase in spending in the six months after September was perhaps in the order of £1,678 million[51].

Meanwhile, data about spending by overseas residents visiting the UK are available from the International Passengers Survey, broken down by quarter, as given in Table 5.3.

Table 5.3 Spending by overseas residents on visits in the UK (in £million)

	Before Sept 11th (2000 data)	*After Sept 11th (i.e. Q4 2001 and Q1 2002)*	*Change*	*% change*
Oct-Dec	2911	2266	−645	−22%
Jan-Mar	2314*	2025	−289	−12%

*Note that 2001 data for Jan-Mar not used due to foot and mouth

Again, without foot and mouth and September 11th, an increase in spending from overseas tourists would have been expected, making the losses even greater than reported here. Between 1999 and 2000, spending by overseas visitors to Britain increased from £12,498million to £12,805 million, an increase of 2.5%

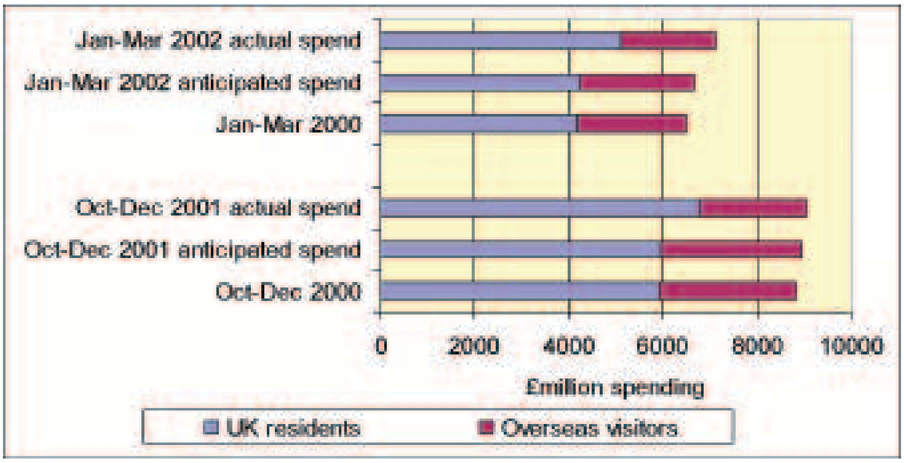


Figure 5.5 Changes in spending patterns caused by September 11th 2001

Note: Anticipated spending is based on an assumption that, without September 11th, there would have been 2.5% p.a. growth in spending by overseas residents and 0.4% p.a. growth in spending by UK residents.

in spending. Therefore, adjusting the figures for overseas loss upwards, to allow for the potential increase in revenue that would have occurred if 2.5% p.a. growth had continued, suggests that the total loss in spending from overseas visitors was in the order of £1,123 million between October 2001 and March 2002.[52]

Hence, having adjusted the figures for domestic gain downwards to allow for a potential increase in spending that might have occurred anyway, and adjusting the figures for overseas loss upwards, to allow for potential increases in revenue that might otherwise have occurred, the figures suggest that the money lost from overseas tourism (–£1,123million) was still significantly outweighed by an increase in domestic spending (+£1,678million) in the six month period after the September 11th attacks. This is illustrated in Figure 5.5.

This is a simplistic analysis and the impacts of security concerns will inevitably be qualitatively different to the effects of an increase in airfares. Nonetheless, the post September 11th experience does indicate that there is considerable opportunity for an increase in spending on tourism by UK residents to compensate for a decline in spending on tourism by overseas visitors, if air travel became less desirable.

Looking over a longer time period, there is some evidence that the impact of September 11th on UK residents deciding to travel abroad was relatively short lived. In contrast, partly due to additional events, including the outbreak of SARS and the Iraq conflict, spending by overseas visitors to the UK only recovered by 2004. Consequently, over a longer period, increased domestic spending by UK residents did not compensate for lost incoming revenue from overseas visitors. However, *unlike* September 11th, there is no reason why UK residents should be more or less resistant to price changes than travellers from abroad, so the same situation is unlikely to apply. It follows that increasing the price of flying could potentially boost the tourism market, rather than undermine it, particularly if combined with supplementary measures to further enhance the attractiveness of the UK as a holiday destination for UK residents.

A further observation is that one legacy of the 2001 Foot and Mouth crisis has been a positive re-assessment of the importance of tourism to the economic vitality of rural areas, and the realisation that this had previously been undervalued in determining policy. It is arguable that a similar reassessment needs to be made on the importance of domestic tourism to the vitality of the UK tourism industry, with consequences for UK policy on aviation.

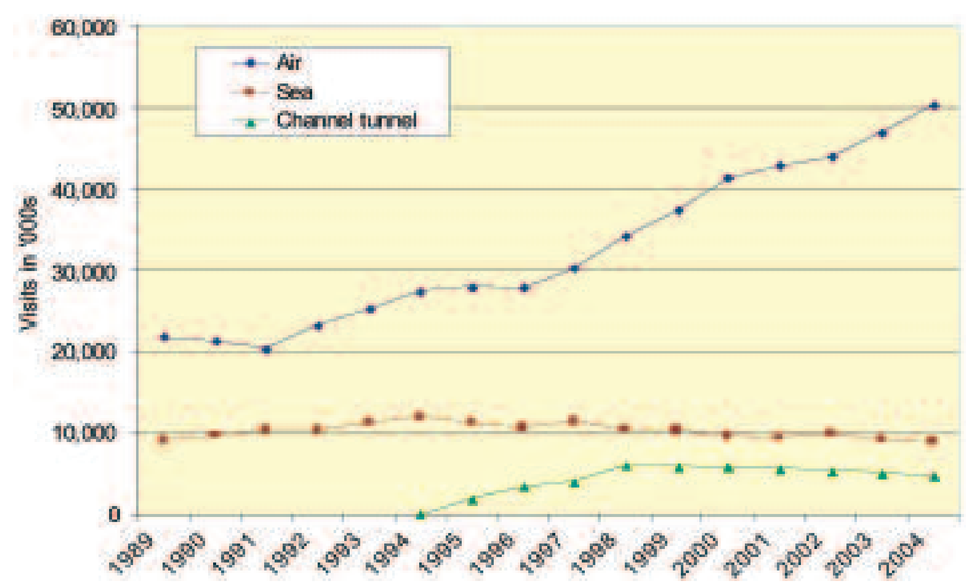


Figure 5.6 UK residents' visits abroad by mode of travel

Source: Data taken from the 2004 International Passenger Survey, Table 1.08 (National Statistics, 2004b)

5.8 Consideration of other travel industries

A general criticism of the Government's presentation of the benefits from aviation is that they focus on the economic winners from an expansion in flying, whilst giving inadequate consideration to significant losers. For example, if air travel were to become more expensive, railway and ferry companies would stand to gain, with some of the same benefits for the wider economy as those that potentially arise from investment in aviation.

Assessing the extent to which the ferry companies have suffered as a result of the growth in cheap flights is problematic, because the liberalisation of the European air market, which took place in 1993, coincided with the opening of the Channel Tunnel, which had a significant effect on cross channel services to France. Nonetheless, there is some evidence that both rail and sea have suffered as a result, as shown in Figure 5.6. Following the opening of the Channel Tunnel, it is clear that the ferry trade suffered (with rail use increasing whilst ferry use dipped). However, this effect seems to have been relatively short-lived. By 1998, Channel Tunnel use had begun to plateau, whilst ferry use continued to slowly decline.

Meanwhile, the number of total weekly seats on 'no-frills' carriers rose dramatically in the late 1990s. In 1995, there were less than 100,000 weekly seats. In 1997, this more than doubled, to over 200,000 weekly seats, and, by 2000, there were more than 500,000 weekly seats on no-frills carriers (ABTA, 2004). This seems to have partly been at the expense of both rail and sea. It is, of course, very difficult to assess how much sea or rail travel would increase if flying became less attractive. However, prior to new competition (from the Channel Tunnel and cheaper air fares), ferry use had been a growing market, as had Channel Tunnel use, prior to the expansion of the cheap airlines. This suggests that these modes could have significant potential to increase again.

This relationship is also addressed by Whitelegg and Cambridge (2004, p32). They point out that 45% of all European flights are over distances of less than 500kms, many of which have the potential to transfer to rail. As an example of successful rail substitution, they quote the introduction of the Paris–Lyon TGV service in 1981, which led to an annual average fall of 17% in Paris–Lyon air passenger traffic between 1981 and 1984. A more recent example of modal shift from air to rail can be found in Britain, with the introduction of high speed west coast tilting trains in September 2004, which are reported to have increased Virgin Train's market share from 40% to 60% over 13 months. The worst hit airline, BMI, reportedly suffered a 26% collapse in passengers between Heathrow and Manchester between September 2004 and October 2005 (The Guardian, 27/1/06). Whitelegg and Cambridge caution that a substantial transfer from air to rail will not happen by chance and requires a clear steer from Government policy. They also suggest that a high speed rail route from Heathrow Airport to other key UK cities could dampen the need to expand regional airports, while acknowledging that better rail routes for airports may also add to the attractiveness of air travel.

The relative environmental credentials of rail, air and other modes are a subject of considerable debate, (see, for example, DETR 2000b, CfIT 2001, Maibach and Schneider 2002, SRA 2003, CE Delft 2003, Kemp 2004, Osmaston 2006, T&E/CAN-Europe 2006). However, there is a general consensus that, per passenger kilometre, a well loaded, modern train, bus or car contributes considerably less to climate change than its aviation equivalent, particularly when non-CO_2 impacts are included. Moreover, where changing modes is accompanied by a change in destination, such that people undertake shorter journeys, the environmental benefits are likely to be considerably enhanced.

5.9 Air freight

As outlined in section 3.8, air freight has significantly different characteristics to passenger travel, being concentrated at London airports, and with a significantly greater proportion of movements to and from non-European destinations.

The Aviation White Paper argues for its economic importance, stating: *"one third of our visible exports, by value, now go by air. Exports of services, which depend on the ability to travel by air, make up a further 80% of our national income."*

However, such claims require further detailed consideration. It is of note that:

- 22% of air freight, by weight, is simply passing through the UK (with extremely limited benefits to the UK).
- 13% of imports, by weight, are fruit and vegetables (which are potentially undercutting the market for home grown crops or could be relatively easily substituted by goods transported in other ways).
- 12% of purchases of air freight, by value, are made by the aircraft industry itself.
- In some areas, such as the transportation of business documents, it is possible that improving telecommunications (including web and email) could reduce the need for some of the express air freight services.
- Bishop and Grayling (2003) claim that more readily available, cheaper air freight services have meant that transport by air is no longer solely the preserve of light-weight, high-value or express goods, for which it has the most obvious value.

Finally, rates of growth of air freight have slowed dramatically in recent years and may now be negligible, making an airport capacity expansion particularly difficult to justify on the basis of air freight alone.

In policy terms, it should be possible to introduce mechanisms to protect the air freight industry from increasing costs that may be placed on aviation to try to reduce passenger demand. However, it is unclear whether, for the sake of the economy, these mechanisms should be invoked. Alternatively, as with passenger demand, there may be an equal case for ensuring that air freight pays its full environmental costs, encouraging more judicious use of air transport and a shift towards other modes, while giving greater comparative advantage to local products. This would be an important area for future research.

5.10 Summary

This chapter has examined many of the economic arguments put forward in favour of aviation. While recognising that the industry brings some economic benefits, it highlights that there are a number of important, offsetting effects that need consideration, and that it cannot be assumed that restricting future growth in air travel will necessarily be economically detrimental. In particular, it argues:

- Assessments of road transport have shown that the relationship between transport provision and economic wellbeing is complex, and improved links between places may benefit either end of that link, potentially at the expense of the other. This argument could apply equally to improved connections from air travel.

- There is no ‘natural’ relationship between GDP and aviation. For example, the UK has higher passenger numbers than any other country in the EU, even though it does not have the highest GDP.
- The explicit cost-benefit analysis undertaken for the Aviation White Paper focused primarily on savings for passengers, assuming that the value of time would increase steeply in future. Both the appropriateness of the measure of value, and the values used, have been questioned.
- Whilst the White Paper emphasises the ‘job creation’ benefits from aviation, it fails to fully address the tax exemptions that the sector enjoys. If these are taken into account, and the impacts of equivalent investment in other sectors of the economy are considered, then an alternative strategy could offer significant economic benefits.
- The main impact from a rise in the cost of air travel would be on leisure rather than business travel. Where businesses are affected by higher air travel costs, they can be expected to adapt in a number of ways, becoming more discriminating about the trips they choose to make and making greater use of communications technology, with potential time and money savings.
- For tourism, spending by UK residents abroad is currently greater, and is increasing faster, than spending by overseas visitors in the UK. In the six months after the terrorist attacks of September 2001, spending on UK tourism actually rose, because more UK residents decided to holiday at home, and their spending more than offset lost revenue from incoming visitors.
- The White Paper gives inadequate consideration to the losers from investing in aviation. There is evidence to indicate that the ferry and railway industry have suffered significantly from aviation growth. There is also evidence to suggest that other modes could compete with aviation, if appropriate conditions were created.
- There are reasons to question the assumption that all air freight is economically essential.

In general, then, a policy of demand restraint in aviation could potentially bring some economic benefits for the UK, for example, by helping to rebalance the tourism deficit, by generating public revenue and by reducing the negative impacts from the growth in flying on competing sectors. The economic case for such an approach is worthy of detailed consideration.

Could a Rise in Air Fares Reduce the Growth in Flying?

6.1 Introduction

This report argues that demand restraint must form part of a strategy to mitigate the environmental impacts of aviation. However, even if this conclusion is accepted in principle, there is considerable controversy about how demand restraint could be achieved in practice.

A number of commentators argue that making flying more expensive could form part of a strategy to make it less attractive. Others argue that it is not politically viable to introduce economic mechanisms that would increase prices enough to have an impact on demand, or that the impact of ticket prices is relatively marginal in determining the demand for aviation, compared to other drivers, such as increasing economic prosperity.

This chapter reviews these arguments and the available literature on the relationship between price and demand and, hence, the scale of price changes that might be needed to achieve behaviour change. Subsequently, Chapter 7 discusses public opinion on the issue, whilst Chapters 8 and 9 examine specific measures to make flying more expensive.

6.2 Why pricing mechanisms are seen as potentially ineffective

There are a number of reasons why economic mechanisms may not be considered an effective way of significantly restraining aviation demand.

First, the cost of an airline ticket is made up of a number of components. For example, according to an EC working paper (CEC, 2005a, p25), on average fuel only constitutes 15% of the operating costs of intra-EU flights. (Other commentators suggest 10% or 20%)[53]. Hence, fuel tax – in isolation – only has the potential to alter a proportion of the final ticket price.

Second, it is argued that other factors, such as the total costs of a holiday abroad, are more important determinants of the overall demand for international leisure travel than air fares alone. For example, Njegovan (2006a) states: *"Based on a recent survey of some 550 outbound leisure passengers at Stansted, and Office for National Statistics data, the share of air fares in total expenditure on holidays abroad is, on average, somewhere in the range between 25% and 35%. This being the case, it does not seem realistic to expect changes in air fares alone to generate more than a proportionate change in demand for air travel."* In a recent report on leisure air travel, the Civil Aviation Authority makes a similar point, noting: *"Air fares have fallen dramatically in recent years and so travel behaviour may increasingly be influenced by the costs of other components of travel abroad"* (CAA, 2005c). The CAA report highlights that, in 2004, UK residents spent an average of about £560 (in 2004 prices) per trip, of which £150 was spent on air fares, commenting: "*This means that a given percentage increase in air fares will be equivalent to a much smaller percentage increase in the total costs of a trip to Europe*".

Other commentators have focused on the importance of income and GDP in determining aviation demand, and argue that such macro-economic factors will be far more important drivers of aviation demand than air fares. (The legitimacy of assuming that GDP and aviation demand are inexorably linked has already been questioned in section 5.2).

These factors have led to the belief that very large increases in fares would be needed to make a difference to demand, and that it would be politically impossible to introduce these. For example, highlighting concerns about the scale of charges that might be needed, in responding to a Select Committee on Liaison, the Prime Minister recently stated: *"if you really want to impede air travel, to cut it back significantly, for example, through some taxation mechanism, it would have to be a fairly hefty whack.... if you really wanted to stop people travelling, be clear, it would be a pretty hefty whack you would have to put on travel within the UK or between the UK and another country and I will wait to see who first proposes it"* (Blair, 2006, Q188-190).

Finally, partly predicated on the belief that the Government would only make small, incremental changes to the cost of air travel, it is often assumed that changes in price would be offset, or masked, by fare reductions occurring for other reasons and would therefore be ineffective.

The real reduction in air fares has already been highlighted in section 3.3. The data given there, released by the Department for Transport, indicate that, in the 15 years between 1989 and 2004, in real terms, prices fell by 31% for long-haul business travel;

by 49% for short-haul business travel; by 45% for long-haul leisure travel and by 47% for short-haul leisure travel. Real reductions in fares are also quoted by a number of other commentators. For example, British Airways recently stated that its one-way fares within the UK and Europe had fallen by an average of 70% over the past decade (BBC News, 20/4/06). Dargay and Hanly (2001) reported that average air ticket prices for UK leisure travellers visiting a sample of 20 OECD countries fell by 38% between 1989 and 1998. Njegovan (2006a) reports that, for UK leisure air passengers visiting a sample of 12 EU countries, the weighted average fare fell by about 26% between 1998 and 2003. In short, there is consensus that air fares have reduced significantly.

Moreover, these reductions are expected to continue. As outlined in Annex A of the Aviation White Paper (DfT, 2003b, para.9), in the central national forecasts, fares are forecast to fall by 1% p.a. in real terms between 2000 and 2020[54]. Key factors are seen as being the role of the 'no-frills' sector, which is expected to capture more of the mainstream domestic and short haul markets; greater competitive pressure on traditional scheduled airlines leading them to cut costs in response to the no-frills carriers; and further liberalisation of current regulatory restrictions. The increase in airport capacity is also expected to exert a downward pressure on costs.

The Aviation White Paper reports on modelling the potential effect of introducing a notional fuel tax which would lead to a 100% increase in fuel costs. This work estimated that this would lead to a 10% increase in airline costs (on the assumption that fuel costs were 10% of airlines costs) and that this would lead to a 10% increase in air fares, (on the assumption that the increased costs were passed through in full to passengers). While the model originally forecast in 2000 that this would lead to a 10% drop in passenger demand, those responsible for the modelling have since concluded that airline costs, and hence fares, are declining faster than was previously forecast, and that *"their effect is sufficient to offset the fall in demand expected from the impact of any economic instruments"* (DfT, 2003b, Annex A, p150–1).

In brief then, there are a number of reasons why commentators argue that economic mechanisms – intended to reduce the demand for aviation by making flying more expensive – are likely to be ineffective. These include the fact that the cost of aviation tickets is determined by many things (such that one measure – like fuel tax – would only have a partial effect); the fact that other factors – including other holiday costs and macro-economic factors like GDP – also affect demand; a belief that only *major* price rises would be sufficient to make a difference but are politically impossible; and the fact that other, external trends are likely to cause air fares to fall, thereby offsetting or masking price increases caused by economic policy measures.

6.3 Counter-arguments in favour of using pricing mechanisms

There are a number of counter-arguments to the points discussed above, particularly if the effect of one instrument (e.g. fuel tax) is not considered in isolation, but as part of a package of measures.

First, the calculation that applying a fuel tax will be offset by a forecast fall in fares or other holiday costs is not a logical reason not to introduce a fuel tax. Any additional charge at least partially offsets any other reductions that are occurring, and therefore has some effect on demand, even if this is small. Taxation on alcohol or cigarettes, for example, is not predicated on the basis that any particular increase has to have a radical effect. Instead, the philosophy is that a small increase each year will have an incremental effect on changing behaviour over time. T&E/CAN-Europe (2006) argue that petrol taxation can be considered effective in dampening demand for motoring, since *"countries where road fuel prices are low consume far more fuel than those where prices are high, even when correcting for differences in per capita income"*.

Second, given the steep fall that has occurred in UK air fares, it is not obvious that the Government needs to think only in terms of small, incremental increases in charges or to assume that major price rises are politically impossible. For example, Sewill comments that while a 100% fuel tax[55] may sound substantial, it would only amount to about half the duty (before VAT) charged on motor vehicle fuel. Since air fares have fallen substantially, passengers have become used to significant changes in price, with particularly large reductions in the lowest fares available. It is notable that people talk about 'cheap' flights, whereas they do not generally perceive many other travel opportunities as being 'cheap'. As discussed in the next chapter, there seems to be a degree of public belief that the typical costs of air fares are incompatible with the typical costs of travel by train or car, and there may be potential to build acceptance for charges which appear to rebalance the relative costs of different modes, even if this involves imposing fairly substantial charges over time.

Third, Dargay and Hanly (2001) have estimated that price reductions for air travel have been significantly greater for UK residents than for overseas residents, (Table 6.1), a conclusion also reached by Visit Britain, 2006a (as discussed in section 5.7.1). Hence, the imposition of new charges might not only help to balance the relative price of air travel with that of other modes, but also help to balance the costs of flights offered in the UK compared with those offered in other countries.

Finally, the argument that other factors – such as other holiday costs or GDP – make changes in air fares relatively unimportant, seems suspect for various reasons. It is notable that by far the biggest growth in aviation has occurred in the 'no frills' sector. For example, according to the data given in section 3.3, in 1998, no-frills carriers were responsible for 5% of the market, whilst by 2002, they were responsible for 19%, and 92% of all additional passenger movements that occurred during that period were made on no-frills carriers.

Table 6.1: Change in the price of air travel 1989–1998

Average change in the price for:	*Leisure*	*Business*
UK residents travelling abroad*	–38%	–13%
Overseas residents travelling to the UK*	–24%	+1%

* In both cases, the change given is the change in fares paid between the UK and the sample of 20 OECD countries. The change in UK fares was calculated by converting International Passenger Survey (IPS) data about real fares paid into 1998 prices, using the retail price index (RPI). For trips by overseas visitors to the UK, IPS data was converted into the individual country's local currency using the respective year's exchange rates, and expressed in real terms using the relevant country's RPI. Note that fares in the IPS do not include the fare portion of package holidays. Source: Dargay and Hanly (2001)

There has also been more explicit analyses. Dargay and Hanly (2001) used pooled time-series cross-sectional data to estimate dynamic econometric models for air travel by British residents to a sample of 20 OECD countries, and air travel by residents of those 20 countries to the UK, for the period 1989 to 1998, treating the leisure and business markets separately. This work showed that, whilst the growth in income and trade was linked to the growth in flying, fare reductions had also been important in stimulating air travel, particularly in the UK leisure market. Specifically, they estimated that fare reductions explained about 40% of the increase in leisure air travel over the period studied.

Graham (2006) also reports on an estimate by Dennis (2004), which suggests that, between 1998 and 2001, approximately 5 million of the 13 million passengers carried on low-cost carriers would not have been expected from the growth forecasts of the conventional scheduled airlines, and can therefore be considered to be newly generated traffic. She also states: *"BAA have reached fairly similar conclusions, estimating that the proportion of new passengers varies by route from 33% to 66% and perhaps averaging 50% overall"* (Graham, 2006, p19).

In brief then, there is evidence that lower air fares are driving at least part of the growth in air passenger demand. There has also been more specific analysis to try to quantify the extent to which changes in the price of air travel affect the demand for flying.

6.4 Studies assessing the relationship between the price and demand for air travel

There are various estimates of price elasticities[56] for aviation demand. In 2001, Dargay and Hanly reviewed the literature and undertook new estimations to examine how the relationship between price and demand for air travel changed over time. They estimated that a 10% reduction in UK leisure air fares could be expected to increase air travel by 2.4% in the short run (1 year) and 5.8% in the long run (5–10 years) – i.e. that the fare elasticity for UK residents was –0.24 in the short run and –0.58 in the long run. Table 6.2 summarises these elasticities and the results that they found in the literature.

Table 6.2 Fare elasticities for air travel

Study	Leisure	Business
Dargay and Hanly (2001)	–0.24 to –0.58*	Not significant
DETR (2000a)~	–1.3	–0.5
Graham (2000)	Not significant	
Jorge-Calderon (1997)	–0.5 to –1.0	
Australian Bureau of Transport and Communications Economics (1994)	–0.1 to –2	0 to –0.6

* Range dependent on timescales ~ Values defined as being 'long-run' elasticities

Source: Dargay and Hanly (2001)

In other academic work, Njegovan (2006a) examined the importance of air ticket price, in conjunction with other costs of leisure travel, for travel on a sample of 12 routes between the UK and other EU countries. He estimated a price elasticity for leisure air fares of –0.7[57].

Estimates of the relationship between price and demand have also been made for policy purposes. For example, the Dutch Government's Civil Aviation Department commissioned the creation of the 'AERO' (Aviation Emissions and evaluation of Reduction Options) modelling system, which has been used by the Netherlands Government, the EC and ICAO. This includes a number of elasticities for the relationship between price and demand. The average used was –0.7[58].

A recent working paper of the European Commission (CEC, 2005a, p25) has attempted to bring together the elasticities from a number of studies[59], including review work by Gillen et al (2003). The paper concludes that: *"estimates for average price elasticities in aviation for the whole market typically range between –0.6 and –1.1"*, with –0.8 given as the mid-range estimate. The paper also comments that elasticities differ between different types of flights, being higher for short-haul and for leisure flights than for long-haul and for business flights.

The importance of fares in determining demand has also been discussed in a report for the European Low Fares Airline Association (ELFAA) as a response to the proposed extension of the EU Emissions Trading Scheme to include aviation (Frontier Economics, 2006). This report argues that demand for the low fares airlines is considerably more price sensitive than the demand for the full service airlines, based on the results from a number of studies, (Table 6.3).

Table 6.3 Fare elasticity results put forward by ELFAA

Study	*Elasticity of demand*
OXERA: annual impact in period 2008–12	–0.8 (business) –1.5 (leisure)
CE Delft: impact in 2012	–0.2 to –1.0
Trucost: impact in 2002	–1.0 to –1.5
DKWR	–0.5 to –1.5
Government of Canada	–0.7 to –1.5

Sources: CE Delft (date not given), OXERA (2003), Trucost (2004), Dresdner Kleinwort Wasserstein Research (2003) and Government of Canada (2004) all as quoted in Frontier Economics, 2006, Chapter 5.

The results quoted in the ELFAA study indicate that the price elasticity of demand for air travel lies between –0.2 and –1.5, with most studies suggesting values at the high end of the spectrum. The report states: *"the range of elasticities quoted in the studies indicate that the overall elasticity of demand may be well below 1 for services provided by Full Service Airlines, while the elasticity of demand for services of Low Fares Airlines (including leisure travel) is likely to be well above 1."* The report concludes that, for low fares airlines, the appropriate elasticity is likely to be in the order of –1.5.

Another recent study on the demand for outbound leisure flights from the UK has been undertaken by the Civil Aviation Authority, (CAA, 2005c). Based on econometric analysis, the study concludes that the overall price elasticity of demand for leisure air travel is –0.7 to –0.8.

The CAA study also included a stated preference survey with leisure passengers at Stansted airport, who were asked to state their maximum willingness to pay for the trip they were undertaking. 210 responses were received, from respondents who had paid an average return fare of £70. From the responses, the CAA researchers constructed a series of elasticities, showing how different prices would affect the demand for air travel amongst the group surveyed.

Figure 6.1 shows how price elasticities change as ticket prices increase, and that this effect is not uniform. In particular, for the group surveyed, if prices were increased from £80 to £110, the demand for air travel would reduce much more sharply than if prices increased from £50 to £80, (although this is perhaps not surprising given that respondents had already paid £70 for a ticket). The elasticity value reached –1.5 somewhere between £90 and £100, providing some corroboration of the conclusion of the ELFAA study. The plateauing between £110 and £140[60] implies that the respondents were probably comprised of subgroups, where the majority of one subgroup would be deterred from travelling if tickets increased to over £110, whilst most members of the next subgroup would not be deterred unless ticket prices rose to £150 or more.

Figure 6.1 How ticket prices affected fare elasticities for a group of leisure travellers at Stansted

Source: Data taken from CAA, 2005c, p46

A similar group of respondents were asked, separately, about their likely response if their ticket had been £10, £20 or £40 more expensive, and the responses showed the same effect – namely, that a greater price increase would deter disproportionately more of the respondents from travelling.

In summary, then, the combined results from the various studies suggest that, on average, for incremental fare changes, the fare elasticities for aviation are likely to lie in the range –0.5 to –1.5. In other words, a 10% change in the cost of air travel could be expected to change demand by 5 to 15%. The studies also suggest that elasticities are lower for business trips, long-haul travel and short-term effects, and higher for leisure trips, short-haul travel and long-term effects. People may be more sensitive to increases in the price of lower cost tickets, although the elasticity value will change with the nature of the price increase. The CAA study suggests that, amongst travellers used to paying relatively cheap prices (£70), demand may reduce sharply as ticket prices rise from £80 to £110, with further major reductions as they reach £150 or more.

More generally, the studies consistently indicate that air fares affect the demand for air travel and, by implication, that the volume of air travel is not solely a reflection of economic growth.

6.5 Changes in price needed for demand restraint

It is interesting to assess what scale of price rises might be needed to achieve demand restraint in aviation.

In 2003, a group of environmental organisations asked the Department for Transport to re-run its computer model for forecasting aviation growth to determine what would happen if aviation fuel were to be taxed at the same rate as motor vehicles and VAT were imposed on all flights from UK airports (Sewill, 2005). It was assumed that these changes would be introduced incrementally to 2025, with Air Passenger Duty removed in 2020. The resulting effect on demand was that the number of passenger movements at UK airports would rise from 180 million to around 315 million in 2030, as opposed to the current, unconstrained forecast of 500 million by 2030. Aviation would continue to grow, but by 2% a year, rather than the then assumed growth rate of around 4% p.a. In this scenario, (as already discussed in section 5.3), the tax generated would equate to an extra £9 billion per year. Sewill (2006) comments: *"Since the yield of air passenger duty is, at present, about £0.9 billion, this would mean (excluding any change in demand) increasing air passenger duty tenfold. On economy class fares to Europe, this would mean putting it up from £5 to £50 over 25 years."* This would equate to a rise of less than £2 per ticket per year.

For this report, a new calculation has been undertaken, using the available data about demand elasticities for aviation, to examine the sort of price rises that might be needed to stabilise the demand for aviation. Whether the aim of policy should be stabilisation, reduced growth, or a reduction from current levels of aviation is discussed in section 6.6. Stabilisation is assumed here, because of its conceptual simplicity.

The calculation undertaken assumes that the degree of price rise needed to offset growth will primarily depend on the elasticity between price and demand, and the anticipated growth rates of the sector. For the sake of simplicity, it is assumed that these growth rates already encapsulate the effect of all other relevant changes that may affect aviation demand, such as industry-led changes to fares and growth in incomes and GDP. It is also assumed that existing price elasticities can be used to examine price rises, as well as price reductions. There are a number of limitations to this approach, as discussed at the end of the calculation.

To undertake the calculation, it is necessary to identify relevant growth rates. As outlined in section 3.7.2, Government forecasts currently assume a growth in passenger numbers of about 4% over the next 15 years. Meanwhile, the Civil Aviation Authority reports that growth in passenger traffic has averaged 6% since the mid-1970s, and the growth rate in 2003/04 was in the order of 8%. These are average rates. Meanwhile, growth in the 'no frills' sector has been significantly greater. Specifically, Ryanair report that passenger numbers between December 2004 and December 2005 grew by 26%[61].

These growth rates have been combined with the range of elasticities described in section 6.4, and illustrative prices, to indicate the sort of price rises that would stabilise demand if fares were otherwise unaffected, as shown in Table 6.4.

Table 6.4 Illustrative price rises needed to deter growth

% annual growth	*Ticket price*	*Elasticity*	*Annual price rise needed*
4%	£50	–0.5 to –1.5	
	£100	–0.5 to –1.5	
	£200	–0.5 to –1.5	£5.34 to £16
	£300	–0.5 to –1.5	£8 to £24
6%	£50	–0.5 to –1.5	
	£100	–0.5 to –1.5	£4 to £12
	£200	–0.5 to –1.5	£8 to £24
	£300	–0.5 to –1.5	£12 to £36
8%	£50	–0.5 to –1.5	£2.67 to £8
	£100	–0.5 to –1.5	£5.33 to £16
	£200	–0.5 to –1.5	£6.67 to £32
	£300	–0.5 to –1.5	
26%	£50	–0.5 to –1.5	£8.67 to £26
	£100	–0.5 to –1.5	£17.33 to £52
	£200	–0.5 to –1.5	
	£300	–0.5 to –1.5	

Note: As outlined in section 3.3, in 2004, the average price of a short-haul leisure ticket was £63 and the average cost of a long-haul leisure ticket was £260.

Vacant boxes represent unlikely scenarios, because higher fares are associated with lower growth rates, and vica versa, hence these situations are not considered.

The full service airlines are more likely to be offering long-haul fares in the order of £200–300, with lower growth rates and lower elasticities. For a growth rate of 4% p.a., and an elasticity of –0.5, tickets currently priced at £200–300 would need to rise by £16–24 p.a. to stabilise demand.

Conversely, the low cost airlines are more likely to be offering cheaper short-haul fares and are more likely to have high growth rates. For a growth rate of 26% p.a., and an elasticity of –1.5, tickets currently priced at £50–100 would need to rise by £8.67–17.33 p.a. to stabilise demand.

In other words, these calculations suggest an additional charge in the order of £10 to £25 per ticket per year (perhaps with a £5 or £10 differential between short-haul and long-haul charges) might be sufficient to stabilise the demand for flying, if all other factors feeding into growth forecasts remain unchanged.

It should be noted that this is the *annual* price rise needed. Hence, this would imply charges of £50 to £125 per ticket over five years (in current prices)[62]. The proposed charges are unlikely to be reflected as a straightforward increase in ticket prices, since reductions in fares occurring for other reasons are likely to offset any new charges to a significant extent. The scale of proposed charges is somewhat higher than those in the calculation reported by Sewill (2005). However, this is partly because these charges are calculated on the basis of what would be needed to stabilise aviation growth, whereas the charges reported by Sewill allow for growth of 2% p.a.

There are some limitations with these calculations.

First, given real world experience (i.e. that air fares have generally fallen), the empirical basis for most existing elasticity estimates comes from observing the consequences of reductions in flight prices. In this study, it has not been possible to identify any research which has explicitly defined separate price elasticities for rising and falling air fares. However, several reports have used elasticity values to consider the effects of a rise in air fares, meaning that others involved in this field clearly believe that the effects of price rises could be of a similar order of magnitude to price reductions. In reality, as discussed in Chapter 4, the effect is likely to be asymmetric – i.e. the price increases needed to reduce air travel by a given amount below existing, habitual levels of flying are likely to be greater than the price reductions needed to generate the same amount of additional travel.

Second, use of these calculations in the longer-term would be inappropriate. This is partly because the proposed charges would mount up considerably over time, at which point, the elasticities would probably change significantly, and more than marginal changes in behaviour would be expected. It is also because there may be other factors limiting growth rates for aviation, such as oil supplies or airport capacity.

Third, this calculation assumes that existing growth forecasts already take into account all other influences on aviation demand. These could include factors that would boost growth, such as more airports, more runways, more destinations offered and reduced waiting and access times, or factors that could reduce growth, such as longer check-in times for security reasons, increased airport access times due to road congestion, delays and cancellations due to air traffic control problems etc. In reality, these factors are also subject to policy decisions, which could therefore have a significant effect on demand elasticity and the relative influence of fares.

Fourth, the industry might react to new charges in a variety of ways, including, for example, finding additional ways to reduce costs further than currently anticipated.

Fifth, the existing research clearly highlights that the price elasticities of demand for air travel are complex, and dependent on factors like the nature of the journey undertaken, the fare paid and traveller characteristics. More understanding of these relationships would therefore enable more sophisticated calculations to be undertaken.

In short, then, the calculations given above are simplistic, and only consider part of the complex picture of interacting influences that affect aviation demand. Nonetheless, they give a useful indication of the scale of charges that might be needed to deter people from flying more than they do at present, and could provide the basis for undertaking a more detailed estimation. This is recommended as an important area for future research.

It is a matter for debate as to whether, say, a 5 year policy of increasing the charges on tickets by £10–25 per year (achieved, for example, by a short-term Air Passenger Duty escalator) would represent a 'hefty' price hike or not. It is notable that public transport fares have often been increased at well above the rate of inflation. In 2000, UK motorists were already paying an average of £1,205 p.a. in tax, although their average mileage is significantly less than a return flight to Australia[25]. In addition, it should be noted that only a proportion of any additional air charges might be obvious to customers, since fares are otherwise forecast to fall.

6.6 Stabilise, reduce growth or reduce demand overall

So far, this report has primarily argued that demand restraint for aviation is necessary. It has not addressed the issue of whether demand restraint should aim to achieve a lower rate of growth, stabilisation or an absolute reduction in the overall amount of flying that takes place. *All of these variants of demand restraint are valid,* in terms of reducing the climate impacts of aviation, albeit that their relative scale of impacts will be different. However, in implementing policy measures to achieve any form of demand restraint, the Government would need to acknowledge that such measures had the explicit purpose of discouraging people from flying – or from flying much more than they do at present – to avoid confusion (and demands for 'offsetting mechanisms to reduce the impacts on passengers').

There are arguments in favour of all three approaches.

First, there are strong arguments in favour of reducing demand absolutely, on the basis that this will achieve the greatest environmental gains; that achieving a 60% reduction in carbon emissions by 2050 will mean that all sectors have to achieve contraction; that a contraction in aviation would be one of the more socially just ways to achieve emission reductions; and that there could be benefits for the UK economy, through, for example, recaptured tourism. However, if this is considered politically unacceptable, then, in environmental terms, stabilising demand or reducing the rate of growth are still considerably better than nothing.

Stabilising demand at current levels is primarily about deterring air trips *which are not currently taking place*. Suppressing such demand would not be expected to have significant detrimental social consequences. (As outlined in section 3.6, much of the growth in flying is coming from the richer sections of society.) The main opposition to a policy of stabilising demand is likely to come from the airlines, who might claim that they cannot survive with a business model involving zero or negative growth. It is also unlikely that this scenario would deliver the reductions in emissions needed from aviation if it is to contribute proportionally to a 60% cut in carbon dioxide emissions.

A third option is to encourage lower levels of growth than would otherwise occur. This is the scenario that emerged from the work on the effects of taxing aviation at the same rate as car travel by 2025 (Sewill 2005). In this scenario, passenger growth was expected to halve (compared to predicted growth rates of the time) and, in 2030, there would be no need for any new runways. Moreover, Sewill (2003) points out that the scenario would still equate to a 60% growth by 2030, and that *"with a prospect of a 60% increase in the number of air passengers, the airline lobbyists ... can hardly say that the result of imposing fair taxation would be to stop people flying, or kill off the aviation industry"*.

In brief, then, there are a number of different variants of demand restraint. Any of these must be considered in the context of the detrimental consequences of climate change. A key point is that any of these will be better, in environmental terms, than taking no action. However, they all require Government intervention to discourage people from flying (more).

6.7 The effect of fuel surcharges

A recent feature of the aviation debate relates to fuel surcharges. Specifically, because the price of oil has gone up, some airlines have begun adding a fuel surcharge or supplement to ticket prices to offset some of the increasing costs. According to the Treasury Press Office, as outlined in section 9.6, the fact that the aviation industry is incurring these additional costs is one reason why Air Passenger Duty was not increased in the 2006 budget. There are various reasons why the recent trend in oil prices will not necessarily provide an adequate long-term demand restraint mechanism.

First, in the same way that fuel taxes can be criticised on the basis that they do not necessarily translate into ticket price changes, the same is true of the oil price rises.

Currently, the way in which fuel price increases translate into additional charges is perceived to be relatively random by observers. For example, Which? (2005) reported that *"supplements appear to bear little relation to what the airlines actually have to pay for fuel for a particular flight"*. For example, British Airways charges a £16 fuel supplement for a short-haul return trip, whereas Ryanair and easyJet do not levy a fuel supplement. There are clearly cost savings that the airlines are able to offset against the increase in fuel costs. For example, on the 18th April 2006, British Airways increased its long haul flight supplement from £30 to £35 per one way ticket, whilst on the 20th April 2006, it cut fares by more than 50% to more than 65 destinations (BBC News 20/4/06) and on 19th May 2006, it reported profit increases which exceeded market expectations (BBC News 19/5/06).

James (2005) reports that jet fuel prices across Europe approximately doubled between 2004 and 2005. In cost terms, this is the same as the 100% fuel tax considered by the Department for Transport, which the DfT predicted would have no impact on either fare prices or demand due to counteracting factors reducing costs (as outlined in section 6.2).

Second, the headline prices quoted to customers often do not include the new charges, meaning that people may make their holiday plans (including organising accommodation and making arrangements with friends) before becoming aware that prices are more expensive than they originally thought. This point was highlighted by Which? (2005), who stated: *"On the websites, it's only at the booking stage that you will find out about the new add-on, either flagged up, or hidden among the other fees and taxes ... we think that these charges should be absorbed into the headline flight price"*. It should be noted that some operators, such as British Airways, have now adopted this practice and there are European plans to make this mandatory (as discussed in section 9.1). However, where it is not clear that prices have risen, the impact on demand is likely to be confused, as it may take time for people to become aware that this is the case.

Third, one of the main ways in which airlines are dealing with the problem is by 'hedging', where airlines buy fuel at a price fixed well ahead of delivery, meaning that fuel price increases only partially affect fares, (James, 2006). Whilst this is only a short-term fix, it could be very successful if the rise in oil prices is temporary.

Fourth, it is not clear why aviation should be any more protected from fuel price increases than, say, cars, buses or trains. Notably, in the 2006 Budget, whilst Air Passenger Duty was frozen, a tax rise of 1.25p/litre on the main road fuels and 'red' diesel (the main rail fuel) was proposed, albeit deferred until

September (although it has since been delayed further).

Finally, looking more broadly, the current volatility in oil prices is widely recognised to be linked to a range of international factors such as uncertainty and instability in the Middle East, current production limitations and the rapid growth of the Indian and Chinese economies. There is no clarity about how long the oil price rises will last, or the extent to which they might continue. It is therefore not robust to rely on these market changes in oil price to deliver a long term demand restraint mechanism for aviation. In contrast to the volatility of changes in the oil market, an increase in the charges or taxes levied on the industry could be phased in, with sufficient clarity and certainty that the airlines were still able to plan for the future, albeit with a new set of cost parameters to deal with.

If fuel prices were likely to increase consistently, and result in a sustained rise in the costs of flights, it would clearly make sense for this to be factored in to any strategy of demand restraint that the Government had adopted. However, the Government does not recognise the need for such a strategy. Hence, there is no means of assessing whether its current decision to freeze Air Passenger Duty is appropriate, given the lack of a clear long-term plan aimed at achieving demand restraint.

In short, then, fuel supplements cannot be relied upon to increase ticket prices consistently over time, or to send a signal to the consumer that flying is more expensive than previously. Short-term increases in the cost of fuel do not provide an obvious rationale against the adoption of a strategy to make flying more expensive on environmental grounds.

6.8 Summary

Some argue that economic mechanisms which increase the cost of aviation would be ineffective, because they would only indirectly affect fares; because they would only have a small effect on fares; because their effects would be offset, or more than offset, by reductions in fares or other holiday costs; or because they are relatively unimportant compared with macroeconomic factors such as GDP growth.

These arguments seem relatively tenuous, not least because any increase in price will increase the costs of aviation compared with what they would otherwise be, and even a reduced rate of aviation growth is better, in environmental terms, than business as usual.

It is clear that the greatest growth in the aviation market has occurred at the cheaper end of the market, and that there have been significant reductions in airline fares over the past 10–15 years. There is a growing body of work which specifically estimates the relationship between flight price and demand, which consistently shows that a 10% change in fares could be expected to change demand by somewhere between 5% and 15%. Flight price increases would be expected to have a bigger effect on leisure travellers and short haul trips.

Initial calculations using existing evidence about price elasticities and projected growth rates suggest that perhaps an additional charge of approximately £10 to £25 per ticket per year (with, say, a £5 or £10 differential between short-haul and long-haul charges) could be sufficient to offset growth. This could be implemented, for example, as a short-term air passenger duty escalator, raising ticket prices by £50–£125 over 5 years. In practice, the air fares paid by customers would probably increase less than this, since fares are otherwise forecast to fall. This proposal could be a useful topic for further research.

Meanwhile, whilst fuel surcharges and supplements may add significantly to some ticket prices in the future, their addition is currently relatively piecemeal and sometimes concealed from the consumer until they are committed to their booking. The case for freezing tax to protect air passengers (but not bus, train or car users) from fuel price increases is unconvincing. The volatility of the oil market means that it cannot necessarily be relied upon to provide a consistent long-term mechanism for demand restraint.

Hence, it seems that there is a good case for using additional economic mechanisms to raise ticket prices in the future, as a way of stemming the dramatic potential growth in aviation. The next chapters of the report therefore consider public attitudes towards such measures, and the available economic measures that could be used.

Would the Public Accept a Rise in the Cost of Flying on Environmental Grounds?

7.1 Introduction

A key reason given by politicians for not attempting to use economic mechanisms to reduce demand for flying is that it would be unacceptable to the public. For example, in replying to a House of Commons Select Committee on Liaison, the Prime Minister recently said: *"I cannot see myself that you are going to be able artificially, through mechanisms based on the consumer, to interfere with aviation travel. I just cannot see how you would get international agreement to that effect and I would certainly worry about putting some special levy on people in the UK because I do not think it would be very sensible ... I cannot see myself that we would be in a position to say to the British consumer, even if you did it on a bilateral basis, 'This is worth your while because of the impact on overall climate change'"* (Blair, 2006, Q187–193).

This chapter reviews several surveys that have investigated public opinions on aviation's role in climate change and policies to constrain the growth in air travel. These include two European surveys which formed part of a public consultation on 'Reducing the Climate Change Impact of Aviation'. These were undertaken between 11 March and 6 May 2005 by the EU Directorate-General Environment, in preparation for a Communication from the Commission to the Council and European Parliament. The first was a survey of individuals, whilst the second was a survey of organisations.

In addition to the EU survey, there have been a number of surveys of individuals in the UK, including research conducted for the Department for Transport (including questions added to the British Social Attitudes Survey), four newspaper opinion polls and a very recent survey carried out for the Airfields Environment Trust. These have aimed to gauge typical public opinion, and questions have tended to focus around two central issues, namely:

- Should there be a restriction on the growth of air travel or people's ability to fly?
- Should new taxes or charges be introduced to make flying more expensive?

The results from these surveys demonstrate the importance of people's knowledge about the issues, and the way in which questions are framed. They also seem to show a significant change in the attitudes of the UK public over time. The main surveys, and their results, are outlined below.

7.2 EU survey of individuals

7.2.1 Survey methodology

The EU survey of individuals was based on an on-line questionnaire, which was made available in English, French and German. It was aimed at the general public and replies were anonymous (EUDGE, 2005).

Responses were received from 5564 individuals. These included those likely to be positive about aviation industry (as 9% had a job directly related to the industry), and those likely to be negative about the aviation industry (as 30% lived near an airport and 29% were *"seriously annoyed by aircraft noise in my home"*). Most replies came from the UK, Germany, Belgium and France, reflecting the languages in which the questionnaire was available. In addition, many individual letters were received, in particular from Germany, the Netherlands and the UK.

Notably, since the consultation was based on self-selection, it is likely to reflect the views of those who were most concerned about aviation, and were also likely to be better informed than the average member of the public. For this group of individuals, there was relatively widespread public recognition and acceptance that the climate impacts of aviation need to be addressed, that demand management is important, and that pricing is an appropriate mechanism for reducing demand. These results are outlined below.

7.2.2 Policy Objectives

The questionnaire sought to establish the level of agreement with a number of potential policy objectives to tackle the climate impacts of aviation. It found that there was widespread support:

- to include the air transport sector in efforts to mitigate climate change (95% rather or fully agreed)
- to strengthen economic incentives for air transport operators to reduce their impact on the climate (90% rather or fully agreed)
- to include the cost of the climate change impact in the price of air transport (85% rather or fully agreed)

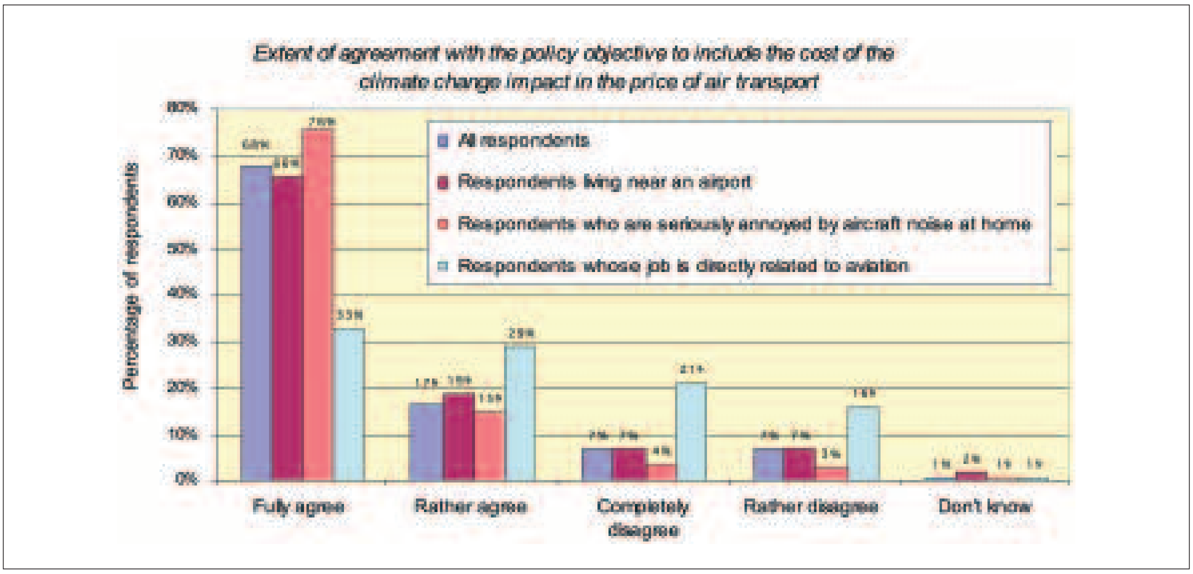


Figure 7.1 Support for including the cost of climate change impacts in the price of air transport

Responses from 5564 individuals. Source: EUDGE 2005

In all three cases, those agreeing included more than 50% of the 490 respondents whose jobs were directly related to aviation. The results for including the cost of climate change in the price of air transport are shown in Figure 7.1

7.2.3 Opinion statements

Respondents were also asked about the extent of their agreement or disagreement with a number of opinion statements. Responses were as follows:

- *"increasing the price of air transport would be acceptable if it is necessary to reduce aviation's impact on the climate"* (86% fully or rather agreed)
- *"increasing the price of air transport should be avoided as it could have an effect on jobs and growth"* (79% fully or rather disagreed)
- *"increasing the price of air transport should be avoided as fewer people could afford to fly"* (79% fully or rather disagreed)
- *"increasing the price of air transport would be acceptable since it would affect 'frequent flyers' most"* (70% fully or rather agreed)

When asked what any revenue from tax on air travel should be used for, 86% of respondents said that it should be used to reduce environmental impacts, 26% said it should be used to fund development aid, 16% suggested that it should be used for general public funding purposes and only 8% suggested that it should be transferred to the aviation industry. (Note that respondents were allowed to tick more than one box.)

It is also interesting that, despite the self-selection bias of the survey described above, 55% of respondents did not feel well informed about the climate change impacts of air transport, and 54% stated that comparisons between the emissions of different airlines per passenger on a given route would greatly influence how often, where and with what airline they chose to fly.

7.2.4 Additional Comments

There was a free-text field at the end of the questionnaire, and 2244 respondents made use of this. While there were some critical remarks, the vast majority of respondents explicitly supported action to reduce aviation's impact on the climate. Amongst the responses received, it is interesting to note that:

- The most frequently made comment was that alternative modes of transport, in particular rail, should be promoted, and that it was important to have a fair taxation system to allow this to happen.
- Many considered that action to reduce demand was necessary.
- It was suggested that price signals were more important than relying on individual action, with respondents positing that individuals would not modify their behaviour if others were not doing the same.

- Whilst some demanded that non-EU industrialised countries should take action relating to airlines as well, most respondents mentioning this topic nevertheless advocated action by the EU and some explicitly stated that they considered the EU to be strong enough to take action on its own, giving an example to the rest of the world.

7.3 Surveys for the UK Department for Transport

7.3.1 2002 ONS Omnibus Survey

In 2002, the UK Department for Transport began a stream of work on understanding the views of the general public towards aviation and its environmental impacts, by adding questions on attitudes to air travel to the 2002 Office for National Statistics Omnibus Survey (DfT, 2002). This is a random probability survey of adults aged 16 and over living in private households in England, Wales and Scotland. 1,850 adults were interviewed in February 2002, randomly selected to be representative of the British population.

This survey highlighted that public opinion on environmental policies is strongly influenced by the context in which questions are asked, a point that has been clearly made by Anable et al (2006). Specifically, in one part of the survey, some of the questions asked highlighted the environmental implications of flying while others did not. Responses are shown in Figure 7.2. Respondents were asked whether they agreed or disagreed with the following statements:

a) *People should be able to travel by plane as much as they like;*
b) *People should be able to travel by plane as much as they like, even if this harms the environment;*
c) *People should be able to travel by plane as much as they like, provided government acts to limit the harm done to the environment;*
d) *People should be able to travel by plane as much as they like, even if new terminals or runways are needed to meet the demand;*
e) *Building new terminals or runways to enable people to travel by plane as much as they like is acceptable if environmental costs are included in the cost of flights.*

While responses to question (a) indicated relatively high support for people flying as much as they liked, this fell hugely when the potential for environmental harm was introduced in question (b), or with the suggestion that new terminals would be needed in question (d). Support for unimpeded flying rose again however on the basis of the Government taking action to limit the harm done to the environment in (c), or if the environmental cost was included in the cost of the flight in (e). The range of responses illustrates the extent to which people modify their

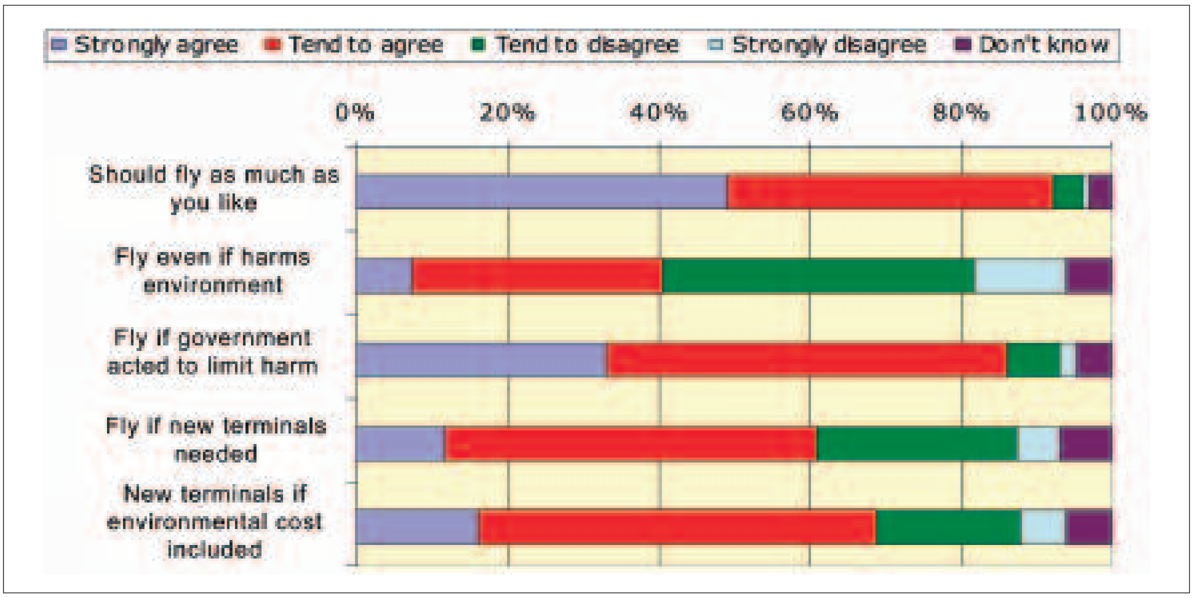


Figure 7.2 How support for flying varies with question context

Source: Original data supplied by DfT (2006c), 1819 responses to this question opinions on aviation after focusing on some of the consequences of such activity.

The survey went on to examine the acceptability of adding environmental costs to the costs of flying. Respondents were first asked whether they thought air travel harmed the environment and if so, in what way. They were then told that, although it does harm the environment, the cost is not included in the price of flights. Next, they were asked how acceptable it would be if flights went up by different amounts (5%, 10% and 15%) to reflect the environmental costs.

In this context, 79% said they would find an increase of 5% either very (28%) or fairly (51%) acceptable, while 21% would not find it acceptable. Half the respondents said they would find an increase of 10% acceptable and a quarter said that they would find an increase of 15% acceptable.

Overall then, this survey points to the importance of framing questions of environmental and social policy in the context of the problems they are designed to address, and ensuring that people have the opportunity to reach informed opinions.

7.3.2 British Social Attitudes Survey

At the request of the Department for Transport, a similar set of questions about air travel were included in the British Social Attitudes Survey[64] in 2003 and 2004, with the same questions used in both. The results again emphasise the importance of the way that questions are framed in determining opinions. Respondents were invited to agree or disagree with a series of statements, as shown in Table 7.1

Table 7.1 Support for unconstrained flying in relation to different statements, 2003 & 2004

Statement	*% agree/ strongly agree* 2003	2004
People should be able to travel by plane as much as they like	78	77
People should be able to travel by plane as much as they like, even if new terminals or runways are needed to meet demand	52	43
People should be able to travel by plane as much as they like, even if this harms the environment	19	15

Responses from 967/888 individuals
Source: British Social Attitudes Survey 2003/2004, supplied by DfT (2006c)

Results indicate that, as before, support for unconstrained flying diminishes when statements highlight issues of cost and harm to the environment. It is also interesting to note that support for these statements diminishes slightly in 2004, indicating, possibly, that an underlying shift in attitudes is occurring. Support for these statements also appears to have fallen, compared with the results in the 2002 ONS Omnibus survey, although it is not possible to clarify how far this may be due to differences in survey methodology.

The 2003 survey also contained several one-off questions, which revealed that the majority of respondents were against explicitly limiting growth in flights: when asked to choose between two statements, 52% aligned themselves with a statement that this would be too damaging to Britain's business and tourist economy, whilst only 23% wanted to limit growth in flying to protect the environment. Similarly, 47% aligned themselves with a statement that limiting growth wouldn't be fair on business travellers and people going on holiday, whilst only 25% wanted to limit growth to improve quality of life for local residents.

A new question, added to the survey in 2004, suggested that 36% of people felt that *"the price of a plane ticket should reflect the environmental damange that flying causes, even if this makes air travel much more expensive"* (with 33% disagreeing).

7.3.3 2005 ONS Omnibus survey

In 2005, a further module of questions were inserted in the Office for National Statistics Omnibus Survey at the request of the Department for Transport (DfT, 2005d). These were aimed at understanding general attitudes to climate change and transport's role in it. The results reported were based on 1,217 face-to-face interviews.

In the survey, 77% of respondents reported that they were very or fairly concerned about climate change.

Respondents were presented with a list of policies that could reduce car/plane emissions and asked which, if any, of these policies they would support. One of these options was *"increase the cost of flying"*. Notably only 15% of respondents supported this option. However, this is possibly because the list of options included both positively and negatively worded policy measures – the two positive policy measures (*'spend more improving rail services'*, and *'spend more on improving bus services'*) were the only measures to receive significant support (69% of respondents in both cases). Increasing the cost of flying received more support than increasing tax on petrol, which only 12% of respondents supported.

In relation to air travel, respondents were also presented with two statements and asked to select the statement that came closest to their own views. The statements were *"air travel should be limited for the sake of the environment"* and *"limiting air travel would be too damaging to the economy"*. The statement that limiting air travel would be too damaging to the economy was selected by 55%, whilst 39% selected the statement that air travel should be limited for the sake of the environment. Amongst those respondents who had declared themselves to be very or fairly concerned about climate change, support for limiting air travel for the sake of the environment was higher. Interestingly, the overall proportion supporting limiting air travel for the sake of the environment (39%) was significantly higher than the proportion supporting this option (23%) in the British Social Attitudes Survey in 2003 (although this could be due to differences in survey methodology).

7.3.4 2006 ONS Omnibus Survey

In May 2006, the Department for Transport again asked for a module of questions on air travel to be included in the ONS Omnibus Survey. Results from this work are not yet available (DfT, 2006c).

7.4 Newspaper opinion polls

A number of recent newspaper polls have also tested public opinion on air travel (in each case, questioning over 1,000 randomly sampled adults).

In June 2005, a Guardian/ICM poll conducted ahead of the G8 summit asked, *'Which of the following do you think people like you should be prepared to consider to limit climate change?'* (The Guardian, 21/6/05). Just over half of the respondents (56%) selected 'fly less'. The same poll, however, showed considerably less support for the use of a tax added to airline flights to deter people from flying – only 26% backed the idea (with 61% disagreeing). Interestingly, however, a poll conducted in the same month by the Observer/ICM found that 51% of respondents expected restrictions on air travel in future as a result of climate change, indicating that more people recognised the need for such measures in the long term than were currently ready to support them (The Observer, 26/6/05). In the same poll, 53% said they currently limited their own air travel to help ease the effects on climate change.

In February 2006, a Guardian/ICM survey found 63% approved of a proposal for *"a green tax to increase the price of things that harm the environment, thereby discouraging their use"* (The Guardian, 22/2/06). Asked *"Which of the following measures have you or your family taken in order to protect the environment?"*, 24% said they had actually *"decided against a holiday that involves flying"*. This survey did not specifically ask about taxing air travel. However, the issue was then raised in a Times Populus Poll, carried out in March/April 2006 (The Times, 11/04/06). This found 50% of respondents agreed with new taxes on air travel with the aim of reducing the number of flights people take. This is a significant shift from the finding of the June 2005 Guardian/ICM poll, and is consistent with the changes in public opinion that are suggested by the Department for Transport surveys.

Taken together, these results suggest a gradual increase in public acceptance for the idea that flying will become more expensive, in the context of other policies to mitigate climate change.

7.5 Research for the Airfields Environment Trust

One of the most recent surveys to be conducted provides further evidence that public opinion in relation to air travel and taxation has shifted. Research for the Airfields Environment Trust was carried out in June 2006 by Ipsos MORI (Ipsos MORI, 2006). Questions on air travel were included as part of a regular survey of the general public, involving a national sample of 2,050 adults, through face-to-face interviews in respondents' homes. As with the 2002 survey for the Department for Transport, the study sought to establish whether there was a difference in views between those who were given a 'preamble' about the environmental impact of air travel, and those who were not. Consequently, respondents were divided into two groups.

Respondents in the preamble group were told that "*most leading scientists believe that environmental pollution is responsible for climate change*", and that, "*according to the UK's Chief Scientist, unless action is*

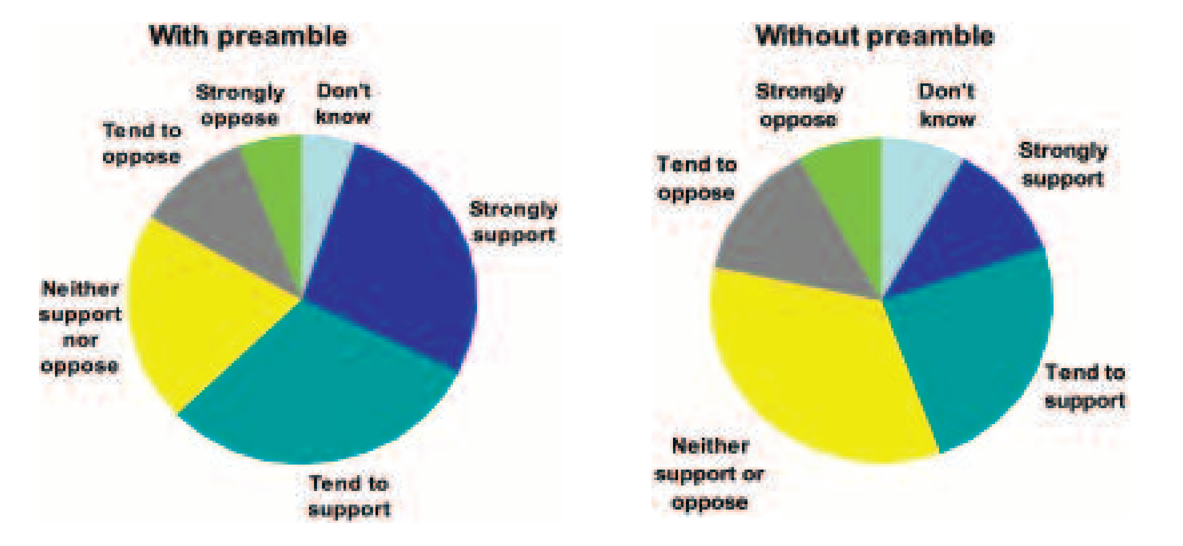


Figure 7.3 Support for constraining growth in air travel, June 2006

Source: Ipsos MORI, 2006, p3

taken, climate change will lead to millions of people worldwide being made homeless or killed by extreme weather conditions in the next 100 years". In addition, they were informed that "*air travel is set to become one of the main causes of climate change due to the emissions of carbon into the atmosphere*". They were then asked *"To what extent would you support or oppose a policy aimed at slowing down the growth in air travel?"*. In this context, the majority said they would either strongly support (26%) or tend to support (31%) such a policy, while less than a fifth said they tended to oppose (11%) or strongly opposed this (6%).

Interestingly however, even *without* the contextual information of the preamble, support for this policy outweighed opposition. Amongst those *not* given the preliminary statement, more than a third said they would either strongly support (12%) or tend to support (25%) a policy aimed at slowing growth in air travel, while just over a fifth said they would either tend to oppose (14%) or strongly oppose this (8%). Results are shown in Figure 7.3.

When compared with earlier findings, these results suggest that public opinion has recently passed a tipping point towards a more general acceptance for policies that constrain air travel. It seems plausible that the growing coverage given to the issue, particularly in the first half of 2006, has increased public awareness of aviation's contribution to climate change to the point where many of those respondents *not* given the environmental preamble had, nevertheless, already internalised similar messages.

The study also provides further evidence that public opinion on policy has changed: across both groups, 68% agreed that *"Protecting the environment should be given priority, even at the risk of slowing down economic growth in the air travel industry."*

A further question specifically investigated views on tax. Again, there was a preamble given to half the sample, to provide context. This explained that "*there is currently no tax levied on aviation fuel, unlike for petrol and diesel for cars, and no VAT on air tickets*", and that *"the existing Government Air Passenger Duty is £5 on most flights to Europe and £20 on a flight to Australia*". For this question, the difference in responses between those who were given the preamble and those who were not was extremely small, as shown in Figure 7.4. Among those that received the preliminary information, 59% supported

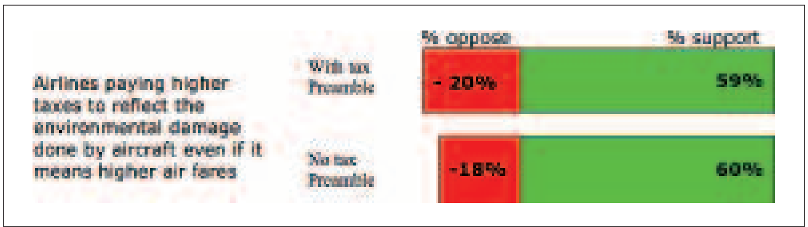


Figure 7.4 Support for airlines paying higher taxes to reflect environmental damage

Source: Ipsos MORI, 2006, p7

"Airlines paying higher taxes to reflect the environmental damage done by aircraft even if it means higher airfares", while 20% opposed this. Without the tax preamble there was actually very slightly more support for the proposal (60%) and less opposition (18%).

There was also majority approval from both groups for doubling APD to reflect the environmental damage done by aircraft, a measure which received support from 52% with the tax preamble, and 50% without.

The study also attempted to gauge the acceptability of specific price rises on the basis of how the revenue raised would be spent. Respondents were asked to consider a hypothetical tax increase of £20 to Paris and £200 to Australia, and to say to what extent they would support or oppose a higher tax on air travel if all the money raised went to a number of alternative purposes. Spending the revenue on improving the environment emerged as the most supported option (73% for, 9% against), followed by funding for education and the health service (58% for, 20% against). However, even for the less popular options, of funding improvements to high speed rail services and cutting income tax, support outweighed opposition.

7.6 EU survey of organisations

In addition to the surveys of individuals, the EU has also undertaken a survey of organisations, based on an on-line questionnaire, made available in English, French and German. It contained more detailed and technical questions than the EU questionnaire aimed at individuals, and involved identification of the respondents (EUDGE, 2005).

A total of 198 organisations participated in the consultation, including 79 NGOs, 60 private sector companies or industry associations (including major European airlines, airport and manufacturers associations) and 30 public authority or government organisations (including the governments of France and the UK, the Finnish Civil Aviation Authority and the Austrian Ministry for Environment). Despite their differing backgrounds, the majority of the organisations agreed with the policy objectives:

- to include the air transport sector in efforts to mitigate climate change (99.5% rather or fully agreed)
- to internalise the external costs of climate change in the price of air transport (91.8% rather or fully agreed)
- to strengthen the economic incentives for air transport operators to reduce their impact on the climate (88.6% rather or fully agreed).

A number of policy instruments were suggested in the survey. Figure 7.5 indicates respondents' first choice of economic instrument. The two Member States submitting formal government positions (France and the UK) considered emissions trading to be the most effective instrument. Airlines, manufacturers and airports also preferred emissions trading to any other economic instrument, as long as the system was open

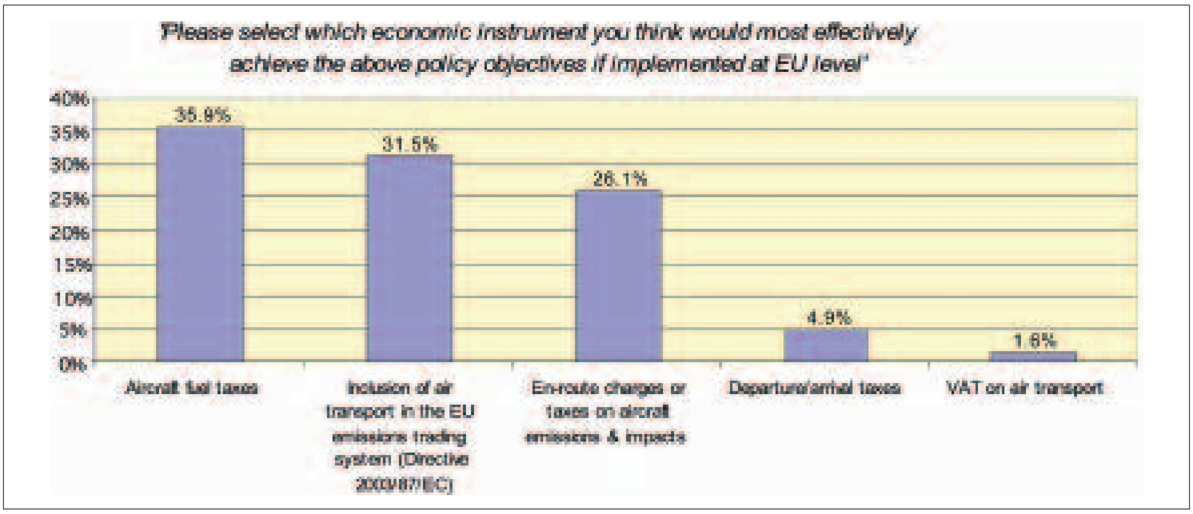


Figure 7.5 Responses from 198 organisations about the most effective policy instrument for reducing the environmental impacts of aviation

to other sectors and limited to CO_2. In contrast, fuel taxation was the preferred option of the Austrian Ministry for Environment and most of the NGOs.

In further questions, there was strong support by organisations that were not active in the aviation industry to reduce demand for air transport. France explicitly argued for a reduction in the growth of air transport in the long term by promoting alternative modes of transport.

7.7 Summary

The EU surveys show that amongst members of the public active in the aviation debate, and various stakeholders (including the airline industry), there is widespread recognition that the climate impacts of aviation need to be addressed, and that economic mechanisms are one appropriate way to achieve this.

In surveys conducted amongst members of the general public, there has been an initial reluctance to increase the cost of flying. Surveys also show however, that people's opinions on these issues are influenced by the contextual information provided and the way in which questions are framed. They are much more likely to accept the need for such increases if they are led to deliberate on information about the environmental impact of air travel and the extent to which these costs are currently met through airfares. For example, in the 2004 British Social Attitudes Survey, support for the statement *"people should be able to travel by plane as much as they like"* fell from 77% to 15%, when the rider *"even it this harms the environment*" was added.

The surveys reviewed here indicate that a gradual shift in public opinion may have taken place over the last few years, which has potentially accelerated significantly in the last year or so. This has perhaps been influenced by significant growth in media coverage of both climate change and the role of aviation in climate change. By mid 2005, about two-fifths (39%) felt that air travel should be limited for the sake of the environment, and about half of respondents believed that they should be prepared to fly less to limit climate change or that some kind of restriction on air travel would be necessary in future. By February 2006, a majority (63%) supported the principle behind green taxes on "things that harm the environment". By June 2006, support for a policy to slow down the growth in air travel outweighed opposition to such a policy, with or without preliminary contextual statements designed to make the case for this. There was also majority support (about 60%) for airlines to pay higher taxes to reflect environmental damage, even if this meant higher airfares.

The rejection of aviation tax in several earlier surveys adds a warning note, highlighting the importance of communicating with the public about the significance of aviation to climate change. Nevertheless, it appears that, along with growing public awareness of the environmental risks of air travel, there is growing public recognition of the need to make flying more expensive.

These findings also suggest that there is scope for further research to monitor attitude change and to assess how the presentation of policy options affects their appeal. For example, questions on increasing tax on flying could be contextualised in relation to achieving parity with taxation of motoring. There may also be important differences in what people perceive as environmental impacts. Greener by Design (2005) highlights that *"the Department of Transport and the Treasury have assessed the external costs of UK civil aviation, putting the cost of impact on climate at from 6 to 12 times that of air pollution around airports and more than 50 times that of noise. This is roughly in inverse proportion to public perception, as measured by letters of complaint."* Again, it would be interesting to establish whether this is the case, and what would make people consider aviation's impacts on climate change to be more serious. There is also a role for considerably more research to establish how people believe they would react to changes in the price and availability of air fares. (The small amount of existing behavioural research – the CAA survey work at Stansted airport – has already been discussed in Chapter 6). A new study has recently been commissioned by the Commission for Integrated Transport and may explore such issues.

Meanwhile, the next chapters consider the EU Emissions Trading Scheme, together with other economic measures, that could be used to curb the emissions from aviation.

Will Emissions Trading be Enough to Safeguard the Environment?

8.1 Introduction

There is considerable political momentum towards including aviation within the European Union Emissions Trading Scheme (EU ETS). The UK Government concluded in its Aviation White Paper (DfT, 2003b, para. 3.39) that emissions trading is *"the best way of ensuring that aviation contributes towards the goal of climate stabilisation"*, and proposed that the sector should be incorporated into the scheme with effect from 2008. Including aviation in the EU ETS has also been endorsed by the International Civil Aviation Organisation (ICAO) in 2001, and, in the UK, is supported by BAA and British Airways. This chapter provides a review of proposals and the anticipated effects of the scheme.

The EU ETS came into being in January 2005. It covers approximately 11,500 energy producing and energy intensive installations. Under the scheme, Member States give permission for each installation to emit a certain amount of CO_2 on the basis of the 'emissions allowances' allocated to them, with one allowance corresponding to the right to emit one tonne of CO_2. The allowances are capped, with the intention of creating a scarcity and leading to the emergence of a trading market. Companies emitting less than their allowances can then sell the carbon permits surplus to their requirements at a price dictated by demand and supply. Meanwhile, companies that are finding it difficult to remain within their permitted allowances can either take steps to reduce emissions – for example, by adopting more efficient technology – or buy extra carbon permits to cover the gap. The scheme is designed to reduce emissions in the most cost effective way. The first phase of the scheme runs from 2005–2007 and the second from 2008–2012, so that the second phase coincides with the first Kyoto Commitment Period.

Aviation is not currently part of the EU ETS, but in September 2005, the European Commission recommended that all intra-European flights and international passenger departures should be included, as part of a comprehensive approach to addressing aviation emissions including research into cleaner air transport, better air traffic management, and the removal of legal barriers to taxing aircraft fuel.

The recommendation was made in a Communication, 'Reducing the climate change impact of aviation' (CEC, 2005b), which highlighted the need for action and identified emissions trading as the best way forward.

The Commission went on to set up an Aviation Working Group including experts from Member States with representation from industry, consumer and environmental organisations. This group met between November 2005 and April 2006 to look at the detailed design of the scheme (European Commission, 2006). The Commission aims to put forward a legislative proposal by the end of 2006. The proposal then has to be adopted by the European Parliament and the Council before it can enter into force (through amendment of an existing Directive which established the EU ETS).

In the Communication and related documentation, the Commission anticipates that bringing aviation into the EU ETS will reduce aviation's climate impact in three ways:

1. In order not to exceed their allocation of emission allowances, airlines will have to buy surplus allowances from other industries, thus bolstering the market for carbon and stimulating reductions in non-aviation sectors.
2. Inclusion in the scheme will provide an added economic incentive for airlines to improve efficiency in a variety of ways and so cut their own emissions – for example, by investing in more efficient engines, by retrofitting technical devices to improve performance and by optimising fleet timetables and flight frequencies to cut the number of empty seats.
3. Because of the costs placed on the airlines as a result of 1 and 2, the scheme will have an impact on ticket prices, and this in turn can be expected to affect demand. However, the Commission expects these price increases to be modest.

Most of the emissions reductions made by the airlines are expected to take place through the first of the routes described above. This conclusion is based on a detailed feasibility study of the proposals, completed for the Commission by CE Delft (Wit et al, 2005). This considered three scenarios, and in all three, the majority of emissions reductions were made in other sectors because this was the lowest cost option for the airlines.

Since the Commission's Communication, the European Parliament has suggested that aviation emissions could be dealt with through a separate 'closed' trading scheme, where aviation would have to reduce its own emissions. However, it is unclear whether the Parliament's suggestion will be adopted in the Commission's forthcoming legislative proposal. This issue is discussed further in section 8.4.3.2.

8.2 Details of the scheme

Although the principle of including aviation within the EU ETS is straightforward, the detail of doing so is complex, and will determine its effectiveness. Some of the more important issues are outlined below.

8.2.1 Inclusion of non-EU operators

The Commission has said that, from an environmental point of view, it considers the scheme should apply to all carriers operating from EU airports, (e.g. all departing flights) without regard to nationality, and that this would also avoid compromising the competitiveness of EU airlines. While the CE Delft report concluded that this would be legally feasible, others have argued that it will prove extremely difficult to gain agreement to this from many non-EU states (House of Lords, 2006). The US Federal Aviation Administration has stated that US companies should be exempted from inclusion, and has questioned the legality of the scheme (EurActiv, 2005).

8.2.2 Capturing the full climate impacts of aviation

The Commission's Communication states that the scheme should address both the CO_2 and non-CO_2 impacts of aviation, as far as possible. Two key alternatives are being considered:

1. A requirement for aviation to surrender a number of allowances corresponding to its CO_2 emissions, multiplied by a precautionary average factor to reflect other impacts. On this issue, the CE Delft study concluded that a multiplier approach could not yet be based on an accurate scientific methodology. If this approach were used, it would have to be justified on the basis of the precautionary principle.
2. An approach where, initially, only CO_2 is included in the scheme, but ancillary (or 'flanking') instruments are implemented in parallel. This could mean, for example, an airport charge differentiated according to NOx emissions or NOx en route charges; flight procedures to prevent contrail and enhanced cirrus cloud formation; reliance on ICAO landing and take-off NOx emission standards or the introduction of ICAO cruise level emission standards. A NOx en route charge was considered in the CE Delft feasibility study as likely to be effective, but potentially difficult, in that it raises the sensitive issue of who should receive the money generated by the charge. Such a flanking instrument represents a form of emissions charging – one of the economic instruments considered in the next chapter.

In reviewing the possible options, participants in the Commission's Aviation Working Group were generally agreed on the need for an impact assessment of different ancillary instruments, to establish whether the goal of mitigating the climate impacts of aviation NOx emissions could be achieved at reasonable costs by these means.

8.2.3 Relationship between aviation and the EU ETS

A key problem for incorporating aviation into the EU ETS, as outlined in the CE Delft study, stems from the fact that, as mentioned in Chapter 2, greenhouse gas emissions from international aviation have not been assigned under the Kyoto Protocol. This means they are not covered by 'Assigned Amount Units' (AAUs) – the tradable units used to specify a country's permitted greenhouse gas emissions during the first commitment period of the protocol. Allowances used in the EU ETS (European Union Allowances) are created by earmarking AAUs, and the registries (or accounts) used by the EU ETS serve at the same time as registries under the Kyoto Protocol.

One obvious solution is to extend the scope of the Kyoto Protocol so that AAUs are also created for international aviation, but it is unlikely that international agreement could be achieved in advance of the protocol's first commitment period from 2008–12, making this option unfeasible before 2013.

Various mechanisms have been proposed for enabling aviation to enter the emissions trading system in the interim, despite not having any of its own AAUs to trade with, and without compromising the integrity of the scheme. One of the options widely supported by Member States in the Aviation Working Group was the creation of a trading 'Gateway' between aviation and other sectors. Under this option, the aviation sector would be able to buy AAUs from other sectors, but would not be able to sell allowances to other sectors (unless they were backed by AAUs which had previously been acquired)[65]. This would ensure that there is no net transfer of allowances into the core EU ETS from the aviation sector and is in keeping with the expectation that, in entering the emissions market place, aviation will be net buyers.

As previously mentioned, a different approach would be the introduction of a closed scheme for aviation (see section 8.4.3.2).

8.2.4 Distribution of allowances

The main options under consideration for the distribution of allowances are:

- Grandfathering – in which emissions rights are allocated free of charge on the basis of past emissions
- Benchmarking – in which emission allowances are distributed free of charge on the basis of benchmarks related to typical output
- Auctioning of emissions rights – with various options for the use of the revenue that would be raised.

In the Aviation Working Group, many participants expressed support for benchmarking, though some Member States favoured grandfathering. An NGO argued that all options apart from auctioning would be unfair to the consumer, because free allocation would allow the aviation sector to benefit from windfall profits.

There is also the over-riding issue about the scale of permits likely to be granted to the aviation industry as a whole – with arguments that too few will destabilise the EU ETS overall, whilst too many will render the scheme ineffective. These issues are addressed in more detail in section 8.4.3.

8.3 Key advantages of the scheme

In general, the key strength of emissions trading is perceived to be the relative certainty it delivers on future levels of emissions, because this is determined by the level at which emissions within the scheme are capped.

In its Communication (CEC, 2005b), the European Commission sets out the advantages of using emissions trading as a driver to reduce aviation's contribution to climate change emissions, comparing this mechanism with alternative economic instruments. While the taxation of fuel for commercial aviation is seen as being an attractive option, and one that the Commission strongly supports, it is not assessed in any detail in the Communication because of the time frame implied by the need to secure all the necessary legal agreements.

The Commission focuses instead on the relative merits of emissions charging and emission trading both of which it finds to be, in principle, equivalent in terms of environmental effectiveness and economic efficiency. However, emissions trading is seen as having a number of pragmatic advantages:

- The machinery for emissions trading has already been established through the existing EU scheme.
- Emissions trading faces no obvious legal difficulties (though as discussed above, the legal simplicity of extending the scheme to non-EU carriers is not unanimously accepted), whereas there is concern that emissions charges could face a legal challenge on the basis that they are, in fact, a form of fuel tax.
- The fact that open emissions trading has been endorsed by ICAO and others, while emissions charges are contentious at international level, means that the former may have better scope for wider application. (This last point must be seen especially as a matter of pragmatism rather than principle, since industries can naturally be expected to resist more demanding forms of regulation in favour of weaker forms of control.)

In the working document which provides the Annex to the Communication (CEC, 2005c), the Commission argues that including aviation in the EU ETS is more economically efficient than applying an emissions charge because it is expected that, at least in the short term, reducing emissions from aviation through efficiency improvements will come at a higher cost than for other industries participating in the scheme. The Communication specifically recognises the constraints on improving efficiency in aviation through technological improvements. Although it outlines some of the options for such improvements, it anticipates that the airlines will be net buyers, introducing greater liquidity into the trading scheme. As a result, in the short term at least, the majority of the aviation industry's reductions are expected to be made in other sectors – that is, through the purchase of allowances from other industries that can use technology to reduce emissions more cheaply. The working document argues that this increases efficiency *"by allowing the same amount of reductions to be made at a lower overall cost to society."* There are some difficulties with this argument, which are explored below.

8.4 Limitations of the scheme

As highlighted above, there are a range of potential benefits from including aviation within the EU ETS. However, there are also a number of potential issues and problems. Many of these relate to the design of the scheme – for example, if routes flown by non-EU carriers are excluded from the scheme, it has the potential to affect a much smaller proportion of emissions from aviation.

There are four main inter-related issues. These relate to:

- Concerns about the Emissions Trading Scheme overall
- Concerns about delaying the implementation of demand restraint measures if these will be needed in the longer-term
- Concerns about the effects of the scheme, both on air ticket prices and carbon prices, and
- Concerns about the timescale for action

Each of these is discussed below.

8.4.1 Overall concerns about the EU ETS

Questions of rigour and stringency have been raised repeatedly in assessments of the wider EU ETS and its environmental effectiveness. While the key strength of the EU ETS is perceived to be the relative certainty conferred by the caps, its success depends on the robustness with which it is administered. Some critics have argued, for example, that an industry anticipating a cap on its emissions at a specific date has an incentive to postpone technological improvements until after the cap has been applied. A report by ILEX (2005) reviewed the first phase of the scheme in six member states representing 68% of EU emissions covered in the ETS, and found that most of the National Allocation Plans had weak targets. A recent assessment by Climate Action Network Europe (CAN Europe, 2006) also found emission limits set in the first phase *"a major disappointment and a worrying precedence for 2008–12"*. CAN Europe is critical of many operational aspects of the scheme on which it makes recommendations for greater effectiveness. Whilst lessons can be learnt, the ETS is likely to be vulnerable to very similar pressures in the aviation sector, especially given aviation's predicted growth rates.

8.4.2 Concerns about delaying the implementation of demand restraint measures if these will be needed in the longer-term

The argument that including aviation within the EU ETS is the most economically efficient way to reduce emissions is made on the basis that, if it is more difficult and more expensive to reduce emissions in the aviation sector, the most practical and efficient option is to reduce them elsewhere, in sectors that have more potential for improving their efficiency.

However, the long term difficulties of relying on other sectors to achieve the necessary reductions, given the scale of reductions needed, have been discussed in Chapter 1. Other sectors are already aiming for extremely challenging reductions. It is not plausible to assume that, in the long term, they will have reductions to spare.

Meanwhile, by initially transferring the onus for carbon reduction to other sectors, the air industry is encouraged to grow further before the brakes of demand restraint are applied. Demand restraint is postponed in an area where it is seen as a highly promising and potentially cost-effective means of reducing future emissions (as discussed in Chapter 4). Moreover, if, in the long term, demand restraint for aviation will be necessary, then it will be more difficult to achieve this reduction at some future date when lifestyles have become more air dependent. The cost to society, in terms of its readjustment to lower levels of flying, can be expected to be higher. Similarly, the price to which air fares would have to rise, to achieve such restraint, can be expected to be higher. Demand restraint applied now is consequently likely to be a 'better buy' than demand restraint applied later.

The proposal for a closed scheme would remove this concern, as discussed in section 8.4.3.2.

8.4.3 Concerns about the effects on air ticket prices and carbon prices

8.4.3.1 Potential impacts on ticket and carbon prices

Another concern about including aviation in the EU ETS is the likely impact on ticket prices and carbon prices, with a lack of consensus about either of these issues.

As already mentioned, the Commission's Communication was based on a detailed feasibility study by CE Delft (Wit et al, 2005). This examined three scenarios, combining different parameters (in terms of the coverage of flights, the coverage of non-CO_2 impacts and the allocation of allowances). Each of the three scenarios was considered in relation to an allowance price range from €10 to €30 per tonne CO_2 equivalent.[66] The authors note that this price range is based on the assumption that the use of the Clean Development Mechanism (CDM) and Joint Implementation (JI) will be available to aircraft operators, meaning that they can gain credit within the EU ETS by investing in projects to reduce greenhouse gas emissions in non-EU countries.[67]

On the basis of the scenarios examined, the effect on ticket prices was expected to be modest, varying between €0.2 and €9 per return flight for an individual passenger. As a result, the study predicted that the demand for air transport would continue to grow, but at a slower rate with a relative reduction of between 0.1 and 2.1% over the 5 year period 2008 and 2012[68]. This is in comparison to the predicted business-as-usual growth rate of more than 4% a year (which equates to a growth of approximately 22% over 5 years).

The study also looked at the impact on prices in the longer term, making a series of estimates for 2017, but the effect was nevertheless modest, remaining within the range of the increases anticipated for 2012.

In addition, the study predicted that there would be a somewhat higher impact on ticket prices (by 2012) if the aviation operators, having received allowances for free, chose to reflect the potential worth of those allowances in the charge for a ticket – in other words, passing on the opportunity cost of the allowances to their passengers and so reaping windfall profits. This, the researchers calculated, could result in a fare increase of (at the top end) €19.8. This would be for a long haul flight and increases for short and medium haul flights in the same scenario were considerably lower at €1.5–€4.6 and €3.0–€9.0 respectively. Thus the envisaged rises were still relatively modest.

In terms of ticket price impact, the results of the CE Delft study have been challenged by ELFAA (the European Low Fares Airline Association). ELFAA argues that emissions trading will have a significantly greater impact on demand for their services, with a price of between €27 and €40 per tonne of CO_2 adding between 5% and 8% to fare costs, and reducing demand by 7.5% to 12% p.a. (Frontier Economics, 2006). Their range of carbon prices is substantially greater than that envisaged in the CE Delft study. Nonetheless, there is still a significant difference between the two studies in the impact envisaged. The main reason is likely to be that the CE Delft study was looking at the aviation market as a whole, whereas the ELFAA study only looked at a subsection of the market. It seems plausible that emissions trading may act as a more efficient demand restraint mechanism at the cheaper end of the market (where airline customers are probably more price sensitive, and airline operators may have less scope to absorb new costs in ways other than passing them on to customers). However, this does not mean that emissions trading will necessarily be an adequate demand restraint mechanism for the aviation sector as a whole. Moreover, within the aviation market, the low fares airlines also have the highest forecast growth rates (c.f. the 2004/5 growth of 26% reported by Ryanair, see section 6.5). Presumably, the impacts that ELFAA anticipate will only be relative (i.e. a 7.5% to 12% reduction in demand compared to what demand would otherwise be). Hence, although the EU ETS may dampen the growth of the low fares sector more than the aviation market as a whole, it is not clear that it is going to act as a sufficient demand restraint mechanism to address emissions from aviation to the extent needed to meet international aspirations to stabilise climate change.

Meanwhile, the issue about how carbon prices and ticket prices interact is critical to the overall debate, since the effects on ticket prices are obviously determined by how much carbon credits cost. Concern has been expressed by a number of commentators about the effect of aviation's entry into the scheme as a net buyer, and the potential for destabilising the wider scheme through a resulting rise in the price of EU allowances. For example, T&E/CAN-Europe (2006, pp25–26) and the House of Commons Environmental Audit Report (2006, p62–63) have both argued that including aviation within EU ETS, with relatively strict carbon caps, could lead to an unacceptably high cost of carbon for other industries, leading to some relocation of production outside the EU, thereby eroding the environmental benefits and generating additional costs for the EU economy.

Conversely, a study commissioned by DEFRA (ICF Consulting, 2006), to assess the likely impact of including aviation in ETS on the EU allowance prices, found that there would be no discernable impact at least in the short term (although the longer term implications were potentially more significant). One of the main reasons for reaching this conclusion was that, as in the CE Delft study, the model assumed that the aviation sector had access to project credits through the Joint Implementation/Clean Development Mechanism (JI/CDM). The use of such external credits in the context of emissions trading has already come under criticism from environmental groups, as being likely to undermine the scheme's effectiveness in achieving domestic action (CAN Europe, 2006). Critics argue that it is ultimately unsustainable for the EU to resource the expansion of a highly environmentally damaging and luxury driven industry on the basis that it is offset by more efficient energy use in countries where lifestyles are already much less environmentally damaging than our own.

Hence, there is a debate around two scenarios. The first envisages that emissions allowances will be relatively generous, and/or there will be relatively widespread use of JI/CDM measures, so that the cost to the aviation industry will be relatively low, and the incentives for the aviation industry to cut its own emissions will be limited. The second envisages that emissions allowances will be stricter, but, as a result, carbon prices will soar, potentially destabilising the whole of the EU ETS.

Some of these views were expressed in evidence given to the House of Lords European Union Committee in its inquiry into including aviation in the EU ETS (House of Lords, 2006). Here, witnesses from the Tyndall Centre for Climate Change Research, argued that, given the UK's target for a 60% reduction in CO_2 by 2050, the consequences of continued aviation growth for other sectors would be severe. They reasoned that if the EU were to adopt a tightly contracting EU emissions cap (commensurate with the UK target), aviation growth would result in a scarcity in allowances, leading to a rise in allowance prices, and, in turn, to a rise in the cost of aviation. They conceded that there was some possibility of the aviation industry seeking growth through Joint Implementation and the Clean Development Mechanism. At the same time, they highlighted the uncertainties involved in such schemes. They also noted the danger that including the aviation sector in the EU ETS might reduce the willingness to control overall CO_2 emissions.

Overall, they argued that the aviation sector should be incorporated within the EU ETS as soon as possible, but that this must not be seen as sufficient in terms of managing aviation's contribution to climate change, adding that: *"without the political will to institute a declining cap in the EU ETS from an early date.....including the aviation sector would not be desirable, because it would not effect control or offset aviation emissions".* In this case, they considered that *"the less desirable option of a severe emissions or fuel charge would be necessary to reduce demand."*

Friends of the Earth also commented, in a similar vein, that the introduction of aviation as a high net buyer in the EU ETS could potentially push up the price of allowances in other sectors to a politically unfeasible level. They argued that, in comparison with other sectors, aviation is relatively sheltered from competition – in that a flight from London to Frankfurt cannot be exported to Asia. They recommended that aviation should be provided with a closed emissions trading scheme – an option discussed in more detail below.

The views from the Tyndall Centre and Friends of the Earth were in marked contrast to those of the majority of witnesses, in the House of Lords report, who told the committee that the impact on passenger air fares and hence on demand for air travel would be very modest. The European Commission's witness explained that, in the shorter term, including aviation within the EU ETS would help reduce overall emissions by financing efforts to reduce CO_2 emissions in other sectors where it was cheaper, while in the longer term the scheme would impact on the environmental performance of aircraft. In response, however, the House of Lords committee commented that, on current evidence they felt this to be an over-optimistic view of aviation's ability to reduce its own emissions, and that it understated the potential conflict with other industries.

In conclusion, the House of Lords committee report argued that clarity is needed about present and future policy on the level of permitted carbon emissions, both in total and for the aviation industry. The report expressed severe doubts about the view that the impact on emissions allowance prices, airfares and air travel would be modest except in the short term. It called on both the UK Government and the European Commission to conduct a rigorous assessment of all relevant issues before making further policy commitments.

8.4.3.2 Proposal for a closed scheme

A resolution adopted by the European Parliament in July 2006, would help to address some of the limitations and potential difficulties outlined above (European Parliament, 2006). This proposes that there should be a separate and dedicated (i.e. closed) trading scheme for aviation emissions. It argues that if aviation *is* to be incorporated into the wider ETS, there should at least be a pilot phase of a separate scheme for the period 2008–12. In addition, it notes that the use of outside credits (e.g. from CDM and JI projects) must be minimised by capping them at a level which guarantees the sector contributes to the overall objective of halting climate change.

The resolution argues that if (as described above) a Gateway were to be created to allow airlines to buy from the EU ETS, then this should be on a carefully limited basis. It proposes that, should aviation eventually be incorporated into the wider ETS, special conditions should be applied to ensure it does not distort the market to the detriment of less protected sectors, namely, a cap on the number of emission rights it is permitted to buy from the market, and a requirement to make a proportion of the necessary emissions reductions without trading, before being allowed to buy permits.

The European Parliament's resolution also stresses the importance of the design of the scheme in achieving environmental effectiveness, emphasising the need for full auctioning of the initial allocation and a rigorous cap.

The deliberations of the EU Commission's Aviation Working Group reveal, unsurprisingly, the widely different views held on the appropriate cap, with one airline association proposing that the cap should allow for business as usual emissions projections that combined the expected annual growth in flights with historic average fuel efficiency improvements. In contrast, an NGO called for drastic cuts.

The European Parliament's resolution argues that the cap should be defined in line with the Kyoto commitment target and must therefore not allow for growth in emissions above the base year.

Under these circumstances, and especially under a separate closed scheme, the chances of ETS delivering emissions reductions from *within* the aviation sector are clearly much better. It remains to be seen how far these proposals, which were supported by a large majority and are effectively a position statement, will be reflected in the European Commission's legislative proposal later in the year. Notably, ICAO's endorsement of emissions trading for aviation is specifically for an open scheme. A closed scheme might also result in greater pressure for a generous cap, given the high costs of abatement in the aviation sector.

8.4.4 Timescale

A final, and fundamental problem with relying on the inclusion of aviation within the EU ETS to address aviation emissions is the relatively lengthy time scale for aviation's entry into the scheme. Incorporation is not expected until 2008 at the earliest and, is thought unlikely before 2012 (House of Lords, 2006). In the time period before it is introduced, significant further growth in aviation is expected to occur.

This is not to say that aviation should not be incorporated in emissions trading at the earliest opportunity, but that it should be brought forward *alongside* other policy instruments, particularly including those measures that can be invoked more rapidly.

It is also worth noting that the cap which is applied to the aviation sector within the EU ETS is, in practice, likely to be influenced by the current and projected levels of demand for flying and that these are arguably artificially high because of the anomalous exemption of aviation kerosene from fuel tax. Again, this indicates that entry into the ETS should not be seen as a substitute for the use of fiscal policies to correct anomalies in the way that aviation is taxed.

The importance of other instruments is, in fact, emphasised by the Commission, which states in its Communication: *"Regarding the application of energy taxation to aviation fuel, the process of removing all legal obstacles from bilateral air service agreements remains essential and will continue"*, adding that *"The Commission will take the necessary action, at both European and international level, to continue to keep all options for economic instruments open in the event* *that complementary measures are required alongside emissions trading to address the full climate impact of aviation"* (CEC, 2005b).

8.5 Summary

Including aviation within the European Union's Emissions Trading Scheme could bring many benefits, in helping to confer a degree of certainty on the scale of emissions reductions to be achieved, by treating aviation on the same basis as other industries, and by encouraging emissions reductions in the sectors where this would be most effective.

However, this final strength of the scheme is also one of its key limitations. If most of the savings made through including aviation in EU ETS are largely made through other sectors, the incentive for the aviation industry to cut back its own emissions are delayed. Since, as already discussed in Chapter 2, the scope for improvements in fuel efficiency or air traffic management are limited, the only other option is to address passenger demand. The longer this is delayed, the more difficult and costly it is likely to be, given the increasing development of an 'air dependent' culture.

There is a debate about what effects the inclusion of aviation within the EU ETS will have on ticket prices, and the related issue of carbon prices. If the recent proposal of the EU Parliament for a closed scheme goes ahead, this would mean that the scheme would have a far more direct impact on the industry and could act as an effective demand restraint mechanism if a sufficiently stringent cap were adopted.

However, regardless of the detail of the scheme, perhaps the most important point is that it is unlikely to affect aviation emissions for at least the next six years. Hence, on this basis alone, solely relying on EU ETS is a mistake. In the next chapter, some of the alternative economic instruments available are considered.

What Other Economic Instruments Could be Used to Address Aviation Emissions?

9.1 Introduction

In addition to emissions trading, a number of other economic instruments have been proposed that could be used to moderate emissions from air travel.

Some of these involve the imposition of taxes that have not previously been applied to aviation, but which are commonly used to influence demand or raise revenue in other areas of the economy, such as fuel taxation and VAT. As highlighted in section 5.3, environmentalists have long argued that air travel to and from the UK has enjoyed a remarkably long tax holiday and that this treatment is an economic distortion that can no longer be justified.

There is also considerable evidence that airport landing slots and landing charges are not charged at market values, due to the historical regulatory environment of the aviation industry, and that this is effectively providing airlines and their passengers with an additional subsidy for flying. For example, it has been reported that capital values attributed to some Heathrow Airport slots suggest a value of £50 per passenger trip, some eight times the maximum allowed airport charge in 2003–04 of £6.48 per passenger (Pearce, 2004). The House of Commons Environmental Audit Committee (HoCEAC, 2003) has called on the Government to re-examine the scope for introducing a new system to ensure that airlines pay a greater share of the infrastructure costs, and to work within the EU to enable slots to be auctioned on a regular basis so that demand is reflected in the price.

The Government's position on the use of economic mechanisms for reducing aviation emissions, in addition to including aviation within the EU Emissions Trading Scheme (EU ETS), is outlined in more detail in section 9.2.

In view of the urgency of preventing aviation from eroding UK progress in addressing climate change, it is likely that a range of economic instruments will be needed. All possible measures, therefore, are deserving of more consideration. Moreover, the speed with which measures can be implemented must be an important criterion for determining the immediate choice of action.

Particular individual measures are sometimes criticised on the basis that they do not provide an incentive for industry to become more efficient. Clearly, it is important that such incentives exist. However, it is also important that economic mechanisms act to achieve demand restraint, since, as already argued in Chapter 2, efficiency improvements alone will not be sufficient to offset the growing emissions from aviation. This implies, then, that a package of different economic measures may be needed, aimed both at encouraging industry efficiency and achieving demand restraint.

Another debate is about whether economic mechanisms that raise prices will actually alter whether people choose to fly. These arguments have already been addressed in Chapter 6, with the conclusion that price does affect demand. There is a related issue about the transparency of pricing to the consumer. The EU has recently produced a document that highlights this as a problem, noting *"the publication of fares that exclude taxes, charges and even fuel surcharges has become a widespread practice that hampers price transparency*". Consequently, it is proposing changes to EU regulations which will require that air carriers inform the public of all applicable taxes, charges and fees when quoting air fares (CEC, 2006).

In this chapter, seven of the more important economic policy options that could be introduced alongside the introduction of aviation into the EU ETS are considered. These are:

- Taxation of aviation fuel
- Emissions charging
- VAT on air tickets
- Air passenger duty
- Ending duty free
- Introducing airport slot auctions and
- Raising airport landing charges.

There is no analysis of how these measures should be applied to air freight, nor of other, downstream carbon trading solutions such as personal carbon allowances. These issues are important, but beyond the scope of the study.

9.2 The Government position on additional economic mechanisms

The Aviation White Paper reports that the Government has investigated various economic instruments for addressing aviation's climate impacts, and recognises that the global exemption of aviation kerosene from fuel tax is anomalous. It explains that economic instruments offer a means of implementing the 'polluter pays' principle and of using price signals to drive improvements in the use of environmentally friendly technology.

Yet the only economic instrument being actively pursued by the Government, as a means of tackling the contribution of flying to climate change, is the inclusion of aviation in the EU ETS. The Aviation White Paper argues that this, together with changes in working practices by airports, airlines and air traffic control, research and development into new technologies and voluntary action by the industry will "*provide a solid foundation for action in tackling aviation's global impacts*". It does, however, recognise that these measures may not provide a total solution. In view of this, it says it will continue to *"explore and discuss options for other economic instruments for tackling aviation's greenhouse gas emissions",* adding *"We reserve the right to act alone or bilaterally with like-minded partners if progress towards agreements at an international level proves too slow"* (DfT, 2003b, para 3.42). The Government has recently reiterated that its focus on including aviation in the EU ETS *"should not preclude further work on other policy instruments*" [to tackle emissions from aviation] (HM Treasury, 2006).

However, although Government rhetoric is in favour of additional economic mechanisms to address aviation emissions, there is little evidence that this is being translated into an active strategy.

This is highlighted in a recent report by the House of Commons Environmental Audit Committee, (HoCEAC, 2006). The Committee notes that the Government has said it may pursue other options in addition to including aviation within the EU ETS. However, it states: *"when we pressed the Secretary of State about what this alternative plan was, and when the Government would decide it was time to adopt it, he claimed that even to hint at what and when it might be would undermine the Government's efforts to persuade other EU governments to agree to the inclusion of aviation in the ETS. His argument was essentially that simply outlining an alternative would be to give the impression that the UK was not serious about the ETS, and give other States an excuse to raise objections to it themselves."* The Committee continues: *"We fundamentally reject this argument, and are concerned that it may simply be a cover for the fact that the Government does not have, in the end, any substantial idea for 'Plan B'."* Instead, the Committee recommends that the Government should set out proposals and a timetable for alternative UK action.

This chapter reviews the available literature on various economic mechanisms which could be invoked for addressing aviation's climate impacts. Each section begins with a summary of findings, and the overall conclusions are set out in section 9.10.

9.3 Taxation of aviation fuel

Summary: Taxation of fuel for domestic flights is legally possible, but there is a risk of 'tankering'. Taxation of fuel for international flights is legally difficult, but could be achievable through cooperation with other EU countries.

Aviation fuel used in commercial domestic and international flights to and from the UK is currently exempt from fuel duty. This is in obvious contrast to the position for petrol used in cars, where fuel duty and VAT together account for more than 60% of the price paid by the public (Mortished, 28/4/06)[69]. The reason for fuel duty exemption dates back to Article 24 of the Chicago Convention – the agreement drawn up in 1944 which established the International Civil Aviation Organisation (ICAO), at a time when the aviation industry was in its infancy.

Article 24 of the Convention states that fuel which is on board an aircraft on arrival in a contracting state, and kept on board on leaving, will be exempt from charges. Although it does not actually prohibit the taxation of aviation fuel, it enables aircraft to fill up in those countries where there is an exemption. In addition, Article 24 has spawned a large number of bilateral air service agreements between signatory countries that do, specifically, prevent taxation of aviation fuel.

Bilateral air service agreements between EU states have been superseded by EU Community Law since 1993. Following the adoption of the 2003 European directive on energy products taxation[70], EU states can waive the exemption on fuel used for domestic flights and, subject to mutual agreement, on fuel used for flights between Member States by any EU carrier. In order to tax fuel used by carriers from other non-EU countries on those routes, it would be necessary to modify the relevant air service agreements accordingly.

Some European states have introduced taxation of aviation fuel for domestic flights – in particular, Norway (though not in the EU) and the Netherlands. Outside Europe, other countries also have such taxation. For example, the US Government raised approximately $0.5 billion from tax on fuel used for commercial domestic flights in 2004.

The European Commission's Communication, on reducing the climate change impact of aviation, concludes that, alongside progress in carbon emissions trading, the process of removing legal obstacles to the energy taxation of aviation fuel remains essential (CEC, 2005b). As discussed in section 9.2, the UK Government is also supportive of the principle of taxing aviation fuel, although there is scepticism about its practical commitment to the process of achieving this.

A key concern for unilateral action by the UK (or any other nation) is the risk, referred to above, of aircraft simply filling up with cheaper untaxed fuel in other countries – a practice described as 'tankering'. Besides undermining the tax regime, this would also add to environmental impact by encouraging aircraft to carry additional fuel. The extent to which this would occur is likely to depend on the level of tax and the proximity of cheaper fuel – since airlines would incur some costs if they diverted to refuel and from the additional weight of carrying extra fuel on board. These issues are worthy of further investigation, and there is likely to be relevant international experience. For example, there could be interesting experience from America, where, in additional to federal fuel taxes, individual states also levy taxes on fuel, with rates ranging from zero to more than 8%, (see Appendix C). There may also be legal ways of avoiding the problem in relation to fuel for domestic flights, as discussed by Pache, 2005[71].

A second option would be for the UK to reach an agreement on fuel taxation with a sub-group of European countries that are favourably disposed to taxing aviation fuel, and that act as the destination for a significant proportion of UK flights. This option is discussed further in section 9.10. The major drawback of this is that it would hand a competitive advantage to any untaxed carriers operating on the same routes.

A better option, if achievable, would be action at EU level. With unanimous agreement from EU states, it would be possible to implement a fuel tax on intra-Community and domestic flights, with the caveat that *all* carriers could be made exempt on those routes where non-EU carriers currently operate and are still exempt from tax under unchanged bilateral agreements (CEC, 2005a). In this way, unfair competition from the relatively small number of non-EU carriers executing intra-EU flights would be avoided[72]. The ongoing renegotiation of international air service agreements would then gradually enable the taxation of third country carriers on intra-EU flights as well. This option has been proposed in the recent resolution to reduce the climate impact of aviation adopted by the European Parliament, see section 8.4.3.2 (European Parliament, 2006).

The renegotiation of the bilateral agreements is evidently a lengthy process, but is one that the European Commission and its Member States have started work on. This process is taking place, regardless of any provisions to allow for the taxation of aviation fuel, in order to remove restrictions within these bilateral agreements that currently apply to foreign ownership and control of airlines, which have been deemed to be illegal under Community law. To date the Commission has modified nearly 300 agreements on behalf of EU member states with non-EU countries to allow for the taxation of aviation fuel. Other agreements have been modified through renegotiation by individual Member States (Nicklas, 2006)[73]. Many more agreements are expected to be re-written in the next few years, making the taxation of aviation fuel increasingly feasible. However, there remains no timetable for the completion of this process or the subsequent introduction of a tax.

In assessing the potential for aviation fuel taxation, it should be noted that, since October 2005, the United States has levied a small tax on fuel used for all flights, including international flights by foreign carriers (at a rate of 0.1 cents per gallon). This has not been introduced through renegotiation of bilateral air service agreements, but by legislation passed by the US Congress, which is seen as taking priority. More details are given in Appendix C.

The American example suggests that the barriers to introducing some form of aviation fuel taxation, even without comprehensive international agreement, are not insuperable.

One limitation of fuel tax is that it would not necessarily translate directly into an increase in ticket prices. However, as part of a package of measures to make flying more expensive, it could be expected to have some impact. Moreover, there are strong arguments for introducing it in terms of creating a fairer situation in relation to other modes, and also because, as discussed in Chapter 7, it may be one of the most publicly acceptable ways to increase the cost of flying.

9.4 Emissions charging

Summary: Emissions charging is a potential alternative to fuel taxation, although the scale of charge would determine efficacy and it could face similar legal opposition to fuel taxation.

As a means of circumventing the potential difficulties with introducing aviation fuel taxes, an alternative would be the introduction of some kind of charge based on en-route emissions. When considering the value of including aviation within the EU ETS, the European Commission considered introducing emissions charges as an alternative to that approach. Some form of NOx emissions charge may still be introduced alongside the EU ETS (as discussed in Chapter 8). Emissions charging could be implemented at EU level and could be levied on all flights connecting to EU airports.

A feasibility study carried out in 2002 examined the potential for introducing such a charge, which would be incurred by aircraft in proportion to the volume of climate damaging emissions discharged into EU airspace (Wit and Dings, 2002)[74]. Specifically, it examined the reduction in forecast emissions in EU airspace between 2002 and 2010 that could be expected to result from different levels of an emissions charge introduced in 2002. The levels were set in a range from 10 euros per tonne of CO_2 with no charge on NOx; to 50 euros per tonne of CO_2 with 6 euros per kg of NOx.

The study found that the resulting reduction in forecast CO_2 ranged from almost 2% at the lowest charge level, to 13% at the highest charge level considered, with the impact on NOx for the same scenarios being between –2% and –15%[75].

In the medium term of 10 years, these reductions were expected to be roughly equally attributable to reduced demand for air transport and improvements in technical and operational measures. Specifically, the study estimated that the growth in demand on routes in EU air space covered by a CO_2 charge of 10 euros to 50 euros per tonne would be lowered by a cumulative amount of 1.0% to 4.5% over eight years, compared with the original forecast for 2010[76].

In its discussion of the results from this study, the EU Commission (CEC, 2005b and CEC 2005c) concludes:

- The effect of the emissions charge is expected, for all the scenarios investigated, to be a redistribution in GDP growth rather than a decrease, since consumers not wishing to pay the higher price resulting from the tax are expected to switch their spending to other purchases, for example, foods that have not been air freighted or holidays that can be reached by rail and sea.
- The scheme is not expected to be to the detriment of the competitive position of EU and non-EU carriers, providing the charge is applied equally to both.
- The charge is only likely to have a marginal effect on the growth of air freight transport, given industry forecasts that cargo traffic growth will average 6.2% a year for the next 20 years.
- The effect is expected to favour short distance over long distance tourism, and so help reverse the present trend for choosing tourist destinations further and further away – which would be an environmentally positive outcome. The study predicts that regions which can be reached by other forms of transport, such as rail, would find tourism increasing, while regions with a high proportion of aviation-based tourism would have reduced growth rates.
- The increased price of air travel would be progressive in its distributional impact – the wealthier parts of the population would tend to pay a relatively larger share of the overall cost.

It is worth noting that all of the five conclusions listed here also hold true for the inclusion of aviation within the EU ETS. although, with the EU ETS, the predicted effect on tourism would be smaller. This is because emissions charging would be expected to have a proportionally greater impact on aviation demand, since, with the EU ETS, impacts on demand are expected to be diluted by the purchase of carbon savings from other sectors.

One drawback of the emissions charge, from the scenarios investigated, is that the forecast effect on demand would be limited. Specifically, since the aviation sector *within* Europe has a predicted growth of 4% per year, the forecast reduction in demand due to the introduction of a charge of 50 euros per tonne CO_2 would be equivalent to only one year of normal growth, while, for routes to and from the EU, the reduced growth in demand due to the charge would be equivalent to less than six months of normal growth.

However, this conclusion is clearly critically dependent on the magnitude of the charge levied, and a greater level of demand restraint might be achieved at higher levels of the charge than those included in the study. By way of comparison, road transport fuels are taxed at over £150 per tonne of CO_2, and some organisations have argued that if the greater impacts of aviation are taken into account, a sum of £400 per tonne is appropriate to create a level playing field.[77]

Another concern is that emissions charging works in a way that is sufficiently similar to fuel charging that it would lead to the same kind of legal challenge as an aviation fuel tax. A counterargument is that, whilst CO_2 emissions may be proportional to fuel burn, this is not necessarily the case for NOx. Moreover, it can be argued that a charge is distinct from a tax, in terms of the use of revenues. Wit and Dings (2002) concluded that the Chicago Convention and bilateral air service agreements do not represent an obstacle to the introduction of the charge and that its introduction is politically feasible[78].

It may be that the issue of legal certainty can only be resolved through legal challenge. In 2004, the International Civil Aviation Organisation urged States to refrain from the unilateral implementation of greenhouse gas emissions charges prior to the next regular session of the Assembly in 2007 (DfT, 2005b). This kind of international pressure has led Sewill (2005) to argue that, in the light of the ecological urgency, withdrawal from the Chicago Convention is also an option that deserves serious consideration. He points out that the Convention itself contains an Article that allows nations to opt out, with effect one year from the date of notification. While conceding that this would be a controversial step, he concludes that it may prove a necessary one. Another approach, as discussed in relation to aviation fuel, might be for the UK to introduce charges in collaboration with a subgroup of European countries that are also favourably disposed to such measures, (see section 9.10).

At the national level, new legislation has recently provided the legal basis for imposing emissions charges to address *local* air quality issues[79]. Specifically, the recent Civil Aviation Bill will enable the airports to include an emissions-related element within their landing charges on the basis of local air quality problems. (A charge can also be levied for noise issues.) The Bill also allows the Secretary of State for Transport to request that such charges are introduced, if the airport does not do so. (Suggested amendments to the Bill by the House of Lords, which would have made such charges mandatory, have so far been resisted). Prior to the Bill, a local air quality cost element had already been included in user charges at both Heathrow, and more recently, Gatwick, and the Bill reinforces the legal basis for imposing these charges. However, the scale of the charges that can be imposed remains an issue of contention. Much will depend on whether they are revenue-neutral, to encourage cleaner aircraft, or revenue raising to finance additional mitigation / prevention measures.

9.5 Imposing VAT on air tickets

Summary: VAT could be added to domestic tickets without international agreement. Adding VAT to international tickets is logistically complex.

Value Added Tax (VAT) is a tax on consumer spending and is generally applied to all types of expenditure in Europe with exemptions reserved for more essential goods and services. Introduced to the UK in 1973, on joining the European Community, it is governed by the 6th VAT Directive.[80]

It has been argued that charging VAT on domestic air tickets offers a relatively straightforward mechanism to start implementing the polluter pays principle for air travel (Sewill, 2005). Since air travel can hardly be seen as a necessity, charging VAT on air tickets would also be consistent with wider VAT policy. Many of the existing exemptions to VAT are designed to help in achieving social and environmental objectives. For example, there is a reduced rate of VAT on the installation of energy saving materials such as loft insulation. In contrast, there is not a good rationale for the lack of VAT on air tickets since air travel is primarily a luxury purchase. (Since a chocolate biscuit attracts VAT on this basis, it is hard to see why a flight to the Algarve should not!)

The UK is currently out of step with much of Europe in not applying VAT to tickets for its domestic passenger flights, which are subject to VAT in all but four Member States (the others not charging being Ireland, Denmark and Malta) (CEC, 2005c).

By contrast, EU states do not, at present, charge VAT on international air passenger transport nor, with the exception of Slovakia, on non-domestic flights within the EU (CEC, 2005d). However, under the 6th Directive, the exemption of international air passenger transport from VAT is an optional one: member states can, if they wish, renounce the exemption (though having done so, they would not be free to reverse the decision).[81]

Without the exemption, under an Article in the Directive, it appears that VAT could be charged on an international air ticket in respect of the portion of the flight that takes place in the airspace of the Member State.[82] In 2004, the German government came close to such action, with a decision to put VAT on air tickets to and from all other EU countries (for the portion of flights over German airspace), though the plan was subsequently defeated by the opposition (Sewill, 2005).

For international tickets, then, the need to allocate the tax in proportion to the part of the journey that takes place in UK airspace presents a serious difficulty in that it adds a good deal of administrative complexity, while substantially reducing the resulting price increase and any consequent demand reduction.

Another criticism of VAT is that it does not include any mechanism to directly encourage the aviation industry to reduce emissions through technological improvement or greater efficiency. Hence, it would need to be part of a package of measures. However, as an instrument to influence demand, VAT is entirely appropriate. It is, after all, a direct tax on consumption, influencing purchases at point of sale.

In short, adding VAT to international tickets appears logistically complex. In contrast, the addition of VAT to domestic tickets is likely to be more straightforward and would bring the UK into line with other EU countries. Although using VAT to reduce demand for domestic flights would only go a small way towards tackling the wider problem of aviation emissions, it would help to discourage the growth of a domestic culture of air dependence, and help to increase the relative attractiveness of other modes such as rail.

9.6 Air Passenger Duty

Summary: Increasing air passenger duty probably offers the simplest and fastest way to reduce emissions from aviation and could be implemented swiftly.

Within the existing tax regime, there is already a tax on both national and international aviation called Air Passenger Duty (APD). Introduced in 1994, APD is a duty levied by the Government on tickets for flights leaving any UK airport. The rate of APD is £5–£40 depending on the class of travel and the destination[83]. The rate has been unchanged since April 2001. HoCEAC (2006) comments that reform of APD in 2001 had the effect of cutting the tax from £10 to £5 for most short-haul flights.

According to the Treasury Press Office, the level of APD is considered at every budget and the decision on whether to raise, freeze or reduce it made on a number of grounds including environmental ones. At the most recent budget (in March 2006) an increase was considered but rejected on the grounds of oil market volatility.

Increasing APD does not require the renegotiation of treaties at either EU or international level. Nor is it subject to evasion through ‘tankering’. It could be increased at the Government’s discretion. Hence, a rise in APD is probably the quickest and simplest step that could be taken by a UK Government to increase the price of flying and thereby apply demand restraint. Sewill (2005) argues that APD should also be extended to international transfer passengers and freight.

It is sometimes objected by the airlines that APD is a ‘blunt instrument’ in that it provides no incentive for industry to reduce emissions and the rate charged does not directly relate to the volume of emissions. This view has been reiterated by the Government in the Aviation White Paper, (DfT, 2003b, p41). This would suggest that, like VAT, a rise in APD is best introduced as part of a package of measures. Meanwhile, as an instrument for demand reduction, APD is entirely appropriate. This is partly because, although not required to do so by law, nearly all airlines pass on APD directly to their passengers, and it is normal commercial practice for them to do so at the point of ticket sale. Hence, an increase in APD is likely to translate directly into an increase in fares and a subsequent reduction in passenger demand.

In terms of whether APD should be more closely tailored to reflect its emissions, it should be noted that the rates of APD already discriminate between EU and non-EU destinations, and could be fine tuned to reflect the distance flown more closely.

An alternative suggestion has come from the House of Commons Environmental Audit Committee, which is a long term critic of the low rate of APD. In a previous report, it had suggested that the tax could be replaced with an emissions charge levied on flights, subject to an annual escalator to increase revenue over time (HoCEAC, 2003). In its latest report (HoCEAC, 2006), it states: *“The Government has no excuse for* *not raising Air Passenger Duty"*. It again suggests possibly changing to a flight-based measure, however continues by saying: *"Above all, however, whether reformed or not, APD should be raised so as to slow the growth in aviation and stabilise its absolute levels of emissions"*. It further comments that, rather than replacing APD with a flight-based measure, instead, a rise in APD could be complemented with 'differential landing fees', which *"could specifically target the fuel efficiency of different models of aircraft"*. (Emissions-related landing charges have already been discussed in section 9.4).

Potential impetus for increasing APD has also come from a different direction, with plans for the UK to use the charge as a source of revenue to finance health development projects that will help in achieving Millennium Development Goals by 2015. In January 2003, the UK Government proposed the creation of an International Finance Facility (IFF), to frontload aid to meet Millennium Development Goals, and in January 2005, the French Government proposed the idea of taxing airline tickets to generate revenue for achieving the Millennium Goals. In September 2005, the UK and France made a joint statement announcing the implementation of an 'air ticket solidarity levy'[84], where part of the revenues would go to fund IFF projects[85]. In March 2006, 11 other countries expressed their intention to implement an 'international air solidarity contribution' (T&E/CAN-Europe, 2006).

The UK Government has made it clear that the UK contribution will be drawn from existing APD revenue. In contrast, other countries are introducing new charges. France introduced its air solidarity tax in July 2006. According the European Federation for Transport and the Environment, (T&E 2006a), this was expected to add an estimated 1% to ticket prices. T&E (2006b) also report that the Swedish government is to make its forthcoming environmental tax on air tickets much higher than originally proposed. The proposed tax is expected to range from 94 kroners (£7) for flights within the EU plus Russia, and 188 kroners (£14) for flights outside Europe. These rates are approximately double those originally envisaged.

The detailed implications of the air ticket solidarity levy for Europe were considered in a European Commission Working Paper (CEC, 2005d). This looked with interest at the existing UK scheme, including a 2002 survey of airline operators which found that 96% felt completing returns was easy and only one third felt that meeting their statutory responsibilities was unnecessarily costly (HMCE, 2003). It concluded that the levy would be most effective if implemented in a co-ordinated manner by EU states, (though the co-ordination envisaged was informal). Such a proposal also offers a potential basis for co-ordinated EU progress on the related issue of aviation fuel tax. Addressing the climate impacts of aviation in conjunction with the assistance for international development is especially appropriate, given the particular vulnerability of poorer nations to the effects of climate change[86].

9.7 Ending duty free

Summary: The availability of duty-free goods for extra-EU travellers contributes to lower air fares, and could be ended. Changes would require action at EU level.

According to HM Revenue and Customs press office, passengers on extra-EU flights can buy goods free of all duty on board their flight and can also purchase goods exempt from VAT at UK airports, once airside[87]. However, duty free goods are no longer available on flights within the EU[88].

It has been argued that duty free should be ended for non-EU flights, with the recovery of the public revenue (Sewill, 2005). The availability of duty free goods to air travellers has been criticised as providing an additional tax break to the aviation industry, and resulting in a market distortion which gives airports and airlines an unfair retailing advantage. For example, it has been reported that, in 2004, BAA made £744 million from retail and duty free sales, compared to £717 million from airport charges, and that, for example, at Gatwick alone, BAA sells 150 million cigarettes each year (Sewill, 2005). Several commentators have argued that the reductions in prices on cigarettes and alcohol are especially unwelcome, given the effects of tobacco on health and the role of drinking in encouraging air rage incidents.

Although not expected to have a major effect on demand, at the margins, there could be some effect as it would mean that airports and airlines would need to recoup more of their costs from their core activities. Sewill (2003) estimated that abolishing duty free would raise about £400 million a year in taxes which could be used for other purposes.

Changes in duty free rules would require EU action, which the UK could actively seek.

9.8 Introducing slot auctions

Summary: Altering the system of runway slot allocation could ensure that airport capacity is used in the most cost-effective way. However, it is not clear that this would result in a reduction in aviation emissions.

Another suggested method for addressing the impacts of aviation is a change to the system used to allocate runway slots (the time of arrival or departure given to an airline for the use of a runway at a congested airport). This is also often put forward as an argument to oppose the creation of additional airport capacity.

At present, the airlines that have use of airport slots enjoy 'grandfather rights' whereby slots are allotted to those that held them the year before, and are only withdrawn if they are not used for 80% of the time. EU regulation provides that, where slots are not subject to grandfather rights, 50% are to be reserved for new entrants. One result of the present system is that there is a 'grey market' in which airlines trade slots with one another to obtain those that would not otherwise become available, although the exchange of slots for financial consideration is not permitted under Community law. In some cases, airlines are inclined to continue operating allocated slots that they do not currently require, in order to keep them for future use or to keep their competitors out. It is widely recognised that the system does not make the most efficient use of capacity, and there have been various suggestions for reform.

For example, in 2003, Bishop and Grayling, of the Institute of Public Policy Research (IPPR), proposed that slot auctioning should be used as a mechanism for managing demand at crowded airports, with a fifth of all slots becoming available every year, and the revenue accruing to national governments.[89] They suggested that a portion of these proceeds could go towards integrated transport schemes, including investment in rail-air substitution schemes, and estimated that, by 2030, (assuming no new runways are built) slot auctioning could secure an impressive £6.7 billion a year for public investment.

The European Commission is currently in the process of revising slot allocation rules, although not as radically as was suggested by IPPR. The main proposal of the Commission to receive support from the UK Government is the legalisation of secondary trading (albeit that the UK Government is in favour of less regulation of such trading than the Commission proposes). Secondary trading would mean that air carriers that have been allocated slots, or that are entitled to use them on the basis of their grandfather rights, could sell the right to use a slot to another carrier, at the highest price offered[90]. Other parts of the Commission's proposals are more controversial (DfT, 2004c)[91].

However, regardless of the way in which it is introduced, the role that a change in the system of slot allocation might play in managing demand is not straightforward. Using existing airport capacity more efficiently could provide a limited benefit to the environment, in so far as it delays the provision of new capacity that would subsequently generate more flying, and if it encourages more efficient use of aeroplanes. Otherwise, in so far as it enables a higher volume of flying, it will have the opposite effect.

This is the conclusion of a study undertaken for the European Commission by NERA (2004) to assess the effects of different slot allocation schemes. NERA reviewed several possible allocation mechanisms and estimated that the additional external environmental costs could amount to several hundred million euros a year, following an increase in the number of movements at congested airports and an increase in flights at off-peak times. All the mechanisms examined led to a central forecast increase in passenger numbers of 4–5%. These included a proposal involving the auction of 10% of slots a year, with each slot coming up for auction every ten years. None of the schemes resulted in increased fares or demand restraint.

Stuart Holder, one of the authors of the NERA study, comments that auctions would not act as a form of demand restraint because they are, by their nature, focused on the most profitable services, run at peak times in busy airports with a shortage of slots, rather than more marginal services (Holder, 2006). He considers that there are some indirect ways in which auctions could affect demand – for example, if a general increase in costs to airlines led to financial difficulties and encouraged a cut back on investment elsewhere, but adds that this probably applies only where an airline bids for slots irrationally or is currently cross-subsidising a less profitable route from a more successful service. It seems that an auction will never reduce the demand for airport slots, and therefore the total number of arriving or departing planes, below the current supply, unless there are some slots in operation that would become so unattractive, compared to paying more to use a more optimum slot, that no-one wished to operate them. This is thought to be a highly unlikely outcome.

The NERA study also found that commercial slot allocation would, in time, lead to an increase in the average size of planes using congested airports, because obtaining slots would be more cost effective for long haul or premium revenue routes. While some have argued that this would make for a more efficient use of airport capacity and fuel, there can be no overall environmental benefit in exchanging a given volume of short journeys or lighter planes for the same volume of long journeys or larger, heavier planes. The Department for Transport has commented however, that the tendency is likely to be limited by the need for short haul feeder flights and the characteristics of underlying demand (DfT, 2004c).

In terms of the parallel with demand management of road use, more efficient slot allocation is perhaps analogous to attempts to 'spread the rush hour' through mechanisms like the introduction of changes to working hours. It is not expected to reduce demand but to accommodate higher levels of demand more successfully. However, as the IPPR has pointed out, slot auctioning could generate considerable public revenue, which would help to redress the existing shortfall in tax paid by aviation, and could also be used to develop alternatives to flying such as high speed rail.

9.9 Raising landing charges

Summary: Raising landing charges could reduce the climate impacts of aviation, although if the revenue is then used to fund airport expansion, this is likely to have the opposite effect.

Another mechanism put forward for addressing the environmental impacts of aviation is to increase standard landing charges at airports. Airports levy landing charges on airlines for the use of their services and facilities, providing a source of revenue. The level of these charges is normally set in accordance to a set of principles, imposed at national level.

In the UK, under the Airports Act (1986), the Civil Aviation Authority (CAA) caps profits at Heathrow, Gatwick, Stansted and Manchester airports. In determining the maximum level of landing charges, the formula used takes into account the costs and revenues of both aeronautical and commercial activities. This approach, known as the 'single till' has meant landing charges at busy airports such as Heathrow and Gatwick are subsidised by the large volume of retail business that also takes place there. The system exacerbates congestion, in that the busier airports become, the lower the landing fees and the more attractive the airport. Charges are consequently higher at regional airports than at congested South East ones, adding to regional economic imbalances. Bishop and Grayling (2003) argue that the single till system should be ended and landing fees allowed to rise slowly to cover full operating and infrastructure costs with the effect of alleviating congestion and pollution at the busier airports and potentially offering a mechanism for demand restraint.

In 2002, the CAA put forward a proposal to introduce 'dual till' arrangements when setting charges (where charges on aeronautical activities and commercial activities would be set separately), and recommended this change to the UK Competition Commission.[92] The intention was to enable airports to raise landing charges, as a means of providing funds for investment in airport infrastructure. (Clearly, where additional revenue generated by airport charges then led to an expansion in capacity, this would, in the long term, prove a driver for greater demand rather than for demand restraint.) There was also some debate about how far the rise in landing charges that would result could be expected to affect fares. The CAA argued that the charges would not be passed on to passengers, though this view was disputed by the airlines. In the event, the Competition Commission rejected the dual till proposal, stating that it was not persuaded that fares would be unaffected, and considered it likely that the move would result in "*a substantial transfer of income to airports from airlines and/or their passengers*" (Competition Commission, 2002).

Although the single till remained in place, a rise in charges of 6.5% a year plus inflation was subsequently introduced at Heathrow for 2003–8, with the aim of raising revenue towards the construction of Terminal Five (CAA, 2003a). Again, the long term consequences of this will be to accommodate demand rather than restrain it. Meanwhile, a reduction in charges of 5% a year plus inflation was introduced at Manchester, in recognition that it was regarded as a high cost airport (CAA, 2003b).

As discussed in section 9.4, an emissions-related element can now be included in landing charges at UK airports, although the introduction and determination of the scale of such charges is a separate issue to that of determining 'standard' landing fees.

9.10 Comparing economic instruments

Chapter 8 has concluded that including aviation within the EU ETS should not be seen as an alternative to other economic instruments, but should be progressed alongside more direct means of applying demand restraint. This chapter has reviewed a range of alternative options, based on existing literature. This has identified some important gaps in understanding about how some of these measures might work in practice. However, on the basis of the existing evidence, the conclusions are as follows.

In the short term, **Air Passenger Duty** offers a means by which the UK Government could act now to initiate demand restraint. An increase in APD warrants particular attention because it has already focused international interest as a means of raising revenue for international aid. The addition of **VAT** to domestic air tickets also deserves serious consideration.

One objection to using these instruments to address emissions, rather than taxing emissions themselves, is that taxing emissions is more closely tied to climate impact, and provides a direct incentive for airlines to make their operations more efficient (including maximising passenger occupancies). However, whilst encouraging efficiency by the airlines is desirable, reducing demand is also likely to be essential to achieving the requisite reductions in emissions. Both APD and VAT offer a relatively direct means of reducing demand since they are likely to impact directly on ticket prices. Moreover, APD could be more closely tailored to reflect the emissions associated with flights than is currently the case.

Adding VAT to international air tickets presents difficulties. However, the fact that VAT on domestic air tickets is already charged by most other EU States makes this an immediate priority for UK consideration. The UK could also press for EU action to abolish **duty-free sales** on extra-European flights since the logic for the current exemption is not clear, and this would have a small indirect effect on demand by forcing the airports and airlines to recoup more of their costs by means more directly related to their core activities.

Changes in the **slot allocation** regime and an increase in **landing charges** could lead to more efficient use of existing capacity and could be pursued as an alternative to airport expansion. Revenue raised through such schemes could be very substantial. In theory, this could be used to finance integrated transport schemes, although, currently, only the revenue generated from changes to slot allocation would accrue to the Government. The revenue from landing charges would accrue to the airport owner, and could be used to fund airport expansion instead. As a mechanism for demand restraint, the effectiveness of these measures looks uncertain and they could actually help to facilitate aviation growth. However, to date, studies undertaken in this area have not considered their potential for meeting environmental objectives or their role as part of a strategy for demand restraint. The scope for using them in this way could be usefully explored.

Taxing aviation fuel is, in theory, an attractive option since it is closely linked to emissions, and so to environmental impact, and there is no obvious reason, in principle, for the current exemption. Taxation of aviation fuel is supported by both the UK Government and the European Commission. In addition, there would potentially be considerable public support for introducing such a tax, in order to create a more 'level playing field' with other modes.

Taxation of fuel for domestic flights is legally straightforward, but there is the danger that airlines would fuel up with cheaper fuel elsewhere. The likely significance of this problem needs further consideration.

Taxation of fuel for international flights faces a series of legal issues, whose resolution requires international agreement. One possibility would be an EU-wide agreement to tax aviation fuel on domestic and intra-community flights, with the possibility of exempting all carriers on specific routes on which non-EU carriers operate.

In the absence of such an agreement (which would have to be unanimous), the UK could nonetheless set out a programme for the implementation of aviation fuel tax in cooperation with other EU states, whilst seeking further progress in the removal of barriers to aviation fuel tax, through the renegotiation of bilateral air service agreements.

In a recent presentation, Kai Schlegelmilch, from the Federal Ministry for the Environment, Nature and Conservation and Nuclear Safety in Germany, talked about the scope for forming a 'coalition of the willing', among those countries which are, in principle, willing to tax kerosene, perhaps beginning with the joint introduction of kerosene tax for domestic flights or an air ticket tax. He identified 12 countries who might form such a coalition – specifically, the UK, Malta, Austria, Switzerland, France, Netherlands, Norway, Germany, Sweden, Denmark, Poland and the Czech Republic (Schlegelmilch, 2005)[93].

Meanwhile, the recent introduction of fuel taxation on international flights by the US Government may provide an alternative model for taking action.

Emissions charging *theoretically* offers one means of circumventing the legal difficulties related to fuel taxation. Emissions charges have already been introduced to address *local air quality* problems and there is international support for doing so. However, there is also international pressure not to consider emissions charges for gases that contribute to climate change before 2007, and any charges introduced may still face legal challenge. Again, in the long term, the best prospects for overcoming these problems may lie in co-operation between those European countries willing to place a charge on aviation emissions and take this agenda forward. Meanwhile, there is discussion about introducing a type of emissions charging as a 'flanking instrument' to account for non-CO_2 gases, in the context of the introduction of aviation into the EU ETS (as explained in section 8.2.2). The potential for this could be further explored.

In relation to either fuel taxes or emissions charging, the UK Government could be more proactive in pursuing European agreement for their implementation, with a clear timetable and targets for completion.

In brief, then, instead of relying solely on the inclusion of aviation in the EU ETS, there are a number of other economic policy measures that could be progressed, with some actions immediately available to Government. These actions could be undertaken without recourse to international consultation and would not necessarily be detrimental to the UK economy. They probably provide the only way of addressing aviation emissions in the time frame required. In the medium to long term, such measures are also likely to form a useful component of a package of policies to address the climate change impacts of aviation. This could usefully include other measures such as personal carbon allowances or non-fiscal forms of emission regulation.

Research Recommendations

There are a number of different, unresolved issues, which arise from the analysis reported here. Some of these – such as debate about the impacts of including aviation within the EU Emissions Trading scheme – can only be resolved when the details of the scheme are decided. Other issues, such as better understanding of public attitudes to aviation, are already the subject of new research. Here, we identify five additional research recommendations, which could be usefully taken forward. These are as follows:

- Further work to explore the viability of alternatives to aviation, including ferry and rail substitution, express coaches and the potential to substitute trips by teleconferencing. This research strand could usefully summarise the relative environmental credentials of different options, in terms of climate change impacts, on the basis of some of the studies outlined in section 5.8.
- Further work to examine each of the economic instruments discussed in Chapter 9 in terms of their potential to achieve a reduction in passenger demand. This work could include consideration of potential negative effects (e.g. could a tax on fuel used for domestic flights be introduced without the risk of a significant amount of tankering?) and look specifically at the role of measures such as landing charges to act as a means of demand restraint. It would also be useful to conduct a more detailed assessment of the analysis in Chapter 6 which suggests that adding a charge of £10–25 per ticket per year might be sufficient to stabilise demand for aviation.
- Further work to examine what would make UK tourism more attractive to UK residents, and what would lead the tourism industry to put more emphasis on promoting holidays to UK residents. Many in the tourism industry still see attracting more overseas visitors as the top priority for British tourism. Therefore, it would be useful to establish, in more detail, why this is the case and/or how much there are misperceptions within the tourism industry itself about the economic implications of supporting aviation growth. It would also be useful to synthesize existing work about what makes holidays attractive to British residents, and what would encourage more of them to stay at home. For example, is there perceived to be a lack of reasonably priced accommodation in attractive areas? Are there difficulties with booking unless planning a long time in advance? Are there well-publicised brochures or vendors that sell the sorts of adventure holidays which are now commonly sold for other parts of the world? Does UK tourism suffer from an old fashioned image in the eyes of UK residents?
- Although discussed briefly in Chapters 3 and 5, this study has not included a detailed consideration of air freight, and the arguments for and against its importance to the economy. This issue could be the subject of more research, to assess whether this sector should be protected from any increases in the costs of aviation (for example, caused by fuel tax increases), or whether the arguments about encouraging a level playing field with other modes, and discouraging transit activities, are equally applicable to aviation freight activities.
- Chapter 5 has considered a number of the economic issues relating to air travel. It highlights that the argument of the Aviation White Paper – that supporting aviation is, overall, beneficial to the economy – appears to have been made on the basis of a relatively narrow cost-benefit analysis, and to have overlooked or downplayed a number of factors which might lead to the opposite conclusion. However, Chapter 5 is not a definitive treatment of the economic impacts of aviation. Hence, one priority for future research is to undertake a more comprehensive and detailed economic analysis of the significance of aviation to the national economy.

Summary and Conclusions

11.1 Introduction

This study focuses on the significance of aviation for climate change, and potential economic policy measures for addressing the issue. Specifically, it examines issues for the UK, including the potential for, and implications of, taking unilateral action to reduce the environmental impact of UK air travel, not least because the UK accounts for a significant proportion of the world's total aviation activity. The study synthesizes much of the large, and often conflicting literature on the topic, as well as reporting on new analysis of key issues.

11.2 Aviation's contribution to climate change

The UK Government's Chief Scientist has stated that *"climate change is the most severe problem that we are facing today – more serious even than the threat of terrorism"* (King, 2004). The International Climate Change Taskforce has highlighted that action in the next 10 years is a priority, in order to avoid reaching certain climatic 'tipping points' (ICCT, 2005). For the UK, it is therefore important to understand aviation's contribution to climate change and how this is changing over time.

Evidence suggests that:

- A fifth of all international air passengers either arrive or depart from a UK airport, implying that, for the UK, aviation's relative contribution to climate change must be significantly greater than its contribution in most other countries.
- Aviation already accounts for about 6% of the UK's carbon dioxide emissions.
- Aviation accounts for a significantly greater proportion of the UK's overall climate change impacts, due to its non-CO_2 emissions.
- Carbon dioxide emissions from UK aviation doubled between 1990 and 2000, at a time when the carbon dioxide emissions from other UK activities fell by about 9%.

Yet the UK Government's Aviation White Paper envisages a substantial expansion in future aviation activity, and provides a policy framework which is widely interpreted as being supportive of airport expansion. If aviation continues to grow unchecked, the emissions from aviation are forecast to become an increasingly significant proportion of all the emissions from UK activities. The Department for Transport's own estimate of aviation's future significance, which uses optimistic industry forecasts of improvements in fuel efficiency and air traffic management, and relatively modest growth rates, suggests that the carbon dioxide emissions from aviation will quadruple between 1990 and 2050. Other forecasts, which still allow for improvements in fuel efficiency and air traffic management, suggest that the carbon dioxide from aviation could grow by more than 10 times over that period. Meanwhile, the UK has a target to reduce the carbon dioxide emissions from all its activities to 65MtC by 2050, meaning a reduction from 1990 levels of about 60%. In brief:

- All of the future forecasts examined here suggest that aviation emissions will double again between 2000 and 2030, in both absolute and relative terms (if other sectors meet their targets).
- Even allowing for significant efficiency improvements, the carbon dioxide emissions from aviation are forecast to reach between 17.4 million and 44.4 million tonnes of carbon by 2050 – an increase of 4 to 10 times 1990 levels
- To offset the carbon dioxide emitted by aviation, other sectors would need to reduce their emissions by 71%–87% instead of 60% by 2050 from 1990 levels.

Moreover, some commentators argue that the UK should be adopting even more stringent environmental limits, and, in these circumstances, the emissions from aviation could equate to the carbon budget for the whole of the UK. Commenting on the Government's aviation policy, the House of Commons Environmental Audit Committee states: "*Power companies, manufacturers, retailers, households, motorists and hauliers are already going to have to make significant efforts to decarbonise their lives and livelihoods. If the Government continues in its policy of allowing just this one industry to grow, it will either cause severe pain to all other sectors or provoke so much opposition as to fatally undermine its 2050 target"* (HoCEAC, 2006, p61). Hence, it seems that **the UK will not be able to meet its targets for reducing climate change impacts without action to restrain demand for air travel**.

If the need for demand restraint is accepted, then it follows that **Government action is needed on several fronts**. These are likely to include:

- **A change in strategic policy to give a presumption against the expansion of UK airport capacity**
- **A fiscal package to make flying less attractively priced**
- **A communication strategy that builds on existing support for addressing aviation's environmental impacts, and ensures that there is ongoing public understanding about the contribution of flying to climate change.**

The extent to which demand restraint is applied, and decisions about whether aviation activities should take priority over those of other sectors, are matters for public debate. However, as a minimum, it seems logical that the priority should be to avert the steep forecast rise in aviation demand, since this is primarily about avoiding the generation of additional air passenger trips *that are not currently taking place*. This would also mean averting a shift in lifestyles and business culture towards levels of air travel that are unsustainable given foreseeable technological development.

11.3 Government policy on aviation

Currently, it is not an objective of Government policy to reduce the anticipated growth in flying. Instead, the Aviation White Paper's preferred scenario for airport expansion would cater for the majority of future forecast demand, and enable the number of air passenger movements to increase from around 200 million in 2003 to more than double this number – around 470 million – by 2030. The Government's rationale for this strategy is that the future growth in air travel will bring benefits to people's lives and to the economy.

The Government's position on fiscal measures for addressing the environmental impacts of aviation is complex. It has investigated various economic instruments, and recognises the global exemption of aviation kerosene from fuel tax to be anomalous. It explains in the White Paper that economic instruments offer a means of implementing the 'polluter pays' principle and of using price signals to drive improvements in the use of environmentally friendly technology. The White Paper does not, however, propose their use as a means of curbing growth in aviation.

The White Paper also rejects a unilateral approach to aviation fuel tax on the grounds that it would not be "*effective*" in the light of international legal constraints. In addition, it reports that the Government does not see Air Passenger Duty as an ideal measure for tackling the environmental impacts of aviation *"because of its blunt nature"* (DfT, 2003b, para 3.43).

The only economic instrument apparently being actively pursued by the Government, as a means of tackling the contribution of flying to climate change, is the inclusion of aviation in the EU Emissions Trading Scheme (EU ETS). The Government considers that this, together with changes in working practices by airports, airlines and air traffic control, research and development into new technologies and voluntary action by the industry, will provide *"a solid foundation for action in tackling aviation's global impacts"* (DfT, 2003b, para 3.42). It does, however, recognise that these measures may not provide a total solution. In view of this, it says it will continue to *"explore and discuss options for other economic instruments for tackling aviation's greenhouse gas emissions"*, adding *"We reserve the right to act alone or bilaterally with like-minded partners if progress towards agreements at an international level proves too slow"*. The Government has recently reiterated that its focus on including aviation in the EU ETS *"should not preclude further work on other policy instruments* [to tackle emissions from aviation]" (HM Treasury, Mar 2006).

However, whilst this is the official position, various commentators remain concerned that, in the pursuit of including aviation within EU ETS, other fiscal measures are not being actively progressed. This message is more than reinforced in a recent comment by the Prime Minister to a House of Commons Select Committee: *"I cannot see myself that you are going to be able artificially, through mechanisms based on the consumer, to interfere with aviation travel."* (Blair, 2006). Concern about Government reluctance to adopt additional fiscal measures has also been expressed in the recent report from the House of Commons Environmental Audit Committee. The Committee questioned the Secretary of State for Transport about alternatives to including aviation within the EU ETS, and stated that it is: *"concerned that... the Government does not have, in the end, any substantial idea for 'Plan B'"*.

Moreover, while the Government has not signed up to the principle of demand restraint for air travel, there is also a strand in Government thinking which holds that an economic instrument will not, in any case, be effective in reducing growth. Airline costs – and hence air fares – are declining faster than previously forecast, offsetting the fall in demand expected from the impact of any economic instruments. Airline costs are expected to continue to reduce due to the increasing role of the no-frills sector, the resulting competitive pressure on traditional scheduled airlines, liberalisation of current regulatory restrictions in long haul markets and increased airline competition resulting from additional airport capacity. Analysis given in an appendix of the White Paper implies that, as a result, fuel tax is again to be consigned to the 'too difficult' box, this time on the grounds that the level of tax required to have an impact on demand – still by no means a declared Government objective – is too great to be contemplated. This interpretation is again reinforced by a recent comment from the Prime Minister to a House of Commons Select Committee: *"If you really want to impede air travel, to cut it back significantly, for example, through some taxation mechanism, it would have to be a fairly hefty whack... and I will wait to see who first proposes it"* (Blair, 2006, Q188 – 190).

In brief, then, it is not clear that the UK Government is prepared to restrict flying for environmental reasons. Yet in order to meet the UK's commitment to reduce its climate impacts, the Government must be prepared to impede a significant amount of future air travel. If this objective is accepted, the barriers to doing so are far from insuperable.

11.4 Issues of social equity

Air travel may be exciting and aspirational, but it cannot be called a necessity or regarded as a basic right. Most of the current demand for air travel is for leisure purposes and future forecasts of air travel presume that UK leisure passengers will still constitute the largest share of all passengers. Taxing a luxury item, especially one that generates a heavy social or environmental cost, and is currently perceived to be 'cheap', is consistent with broader social policy. In addition, any revenue generated from taxing flying could be used for more socially inclusive purposes.

It has been argued that making air travel less affordable would be inequitable. But evidence suggests that flying is not a socially inclusive activity. For example:

- The 2003 British Attitudes Survey found that over half of those in semi-routine or routine occupations have never flown, whereas nearly half of those in higher managerial and professional occupations fly three or more times a year.
- New analysis for this study, based on data from Manchester, Heathrow, Gatwick, Stansted and Luton, showed that, contrary to widely held perceptions, between 2000 and 2004, the number of international leisure trips made from these airports by people with a household income of less than £29,000 p.a. actually fell.

Hence, the evidence indicates that **much of the recent growth in aviation has occurred because richer people are flying more often and it seems likely that much of the future demand would also be generated in this way**.

Any assumption that social exclusion can be addressed with cheap air travel shows a certain lack of social realism anyway, since holidays abroad will still remain out of reach for many of the poorest UK residents. Over a fifth of two-parent families and nearly three-fifths of lone parent families are currently unable to afford a week's holiday at all unless staying with relatives (Haezewindt and Christian, 2004). Making leisure and tourism more socially inclusive could probably be more effectively achieved by widening UK-based leisure opportunities. For example, schemes such as the YHA's 'Do It 4 Real' have used lottery funding to reduce the cost of UK activity holidays for young people.

11.5 Economic implications of restraining air travel

Aviation brings economic benefits. However, there could also be economic advantages to the UK from making flying more expensive, which deserve closer consideration.

Critics argue that, compared with motoring, air travel is currently under-taxed, enjoying a net tax subsidy that economist Brendon Sewill has calculated to be in the order of £9 billion a year, as a result of exemption from fuel duty and VAT on tickets, and the opportunity to offer duty free sales. This distortion can inflate assessments of the economic contribution of the aviation industry. If air travel were taxed at the same rate as motoring, the additional public revenue could be invested to achieve national economic benefits (and the benefits of such investment could prove more socially inclusive than low price air travel).

There could also be long term economic and social benefits to the UK in narrowing the growing 'tourism deficit', reported to have hit £17 billion in 2005, despite record numbers of overseas visitors. The Department for Culture, Media and Sport explicitly recognises this 'tourism deficit', which is resulting from UK residents spending far more money abroad than overseas visitors are bringing in. Consequently, its future tourism strategy places new emphasis on promoting the UK to its own residents. Notably, analysis of data from the International Passenger Survey suggests:

- In 2004, about 60% of all international trips from UK airports were UK residents going abroad for leisure purposes. Of the growth in international trips that occurred between 1994 and 2004, 70% of the additional trips were of this nature.

A rise in the cost of flying could therefore provide a welcome boost to spending by UK residents in the UK. This seems particularly probable given that new analysis for this report shows:

- In the six months after September 11th 2001, people's reluctance to fly actually benefited the UK tourist industry, as increased spending by UK residents staying at home more than outweighed lost incoming revenue from overseas visitors.

There are also potential economic benefits that could accrue to rail and ferry services if not competing with the extremes of cut price air fares.

National economic justifications for supporting aviation growth could be reconsidered in the light of all these factors, which appear to receive little attention in the White Paper.

The Government's explicit economic analysis of the benefits to be derived from an expansion in airport capacity focuses primarily on savings for future passengers and places a strong emphasis on time savings, assuming that the value of these will increase steeply in future. Both the appropriateness of this measure of value, and the values used, have been criticised.

Whilst rising incomes may be one driver of aviation, it would be wrong to assume that the UK's prosperity is dependent on high levels of flying – since, among EU countries, there is no clear relationship between air passenger numbers and GDP. Assessments of road transport have also shown that the relationship between transport provision and economic well-being is complex and that improved links between places may benefit either end of the link, potentially at the expense of the other. This finding appears particularly relevant to UK air travel.

Finally, the economic implications of air freight need consideration. These have not been addressed in detail in this study. However, it is notable that there are a number of reasons why all air freight may not be economically essential. For example, 22% of air freight, by weight, is simply passing through the UK, 13% of the UK's imports, by weight, are fruit and vegetables and 12% of purchases of air freight, by value, are made by the aircraft industry itself. In policy terms, it should be possible to introduce mechanisms to protect the air freight industry from increasing costs placed on aviation intended to reduce passenger demand. However, it is unclear whether, for the sake of the economy, these mechanisms should be invoked, or whether, as with passenger demand, there is an equal case for ensuring that air freight pays its full environmental costs, encouraging more judicious use of air transport and a shift towards other modes, while giving greater comparative advantage to local products. This is an important area for future research.

11.6 The role of emissions trading

Supported by the UK Government, the European Commission is in the process of developing a legislative proposal that will enable aviation to be included in the EU Emissions Trading Scheme (EU ETS). This is a welcome development, since it will help to establish that aviation should not receive preferential treatment compared with other industrial sectors, and because it will provide a direct incentive for airlines to make their operations more efficient. However, a detailed feasibility study of the proposals, completed for the Commission by CE Delft (Wit et al, 2005), highlights that inclusion of aviation within the existing EU ETS is only expected to lead to small increases in air fares, and, consequently, is likely to have a minimal impact on demand for flying. Instead, the study predicts that the majority of any consequent reduction in emissions will come from non-aviation sectors, which will choose to become more efficient in order to sell their emission allowances to the aviation industry.

Given the forecast growth in flying, relying solely on the inclusion of aviation within the EU ETS does not appear to be an adequate strategy for ensuring that the aviation sector contributes proportionately to reducing the UK's climate impacts. There is also considerable uncertainty about the overall effectiveness of the EU ETS and the robustness with which it will be administered. For example, if airlines are given relatively generous emissions allowances, they will have no particular incentive to reduce emissions.

A resolution recently adopted by the European Parliament would help to address many of these concerns. This proposes that there should be a separate and closed trading scheme for aviation emissions, and argues that if aviation *is* to be incorporated into the wider ETS, there should at least be a pilot phase of a separate scheme for the period 2008–12. Under these circumstances, the chances of emissions trading delivering emissions reductions from *within* the aviation sector are clearly much better. However, it remains to be seen whether there will be the political will to adopt these suggestions in the European Commission's legislative proposal later in the year.

Even if the EU ETS could be relied upon to deliver a rise in the cost of air travel through market mechanisms, aviation will not be incorporated into the scheme until 2008 at the earliest, with many people arguing that this will not occur until 2012 or later. Significant aviation growth is likely to occur if flying is allowed to continue growing unchecked until that time. Moreover, **entry into the EU ETS does not negate the case for taxing flying** at comparable levels with motoring, since other sectors are not exempt from other taxes just because they fall within the remit of the scheme. Hence, additional fiscal measures are likely to be needed.

11.7 Fiscal measures that could be deployed

There are various fiscal measures that the UK Government could actively pursue in order to reduce the climate impacts of aviation. The greatest benefits are likely to be achieved through a package of measures, which encourage greater efficiency in the industry but which also have a direct impact on the desirability of flying through increasing ticket prices. Fiscal measures may also be less contentious, and more robust, if spread across a fair tax package, rather than loaded onto a single economic instrument.

While the Government has observed that the lack of tax on aviation fuel is anomalous, there are difficulties in correcting this anomaly. Taxation of fuel used on domestic flights is legally possible but could be subject to tankering (airlines fuelling up with cheaper fuel elsewhere). The likely scale of this problem would need to be considered. In contrast, in principle, taxation of fuel for international flights requires the renegotiation of the terms of multiple bilateral agreements with other countries, arising from the Chicago Convention (1944). The European Commission has concluded that, alongside progress in carbon emissions trading, the process of removing legal obstacles to energy taxation of aviation fuel remains essential. Yet, although the White Paper states that the Government intends to *"explore and discuss options for other economic instruments for tackling aviation's greenhouse gas emissions*", there is little evidence that the UK Government is actively pursuing the implementation of an aviation fuel tax as a policy option.

An alternative mechanism to taxing aviation fuel would be a charge on en-route emissions, i.e. a charge proportional to the volume of environmentally damaging emissions discharged in the course of a flight, but this may also be open to legal challenge. (A form of en-route emissions charge for non-CO_2 emissions from flying is under consideration at EU level, as a 'flanking instrument' to complement the inclusion of aviation within the EU Emissions Trading Scheme.)

In opposition to these policies, the International Civil Aviation Organisation (which sets international standards and regulations for air travel) has urged countries to refrain from unilateral implementation of greenhouse gas emissions charges prior to 2007. Hence, in the absence of wider international agreement, the best prospects for overcoming the legal problems associated with emissions charging or aviation fuel tax may lie in agreement at European level to tax aviation emissions on intra-EU flights (with the possibility of excluding specific routes where there are non-EU carriers in operation). As a mechanism for demand restraint, European level action could be an effective initial step, since 66% of international air trips affecting UK airports are made to or from other EU countries (albeit that these account for a smaller proportion of emissions).

As part of a revised aviation policy, the Government should vigorously pursue both European and wider international agreement on the implementation of either aviation fuel tax or en-route emissions charges, setting out a programme and timetable for action on these measures.

The legal difficulties posed by the Chicago Convention and its bilateral treaties have not represented an intractable barrier to taxing aviation fuel in the United States. In 2004, the US Government raised approximately $0.5 billion from tax on fuel used for commercial flights. Although the majority of this money has come from taxes on fuel used for domestic flights, since October 2005, a new Act of the US Congress has led to the levy of a small tax on the fuel used for all flights and by all carriers.

There are also compelling arguments for the UK to raise the level of Air Passenger Duty (APD). The first, pragmatic, reason, is that APD can be readily deployed. Raising APD – which has been frozen since 2001 – does not require international agreement or the removal of legal barriers, and action could be taken in the next budget. As a tax on all departing flights, APD has the potential to impact on air travel decisions across the world. Since UK residents appear to holiday overseas more than the residents of many other countries, such an intervention, even by the UK alone, would be influential.

A second argument is that APD is likely to have a more direct effect on demand than other economic instruments. This is because it is normal commercial practice for airlines to pass on the APD charge directly to their passengers. An increase in APD is therefore likely to translate directly into an increase in fares. In comparison, the effect of a fuel tax on ticket price and its knock-on effect on demand, is much less predictable. Therefore, where demand restraint is the objective, APD is an appropriate tool.

A third argument is that there is already international agreement to use air passenger taxes – being called 'air solidarity levies' – as a mechanism for funding the UN's Millennium Development Goals, via the International Finance Facility. Hence, there is an established basis for using some APD revenue to finance health and development projects in poorer countries, which is likely to make this a more acceptable tax rise in the eyes of the general public. The public response to events such as the Tsunami, Live Aid and other campaigns demonstrates that there is a high level of awareness and concern for the problems of the poor in the developing world.

Finally, APD could be more closely tailored to reflect the emissions associated with flights than is currently the case, redressing the criticism that it is too blunt an instrument to assist in reducing emissions.

In addition to the measures set out above, in order to achieve a fairer tax situation in relation to other modes, and to apply demand restraint, **the UK should consider applying VAT to domestic air tickets**. It is one of only four EU Member States which does not do so. **The UK could also lobby the EU to end duty free sales on extra-European flights.** Tax breaks for tobacco and alcohol seem particularly illogical given the health concerns that they generate.

Changes to landing charges and the system of allocating runway slots may also be due for reform, and enable a more efficient use of airport capacity. However, it is unclear that these measures would reduce aviation emissions, and they could have the opposite effect.

11.8 Public support for addressing aviation's climate impacts

A series of surveys have investigated public opinion on environmental pricing for aviation. EU survey work in Spring 2005 showed that, amongst members of the public active in the aviation debate, and various stakeholders (including the airline industry), there is widespread recognition that the climate impacts of aviation need to be addressed, and that economic mechanisms are one appropriate way to do this. Amongst members of the public active in the aviation debate (including those whose jobs were related to the aviation industry), and stakeholders that were not part of the aviation industry, the survey also found strong support for increasing the price of air transport, and a recognition that demand management is necessary. Many also advocated increasing the viability of alternatives such as rail, commenting on the importance of having a fair taxation system for all modes.

There have been various UK surveys of members of the general public, including research conducted for the Department for Transport, four newspaper opinion polls, and, most recently, a major study by the Airfields Environment Trust. These surveys, dating from 2002, show that, initially, there was reluctance to limit the growth in air travel or increase the cost of flying. The surveys also show however, that people's opinions on these issues are influenced by the contextual information provided and the way in which questions are framed. People are much more likely to accept the need for changes if they are led to deliberate on information about the environmental impact of air travel and the extent to which these costs are currently met through airfares. For example

- In the 2004 British Social Attitudes Survey, support for the statement *"people should be able to travel by plane as much as they like"* fell from 77% to 15%, when the rider *"even it this harms the environment"* was added.

The UK surveys also indicate that a shift in public opinion may have taken place over the last few years, which has potentially accelerated significantly in the last year. This has perhaps been influenced by significant growth in media coverage of both climate change and the role of aviation in climate change. By mid 2005, about two-fifths (39%) of people felt that air travel should be limited for the sake of the environment (DfT, 2005d), and about half of respondents believed that they should be prepared to fly less to limit climate change or that some kind of restriction on air travel would be necessary in the future (The Guardian, 21/6/05). By February 2006, a majority (63%) supported the principle behind green taxes on "things that harm the environment" (The Guardian 22/2/06). In June 2006, survey work conducted for the Airfields Environment Trust (Ipsos MORI, 2006) showed that, with or without preliminary contextual statements designed to make the case for change:

- Support for a policy to constrain the growth in air travel outweighed opposition, with less than 22% of respondents opposed to such a policy.
- There was majority support (about 60%) for airlines to pay higher taxes to reflect environmental damage, even if this meant higher airfares.

The rejection of aviation tax in several surveys from earlier years adds a warning note, highlighting the importance of communicating with the public about the significance of aviation to climate change. Nevertheless, it appears that, along with growing public awareness of the environmental risks of air travel, there is growing public recognition of the need to make flying more expensive.

11.9 The likely impacts of increasing aviation costs

It is sometimes argued that new taxes or charges on aviation would be ineffective for a variety of reasons. First, these would only indirectly affect air fares or would only have a small effect; second, their effect would be offset, or more than offset, by reductions in fares or other holiday costs occurring for other reasons; and third, because fares are relatively unimportant in driving demand, compared with macroeconomic factors such as GDP growth.

These arguments seem relatively tenuous, not least because any new charges will increase the costs of aviation compared with what they would otherwise have been, and any reduction in the rate of aviation growth is preferable, in environmental terms, to business as usual.

It is also clear that the greatest growth in aviation demand has been at the cheaper end of the market, involving short-haul leisure trips to Europe, and that this has been partly driven by significant reductions in airline fares over the past 10–15 years. A growing body of work suggests:

- **At least 40% of the recent growth in air travel has been generated by fare reductions.** Dargay and Hanly (2001) explicitly calculated that fare reductions explained about 40% of the increase in UK leisure travel between 1989 and 1998, and several other commentators have produced similar or larger estimates.
- A 10% change in fares could be expected to change demand by somewhere between 5% and 15%.
- Flight price increases are expected to have a bigger effect on leisure travellers and short haul trips.

Initial calculations, using existing evidence about price elasticities and projected growth rates, suggest that an additional charge of approximately £10 to £25 per ticket per year, applied over a number of years, could be sufficient to offset growth. In considering the political viability of such increases, it is worth noting that above inflationary fare increases are relatively common in other sectors such as rail, and that customers would only 'see' a proportion of these rises since fares are otherwise forecast to fall.

A newly emerging argument is that recent increases in oil prices will increase the cost of flying significantly, thereby negating the need for Government action. However, the volatility of oil prices makes this unreliable as a long term strategic approach. Moreover, it is not clear that fuel price rises are being systematically passed on to the consumer. Hence, relying on fuel price increases to have a consistent, long-term effect on fares is currently unrealistic.

A final argument sometimes made against the use of pricing mechanisms to address the demand for aviation is that they are less socially fair than other mechanisms, such as introducing personal carbon allowances (PCAs). The environmental and social case for PCAs or similar schemes is strong, and they could undoubtedly complement other economic mechanisms in the future. However, the profile of aviation use means that new charges for flying are primarily likely to deter richer members of society from flying more, and are therefore unlikely to be socially regressive. Moreover, one of the key advantages of a mechanism like Air Passenger Duty is that it could be deployed swiftly.

11.10 The case for demand restraint

In absolute terms, the UK generates more flights than any of the other EU25 countries. Moreover, our capacity for flying is still, even now, in its infancy. Between 2004 and 2005, passenger numbers rose by 6%, and prior to September 11th, annual growth rates were increasing. Growth in the low fares sector has been particularly dramatic. For example, between December 2004 and December 2005, Ryanair reported a growth in passenger numbers of 26%. Consequently, there is an urgent need to adopt a policy of demand restraint. **If action is postponed now, tackling air dependence in future is likely to become more difficult.** As a society, we will enter an era in which frequent flying is the norm for better off households, and lifestyles are increasingly adapted to this expectation, with far greater ownership of second homes abroad, and increasingly geographically distant networks of friends and family. These lifestyles will develop because the public is led to believe that cheap international flights are a permanent and sustainable feature of modern life.

We have been here before. The predict and provide road transport policies of the last fifty years have earned the UK some of the most congested roads in Europe (WS Atkins, 2001), and reducing emissions from road transport now represents one of the more significant stumbling blocks to meeting climate change reduction targets.

In the case of air travel, **there is the opportunity to choose a more sustainable trajectory, in which we do not continue to build our society around increasingly high levels of flying or encourage an expanding 'air culture'. This path could offer significant benefits in terms of public revenue and the regeneration of UK domestic tourism, and, most importantly, in setting a credible course towards fulfilling the UK's commitments on climate change**.

Notes

[1] The UK Chancellor announced on 19 July 2005 that he had asked Sir Nick Stern to lead a major review of the economics of climate change, to understand more comprehensively the nature of the economic challenges and how they can be met, in the UK and globally. The review is being taken forward jointly by the Cabinet Office and HM Treasury, and will report to the Prime Minister and Chancellor by the end of 2006. It takes place within the context of existing national and international climate change policy.

[2] ICAO sets international standards and regulations for the safety, security, efficiency and regularity of air transport and provides the means of cooperation in civil aviation among its 189 contracting States. ICAO's current environmental activities are largely undertaken through its Committee on Aviation Environmental Protection (CAEP), which was established by the Council in 1983.

[3] DfT (2006a) have clarified that this figure can be justified as follows. In 2005, the International Civil Aviation Organisation (ICAO) reported that there were 648.5 million international passenger trips on scheduled airlines worldwide. Meanwhile, the UK Civil Aviation Authority (CAA) reports that, in 2004, there were 99.9million passenger trips on scheduled flights terminating at UK airports, and 30.9million passenger trips on scheduled international flights by passengers who were transferring between international flights. Hence, of worldwide scheduled international passenger trips, 20% were using UK airports and 15% were terminating at UK airports. These figures exclude passengers on charter airlines, since charter airlines do not report to ICAO. Hence, charter passengers have been removed from the CAA data for the purposes of this comparison. There is no obvious reason to think that the UK has a lower proportion of charter passengers than its worldwide share of scheduled passengers. However, it should be noted that this is a figure for *international* flights and that some countries, like the US, undertake a particularly significant volume of domestic air travel.

[4] Emissions of carbon dioxide are often expressed in terms of tonnes of carbon, referring to the weight of the carbon atom in the CO_2 molecule. To convert into tonnes of CO_2, it would be necessary to multiply by 3.667. Government targets are often expressed in terms of tonnes of carbon, although emissions trading is based on tonnes of CO_2. Throughout the report, care has been taken not to confuse the two terms.

[5] In UN discussions, the concept of 'luxury' emissions has already been introduced in relation to the emissions from richer countries and Muller (2006) argues that emissions should be classified as 'luxury' or 'survival' based on activity. He identifies international air travel as a specific category of emissions that might reasonably be classified as 'luxury', and suggests that luxury emissions should be subject to a special levy to fund climate change adaptation measures in developing countries.

[6] If a 60% cut in emissions would lead to annual emissions of 65MtC, this implies that, in 1990, emissions were 162.5MtC. DTI (2004) states that emissions in 1990 were, in fact, 165.1MtC. The Energy White Paper (DTI, 2003, para 2.12) clarifies that this is largely a rounding difference – the aim is to reduce emissions by approximately 60% to achieve 'around 65 million tonnes' of carbon.

[7] Specifically, DfT (2006b) clarify that the most appropriate data for use are given in para. 3.56 (DfT, 2004a). Although reported to be so, these data are not compatible with those given in para. 2.14 of 'The Future of Air Transport' White Paper and associated graph, since the horizontal axis of that graph is misplaced by 5 years. In addition, the figure for emissions in 1990 given in para. 3.5 of the 'Aviation and Global Warming' document is incorrect as it was taken from an earlier analysis. The apparent inconsistencies within the DfT (2004a) document and between this document and other published reports have already been highlighted by the House of Commons Environmental Audit Committee (2004a, recommendation 10), and the DfT has provided an explanation in relation to the issues they raise.

[8] DfT (2004a, para 3.7) note that their estimates of CO_2 emissions from aviation are lower than those calculated by NETCEN.

[9] Emissions for all UK activities were 165.1MtC in 1990 and 152.7MtC in 2000, according to DTI (2004, p3). According to DfT (2006b), domestic civil aviation is typically responsible for about 6% of UK aviation emissions. If, in 1990, emissions from all aviation were 4.6MtC, those from domestic aviation would be 0.3MtC. The equivalent figure for 2000 would be 0.5MtC. Hence, discounting for domestic aviation emissions would make the total emissions from all other UK activities about 164.8MtC in 1990 and 152.2MtC in 2000.

[10] According to Transport Statistics Great Britain (DETR 2000b, Table 2.2b), in 2004, 19% (36.5 of 191 million terminal passenger movements) were for charter flights. According to the CAA (2005a, Table 8), 10% (23 million of 229 million terminal and transit passenger movements) were for charter flights.

[11] Owen and Lee clarify that the UNFCCC Subsidiary Body on Science and Technological Advice has recommended that five allocation options for international aviation emissions are worthy of detailed consideration. For three of the options, Owen and Lee calculate the scale

of emissions allocated to the UK would vary by less than 5%. Of the other two options, one involves not allocating international aviation emissions to anyone.

[12] Owen and Lee undertook this calculation by adding 1990 emissions from international aviation to the UK total for 1990, assuming that the aim is a 60% reduction in this total, and then examining the proportion of that total that the calculated emissions from aviation for 2050 would represent.

[13] Bows et al (2006) have also considered other scenarios which are not examined here.

[14] As a rough approximation, if non-aviation activities achieve emissions of 110–120MtC, and aviation emissions add a further 15MtC, aviation would then represent 11–12% of CO_2 emissions, compared with 5.5% in 2000. Deducting domestic aviation emissions from the 110–120MtC target would not significantly affect this finding.

[15] The IPCC (1999, p7) notes: *"Changes in tropospheric ozone are mainly in the Northern Hemisphere, whilst those of methane are global in extent so that, even though the global average radiative forcings are of similar magnitude and opposite in sign, the latitudinal structure of the forcing is different so that the net regional radiative effects do not cancel."*

[16] Specifically, p198 of the IPCC report states that aviation has been responsible for about 1ppm of the 80ppm rise in CO_2 present in the atmosphere from 1860 to 1990.

[17] Meanwhile, the IPCC estimated that, in 1992, the radiative forcing index for *all* human activities was approximately 1, although they clarified that, *"for greenhouse gases alone, it is about 1.5, and it is even higher for sectors emitting CH_4 and N_2O without significant fossil fuel use"* (IPCC, 1999, p188).

[18] Forster et al's calculations were based on GWP estimates. They comment: *"We found that the GTP values for constant aviation emissions were very similar to their GWP values"*.

[19] As reported on the SESAR website, accessed 09/08/06, http://www.eurocontrol.int/sesar/public/standard_page/overview.html

[20] www.greenerbydesign.org.uk. Accessed 18/4/06.

[21] It is unclear whether the Greener by Design estimate includes or excludes the gains likely from improvements in air traffic management and other operational procedures.

[22] Owen and Lee (2006a, Table 8), clarify that global revenue passenger kilometres (RPK) in 2005 were 3366.4billion, and were forecast to rise to 16,401.1 – 24,406.6 billion in 2050. Data from their data appendix clarifies that, for allocation option 6, corresponding emissions of CO_2 were expected to be 482,460, 1992547 and 2965100 $GgCO_2yr^{-1}$. This implies that emissions were anticipated to reduce from 143gCO_2 to 121gCO_2 per RPK, an improvement of 15%. This has been confirmed with Owen and Lee (2006b).

[23] Clarification provided by Bows, 2006.

[24] These are the forecasts for passenger numbers if airport capacity is unconstrained, which were the basis for the Department for Transport emission forecasts, (DfT, 2004a, para. 3.53).

[25] This growth rate has been calculated by dividing the total emissions expected for UK aviation under allocation option 6 (as set out in Table 13 of Owen and Lee, 2006a), with emissions per RPK of 143gCO_2 in 2005 and 121gCO_2 in 2050. Again, this calculation has been confirmed with Owen and Lee (2006b).

[26] Additional data supplied by Bows, 2006. 6.4% calculated to be the pre-2001 passenger growth rate for the UK. 3.3% reported to be in line with DfT projections.

[27] The Civil Aviation Authority conducts regular surveys of departing air passengers at UK airports, conducting interviews with something like every third or fifth passenger entering a departure lounge. Successful interviews are conducted with 95% of those approached. Some airports are surveyed every year; others are surveyed more infrequently.

[28] The International Passenger Survey is undertaken by the Office for National Statistics, and, in 2004, involved interviews with over 250,000 passengers passing through passport control, selected randomly, including passengers both entering and leaving the UK.

[29] 'No frills' airlines are also known as low-cost or low-fares airlines, and there is a 'European Low Fares Airline Association', www.elfaa.com.

[30] For both Table 3.3 and Figure 3.3, data were supplied by ONS (2006), from the International Passenger Survey, based on historical data of the kind given in Tables 2.07 and 3.07, Travel Trends, (National Statistics, 2004b).

[31] For UK residents, data are for the main country of visit, and for overseas visitors, data refer to the country of residence. Hence, countries used for connecting flights are not included in these statistics.

[32] These are Spain, the USA, France, Italy, Greece, the Irish Republic, Germany, Netherlands, Portugal, Turkey, S Cyprus, Switzerland, the Czech Republic, India, Canada, Austria, Australia and Malta.

[33] The CAA surveys ask business passengers about their annual income, whilst leisure passengers are asked about the total annual income of all people in their household (in both cases, before tax and other deductions).

[34] According to the 2002/3 Family Spending Survey, in 2002/3, the average gross weekly household income was £552, implying an average yearly income of £28,704 (National Statistics, 2004a).

[35] The CAA data divides the data into the household income categories: under £5,750; £5,750–£8,624; £8,625–£11,499; £11,500–£14,374; £14,375–£17,249; £17,250–£22,999; £23,000–£28,749; £28,750–£34,499; £34,500–£40,249; £40,250–£45,999; £46,000–£57,499; £57,500–£80,499; £80,500–£114,999; £115,000–£172,999; £173,000–£229,999; and over £230,000. To simplify the calculations, these categories have been aggregated into the bands given in Table 3.5. It is unlikely that a different aggregation would have given a significantly different picture.

[36] While the White Paper does not, in itself, authorise the development of airport capacity, it sets the policy framework for decisions on future planning applications, and is widely interpreted as giving a green light to expansion.

[37] In Chapters 4 and 5, claims about the extent to which demand restraint would have detrimental effects are questioned.

[38] This statement is consistent with the statistics given in Table 3.6. 201 million international trips by UK residents equates to 100.5 million return trips and 68 million domestic passenger movements equates to 17 million return trips, which would be less than 2 trips per person assuming no major change in population.

[39] Data from personal correspondence with the DfT in relation to previous project work in 2004.

[40] GDP range chosen to exclude the top six economies, as these would make it difficult to distinguish between the countries in the middle part of the graph.

[41] When buying tickets, there are often a number of fixed charges added at the point of purchase. However, these are not being paid to Government. They usually include passenger service charges paid to the airport operator. Other potential charges include payments to the airline to allow for additional costs, such as the recent rise in fuel prices; the rise in the airline's insurance premiums after September 11th; and the fact that the airlines have to make their facilities accessible to people with mobility problems.

[42] These are defined as changes in passengers x (revenue per passenger – operating costs per passenger).

[43] Elsewhere it is clarified (DfT, 2003a, Annex B) that although wider economic benefits were identified and assessed, the focus in the economic evaluation (of packages of options for increased capacity) was on the estimation of direct impacts of this capacity, as being the most tangible, certain and measurable outcomes.

[44] This has been confirmed by the Department for Culture, Media and Sport (DCMS, 2006).

[45] Excludes spending on day trips by UK residents.

[46] Figures quoted in the House of Commons paper for contribution to the economy (%GDP and employment) pre-date the Tourism Satellite Account (TSA) figures that are now used by the Department for Culture, Media and Sport.

[47] This excludes spending on domestic day trips which had been over £30 billion for each of the previous five years, but is often excluded from considerations of tourism expenditure.

[48] The House of Commons calculation sets £14.9 billion against £27 billion, implying a tourism deficit of about £12 billion. However, it has included fares paid by overseas residents to UK carriers (£3.2 billion in 2002) but not fares paid by UK residents to overseas carriers. If fares paid to all carriers are excluded from the calculations, the data would imply a £15 billion tourism deficit, the figure given in Tomorrow's Tourism Today (DCMS, 2004).

[49] Data downloaded from the Visit Britain website, May 2006, www.visitbritain.com/corporate/factsfigures. Spending on day trips by UK residents is included in the figure.

[50] The UK Tourism Survey is a survey of trips undertaken by UK residents by the National Tourist Boards. The survey covers all trips away from home lasting one night or more for holidays, visits to friends and relatives, business, conferences or any other purpose except such things as hospital admissions or school visits. The survey has been conducted since 1989, although there was a significant change in survey methodology in 2000, making pre/post comparisons problematic.

[51] This is based on the assumption that, with a 0.4% increase in spending per year, spending in Q4 for 2001 would have been £5,964 million and spending in Q1 for 2002 would have been £4,236 million.

[52] This is based on the assumption that, with a 2.5% increase in spending per year, spending in Q4 for 2001 would have been £2,983 million and spending in Q1 for 2002 would have been £2,431 million.

53 James (2006) reports: *"European airlines say fuel accounts for around 20% of their operating expenses on average, while Asia-based airlines put it as high as 40%".* In preparing the Aviation White Paper, the Department for Transport used a figure of 10%, (DfT, 2003b). However, given that the price of oil has increased significantly, it would probably be accepted that this figure should now be higher.

54 DfT (2003b) note that the historic trend has been a 2% p.a. real decrease in air fares over the last 20–30 years. DfT (2006a) report that a decline of 1% p.a. was used because Government expects to introduce some offsetting economic mechanisms to ensure that aviation meets its environmental costs. There is some indication that this expectation relates to the proposals to introduce aviation into the EU Emissions Trading Scheme, (DfT, 2003b, Annex A, para.11).

55 That is, a tax which is equivalent to 100% of the cost of the fuel.

56 An elasticity measures the direction and strength of the market response to a change in a given demand driver such as price, income or the quality of services. It is defined as the ratio of the percentage change in quantity demanded to the percentage change in the variable that brought the demand change about, holding all other independent variables constant (Njegovan, 2006a).

57 Njegovan also identified work on price elasticities undertaken for the Australian market by Battersby and Oczkowski (2001) and for the USA by Bhadra (2003). However, values are not given, presumably because these could potentially be affected by context.

58 From personal correspondence with Steve Lowe (MVA), following a recent conference presentation (Lowe, 2005).

59 These are reported to include Gillen, Morrison, Stewart (2003) *Élasticités de la demande de transport aérien de passagers: Concepts, problèmes et measures*; DETR (2000) *Valuing the external cost of aviation, 2000*, and DETR (2000) *Air traffic forecasts for the United Kingdom*; Resource Analysis et al. (2000) *Aviation Emissions and Evaluation of Reduction Options* (AERO); and ICAO (1995) *Outlook for air transport to the year 2003*.

60 The reduction in elasticity for fares of £130 is probably just a 'blip' as the sample was relatively small.

61 Information taken from a presentation downloaded from Ryanair.com, described as 'Quarter 3 results 31/12/05'.

62 As an individual ticket becomes more expensive, it could be expected to move between bands in the table – i.e. to be subject to different growth rates and elasticities.

63 Data on motoring tax paid is from Colin Buchanan and Partners, 2000. According to the RAC, the average car travels about 12,000 miles p.a., as stated on http://www.rac.co.uk/web/knowhow/glossary/vehicle_status_checks. The distance between London and Sydney is about 10,500 miles.

64 The British Social Attitudes Survey (BSAS) is a household based survey, designed to be representative of the population of Great Britain. Fieldwork takes place over the summer. Up to 3,500 respondents are included each year, although some questions, like those on aviation, are only asked of a smaller sub-group. Data on the BSAS were obtained from DfT (2006c) and the website www.britsocat.com

65 Specifically, initially the aviation industry would be allocated EU allowances that were not backed by AAUs. They would then, in principle, be able to buy and sell these EU allowances from and to other market participants in the EU ETS through the Gateway. On passing through the Gateway from the core ETS to the aviation sector, an allowance would discard its AAU, effectively leaving it to be held in keeping at the gate. Conversely, an allowance passing in the other direction, from the aviation sector to the core EU ETS would have to pick up an AAU (previously discarded by an allowance passing in the opposite direction). Trade would be limited in as much as, if there were no AAUs left at the Gateway, then the aviation seller would not be able to make the sale. To ensure environmental integrity, at the end of the commitment period, any AAUs remaining at the Gateway would be cancelled. Overall then, the Gateway scheme would stop the sale of ETS allowances by the aviation industry but enable the aviation industry to buy allowances.

66 In practice, the price of allowances reached €30 per tonne CO_2 in April 2006, before tumbling in May 2006 to under €10 per tonne – since the generosity of allocations by many countries reduced the need to purchase allowances.

67 Joint Implementation (JI) and the Clean Development Mechanism (CDM) are mechanisms of the Kyoto protocol that involve developing and implementing projects to reduce greenhouse gas emissions overseas. The 'Linking Directive', adopted by the EU parliament in April 2004, allows emission reductions generated by JI and CDM projects to be used for compliance by companies operating under the EU ETS. For the first phase of the ETS, Member States have discretion about whether to impose a limit on the use of project credits. It is generally accepted that the use of Kyoto

mechanisms in the ETS should be supplementary to domestic action, but there is no definition of the extent to which this supplementarity is allowed, and it is left to each Member State to decide this. For the second phase, governments should state in their National Allocation Plans whether they intend to limit use of JI and CDM. If they do so, these limits will be applied to each installation separately. Source: DTI Climate Change Projects Office, 2005.

68 This would mean that instead of increasing by 22% over 5 years, aviation would increase by between 19.9% and 21.9% instead.

69 Mortished (28/4/06) reports that, in April 2006, of the 96.1 pence typically paid for a litre of unleaded petrol, 61.4 pence was excise duty and VAT. Whilst VAT is not charged on aviation fuel for international flights, it is charged on fuel supplied for domestic flights. However, this sum is subsequently recoverable by the airline from HM Revenue and Customs.

70 Until 2003, within the EU, the mineral oil directive prohibited the taxation of the commercial use of kerosene. However, as part of 'ecological tax reform', the EU Energy Tax Directive of 27 October 2003 (2003/96) was introduced, which restructured the Community framework for the taxation of energy products and electricity. It came into force on the 1st January 2004. Article 14, para 1 and 2, allow in principle for the taxation of kerosene used on domestic flights, the domestic portion of international flights, or the flights between two Member States.

71 Examining the legal situation for the Federal Environmental Agency in Germany, Pache argues it should be able to simultaneously introduce two taxes on fuel used for domestic flights, one being a tax based on the purchase of fuel in Germany for domestic flights, whilst the other would be a consumption-based tax for imported fuel used on domestic flights. Introduced together, the two taxes would therefore make tankering impossible (Pache, 2005). The second tax suggested by Pache may be equivalent to an emissions charge – emissions charging is discussed in section 9.4.

72 Open Skies talks with the US could potentially give more freedom to US carriers to operate in the intra-EU market, making negotiations on fuel tax with the US particularly important.

73 Nicklas (2006) clarifies that the air service agreements negotiated by the Commission to allow for taxation of aviation fuel relate to 20 countries, including most non-EU European countries that border on the EU. This means that if aviation fuel taxation were brought in at EU level, the risk of tankering could be minimised.

74 The study was carried out by the same organisation (i.e. CE Delft) that investigated the potential for including aviation in emissions trading. However, the parameters examined in the two studies are different, making it difficult to draw direct comparisons of the outcomes from the two types of scheme.

75 If there were a charge for CO_2 only, it was estimated that a charge of 10 euros per tonne CO_2 and 30 euros per tonne CO_2 would lead to reducing CO_2 emissions by 1.9% and 5.9% respectively, though there would still be a reduction in NOx emissions. The analysis took into account that there was potential for both synergies and trade offs between reduction of CO_2 and reduction of NOx. However, the demand effects and the majority of supply side measures envisaged in the short term were thought likely to imply synergies.

76 It has not been possible to assess whether this analysis is compatible with the elasticities discussed in Chapter 6.

77 Evidence from the Sustainable Development Commission quoted by the House of Commons Environmental Audit Committee (2003).

78 Wit and Dings (2002) proposed that the charge should be based on Article 130s of the EC Treaty and the revenue used to create a European fund for greenhouse gas abatement measures. Critically, they argued that, following this route, the introduction of the charge would not require unanimity from EU States because it would not be a tax in the sense of Article 130s#2.

79 The International Civil Aviation Organisation is in the process of developing guidance for member states on the introduction of emission charges at airports to improve local air quality. This guidance is expected in 2007.

80 This legislation has no direct effect in any country but member states must draw up local legislation enacting its provisions. Where local laws differ from its intent, tax payers can insist that the intent is applied.

81 CEC (2005c) explains that this situation is because the exemption from VAT on international passenger air transport is based on a 'standstill' provision in the 6th Directive, which allows Members States to continue an exemption already applied when the Directive entered into force on their territory.

82 The place and supply of transport services, and, accordingly, the place of taxation, is covered by article 9(2)(b) of the 6th Directive, which says that *"the place where transport services are supplied shall be the place where transport takes place, having regard to the distances covered."* Although not the clearest of wording, this can be interpreted as meaning that

international air transport can only be subject to UK VAT to the extent of the distance covered being within the territory of the UK, such that each trip would have to be subdivided into its taxable and non-taxable element.

83 Customs and Excise figures suggest that the UK collected some £791m in duty from APD in 2003–4 from 279 registered airlines, as reported in CEC (2005d).

84 This is a generic term being used for measures like Air Passenger Duty.

85 Statement given at www.hm-treasury.gov.uk/media/83A/B7/UK_French_statement_final.pdf

86 As discussed in Chapter 1, this point has also been made by Muller, 2006.

87 On returning to the UK from a non-EU country, certain volumes of alcohol, perfume and tobacco, together with other goods totalling less than £145 are exempt from duty. However, goods purchased that exceed those limits are subject to tax. In 2005, the UK Government asked the EU to increase the £145 limit, and the EU has subsequently proposed that this should occur. More details are available on www.hmrc.gov.uk

88 Although airports often offer 'tax free shopping' once airside for an EU flight, in practice, there is no duty exemption – this is a retail decision to offer goods at a reduced rate (HM Revenue and Custom Press Office, consulted August 2006).

89 According to the Department for Transport, the current legal position is that the primary sale of slots by airport authorities would see revenue accruing to the Government (DfT, 2004c).

90 The introduction of secondary trading should mean that the scarcity of slots at EU airports would be expressed in monetary terms and that the present and potential users of the slots would be made aware of this. As a result, they would either use the slots allocated to them to the full or, alternatively decide not to do so and receive financial compensation in full or part instead. The result is expected to be that slots eventually go to the air carriers that want them most badly, promoting the most efficient use of airport capacity. Where air carriers continually refused to trade their slots to avoid losing their competitive edge, they could be sanctioned by the forced release of slots, though this would be subject to conditions to prevent undue disruption to the air carrier's operations.

91 The Commission also proposes the possibility of withdrawing, on the basis of a lottery system, a small percentage of grandfathered slots – e.g. 3% – where trading does not lead to satisfactory slot mobility. The UK Government is opposed to the redistribution of a percentage of grandfather rights, which, it argues, would cause uncertainty and disruption. However, it argues for the creation of an option to allow States to introduce auctioning mechanisms as a way of distributing *new* slots that may arise if new capacity comes on stream at congested airports. In this proposal, the revenue generated by such auctions would accrue to Member States. In response to the Commission's consultation, the UK asked the Commission to assess this option, whilst going ahead with the introduction of secondary trading.

92 Under the Airports Act 1986, the CAA sets price caps on airport charges every five years at airports designated by the Secretary of State. The airports currently designated are Heathrow, Gatwick, Stansted and Manchester. Before it can set a price cap, the CAA must, consistent with the Airports Act, make a reference to the Competition Commission unless the Secretary of State directs otherwise. The reference asks the Commission to report on what the maximum limit on airport charges for the following period of five years should be, and whether, since the date of the previous reference, the airport has pursued a course of conduct contrary to the public interest. Source: Data taken from the CAA's website, www.caa.co.uk

93 Schlegelmilch (2006) suggests that Estonia should now be added to the list since it is planning comprehensive 'ecological tax reform'.

94 Forecasts up to 2020 were originally made from 1998 base year data – when there were about 160 million passenger movements, as reported in DETR (2000a). In additional analysis released to support the Aviation White Paper (DfT, 2003c), actual numbers for the year 2000 are also given as a basis. In 2000, there were about 180 million passenger movements. The Aviation White Paper (DfT, 2003b) also refers to about 200 million passenger movements for 2003.

95 There are exceptions for aircraft with a maximum certified weight of 6000 pounds or less, those used exclusively for skydiving, and those which are only available for hire by members of an affiliated group.

96 Information from www.gaservingamerica.org/how_work/work_funding.htm

97 Jet fuel is often used as a synonym for aviation-grade kerosene.

98 In 1986, a court case between the airline Wardair Canada Inc., and the Florida Department of Revenue led to the Florida Supreme Court upholding that Florida had the right to impose a sales tax on aviation fuel, regardless of whether the fuel was used to fly within or without the state, or whether the airline engaged in a substantial or nominal amount of business within the state. This implies that states have the discretion

to apply taxes to domestic or international flights, and to decide whether foreign carriers should pay such taxes. Information about the Florida case was obtained from: caselaw.lp.findlaw.com/scripts/getcase.pl?court=US&vol=477&invol=1

In this study, it has not been possible to discover whether this is still the legal precedent. However, for this study, David Cross, from the National Association of State Aviation Officials (NASAO), kindly circulated a request around the NASAO membership, asking whether any states taxed fuel used on international flights. Kansas and Mississippi reported that they did not. Minnesota, Utah, Alabama, Arizona and Georgia reported that they did apply a tax to fuel, and that this was applied in the same way for both national and international flights. Florida and New York reported that they taxed international flights, but only for the fuel consumed during the portion of each flight taking place in their own state's airspace. Understanding how state taxation of aviation fuel works in the US, together with its impacts, could be a useful area of further research.

99 'Excise tax' is a tax levied on the sale or consumption of a non-essential good or service, such as gasoline. Excise tax is levied on a particular product as opposed to being levied because a sale has occurred, in contrast to sales and use taxes. Definition taken from www.theaccountspayablenetwork.com/html/modules.php?name=Articles&file=article&sid=7

100 'Sales tax' and 'use tax' are two of several 'trustee taxes'. They are called trustee taxes as employees and customers have to entrust businesses to collect and pay these taxes to the Commonwealth. Sales tax is paid at the time of purchase, and the use tax is paid if no sales tax has been paid for commodities which are to be used in the Commonwealth. The rate of sales or use tax varies between states (Massachusetts DOR, 2005).

101 Information from www.gaservingamerica.org/how_work/work_funding.htm

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Appendix A: Calculations of Aviation's Climate Change Contribution

A.1 Calculations of aviation's impacts

The main elements of the methodology used by the IPCC (1999) to calculate aviation's overall climate impacts are described in section 2.4. For clarity, Figure A.1 shows the relative contribution made by different emissions from aviation by 1992, according to the IPCC calculations.

Based on better scientific understanding, these results have since been updated by the EU TRADEOFF project, as shown in Figure A.2.

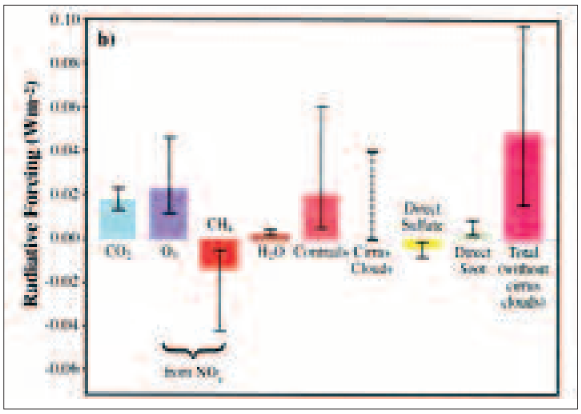

Figure A.1 Radiative forcing impacts of aviation, 1992

Source: IPCC, 1999, p210

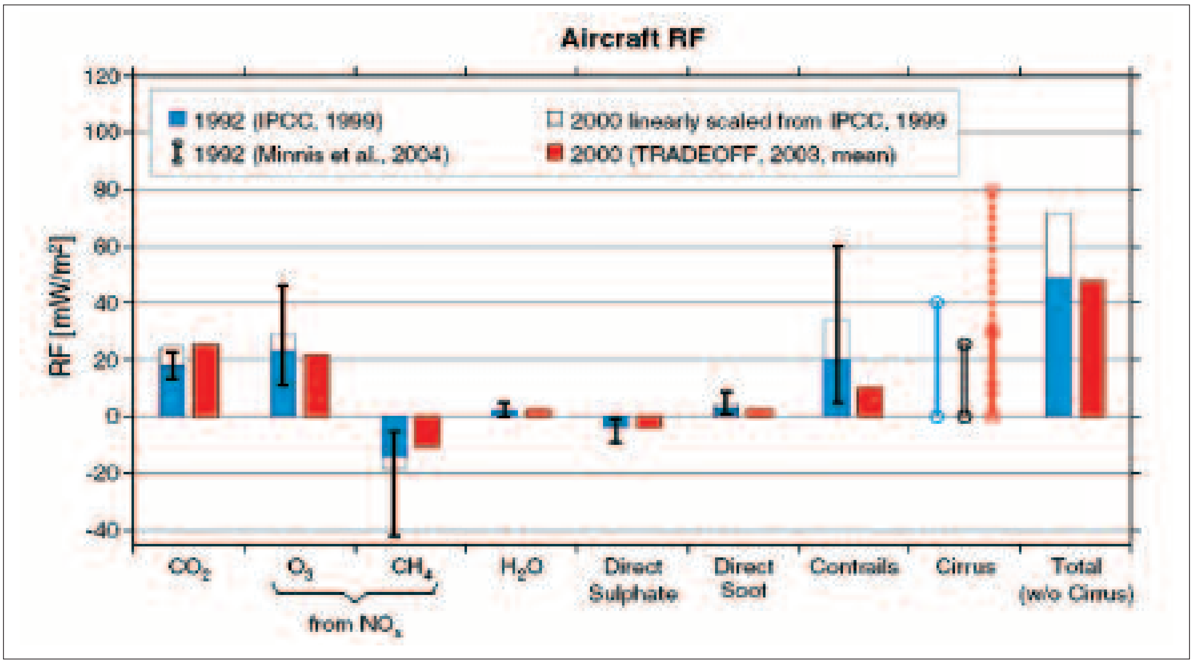

Figure A.2 Radiative forcing impacts of aviation, 2000

Source: Sausen et al, 2005, p556

A.2 Limitations of using radiative forcing as a measure of climate impacts

As highlighted in section 2.4, since the IPCC (1999) study, the use of the 'RFI' or 'multiplier factor' has become an issue of controversy (Lee, 2006, Forster et al 2006). There are particular concerns in relation to plans to include aviation within the EU Emissions Trading Scheme, and proposals that this should involve applying a multiplier factor to the carbon dioxide emissions emitted from the sector.

First, there is concern that because some emissions appear to have a positive radiative forcing effect, this will be interpreted as being beneficial for the climate. Specifically, Forster et al (2006) state: *"diesel engines in ships and unscrubbed coal-fired power stations emit tiny aerosol particles or their gaseous precursors, which stay in the atmosphere for about a week. Sulphate aerosol particles are believed to cool the climate by both reflecting sunlight directly and changing the properties of low-level clouds to reflect more sunlight. If we used an RFI-based weighting system to assess these sectors, we might find that increasing their emissions could incorrectly be interpreted as being beneficial to climate."*

Second, the most significant policy concern is that applying a specific 'multiplier' value could lead to perverse outcomes. For example, the opportunities for the airline industry to reduce non-CO_2 emissions compared with those to reduce CO_2 may differ, and it is therefore important that the EU Emissions Trading Scheme does not incentivise reduction of one type of emission at the expense of another which may turn out to be more important. For example, Forster et al clarify: *"When aircraft fly at a low altitude, they burn more fuel – and hence emit more CO_2 but they are also much less likely to form contrails (Williams et al, 2003). Flying at low altitude could therefore reduce the RFI but exacerbate climate change. If the emissions weighting factor was based on RFI, the aircraft industry might then argue for a reduced factor, when in reality this "mitigation" would be adding to climate warming."*

This is a particular problem, given that the EU Emissions Trading Scheme is intended to encourage technological change over a period of decades. However, it is clearly important that the non-CO_2 impacts are taken into account in some way, since, otherwise, the main incentive for the industry will be to reduce CO_2 at the expense of everything else. The potential role for flanking instruments is discussed in Chapter 8.

A final concern expressed is that some commentators are applying the IPCC's RFI factors to emissions in a given year, whereas the IPCC's calculations were based on the change in radiative forcing caused by the change in atmospheric concentration of CO_2, due to the build up of CO_2 from aviation over time.

Appendix B: Government Forecasts of the Future Demand for Flying

B.1 Introduction

The Government's forecast for demand at UK airports is for 400 million passenger movements by 2020, rising to 500 million passenger movements by 2030, (DfT, 2003b).[94] This is a forecast for unconstrained demand – without the capacity limitations of individual airports. According to Annex A of the White Paper, the growth in future demand for air travel is expected to be driven by several factors including future growth in UK and world GDP, increased world trade, declining air fares, exchange rates and the onset of increasing market maturity.

B.2 How does the predicted demand break down?

According to Annex A of the White Paper, for the central national forecast:

- International traffic is expected to grow by 4.6% per annum in the period to 2020, while domestic traffic is expected to grow at 3.5% per annum.
- Short-haul traffic is expected to grow at 4.5% per annum over the same period, while the predicted long haul growth rate is 5% per annum to 2020.
- No-Frills Carrier traffic is predicted to grow at 6.6% per annum from 1998 to 2020, including a phenomenal 15% per annum between 1998 and 2005, as a result of the introduction of new routes during this period, with growth after this expected to be due to the expansion of passenger numbers on existing routes.
- Leisure traffic is expected to grow more slowly, at 4.4% per annum, than business traffic, at 5.5% per annum, between 1998 and 2020, apparently reflecting the slower maturity of the business market.
- Because of higher economic growth rates for countries outside of Western Europe, demand from foreign leisure passengers is forecast to grow faster, at 4.9% per annum, than demand from UK leisure passengers, at 4.1% per annum up to 2020.
- The propensity to fly is assumed to grow more quickly in the regions, because the South East market is considered to be more mature.

Overall the central passenger forecast is for growth of about 4.25% p.a. to 2020 (DETR 2000a, para. 3.3), with a lower rate of growth between 2020 and 2030 (which can be calculated to be approximately 2.3% p.a.).

A detailed breakdown giving the composition of forecast demand for 2030 (in terms of UK and non-UK passengers) for the White Paper's favoured airport capacity scenario is shown in Table B.1.

B.3 Relative changes in international travel for business/leisure and foreign/UK trips

The following tables, derived from *Passenger Forecasts: Additional Analysis* (DfT, 2003c), show how the composition of international terminal passengers is expected to change in 2015 and 2030, in terms of whether trips are for business or leisure, and are made for foreign or UK travel. The tables illustrate the favoured airport capacity scenario in the Aviation White Paper, or, alternatively, the likely situation achieved by making maximum use of existing runways.

Table B.1 DfT forecasts for overall passenger demand by 2030

Passenger movements p.a.	*Total*	*International – UK residents*	*International – foreign residents*	*Domestic*	*Connecting*
Million	466	201	149	68	48
%	100%	43%	32%	15%	10%

Source: DfT 2006a, based on some update of the data used in DfT, 2003c. Figures given are for individual passenger movements – hence an international return journey would be counted twice in these figures, whilst a domestic return journey is counted four times. 'International – UK passengers' and 'international – foreign residents' include flights made within the UK to connect to an international flight. 'Domestic' refers to flights made by UK residents which start and end in the UK. 'Connecting' only refers to passengers arriving on an international flight and connecting with another international flight.

Table B.2 International passenger movements at UK airports in 2015

Millions of terminal passengers	*Foreign residents Business*	*UK residents Business*	*Foreign residents Leisure*	*UK residents Leisure*
2000 ACTUAL	14 (11%)	18 (14%)	22 (18%)	71 (57%)
Max. use of existing runways	28 (12%)	38 (16%)	63 (27%)	106 (45%)
White Paper favoured option	29 (12%)	39 (16%)	64 (27%)	108 (44%)

This table excludes the domestic and connecting passsenger movements given in Table B1. Source: DfT, 2003c, p51.

Table B.3 International passenger movements at UK airports in 2030

Millions of terminal passengers	*Foreign residents Business*	*UK residents Business*	*Foreign residents Leisure*	*UK residents Leisure*
2000 ACTUAL	14 (11%)	18 (14%)	22 (18%)	71 (57%)
Max. use of existing runways	59 (18%)	53 (16%)	85 (25%)	138 (41%)
White Paper favoured option	61 (17%)	57 (16%)	88 (25%)	144 (41%)

This table excludes domestic and connecting passsenger movements. Source: DfT, 2003c, p51.

Both tables exclude both international transfer and domestic end-to-end passenger movements. All charter passenger movements are assumed to be leisure, 15.5% of which are assumed to be made by foreign residents by 2015. The foreign component of no frills carrier traffic is assumed to have grown to 37.5% by 2015.

Appendix C: Aviation Fuel Taxes in the USA

C.1 Introduction

In the US, a range of taxes are levied on aviation, at both federal and state level, including taxes on fuel. The majority of the money raised is used to improve America's air transport system.

C.2 Overview of federal taxes on aviation

According to the website of the US Air Transport Association (ATA), the federal excise taxes shown in Table C.1 are levied on commercial aviation.

Table C.1 Taxes and fees levied on commercial aviation*

Effective January 1, 2006	*Rate*	*Unit of taxation*
Passengers		
Federal Ticket Tax	7.5%	Domestic Airfare
Federal Flight Segment Tax	$3.30	Domestic Enplanement
September 11th Fee	$2.50	Enplanement at U.S. Airport
Airport Passenger Facility Charge	Up to $4.50	Enplanement at Eligible U.S. Airport
International Departure Tax	$14.50	International Passenger Departure
International Arrival Tax	$14.50	International Passenger Arrival
INS User Fee, funding inspections by US Immigration and Customs enforcement	$7.00	International Passenger Arrival
Customs User Fee, funding inspections by US Customs and Border Protection	$5.00	International Passenger Arrival
APHIS Passenger Fee, funding agricultural quarantine and inspection services	$5.00	International Passenger Arrival
Shippers		
Cargo Waybill Tax	6.25%	Waybill for Domestic Freight
Sales/operations		
Frequent Flyer Tax	7.5%	Sale of Frequent Flyer Miles
APHIS Aircraft Fee, funding agricultural quarantine and inspection services	$70.25	International Aircraft Arrival
Jet Fuel Tax	4.3¢	Domestic Gallon
Leaking Underground Storage Tank (LUST) Fuel Tax	0.1¢	Domestic Gallon
Aviation Security Infrastructure Fee	Carrier-Confidential	CY2000 Screening Costs

* More details available at: www.airlines.org/econ/d.aspx?nid=4919

Henry (2002) reviewed the federal taxation of aviation and calculated that, in 2002, aviation-related excise taxes were generating $9.09billion, and constituted 13.1% of total US federal excise taxes raised. ATA (2006) report that, by 2005, US federal tax take from aviation had risen to $16.02 billion.

C.3 Federal taxation of aviation fuel

Nichols (2005) has provided data on the revenue collected from aviation fuel taxes, as given in Table C2. This indicates that the US Government raised about $0.5billion from mainstream commercial aircraft fuel in 2004.

Table C.2 Revenue raised from federal excise tax on aviation fuel, 2004

Type of fuel	*Rate (cents per gallon)*	*Revenue raised (million $)*
Aviation-grade kerosene (except gasoline) for commercial use	4.4	503.696
Aviation-grade kerosene (except gasoline) for non-commercial use	21.9	322.440
Aviation gasoline~	19.4	44.611
Total		870.747

~ Aviation gasoline is a high octane, speciality fuel usually only used in small aircraft. Source: Nichols (2005)

Of the taxes on aviation-grade kerosene used for commercial purposes, a rate of 4.3 cents per gallon applies to fuel used for domestic flights by US commercial aircraft operators, dealing with registered fuel suppliers, and operating mainstream aircraft[95]. This rate does not apply to fuel purchases by foreign airlines, nor to fuel uplifted for international flights (IRS, 2005a, Wharff, 2006). Revenue from this tax is deposited into the Airport and Airway Trust Fund. Established in 1970, the Fund pays for airport improvements, airport repair projects and general modernisation of the air traffic control system. It is also one of the main funding sources for the Federal Aviation Administration[96].

There is a second component to the taxation of aviation-grade kerosene used for commercial purposes called the 'Leaking Underground Storage Tank' (LUST) fuel tax. This is charged at a rate of 0.1¢ per gallon, and the revenue is used to support the LUST Trust Fund, which deals with clean-up operations from leakage. A change in federal law, effective from 1st October 2005, removed the prior exemption from the LUST tax for fuel used for foreign flights or by foreign carriers. Hence, this tax now applies to fuel uplifted by all airlines for all flights (as confirmed by IRS 2006). This change was made as part of the Energy Tax Incentives Act passed by the US Congress in July 2006, and is set out in their finally agreed position (Joint Committee on Taxation, 2005, p130). In a 2005 bulletin, the Internal Revenue Service clarifies that "*for kerosene removed directly into the fuel tank of an aircraft for use in foreign trade ... the position holder is liable for tax of $0.001*" (IRS, 2005b, p953). Seemingly, this would go against existing bilateral air service agreements and ICAO provisions. However, Hultquist (2006) reports that the change has been justified on the basis that the ICAO provisions are not binding; that the bilateral agreements technically do not prohibit fuel taxes, but provide for an exemption based on reciprocity; and that federal law takes precedence over the bilateral agreements. However, he notes that this is an issue of controversy between the airlines and the US Government. IRS (2006) confirms that the tax applies since legislation passed by the Congress takes precedence.

C.4 State taxation of aviation fuel

State taxes on aviation jet fuel[97] vary both in scale and in scope[98].

There is some information available on current state taxation of jet fuel, as outlined in the National Business Aviation Associations' 2004 State Aviation Tax Report (NBAA, 2004). These data are given in Table C.4 and summarised in Table C.3.

Table C.3 Variation in state tax rates applicable to jet fuel (2004)

	Excise tax[99] ($ per gallon)	*Sales/ use tax[100]*
Range	0.008 – 0.09	2.9%–7.25%
Number of states who do not impose a charge	10 (+ 5 states not providing information)	19 (+ 10 states not providing information)

Source: Analysis of dataset given in Table C.4, taken from NBAA (2004)

The NBAA data suggest that, in 2004, the excise tax (per gallon) charged for aviation fuel ranged from 0.8¢/gallon (Oklahoma) to 9¢/gallon (Utah). The majority of states were imposing some kind of excise tax, albeit often with exemptions, refunds or reduced rates for certain types of activity in place. The rate of sales/use taxation on aviation fuel also varied between states. At least 21 states were imposing some form of sales/use tax, albeit, again, with a significant variety of exemptions, refunds or reduced rates. Rates charged ranged between 2.9% (Colorado) to 7.25% (California). In addition to state sales/use taxation, in the NBAA (2004) report, California, Arkansas and North Carolina also reported that they had local sales/use taxation on jet fuel. Indiana and Wisconsin were charging oil inspection fees. There were at least 3 states (Connecticut, Rhode Island and Texas) where there were no taxes on jet fuel. In contrast, some states had relatively high levels of both excise and sales/use tax (albeit with exemptions).

This implies then, that the price of fuel between states differs significantly. For example, Hultquist (2006) notes that California currently has the highest combined sales and local sales tax rates, such that the average rate paid by members of the US Air Transport Association is about 8.25%. According to Skertic (2006), differentials in fuel taxation lead to some airlines fuelling up in states with more favourable fuel tax rates. Skertic also reports that there have been discussions of 'fuel tax relief' being given by particular states to particular airlines.

Use of state taxes is not prescribed. They are often used to provide matched funding for capital grants from the Federal Aviation Administration for airport improvements[101].

C.5 Data used for analysis of state fuel taxation

The information given in section C.4 is based on the data given in the table below.

Table C.4: State aviation fuel taxes in the USA

State	*Excise Tax $/Gal*	*Sales/Use Tax*	*Exemptions/refunds~*
Alabama	0.01	0	Purchase for resale
Alaska	0.032	0	International operations Alaska
Arizona	0.0305	0	Amounts >10million gallons
Arkansas	0	4.625% plus local 1–4%	Yes
California	0.02	7.25% plus local	Yes
Colorado	0.04	2.90%	Yes
Connecticut	0	0	Yes
Delaware	N/A	N/A	N/A
Florida	0.06	N/A	International operations
Georgia	0	4%	N/A
Hawaii	0.01	4%	Yes
Idaho	0.045	0	No
Illinois	0.08 environmental impact fee, 0.03	6.25%	Yes
Indiana	0.008, oil inspection fee	5%	Export and international operations
Iowa	0.03	0	No
Kansas	N/A	4.9%	N/A
Kentucky	0	6%	N/A
Louisiana	0	4%	No

Maine	0.034	N/A	Commercial international flights
Maryland	0.07	5%	Yes
Massachusetts	Maximum 0.05	0	Yes
Michigan	0.032	6%	Yes
Minnesota	0.05	N/A	Yes
Mississippi	0.0525	0	N/A
Missouri	0	4%	No
Montana	0.04	0	Yes
Nebraska	0.03	0	N/A
Nevada	0.01 State 0.04 County	N/A	N/A
New Hampshire	0.02	N/A	Yes
New Jersey	0.02	0	Yes
New Mexico	N/A	5.125%–7.1875%, less 40% reduction for aircraft use	N/A
New York	0.08 (1998 info)	4%	Yes
North Carolina	N/A	4% state, 2% local, except for 2.5% Mecklenberg County	Certain charities
North Dakota	0.08	0	Yes
Ohio	N/A	5%	No
Oklahoma	0.0008	N/A	No
Oregon	0.01	0	Export and international flights
Pennsylvania	0.02	N/A	No
Rhode Island	0	0	N/A
South Carolina	0	5%	Yes
South Dakota	0.04	0	No
Tennessee	0.014	4.5%	Yes
Texas	0	0	N/A
Utah	0.09	0	Yes
Vermont	0	N/A	N/A
Virginia	0.05	0	Yes
Washington	0.065	6.5%	Interstate commerce
West Virginia	0.0485	N/A	No
Wisconsin	0.06 general aviation only	0.03/gal fees for oil inspection	Yes
Wyoming	0.05	0	No

Source: Data compiled from NBAA (2004)

~ Subsequent investigation suggests that details of exemptions may not be fully comprehensive or accurate.

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