Demand Reduction Theme
University of Oxford

PREDICT AND DECIDE:
The potential of economic policy to address the effect of aviation trends on climate change

Paper prepared for the Stern Review, 9th December 2005

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UK Energy Research Centre WP/DR/2005/006

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Acknowledgements

Grateful thanks to Jillian Anable, Brenda Boardman, Chris Jardine, Christian Brand and Lex Waspe, UKERC; Anne Binsted, Stuart Reid, Bill Gillan, Ian McCrae, Stephen Latham and Stefan Laeger, TRL; Joyce Dargay, Oxford Transport Studies Unit; David Lee, Centre for Air Transport and the Environment, Manchester Metropolitan University; Ron Wit, CE Delft; Eric Crane and Devi Mylvaganam, DfT; Mario Deconti, HM Revenue and Customs; Niels Ladefoged, Arthur Kerrigan and Rolf Diemer, European Commission; Ece Ozdemiroglu, eftec; Andy Kershaw, BA; Steve Lowe, MVA; Brendon Sewill, Aviation Environment Federation; Kurt Janson, Tourism Alliance.

Note:

This paper is an interim output of an ongoing project due to finish in March 2006, and reports on an initial examination of the evidence. The arguments presented here will be developed in more detail.

Please contact the authors if you would like further information from the project.

EXECUTIVE SUMMARY

This paper argues that reducing the impacts of aviation should be treated as a priority by those interested in averting climate change, and that the scale of reduction needed can only be achieved through demand restraint – i.e. discouraging people from flying. Economic policy potentially has a key role to play in this process. The UK Government has the power to introduce a number of economic measures to complement the EU Emissions Trading Scheme, and these measures probably offer the best hope of starting to restrain demand in the immediate future.

Specifically, calculations based on official government estimates about the emissions from domestic flights, international passenger departures from the UK and air freight traffic movements, suggest that:

- The radiative forcing[1] from aviation already constitutes about 10-18% of the radiative forcing from all UK activities.
- Compared with other activities, the relative impacts of aviation approximately doubled between 1990 and 2000.
- By 2050, if other sectors achieve their target reductions in emissions, the forecast radiative forcing from aviation will be equivalent to 60-100% of the radiative forcing from all other sectors.

It should be noted that future forecasts of aviation impacts already allow for some technological improvement in the industry, and there is a general consensus that, whilst welcome, technological improvement will not be sufficient to offset aviation growth. Consequently, demand management is needed, if aspirations to stabilise climate change are to be achieved.

There are various reasons why introducing demand management now could be both beneficial and cost-effective.

First, 'air dependence' is still at a relatively early stage. Hence, discouraging people from flying does not require complex strategies to mitigate adverse social effects, and is primarily about asking people to forego a benefit that they are not yet accustomed to. Moreover, the price rises required to discourage flying now are likely to be lower than they would be once flying becomes more habitual. Businesses that aim to minimise their reliance on aviation are likely to be well-placed if aviation becomes more restricted internationally in the future.

Second, the growth in air travel is primarily comprised of increasing numbers of leisure trips by richer people to mainland Europe. Given that averting climate change is likely to require some kind of restriction or regulation, discouraging a luxury, discretionary activity is likely to be one of the more socially equitable forms of intervention. Moreover, data about spending by air travellers shows that UK residents are spending more abroad than foreign visitors are spending here, and that this 'tourism deficit' has increased over time. Hence, discouraging flying could actually benefit the national tourist industry and economy.

Third, there is clear evidence that price affects the demand for flying, such that economic measures – which make flying more expensive – could provide an effective

[1] Radiative forcing is one measure of climate change impact.

means of demand restraint. Empirical research by Dargay and Hanly (2001) suggests that about 40% of the increase in leisure air travel by UK residents between 1990 and 1998 was due to real reductions in the cost of flying. The price-demand elasticities calculated in their work are consistent with the results from a number of other modelling studies, including recent estimates from the EC.

In terms of economic measures to address the climate change impacts from aviation, the EU Emissions Trading Scheme (ETS) is currently receiving the greatest attention, since there are proposals for aviation to be included in the future. The scheme is thought to be one of the most cost-effective ways of reducing the impacts of aviation. This is because it provides a direct incentive for the airline operators to make their operations more efficient, and because aviation will be able to buy credits from other sectors, which may be able to achieve emissions reductions more cheaply than the aviation sector itself.

However, whilst including aviation in the ETS is likely to mitigate some of the impacts of aviation, it is unlikely to be sufficient, on its own, to address the climate change impacts of aviation fully. This is for two reasons. As highlighted above, first, the potential for technological improvement in the aviation industry is limited, and second, it is highly unlikely that there will be enough capacity in the other sectors to offset all of the impacts that would result from the forecast growth in aviation. In addition, whilst including aviation in the ETS may have some impact on ticket prices, the extent to which this occurs will be partly determined by the scale of allocations given to the aviation industry. Also, the earliest that aviation is likely to be included in the ETS is after 2008, by which time demand will have increased further.

Consequently, this paper has reviewed four other economic mechanisms that could be used to address the climate change impacts of aviation, namely taxation of aviation fuel, emissions charging, imposing VAT on air tickets and air passenger duty. It concludes that all four measures have potential, and merit further consideration.

In particular, imposing VAT on domestic air tickets, and increasing air passenger duty could both be implemented swiftly, and would probably have a direct impact on ticket prices, thereby acting as a direct means of demand restraint. If VAT were imposed on domestic aviation tickets, this would simply bring aviation in line with other luxury purchases, and would match existing practice across most of the EU. Increasing air passenger duty has received the strong support of the House of Commons Environmental Audit Committee, and could be directly linked to UK commitments to provide a source of revenue for achieving some of the Millennium Development Goals.

Meanwhile, taxation of aviation fuel, introducing VAT on international air tickets and emissions charging could be explored as medium or long term options. The best prospects for progressing these options may lie in co-operation with other European countries which are also prepared to take this agenda forward.

In short, then, the best prospects for mitigating the climate change impacts from aviation probably involve *combining* emissions trading with a range of other short and medium term economic policy measures that offer a direct way of making flying more expensive.

PREDICT AND DECIDE:
The potential of economic policy to address the effects of aviation trends on climate change

1. INTRODUCTION

In November 2005, the Demand Reduction team of the UK Energy Research Centre commissioned Sally Cairns and Carey Newson to undertake a review of the evidence about the significance of aviation to climate change, and potential economic policy measures for addressing the issue.

This study primarily focuses on the scale of emissions that aviation is responsible for, and the validity of the case that demand management (through economic mechanisms) is necessary, in order to achieve the scale of emission reductions from aviation that will be required to avert climate change. It also primarily focuses on the issues for the UK, not least because a fifth of all international air passengers currently arrive or depart from a UK airport, (DfT, 2004, para. 3.2).

Rather than undertaking new data collection, this study brings together the substantial evidence base that has been generated by a range of other organisations, including work by national and international government organisations such as DG Environment, the Royal Commission for Environmental Pollution; the House of Commons Environmental Audit Committee and the Sustainable Development Commission; work by think tanks and pressure groups, such as the Aviation Environment Federation, the Institute for Public Policy Research and the Ashden Trust; industry estimates, including work by BA and MVA; and the work of academics, including work undertaken at the Centre for Air Transport and the Environment, Manchester Metropolitan University, the Tyndall Centre for Climate Change Research, and the scientific outputs of the Intergovernmental Panel on Climate Change.

The arguments about aviation, its climate impacts, and the potential policy options for addressing its impacts, are remarkably complex. This complexity potentially acts to obscure a number of fundamental points, which are as follows:

- **Aviation *must* be addressed if aspirations for stabilising climate change are to be achieved.**

- **Technological development will not be sufficient to offset the dramatic forecast growth in aviation emissions.**

- **There are strong arguments in favour of addressing the issue now, whilst 'air dependence' is still at a relatively early stage.**

- **Economic policy measures, which make flying more expensive, could significantly reduce aviation demand.**

- **Emissions trading, whilst welcome, is unlikely to be sufficient, in isolation, to achieve the demand reduction needed from aviation for environmental reasons.**

- **There are other complementary economic policy measures which could contribute to demand reduction, including fuel taxes, emissions charging, VAT on tickets and an increase in air passenger duty. In some cases, the Treasury could introduce these in the immediate future.**

This paper aims to provide a summary of the evidence and information relating to these points. It has been specifically prepared as evidence for the Stern Review[2], and is an interim output from an overall project, which is due for completion in March 2006.

The specific topics addressed in this report are as follows:

- Collation and assessment of available evidence about the current and future significance of aviation to climate change – see Chapter 2.

- A consideration of factors affecting the case for demand restraint – specifically, the benefits of immediate action, the types of trips and people that would be affected and the evidence that price has a significant effect on demand – see Chapter 3.

- A summary of the plans for including aviation in the 2008 European Emissions Trading Scheme, its anticipated impacts, and the apparent consequent need for additional measures – see Chapter 4.

- A brief assessment of some of the other economic policy options for addressing aviation – see Chapter 5.

[2] 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 will be taken forward jointly by the Cabinet Office and HM Treasury, and will report to the Prime Minister and Chancellor by Autumn 2006. It takes place within the context of existing national and international climate change policy.

2. AVIATION'S CONTRIBUTION TO CLIMATE CHANGE

2.1 Introduction

When making policy decisions about aviation, it is important to be clear about the climate change impacts of the sector, and how these compare with the impacts of other sectors.

Taken at face value, current estimates of the relative impact of aviation appear to vary significantly. For example, according to the 2003 Energy White Paper: *"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, aviation and shipping together currently account for less than 4% of the UK's total carbon emissions, and are only a small part of the problem. In contrast, recent data from Hillman and Fawcett (2004, p148), suggest that, for the average UK household, air travel currently accounts for the equivalent of 34% of all $C0_2$ emissions from direct household energy use. This suggests that aviation is a very much bigger proportion of the problem. In policy terms, it is important to understand how these estimates are derived, and which gives a 'truer' impression of aviation's relative impact.

Therefore, this chapter reviews the evidence about the overall significance of aviation to the UK's climate change impacts, and its potential role in the future, including some consideration of the way in which climate impacts can be quantified and compared between sectors.

2.2 The background to assessing the role of aviation

The Kyoto Protocol has driven much of the work on averting climate change. For assessing the importance of aviation, there are two reasons why this is problematic.

First, because of political difficulties in agreeing responsibilities, the emissions from international aviation were excluded from Kyoto – meaning that the target setting, and much of the associated reporting of national emission allocations, excludes the emissions from international aviation.

Second, Kyoto applies to a basket of 6 gases – carbon dioxide, methane, nitrous oxide, the hydrofluorocarbons, the perfluorocarbons and sulphur hexafluoride. However, aviation has significant *additional* environmental impacts which contribute to global warming.

Specifically, according to the DfT (2003, p39), the main emissions arising from the combustion of kerosene[3] are:

- Carbon dioxide
- 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 issue is particularly complicated because:

- The effects of some of the emissions vary at different altitudes, and in different climatic conditions (in particular, NOx and water vapour).
- There are potential trade-offs between controlling the different emissions – for example, as fuel efficiency has increased (reducing CO_2 emissions), the emission index for NOx has tended to increase, because of difficulties in controlling NOx formation at the higher combustor temperature and pressures of some modern aircraft engines.
- Some emissions play a complex role in atmospheric chemistry. For example, the NOx emissions from aircraft can indirectly result in the destruction of a small amount of ambient methane (a greenhouse gas present from other sources), although NOx also forms ozone, a different greenhouse gas, and the net effect is usually an increase in global warming.
- The radiative forcing from different emissions last, in the atmosphere, for different lengths of time. For example, CO_2 has a lifetime in the atmosphere in the order of 100 years or more, and therefore has a long lasting effect on radiative forcing. In contrast, contrail and cirrus clouds have a shorter lifetime in the atmosphere, such that their direct radiative forcing effect is removed more quickly, although their climate change effects in terms of temperature may be longer because of the complexity of the coupled ocean atmosphere system.

There have been various attempts to find a ‘metric’ which gives an overall measure of the climate change effects of the emissions from aviation.

The Intergovernmental Panel on Climate Change’s Special Report on ‘Aviation and the Global Atmosphere’ (IPCC, 1999), used the conventional climate metric ‘radiative forcing of climate’, which is a globally averaged measure of the imbalance in solar and thermal radiation caused by the addition of an activity or emission. It is seen as useful since models have shown that the change in globally averaged surface temperatures is usually approximately proportional to radiative forcing (RCEP, 2002, p14).

The IPCC calculated that, for 1992 traffic, the total radiative forcing from aviation was approximately 2.7 times that of its CO_2 forcing alone. Since their report, there have been a number of other studies, including work by the Royal Commission for Environmental Pollution (2002) and the EU TRADEOFF project (Sausen et al, 2005). The Aviation White Paper (DfT, 2003, p40) reported that

[3] Whilst commercial jets typically run on kerosene, small aircraft are often run on aviation gasoline, although this constitutes only a small fraction of total aviation fuel usage.

studies have generally suggested the radiative forcing effect from current-day aviation is 2-4 times greater than that of its CO_2 emissions alone, and this conclusion is in line with the findings of more recent studies.

It should be noted that there are a number of limitations to using radiative forcing as a way of comparing the impacts of different emissions – in particular, the steps to relate emissions to radiative forcing are rather complicated, and, for some emissions, the effects depend on ambient conditions. Consequently, a number of other metrics are also under consideration, and in use for particular purposes. However, to date, radiative forcing is the most commonly used metric for comparing the impacts of aviation emissions with the impacts of emissions from other sectors.

2.3 UK aviation emissions and relative impacts so far – estimates based on Government figures

The main source of data about greenhouse gas emissions in the UK is the National Environmental Technology Centre's (NETCEN's) greenhouse gas inventories, which they produce for DEFRA. The DTI has its own 'Energy Model' which processes this data to produce specific data outputs. DEFRA and DTI both use information from the DTI's Energy Model, but break down the data in different ways. Moreover, as outlined by the DTI (2004, p3), as scientific understanding improves, historic data is often revised, as well as projections data.

The following table summarises the latest figures released from the DTI (2004, p3). The data relate to CO_2 emissions from UK activities which are relevant to the Kyoto Protocol[4]. They also reflect updated versions of the figures used in the 2003 Energy White Paper.

Table 2.1: UK annual emissions (MtC) from the DTI Energy Model

Year	MtC emissions for the UK (total)
1990	165.1
1995	153.4
2000	152.7

It should be noted that these figures include the CO_2 emissions from domestic civil aviation, but do not include the emissions from private or international aviation. Anable and Boardman (2005, Table 4, p13) provide a breakdown showing that, according to DEFRA, in 2003, domestic civil aviation accounted for a total of 0.6 MtC by source. This was equivalent to only 1.8% of all transport CO_2 emissions in 2003, by source. In contrast, 'The Future of Air Transport' (the Aviation White Paper), produced in 2003, examined the CO_2 emissions from aviation more generally, (DfT, 2003). In 2004, the DfT published a report called 'Aviation and global warming', which aimed to clarify the figures given in the

[4] Our understanding is that, unlike the situation for aviation, overall, most of the radiative forcing caused by other UK activities comes from their CO_2 emissions. In the later stage of this project, we will refine our analysis to allow for the radiative forcing caused by other greenhouse gas emissions from other sectors. This is not expected to significantly alter the headline figures.

Aviation White Paper on this issue, and report that their figures are based directly on NETCEN data, (DfT, 2004).

Specifically, DfT (2004) reports that, according to NETCEN, in 1990, the UK aviation sector, including all domestic flights plus international passenger departures and freight air traffic movements, emitted 4.6 MtC (para. 2.2). (This apparently aims to explain the information given in para. 2.14 of 'The Future of Air Transport' White Paper, although, in practice, para. 2.14 refers to a graph where aviation emissions in 1990 appear to exceed 6MtC.)

In para. 3.5, DfT (2004) reports that, in 2000, NETCEN figures show that 8.6MtC was emitted by civil passenger aviation and air freight (excluding the emissions from surface access transport). In para. 3.53-3.54, DfT reports that, in 2000, the emissions from aviation were 8.8MtC, and highlights that no radiative forcing effect is included in this figure. (The graph given in para. 2.14 of 'The Future of Air Transport' White Paper implies that aviation emissions may actually be in excess of 9MtC.)

The apparent inconsistencies within the DfT (2004) document and between this document and other published reports have already been highlighted by the House of Commons Environmental Audit Committee (2004, recommendation 10), and the DfT has provided an explanation in relation to some of the issues they raise[5]. Due to the time limitations of this study, it has not been possible to address these issues with the Department (although this will take place during a later phase of the work). However, the main aim of examining the figures is to gain a rough idea of the relative radiative forcing impact from aviation compared with other sectors.

A minimum estimate of the relative impact of aviation can be calculating from the emissions data by using a number of conservative assumptions. These are that:

- The recent DTI Energy Model figures provide the best estimates of UK CO_2 emissions in 1990 and 2000, including domestic civil aviation, but excluding private and international aviation emissions.
- In 1990 and 2000, the CO_2 emissions from domestic civil aviation were unlikely to have been greater than they were in 2003 (i.e. the 2003 figure of 0.6 MtC is the maximum amount of emissions that domestic civil aviation could have accounted for in those years).
- Aviation CO_2 emissions in 1990 and 2000 were at least as great as the lower figures for emissions given in the DfT 2004 document for civil and airfreight aviation (i.e. 4.6MtC in 1990 and 8.6MtC in 2000).

There is no direct way of assigning a value to the radiative forcing effect of introducing a tonne of CO_2 into the atmosphere, as radiative forcing is the change in energy balance between two different points in time, and is affected by

[5] Although not relevant to this analysis, to avoid confusion, it is perhaps worth noting that the DfT (2004) document reports that, in 2000, the UK emitted 147MtC overall (para. 2.9). This differs significantly from the DEFRA and DTI figures given in Table 2.1. In their response to the House of Commons Environmental Audit Committee (HoCEAC, 2004), the DfT explain that this figure excludes the emissions from land use change and forestry.

the changing profile of emissions and sink strength in that period. Between two timeframes, greenhouse gases have been cumulatively emitted to the atmosphere, and also removed by sinks. However, it is robust to think of average values, and to attribute the change in radiative forcing over a year to the emissions in that year. For example, in 1990, a certain amount of greenhouse gas emissions were introduced into the atmosphere (and some historical emissions removed), which, overall, resulted in a specific increase in radiative forcing. If the total sum of those emissions was known, together with the overall value for the radiative forcing that occurred in that year, it would be possible to work out the average amount of radiative forcing that each unit of emission was responsible for. This data is not readily available, so, in order to examine aviation's *relative* contribution to radiative forcing in 1990, we call this value 'RF90'. A similar value can be envisaged for 2000, which we call 'RF00'.

This leads to the following calculations:

Table 2.2: Comparing the radiative forcing effects of aviation emissions with the radiative forcing effects of the emissions from other sectors

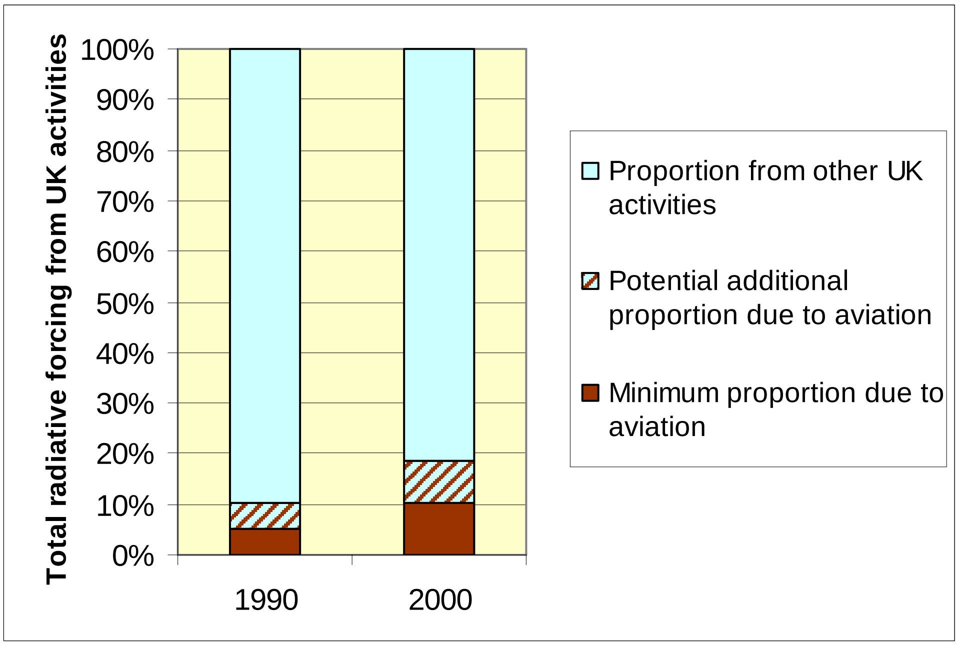
		1990	2000
A	Total emissions of $C0_2$ according to the DTI Energy Model (in MtC equivalent), including domestic civil aviation	165.1	152.7
B	Total emissions of $C0_2$, according to the DTI Energy Model (in MtC equivalent) , discounting for domestic civil aviation	164.5	152.1
C	Radiative forcing effect of the emissions given in row B	164.5*RF90	152.1*RF00
D	Lowest estimate of CO_2 emissions from aviation, according to DfT (2004), including domestic flights, international passenger departures and air freight traffic movements (in MtC equivalent).	4.6	8.6
E	Radiative forcing effect of the CO_2 emissions given in row D	4.6*RF90	8.6*RF00
F	Total radiative forcing effect of aviation emissions, assuming that these are 2-4 times the radiative forcing effects of the CO_2 emissions alone (i.e. E * 2 to 4)	9.2*RF90 to 18.4*RF90	17.2*RF00 to 34.4*RF00
G	Combined radiative forcing effect of aviation and other sectors (i.e. C+F)	173.7*RF90 to 182.9*RF90	169.3*RF00 to 186.5*RF00
H	**The radiative forcing effects of aviation as a percentage of the total radiative forcing effect of UK activities** (i.e. F/G * 100)	**5.3%-10.1%**	**10.2%-18.4%**

These figures show two important things:

- **Aviation already accounts for between about 10 and 18% of the radiative forcing caused by UK activities.**
- **Aviation's contribution to the radiative forcing effects of UK activities is growing fast – and, in relative terms, approximately doubled between 1990 and 2000.**

These figures can be illustrated graphically, as follows.

Figure 2.1: Change in aviation's relative contribution to the radiative forcing effects of UK activities



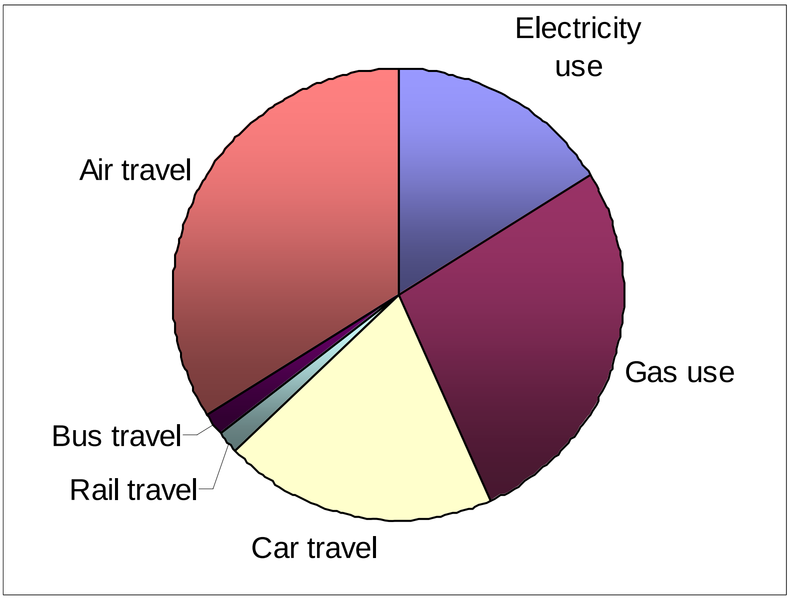
2.4 Consistency check – work by Hillman and Fawcett

As a credibility check on the calculations given above, it is interesting to assess whether these figures are consistent with recent work by Hillman and Fawcett (2004, pp146-150).

Hillman and Fawcett (2004) assess the issue from a different starting point. They focus on direct energy use by UK households, that is - use of electricity, gas, cars, public transport and air travel. They look at the use of each of those for the average household. To assess the climate change impacts, they convert all use into a co-efficient of $kgC0_2$, including a multiplier factor of 3 for the aviation energy use. Their figures imply that aviation accounts for about 34% of the climate change impacts[6] of direct household energy use, as shown in Figure 2.2.

[6] Although Hillman and Fawcett do not specify, their calculations effectively give a measure of the relative radiative forcing effects of different household energy uses.

Figure 2.2: Illustration of data for the climate change impacts of direct household energy use from Hillman and Fawcett (2004, table 4, p148)



According to Anable and Boardman (2005), in 2000, of the 152.7MtC estimated in the DTI Energy Model, residential and transport use in the UK (excluding international and private aviation) accounted for 59MtC by sector and 57.7MtC by source. (The difference between these two figures is explained by Anable and Boardman). In other words, the radiative forcing effect of the Kyoto gases emitted by residential and transport use in the UK (excluding international and private aviation) accounted for about 38-39% of the radiative forcing effect of all Kyoto emissions. According to Hillman and Fawcett's calculations, the impacts of aviation should add approximately half as much again.

As an approximation, therefore, if household emissions, excluding aviation, are about 58MtC, this would represent a radiative forcing effect of 58*RF04[7]. If this is about 66% of the radiative forcing effect of total household emissions, where the other third comes from aviation, the radiative forcing effect of aviation should be about 29*RF04. Using the same assumptions, the total radiative forcing effect of all UK emissions included in the DTI Energy Model would be 152.7*RF04, and, if aviation is included, the total effect would be 181.7*RF04. Aviation, as a proportion of the total, would therefore represent about 16% of the radiative forcing effect of UK activities.

In short, despite working from a completely different starting point, Hillman and Fawcett's figures about aviation's *proportional* contribution to the UK's climate change impacts are consistent with the calculation given in section 2.3.

[7] RF04 is the notional value given to the average radiative forcing effect caused by one tonne of emitted carbon equivalent in the UK in 2004.

2.5 Projections of aviation's relative significance in the future

So far, the analysis has concentrated on aviation's current contribution to the UK's climate change impacts. However, many of those involved in the debate highlight that the biggest cause for concern is the projected growth in aviation and, therefore, its potential climate impacts in the future. There are a number of different forecasts. Due to time limitations, this paper primarily concentrates on calculations that use the 'central case' figures for emissions produced by the Department for Transport (2004) in support of The Future of Air Transport White Paper, including some comparison with other estimates.

Specifically, the DfT's paper (2004, para. 3.56) gives the forecasts given in Table 2.3 for the future CO_2 emissions from aviation. These forecasts include fuel efficiency improvements envisaged by the Intergovernmental Panel on Climate Change (IPCC) and the Advisory Council for Aeronautics Research in Europe (ACARE), but exclude the impacts of any new economic instruments. Specifically, a fuel efficiency improvement of 50% is envisaged between 2000 and 2050. (Although not specified, we assume, from other parts of the paper, that these figures relate to emissions from domestic flights, international passenger departures and freight air traffic movements.)

Table 2.3: DfT forecasts of future aviation emissions of CO_2

Year	Emissions (MtC)
2000	8.8
2010	10.8
2020	14.9
2030	17.7
2040	18.2
2050	17.4

Meanwhile, to accompany the Energy White Paper, DEFRA produced an estimate of the levels of emissions that would need to be reached each year in order to achieve a 60% reduction by 2010, (DEFRA, 2003, Annex p12). Their figures apply to the emissions recorded in the DTI Energy Model (which, for aviation, only includes the CO_2 emissions from domestic civil aviation). The totals are as follows.

Table 2.4: For emissions included in the DTI Energy Model, emission levels required to achieve a 60% reduction in emissions by 2050

Year	Emissions (MtC)
2000	152
2010	138
2020	122
2030	103
2040	84
2050	62

Hence, it is possible to carry out a similar calculation as undertaken in section 2.3, to show the *proportion* of radiative forcing from UK activities that aviation would account for, if all other sectors met their target, and aviation grew in the way that the DfT Aviation White Paper (2003) forecasts.

There are several problems. First, the CO_2 emissions from domestic civil aviation are included in both sets of figures. In 2003, we know that, according to Anable and Boardman (2005), domestic aviation in the UK accounted for 0.6MtC and that, according to DfT (2004), in 2000, total emissions from aviation were 8.6-8.8MtC. This implies that, as an approximate rule of thumb, at the moment, domestic aviation accounts for about 7% of all CO_2 emissions from aviation. In the absence of more specific information, this figure is used in the following calculations. At later stages of the project, we will seek more accurate figures.

Second, we do not have the relevant average figure for radiative forcing for each of the future years. Again, we simply use the term 'RF' to highlight that the number given in the row would need to be converted using that figure. It should be noted that this value would be different for each of the years, hence we have used RF00, RF10, RF20, RF30, RF40 and RF50.

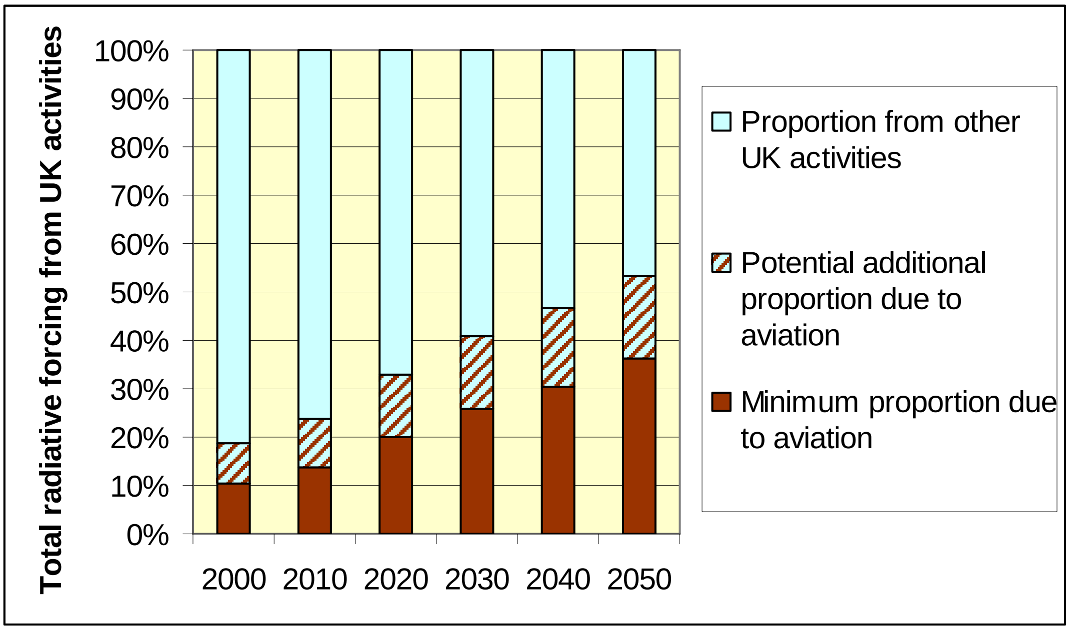
The following calculation has been undertaken:

Table 2.5 Forecasts of emissions, and associated radiative forcing

		2000	2010	2020	2030	2040	2050
A	Total emissions to achieve a 60% reduction from the sectors recorded in the DTI Energy Model (MtC equivalent)	152	138	122	103	84	62
B	DfT forecast of aviation CO_2 emissions (MtC equivalent)	8.8	10.8	14.9	17.7	18.2	17.4
C	7% of aviation emissions in MtC equivalent (i.e. a rough estimate of domestic aviation CO_2 emissions)	0.6	0.8	1.0	1.2	1.3	1.2
D	Radiative forcing effect of emissions recorded in the DTI Energy Model, excluding the impacts from domestic aviation (i.e. A-C*RF)	151.4 *RF00	137.2 *RF10	121 *RF20	101.8 *RF30	82.7 *RF40	60.8 *RF50
E	Radiative forcing effect of aviation emissions, assuming that they are 2 to 4 times the impacts of the CO_2 emissions alone, (i.e. B*2 to 4*RF)	17.6*RF00 to 35.2*RF00	21.6*RF10 to 43.2*RF10	29.8*RF20 to 59.6*RF20	35.4*RF30 to 70.8*RF30	36.4*RF40 to 72.8*RF40	34.8*RF50 to 69.6*RF50
F	Total radiative forcing effects including those from aviation (i.e. D+E)	169.0*RF00 to 186.6*RF00	158.8*RF10 to 180.4*RF10	150.8*RF20 to 180.6*RF20	137.2*RF30 to 172.6*RF30	119.1*RF40 to 155.5*RF40	95.6*RF50 to 130.4*RF50
G	**Radiative forcing effects of aviation as a percentage of the total radiative forcing effects of UK activities** (i.e. E/F *100)	**10.4 to 18.9%**	**13.6 to 23.9%**	**19.8 to 33.0%**	**25.8 to 41.0%**	**30.6 to 46.8%**	**36.4 to 53.3%**

Again, this can be illustrated graphically as follows.

Figure 2.2 Aviation's forecast share of radiative forcing, if other sectors achieve their emission reduction targets



As a consistency check, it is interesting to note that, in para. 4.7, DfT (2004) quote a letter from the Royal Commission from Environmental Pollution, suggesting that "aviation's share of greenhouse gas emissions in the economy will increase to 35% in 2030 and over 70% in 2050", implying that its contribution to radiative forcing will increase by at least this amount. In para. 4.9, DfT (2004) suggest that these figures should be corrected to be 28% in 2030 and 35% in 2050 – which is broadly consistent with our lower estimates.

There have been two other recent studies on this issue, both of which have also allowed for some improvements in technological efficiency in the aviation industry. Work by Owen and Lee (in press) from the Centre for Air Transport and the Environment, Manchester Metropolitan University, has recently concluded that *"the contribution of international aviation to UK CO_2 emissions has been shown to represent [between 43% and 65%] of the targeted emissions in 2050 [depending on the scenario]"*. Given that aviation's radiative forcing effects are considerably greater than those resulting from their CO_2 emissions alone, this implies that the radiative forcing from aviation would be significantly greater than 43-65% of the target radiative forcing from all UK activities in 2050.

The second relevant report is by the Tyndall Centre for Climate Change Research (2005). This research involved extensive scenario building to explore how the UK could meet its target of a 60% reduction in carbon emissions by 2050, given an aviation growth rate of approximately 8% a year and an incremental improvement in overall fuel burn for a typical journey of 1.2% a year [8]. The researchers conclude that permitting even 'moderate' aviation growth in the

[8] 1.2% is the mean suggested by the International Panel on Climate Change (1999). The scenarios are conservative in that they take no account of the greater climate change impact associated with aircraft emissions of CO_2, i.e. a multiplier has not been applied.

context of the UK's carbon reduction objective of 550ppmv CO_2 concentrations, would mean 50% of UK emissions were caused by aviation by 2050. Moreover, if the UK were to follow the scientific consensus that the lower stabilisation level of 450ppmv is required, then the aviation sector would exceed the carbon target for all sectors by 2050. Again, their work is primarily about CO_2 emissions – meaning their calculations imply that aviations' share of radiative forcing would be an even bigger proportion of the radiative forcing from all UK activities by 2050.

Understanding the precise comparability of these different estimates requires more detailed analysis. However, in general terms, they are all highlighting the same issues, namely:

- Aviation emissions, and their related climate change impacts, are forecast to grow substantially.
- Efficiency improvements are only expected to 'dampen down' this growth.
- It is implausible that other sectors can reduce their emissions sufficiently to offset the increasing impacts of aviation.

Put more starkly, if the figures given in Table 2.5 are right, in order **to offset the impacts of the aviation sector, all other sectors would have to reduce their CO_2 emissions even further than planned, to half of the current targets for 2050, or, possibly, even to zero by 2050.**

All of the forecasts given above allow for some improvements in the efficiency of aviation. We are unclear about whether these forecasts have used optimistic or pessimistic assumptions about the potential for technology to reduce aviation emissions, and to mitigate its associated environmental impacts. However, we note that the overall conclusion – namely, that technology will not be enough to address aviation's climate change impacts – is widely held. For example, the issue was explicitly addressed by the Royal Commission on Environmental Pollution in its special report on aviation (2002). The RCEP concludes that, *"the ambitious targets for technological improvement in some industry announcements are clearly aspirations rather than projections."* It argues that, while there are considerable opportunities for incremental improvements in the environmental performance of individual aircraft, these will not offset the effects of growth in aviation. Moreover, it finds that the most promising developments, offered by new airframe designs, are not expected to affect the industry for decades and then, only to apply to large long-haul aircraft. The prospects for hydrogen fuelled aircraft are considered particularly poor, because the fuel would have to be carried on board and would produce additional water vapour at high altitudes with the consequence of increased climate impact.

The strong emerging finding, then, is that a substantive reduction in the projected growth of aviation is required, and that **it will be impossible to reduce the UK's climate change impacts to the extent needed to meet international aspirations *unless there is demand restraint in the aviation industry.***

3. CONSIDERATIONS FOR DEMAND RESTRAINT

3.1 Introduction

Demand restraint – i.e. encouraging people to fly less, or, at least, not to fly more – is likely to be resisted by the aviation industry. However, there are various reasons why it would be beneficial, and cost effective, to introduce a policy of demand restraint now, and why demand restraint is a feasible option. These arguments are explored in this chapter.

This chapter also highlights that economic measures – which make the price of flying more expensive – offer a viable mechanism to achieve demand restraint, and could complement other measures (such as personal carbon allowances or tradable domestic quotas), should these be introduced at a later date.

Given the scale of demand restraint needed to avert the vast, forecast growth in aviation, all possible demand restraint measures will need to be applied. The Treasury has a critical role to play in this area of policy, being one of the few organisations with the power to introduce economic policy measures that would affect the aviation industry quickly.

3.2 The benefits of immediate action

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. We have 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. We have 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 3.3, 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. 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%[9]. In demand management terms, therefore, air travel is likely to be ‘a good buy’. Air travel is relatively amenable to change because it 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

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

mitigate adverse social effects. It does not, for example, require us to redesign our cities to make them less air reliant or to fund alternatives 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, 2005). 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 also illustrated empirically by research into individual patterns of car use over time in research by Joyce Dargay (2004). This shows that the relationship between rising and falling income and car travel is not a symmetrical one. 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 mathematically as a hysteresis loop. This is because 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 traveled increased by 10.9%, but a 10% fall in income only resulted in an 8.6% reduction in the car distance traveled.

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, 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 the 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, (Sewill, 2005, p18). 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 [presumably return] trips a year, then on present growth rates, owners of second homes will soon be taking 12 million flights a year.

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 the reports that house prices near regional airports have soared with the arrival of low cost flights. Increasing numbers of international marriages are likely to be another outcome of growing air travel.

Reversing the argument, it should also be noted that if, long term, international aviation has to be curbed, countries which have a lower level of air dependence will actually have a long term advantage. At a micro level, for example, businesses that invest in video conferencing technology and review their operations to cut business flying, will adapt more readily if aviation is constrained. In many organisations, there is already an existing business case for such action.

For example, prior to the formal introduction of emissions trading, BP introduced an internal emissions trading scheme. The scheme cost $20million to introduce, but is estimated to have saved the organisation $650million over three years, because it encouraged different parts of the organisation to consider whether they could operate more efficiently, (King, 2005). This demonstrates that businesses are not necessarily working in the most optimal ways already.

Specifically, there is a considerable body of work, in relation to workplace travel plans and fleet management initiatives, which highlights that many businesses do not know how much the travel activities of their organisations cost them[10]. Few businesses have a proper auditing system which records, for example, the amount of staff time spent travelling or the overall amount of expenses paid on travel and subsistence claims. Given this lack of information, and the fact that decisions about travel are often made in a relatively fragmented way throughout an organisation, it is unlikely that all business air travel is currently optimal. Consequently, making organisations rethink their air travel strategies might actually contribute to improvements in business efficiency.

3.3 The characteristics of air travel

In considering the role for demand restraint, it is also important to understand the current nature of air travel – i.e. what kinds of trips and what kinds of people are likely to be affected. This section provides a very brief review of the available data.

First, for passengers, there is evidence from the International Passenger’s Survey (IPS[11]) that the biggest component of the growth in aviation is likely to

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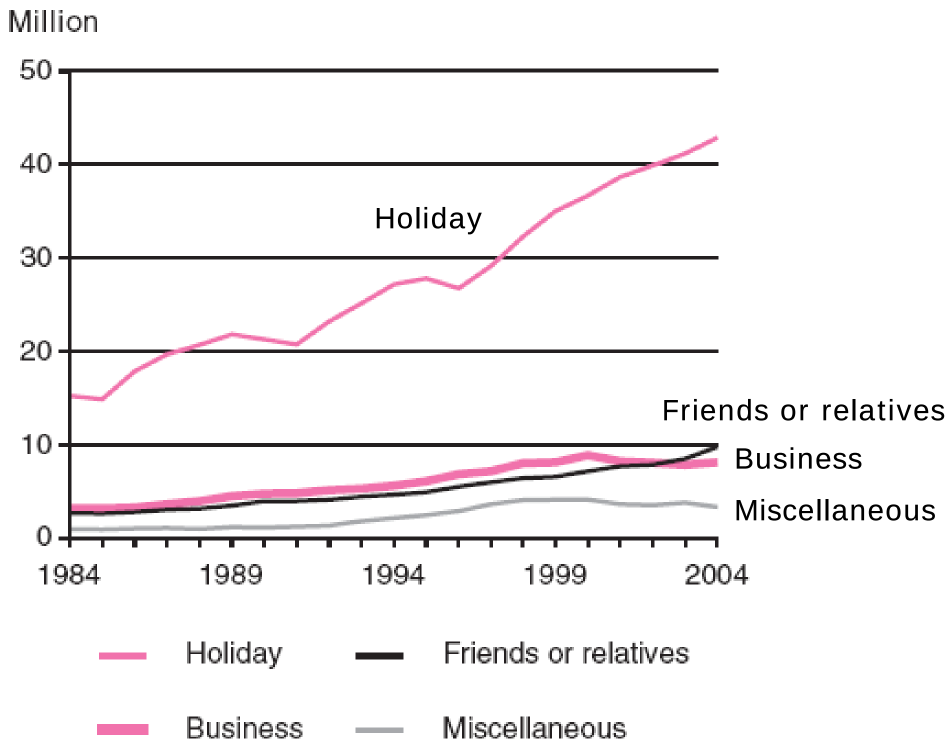
[10] This includes work by the authors for the DfT on ‘Making travel plans work’ (2002), and ongoing work for the DfT by the Energy Savings Trust.

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

have come from leisure trips, as shown in Figure 3.1. It should be noted that this graph is for visits abroad by UK residents *by all modes*, but according to a different breakdown (NS, 2004, pp22-23), 36,501,000 of all 42,121,000 new trips abroad between 1984 and 2004 (i.e. 87%) were made by air, so it is fair to assume that the growth in aviation dominates this graph. This represents an average growth of 1.8 million air passenger trips p.a. abroad by UK residents over that period. (At a later stage of this project, specific data to redraw this graph for air passengers will be sought).

Figure 3.1 UK residents' visits abroad by purpose of visit
(Taken from Figure 1.11 in Travel Trends, National Statistics, 2004)



As corroborative evidence, according to work by Dargay and Hanly (2001, p2), which involved detailed analysis of the IPS for the period 1989-1998, during that period, only 16% of UK residents' international air journeys were for business purposes, meaning that 84% were for holidays, visiting friends or relatives, or 'miscellaneous'.

Next, it is clear that aviation is not a socially inclusive activity. Air travel is still primarily undertaken by richer sections of society, and much of the increase in air travel is occurring because existing aviation passengers are travelling more often. Specifically, according to the Aviation White Paper, in 2001, only 50% of the UK population had flown at least once in that year, (DfT, 2003, 'Key facts'). Data from the Civil Aviation Authority 2003 Summary Statistics, which are based on 180,000 passengers, showed that the *average* annual salary for UK passengers passing through UK airports ranged from £36,000 at Nottingham East Midlands, through to £66,000 at Heathrow, and £72,000 at London City Airport, (DfT, 2005a). In contrast, for the UK as a whole, in 2003, the average annual earnings of full-time employees was £24,752[12]. In addition, data from the Civil Aviation Authority's passenger survey showed that, of 62,849 leisure passengers terminating at Gatwick, Heathrow, Luton, Manchester and Stansted, 76% 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 2003 British Social Attitudes survey (DfT, 2005a), which show that, for example, 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. The data are shown in Table 3.1.

Table 3.1 Data from the 2003 British Attitudes Survey about frequency of flying

How many air trips in the last year?	**None**	**One**	**Two**	**Three or more**	**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

In short, it is clear that the current profile of air passengers does not reflect the average UK socio-demographic profile, and it is likely that a significant part of the growth in aviation has occurred because richer people are flying more often.

Next, it is clear that the majority of travel by UK air passengers is to mainland Europe. Specifically, according to Dargay and Hanly (2001, p2), over two-thirds of British residents' international air trips are made to European destinations, and the proportion is likely to have increased, given the growth in low cost routes to Europe. This is relevant when considering the geographical scope of economic policy solutions.

Finally, spending by UK residents travelling abroad by air is greater – and has increased faster, than spending by overseas residents visiting the UK by air, as shown in Figure 3.2. This is based on data taken from table 1.07 and 1.08 of the IPS (NS, 2004, pp22-23), and refers specifically to spending by air travellers. Overall, then, it seems that the growth in air travel is contributing to a growing 'tourism deficit'. There have also been negative effects for competing modes, such as the UK ferry companies.

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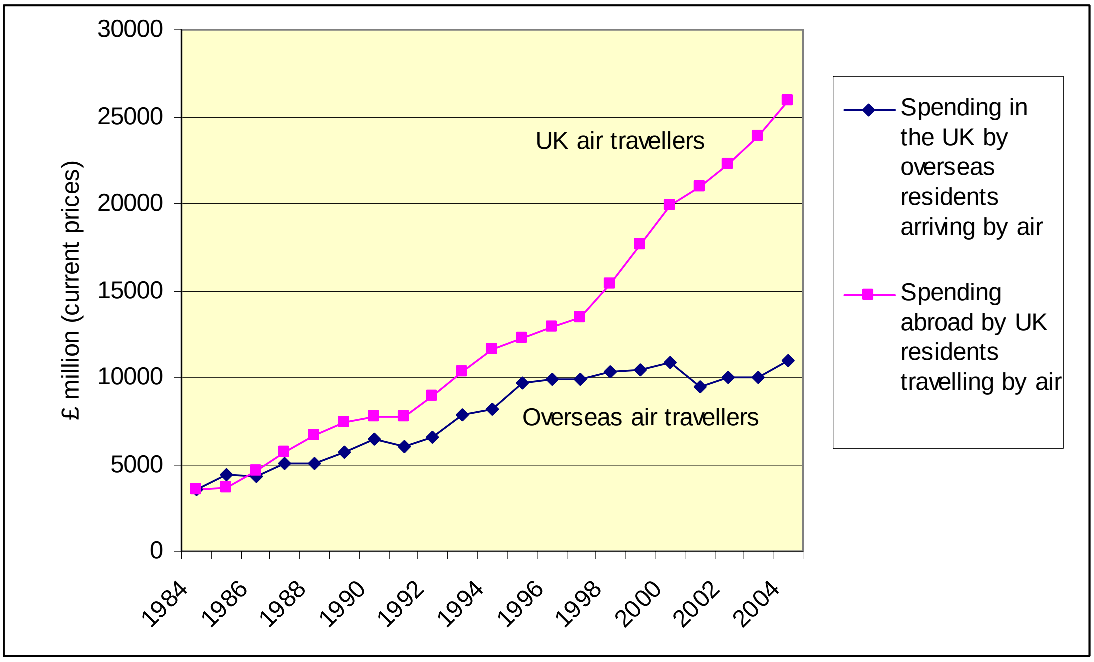
[12] Data calculated from Social Trends, (NS, 2005, p68).

Figure 3.2 Spending by UK travellers and overseas visitors, current prices



Overall, the picture emerging from these statistics is that demand restraint has significant potential. For passenger trips, it would primarily be about deterring increasing numbers of leisure trips by richer members of society. This seems like one of the more socially-equitable forms of regulation that may be required to meet climate change objectives. The fact that a significant proportion of trips are to mainland Europe means that action with the EC, or by altering existing bilaterial aviation agreements with individual European member states, has the potential to address a large number of air trips. Moreover, given that the growth in aviation is currently fuelling a 'tourism deficit', it is entirely plausible that there could be economic benefits for the national tourist industry and wider economy. In the later stages of the project, these arguments will be reviewed in more detail.

3.4 The role of pricing in affecting demand

The viability of demand restraint can also be considered from another perspective. Specifically, it is sometimes argued that, as societies become wealthier, the amount of air travel that people undertake will *inevitably* increase. The implication is that it is impossible to reduce the demand for flying, unless GDP and average incomes reduce. However, there is a considerable body of evidence that, whilst economic growth may be one driver of the growth in air travel, the demand for air travel is also strongly influenced by other factors – in particular, price.

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 Energy White Paper highlights (DTI 2003, p26, para 2.16 and chart 2.1) that the two have been successfully decoupled, since overall energy consumption in the UK has risen by only about 15% since 1970, whilst the economy has doubled. It seems implausible to argue that the amount of air travel is more inextricably linked to GDP than energy consumption overall.

In addition, there has been specific analysis to assess the extent to which fares, and changes in fare levels, have affected the demand for flying.

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[13], 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. Their work was based on information about air trips and air fares from the International Passenger Survey; information on disposable income from the OECD; information on population from the World Bank; information on the retail price index, exchange rates and local currency from the IMF; and information on trade (imports + exports) from the Office of National Statistics.

First, their work highlights that air fares fell substantially in real terms over the period 1989 to 1998, and that this reduction in price was greatest for UK leisure fares. A summary of results is given in Table 3.2.

Table 3.2: 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 has been calculated by converting IPS data about real fares paid into £1998 prices, using the retail price index. For trips by overseas visitors to the UK, IPS data has been 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.

Second, the modelling work undertaken by Dargay and Hanly showed that, whilst the growth in income and trade was linked to the growth in air travel, fare reductions had also been important in stimulating 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***. They also estimated that a future 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 3.3 summarises the fare elasticities calculated by Dargay and Hanly, and the other results that they were able to find in the literature on the topic. In brief, apart from the work by Graham (2000), taken together, these figures suggest, in the long run, a 10% reduction in air fares increases the demand for leisure travel by something in the order of 5-10%.

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[13] Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Japan, Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland and the USA

Table 3.3: Long run fare elasticities for air travel

Study	Leisure	Business
Dargay and Hanly (2001)	-0.58	Not significant
DETR (2000)	-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

Since this work, there have been a number of further calculations. For example, the Dutch Government's Civil Aviation Department commissioned the creation of an '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[14].

Moreover, a recent working paper of the European Commission (CEC, Apr 2005, p25) has attempted to bring together the elasticities from a number of studies.[15] The paper highlights 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[16].

These results are broadly consistent with those found by Dargay and Hanly (2001), and, if anything, suggest that price is a bigger influence on demand than they found. Hence, although a relatively small body of work, it does point, relatively consistently, to the conclusion that air fares affect the demand for air travel and that the volume of air travel is not simply a reflection of economic growth.

In considering future policy initiatives, it seems, then, that economic measures which increase the price of flying could have a significant impact on demand, i.e. that economic policy measures could constitute an effective method of demand restraint.

There are two reasons why this conclusion is not always widely accepted.

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[14] From personal correspondence with Steve Lowe (MVA), following a recent conference presentation (Lowe, 2005).

[15] 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, 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.

[16] We are unclear whether there is any research which has explicitly defined separate price elasticities for rising and falling air fares. We will investigate this in a later phase of the study. Since the dominant trend has been a decline in aviation prices, there is unlikely to be much empirical evidence about the effects of increasing aviation prices on the market as a whole.

First, the cost of an aviation ticket is comprised of a number of components. For example, according to the EC working paper (CEC, Apr 2005, p25), on average, fuel only constitutes 15% of the costs for intra-EU flights. Hence, for example, fuel tax – in isolation – only has the potential to alter a proportion of the final ticket price.

Second, there seems to be the belief that the Government could only make small, incremental changes in price. For example, this view has been expressed by Mario Deconti, HM Revenue and Customs[17]. He endorses the elasticities given above, but argues as follows: *"Air Passenger Duty (APD) could be increased by £1 for leisure flights to the EU (10% increase in APD but just 1.25% on a flight of £80) and demand would only fall marginally relative to what it would have been if the rate was not increased. Given the income elasticity, income growth is likely to more than offset any impact of the higher APD, and there is unlikely to be an absolute fall in demand, just a slower rate of growth than would otherwise have been the case."*

There are a number of counterarguments to the points above, as follows:

- First, the effect of one instrument (e.g. fuel tax) should not be considered in isolation, but as part of a package of measures.

- Second, in environmental terms, a slower rate of growth is still better than 'business as usual'.

- Third, there is no reason why the Government needs to think only in terms of small, incremental changes in price. In contrast, passengers have become used to significant changes in price. Dargay and Hanly's work highlights that *average* price of air tickets for UK leisure travellers fell by 38% in less than 10 years. Although we have not yet been able to obtain the figures, it would also be useful to look at the change in minimum fares available. Fifteen years ago, it would probably have been difficult to buy any flight for much less than, say, the equivalent of £100 in current prices. Now, the cheap airlines offer some flights which cost nothing except the taxes that are levied.

- Fourth, the effect of economic measures on the *average* flight price is likely to be significantly different to their effect on the *cheapest* flight prices. Raising the cost of the cheapest tickets may have a more significant effect on demand than is apparent from considering the effect on the average ticket price.

The next sections of the report now consider the available economic measures that could be used to promote demand restraint in aviation.

[17] Personal correspondence with Mario Deconti.

4. WILL EMISSIONS TRADING BE ENOUGH?

4.1 Introduction

The economic measure currently receiving the greatest attention for addressing the environmental impacts of aviation is the EU Emissions Trading Scheme – specifically, the future inclusion of aviation within this scheme. This chapter provides a brief review of the proposals and anticipated effects of the scheme.

The European Union Emissions Trading Scheme came into being in January 2005. It covers approximately 11,500 energy producing and energy intensive installations – together responsible for nearly half of all EU CO_2 emissions. 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 within 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 it coincides with the first Kyoto Commitment Period.

Aviation is not currently included in Europe's Emissions Trading Scheme (EU ETS), but the European Commission has recommended that all intra-European flights and international passenger departures should be, as part of a comprehensive approach including research into cleaner air transport, better air traffic management, and the removal of legal barriers to taxing aircraft fuel.

The recommendation is made in a Communication, *Reducing the climate change impact of aviation*, published on 27 September 2005 (CEC, Sep 2005a), which highlights the need for action and identifies emissions trading as the best way forward.

The Commission is inviting responses to the Communication, and will also set up an expert working group to look at the detailed design of the scheme. The group will include experts from Member States with representation from industry, consumer and environmental organisations, and is expected to report back by the end of April 2006. This process will be co-ordinated with a general review of the EU ETS due in mid-2006. The Commission aims to put forward a legislative proposal by the end of that year. 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). The process typically takes between two and three years. On this timescale, it is considered unlikely that aviation could be brought into the scheme at the start of its next phase in 2008. However, it may be possible for it to be incorporated ahead of the third phase, which begins in 2013.

The Commission's Communication is supported by the UK Government, which had already concluded in its White Paper *The Future of Air Transport* (DfT, 2003, p40, para. 3.39), that emissions trading is *"the best way of ensuring that aviation contributes towards the goal of climate stabilisation*", and proposed that aviation should be incorporated into the scheme with effect from 2008. Emissions trading for international aviation has also been endorsed by the International Civil Aviation Organisation (ICAO)[18] in 2001, and, in the UK, is also supported by the British Airports Authority and British Airways. An EU scheme is seen as being a precursor to a fully international one.

4.2 Expected effects from the operation of the scheme

Once aviation is incorporated into emissions trading, the reduction in its climate impact is expected to take place on three different fronts:

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. On the basis of the scenarios examined, the Commission expects these price increases to be modest, varying between €0.2 and €9 per return flight for an individual passenger. As a result, it is predicted that the demand for air transport will continue to grow, but at a slower rate with a relative reduction of between 0.1 and 2.1% between 2008 and 2012. This is in comparison to the predicted business-as-usual growth rate of more than 4% a year. Critically, the Commission has concluded that including aviation in the EU emissions trading scheme will have a smaller impact on ticket prices than if the same environmental improvement [presumably in terms of emissions] were to be achieved through other measures such as a fuel tax or an emissions charge, (CEC, Sep 2005b, p33-34).

It is important that most of the emissions reduction made by the airlines is expected to take place through the first of the routes described above. The Commission's analysis is based on a detailed feasibility study led 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). In all three scenarios, for the two allowance prices considered (€10 per tonne of CO_2 and €30 per tonne of CO_2) the majority of

[18] ICAO is a specialised agency of the United Nations, which 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 183 contracting States.

emission reductions were made in other sectors because this was the lowest cost option for the airlines.

Inclusion of non-EU operators

It is envisaged that the emissions allowances will be allocated to aircraft operators, and that this will apply to all carriers operating from EU airports, without regard to nationality, so that the scheme will not compromise the competitiveness of EU airlines.

Options being considered to capture the full climate impacts of aviation

The intention is that the ETS should address both the CO_2 and non-CO_2 impacts of aviation, as far as possible. Two 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[19]. On this issue, the CE Delft study concluded that a multiplier approach could not yet be based on an accurate scientific methodology, but 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, such as airport charges related to NOx emissions. (A NOx en route charge was considered in the CE Delft feasibility study, and considered likely to be effective, but possibly more difficult, in that it raises the sensitive issue of who should receive the money generated by the charge.) It should be noted that such a flanking instrument represents a form of emissions charging – one of the economic instruments considered in the next chapter.

4.3 Advantages

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, Sep 2005a), 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 because of the time frame implied by the need to secure all the necessary legal agreements.

The Communication 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:

[19] For discussion of relevant multiplier factors, see Chapter 2, section 2.2.

- The machinery for emissions trading has already been established through the existing EU scheme.

- Emissions trading faces no obvious legal difficulties (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 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 to be especially 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, Sep 2005b), the Commission argues that inclusion 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 in aviation will come at a higher cost than for other industries participating in the 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 are having greater success. 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.

4.4 Limitations

The chief limitation to controlling aviation emissions through emissions trading, rather than an emissions charge, is that it offers a less direct means of applying demand restraint.

The argument for its economic efficiency is made on the basis that, since 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, at least initially, in sectors that have more potential for improving their efficiency. In its Communication, the Commission 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.

Overall then – as discussed briefly in Chapter 2 (section 2.5) - it is accepted that technological progress will not allow for unfettered growth in aviation if the UK is to become a low carbon society. Consequently, the majority of aviation's carbon reduction must come either from emissions reduction in other sectors (over and above what would otherwise be required) or from a reduction in demand.

The long term difficulties of relying on other sectors to achieve the necessary reductions have also been briefly discussed in Chapter 2 (section 2.5), given the scale of reductions needed[20]. The key weakness of emissions trading is that, in transferring the onus for carbon reduction to other sectors, it enables the air industry to grow further before applying the brake of demand restraint through increased ticket prices. It postpones demand restraint in an area where demand restraint is a highly promising, low cost means of reducing future emissions (as discussed in Chapter 3, section 3.2).

A further limitation of emissions trading is that, although it is closer in prospect than some economic instruments, such as taxation on aviation fuel, it still entails a relatively lengthy timescale, since aviation is not expected to be fully incorporated into the scheme until some time after 2008, and, in the time period before it is introduced, significant further growth in aviation is likely to occur.

In addition, the effectiveness of emissions trading is not yet clear. While its key strength is perceived to be the relative certainty conferred by the caps, its success depends on the stringency of the cap allocations, and on the effective operation of the scheme at a detailed level. Some critics have argued, for example, that an industry anticipating a cap on its emissions at a specfic date will have an incentive to postpone technological improvements until after the cap has been applied. In this sense, the success of the scheme depends on the robustness with which it is administered – an issue already raised in a report by ILEX (2005), which 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.

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. This 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, Sep 2005a).

In the next chapter, we consider some of the alternative economic instruments available to the UK Government.

[20] The Clean Development Mechanism theoretically allows for the continuing expansion of EU emissions, if they are offset by investment in cleaner technologies in the developing world, although this raises a whole set of additional policy issues.

5. OTHER ECONOMIC INSTRUMENTS TO MODERATE DEMAND FOR AIR TRAVEL

5.1 Introduction

In addition to emissions trading, a number of other economic instruments have been proposed that could be used to moderate demand for 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. Environmentalists have long argued that air travel to and from the UK has enjoyed a remarkably long tax holiday amounting to a net tax subsidy from the Treasury in the order of £9 billion a year (Sewill, 2003), and that this treatment is an economic distortion that cannot be justified.

In view of the urgency of preventing aviation from completely eroding UK progress in addressing to climate change, it is likely that a range of economic instruments will be needed to achieve any significant impact. Moreover, the speed with which measures can be implemented must be an important criterion for determining the immediate choice of action.

Below, we consider four of the options available besides emissions trading, namely taxation of aviation fuel, emissions charging, VAT on air tickets and air passenger duty. The last section of this chapter provides a summary of the main findings. In later work, we will aim to make a more comprehensive assessment, both of these options and of other economic policy measures that could be considered.

5.2 Taxation of aviation fuel

Aviation fuel used in 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 about 80% of the price paid by the public. The reason for this tax-free status 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.

Following the adoption of the European directive on energy products taxation[21], EU states can waive the exemption on fuel used for domestic flights[22] and, subject to mutual agreement, on fuel used for flights between member states. However, to avoid this handing a competitive advantage to untaxed non-EU carriers, there is a need to renegotiate bilateral agreements between EU and non-EU states as well. Another difficulty for any unilateral action taken by individual nations or even by the EU as a whole is the risk 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 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. In September 2005, close to 200 bilateral agreements had already been amended to allow, as a first step, for the possibility of taxing fuel supplied to third country aircraft operating on intra-EU routes, (CEC, Sep 2005b). As already mentioned, the European Commission's recent 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.

Nevertheless, in the face of rapidly rising aviation emissions, the time involved in these multiple renegotiations presents a formidable barrier. This has led some commentators to argue that the best way forward would be for the EU to withdraw from the Chicago Convention – discussed further in section 5.3. Another suggestion is to reach agreement with a sub-group of European countries who are favourably disposed to the idea, and who act as the destination for a significant proportion of UK flights, as discussed further in section 5.6. As a means of circumventing these difficulties, a separate option that has been explored is the introduction of emissions charges.

5.3 Emissions charging

One way to fulfil the 'polluter pays' principle, whilst also applying demand restraint, would be to reflect the external costs of aviation in a charge that is based on en-route emissions rather than on fuel. Such a charge would be implemented at EU level and would be levied on all flights connecting to EU airports.

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[21] 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 for the taxation of kerosene used on domestic flights, the domestic portion of international flights, or the flights between 2 Member States, if their bilateral air service agreements are modified and adopted accordingly.

[22] So far, the Netherlands has used the new directive to remove the exemption, and tax kerosene for its domestic flights.

A feasibility study carried out in 2002 examined the potential for introducing an environmental charge, which would be incurred by aircraft in proportion to the volume of greenhouse gas emissions discharged in EU airspace, (Wit and Dings 2002). 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.

The emissions charging study, (Wit and Dings 2002), looked at 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 charge on NOx.

The study found that the resulting reduction in forecast CO_2 ranged from almost 2% (2.9 $MtCO_2$) at the lowest charge level to 13% (19.9 $MtCO_2$) at the highest charge level considered, with the impact on NOx for the same scenarios between –2% and –15%.

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.

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 as a result of some synergies[23] between reduction of the two gases.[24]

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.

To put this into context, since the aviation sector *within* Europe has a predicted growth of 4% per year, the reduced growth in demand due to the introduction of a charge of 50 euros a tonne CO_2 would be equivalent to one year of normal demand growth over eight years, 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. However, as discussed below, this conclusion is clearly critically dependent on the magnitude of the charge levied.

In its discussion of the results from this study, the EU Commission (CEC Sep 2005a + b) concludes:

[23] The analysis takes into account that there is 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 are thought likely to imply synergies.

[24] Estimates quoted here come from figures given in CEC (Sep 2005b), which corrected the original results from CE Delft, to take into account the improved quality of available data on aviation emissions.

- 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 the 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 that 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 lower 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 large share of the overall cost.

It is worth noting that all of the five conclusions listed here also hold true for emissions trading, though the predicted effect on tourism would be smaller because it is demand-related and emissions trading is expected to have less effect on demand than emissions charges.

In summary, it would appear that the main drawback of the emissions charge, from the scenarios investigated, is that it will not have as much effect on demand as would be desirable. Nevertheless, it offers a mechanism for affecting demand and one which would presumably be more effective 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.[25]

As discussed earlier, emissions charging would be expected to have a proportionally greater impact on aviation demand than emissions trading, since, in the emissions trading scheme, this effect is expected to be diluted by the purchase of carbon savings from other sectors.

[25] Evidence from the Sustainable Development Commission quoted by the House of Commons Environmental Audit Committee (2003).

One 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. However, 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 was politically feasible. They 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.

It may be that the issue of legal certainty can only be resolved through legal challenge. In 2004, the ICAO 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, EU 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.

5.4 Imposing VAT on air tickets

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.[26]

It has been argued that charging VAT on air tickets offers a relatively quick and easy mechanism that would go some way towards implementing the polluter pays principle for air travel. Moreover, since air travel can hardly be seen as a necessity, charging VAT on tickets is consistent in policy terms.

Sewill (2005) points out that, unlike a tax on fuel, applying VAT to air tickets would not involve renegotiation of international treaties. Nor would it be subject to evasion through the 'tankering' of fuel from one country to another. As a result, there is not a problem in instigating change at a UK level, and there may be scope for encouraging wider adoption of the policy, through EU co-operation.

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 Sep 2005b.

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[26] This legislation has no direct effect in any country but members 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.

By contrast, EU states do not, at present, charge VAT on international air passenger transport or, with the exception of Slovakia, on non-domestic flights within the EU.

However, under the 6th Directive, the exemption of VAT from international air passenger transport is an optional one: member states can, if they wish, renounce it (though having done so they would not be free to reverse the decision).[27] 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 UK airspace.[28]

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).

Sewill (2005) argues that, to impose VAT on tickets on all flights from the UK to the EU, and all domestic flights, would be relatively administratively simple, with airlines given the legal responsibility to pay the tax, and that the work involved in this would be *"no more complicated than that undertaken each week by any shopkeeper."*

One argument raised against the use of VAT to achieve the polluter pays principle is that it does not include any mechanism to directly encourage the aviation industry to reduce emissions through technological improvement or greater efficiency. However, as has already been discussed, it is widely held that the scope for the reduction of flight emissions by this means is relatively poor, so that demand restraint offers the most promising strategy for cutting the climate change impact of aviation. 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. Moreover many of the existing exemptions to VAT are clearly 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. There is also a good rationale for removing VAT exemption on tickets on the basis that air travel is 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!)

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[27] CEC (Sep 2005b) 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.

[28] 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.

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

The addition of VAT to domestic air tickets is a much more straightforward proposition. It could be quickly implemented and would bring the UK into line with other EU countries. Although using VAT to reduce demand for domestic flights goes a small way towards tackling the wider problem in terms of UK emissions, it can be regarded as a critically important step in terms of discouraging the growth of an air dependent culture, in which, as discussed in Chapter 3 (section 3.2), stepping on to an aeroplane to visit friends and family in other parts of the country becomes a commonly held expectation.

5.5 Air Passenger Duty

There is, within the existing tax regime, the scope to tax international aviation through Air Passenger Duty (APD). Introduced in 1994, APD is the duty levied by the government on flights leaving any UK airport. The rate of APD is £5 - £40 depending on the class of travel and the destination. The rate has been unchanged since April 2001.

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. It is sometimes objected by the airlines that Air Passenger Duty is a ‘blunt instrument’ in that it provides no incentive to reduce emissions. There are two arguments against this.

First, while it is true that an emissions charge is a more sophisticated instrument for reflecting the impact of flying on climate charge, the barriers to applying such a charge are substantial enough to prevent early progress in this area. APD, by contrast, is the most readily available instrument to hand, and does not require the renegotiation of treaties at either EU or international level. Nor is it subject to evasion through ‘tankering’.

As argued in Chapter 2, the fact that aviation growth is currently on course to offset CO_2 emission reductions from other sectors, together with the fact that there is a relatively poor prognosis for major improvements in efficiency, both suggest that demand reduction offers the most promising way forward. As an instrument for demand reduction, APD is entirely appropriate. Moreover, the rates of APD already discriminate between EU and non-EU destinations, and could be fine tuned to reflect the distance flown more closely. In addition, Sewill (2005) argues that APD should be extended to international transfer passengers and freight.

Criticism of the low rate of APD has also come from the House of Commons Environmental Audit Committee (2003), which argues, instead, for the tax to be replaced with an emissions charge levied on flights and clearly displayed in travel documentation, initially set at a rate to raise £1.5 billion a year[29], but subject to an annual escalator to increase revenue over time.

Potential impetus for increasing APD has come from a different direction, with plans for the UK to use Air Passenger Duty as a source of revenue to finance health development projects that will help in achieving Millennium Development Goals by 2015[30]. In September, the UK and France made a joint statement announcing implementation of an air ticket solidarity levy. However, the UK Government has made it clear that the funds will be drawn from existing APD revenue, and it does not intend to raise the level of APD. Therefore, under present proposals, the UK levy will not raise prices on air tickets or deliver additional demand restraint.

The detailed implications of the air ticket solidarity levy for Europe have been considered in a European Commission Working Paper (CEC, Sep 2005c). This looks 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.[31] It concludes that the levy will be most effective if implemented in a co-ordinated manner by EU states, (though the co-ordination envisaged is informal). Such a proposal also offers a potential basis for co-ordinated EU progress on the related issue of ecological tax reform for aviation. 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: progress in both areas is inextricably linked.

5.6 Comparing economic instruments

Of the economic instruments that we have initially examined here, it seems that, in the short term, Air Passenger Duty and VAT on domestic air tickets both offer means by which the UK Government could act now to initiate demand restraint. An increase in APD warrants particular attention because of the fact that it has already focused international interest as a means of raising revenue for international aid.

One objection to using passenger duty and VAT to address emissions rather than taxing emissions themselves is that the second option is more closely tied to climate impact, and provides a direct incentive for airlines to make their operations more efficient (including maximising passenger occupancies). These arguments needs to be critically examined, since, whilst encouraging efficiency by the airlines is desirable, reducing demand is also likely to be essential to

[29] Customs and Excise figures that the UK collected some £791m in duty from 2003-4 from 279 registered airlines, reported in CEC (Sep 2005c).

[30] This follows the proposal for an International Finance Facility, designed to frontload aid to meet Millennium Development Goals, launched in January 2003 by the Treasury and the Department for International Development.

[31] *Excise and Other Taxes Business Needs Survey 2002 (Air Passenger Duty)* Market Research Report prepared for HM Customs and Excise March 2003, reported in CEC, Sep 2005c.

achieving the requisite reductions in emissions, and both passenger duty and ticket taxes offer a relatively direct means of reducing demand, through their effect on ticket price. 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 some difficulties because of the need to allocate the tax to the UK portion of the flight. However, the fact that VAT on domestic tickets is already charged by most other EU States should make this an immediate priority for the UK. EU cooperation on air ticket solidarity levies could also potentially seed further co-operation on aviation tax reform.

Taxing aviation fuel is, in principle, an attractive option since it is closely linked to emissions, and so to environmental impact, and there is no obvious rationale for the current exemption. However the legal barriers to the taxation of international aviation fuel are formidable and preclude immediate action. In the longer term, progress can be made in co-operation with other EU states through the renegotiation of bilateral agreements, arising from the Chicago Convention. This is obviously a lengthy process, but one which deserves a high level of commitment. Other European states are also looking at the scope for taxing aviation. Sweden, for instance, plans to introduce an air ticket tax in 2006. 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’, to introduce measures such as fuel tax more widely across Europe, by all agreeing to alter bilateral service agreements (Schlegelmilch, 2005). 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.

Emissions charging offers one means of circumventing the legal difficulties related to the Chicago Convention and its bilateral agreements. But charges cannot be considered before 2007 and 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 tax aviation emissions and take this agenda forward. Ultimately however, it may prove necessary, as Sewill (2005) suggests, for the EU to withdraw from the Chicago Convention in order to make progress on either emissions charges or aviation fuel tax. There appears to be some scope for introducing a type of emissions charging as a ‘flanking instrument’ to account for non-CO_2 gases, in the context of emissions trading, and the potential for this needs to be further explored.

In general, the EU Emissions Trading Scheme (ETS) faces fewer political barriers than emissions charging. However, progress on incorporating aviation into the ETS can also be expected to be relatively slow, with the expectation that this will be achieved some time after 2008. The effectiveness of emissions trading in reducing emissions in also uncertain in so far as it depends on the stringency of the caps applied. The incorporation of aviation in the scheme is expected to stimulate reductions in non-aviation sectors first, with relatively little impact on demand. In this way, relying solely on the ETS as a means of tackling the growth in aviation emissions risks postponing a demand reduction now that will be more difficult to achieve at a later date. For this reason, it is important that ETS is not seen as an alternative to other economic instruments but is progressed alongside more direct means of applying demand restraint. At present however, there is a danger that the ETS will divert attention from urgently needed action that could be taken now. Instead, as highlighted here, the Treasury needs to look to a wider range of economic policy measures in order to address the urgency of the threat to climate change which aviation presents.

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