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An evaluation of possible EU air transport emissions trading scheme allocation methods

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The European Commission has been requested by member states to study the incorporation of air transport into their existing Emissions Trading Scheme (ETS). Only CO_2 is to be included, at least initially.

This paper focuses on the method of allocation of emissions permits in the EU context. It has been assumed here that the EU ETS will be applied only to intra-EU flights and that airlines will be the entities selected for implementation. Three UK airlines were selected to evaluate three main types of allocation: grandfathering, auctioning and benchmarking. The airlines were representative of the three major airline business models: network, LCC and charter/leisure. Based on 2003/04 aircraft/engine type and operating data, the per passenger impact of each allocation option was analysed for each airline. A new benchmarking approach is proposed that takes into account both the landing and take-off cycle (LTO) and per kilometre emissions: this avoids penalising shorter sector operators and focuses on the damage caused by aircraft and their engines and not on passengers.

Keywords: aviation emissions trading; aircraft emissions allocation; airline environmental economics

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1 Introduction

There has been a growing interest in the environmental impact of aviation, both in terms of noise and aircraft engine emissions. Discussions have included both mitigation measures and methods of internalisation of these environmental costs (or the principle of polluter pays).

This paper focuses on engine emissions, which have both local and climate change implications, and where the emphasis of most recent discussions has centred. This has taken place at an international, regional and local level: The standing Committee on Aviation Environmental Protection (CAEP) of the International Civil Aviation Organisation (ICAO) has been asked to investigate proposals for emissions trading, in addition to ICAO's role in setting international standards for engine emissions.

At the regional level, the European Commission is studying the possibility of incorporating emissions trading into their existing Emissions Trading System (ETS) from 2012 (European Commission, 1999, and subsequent press releases). They are also likely to introduce a directive that sets limits of local air quality that would also affect local emission levels around airports. Thus in Europe, aviation is likely before too long to be required to control or pay for both its local and climate change impacts of aircraft engine emissions. Up to now this has only been subject to longer term changes through increasingly stringent ICAO standards applied to new aircraft engines, and airport emissions charges at a few EU airports.

The pollutants considered as the main ones emitted from aircraft movements (Woodmansey and Patterson, 1994) are CO_2, PM, SO_2, NO_x and HC. The first, CO_2, has lower unit social cost than the others, but the total amount emitted is far larger (especially for the cruise part of the flight). Social costs are defined as the damage to human health, vegetation, buildings and climate change. Their valuation is discussed in Mayeres et al (1996) and Perl et al (1997). The other pollutants account for a lower weight of emissions but have higher unit social costs. CO_2 is estimated to have the longest life (50 to 100 years) followed by methane (8-10 years), with NOx lasting only a number of days or weeks. However, the global warming impact from aviation is compounded by the emissions of NO_x and water vapour in the upper atmosphere, the latter sometimes leading contrails and cirrus cloud formation (these effects are summarised in Annex 2 of European Commission, 2005). This is difficult to deal with through an ETS and it is intended to address it through other measures, one of which (standards) is discussed below.

Europe is the region of the world with the greatest pressure to reduce emissions, and it is also the region where almost all of the countries have ratified the Kyoto Convention. The EU has also pushed for the inclusion of environmental impacts in the EU/US aviation bilateral agreement. Growing concern is also evident in other world regions, reflected in the work programme of ICAO referred to above.

The first section of this paper will discuss Kyoto and the context for emissions trading, and the efforts at an international and regional level to reduce aircraft engine emissions. This will be followed by a look at the various voluntary measures (targets) initiated by the industry. The fact that such progress is too slow (see ECAC, 2005) leads to the need for imposing incentives, which can be addressed emphasising emissions trading.

2 Means of engine emissions reduction

2.1 Regulatory standards

Regulatory initiatives have been taken in order to limit both local health impacts of emissions and climate change gases. The first covers a number of gases and is more relevant to airports, with air transport treated in the same way as other industries. The second is focused on CO_2 and NO_x, and the cruise mode of operations, with air transport generally thought to have a greater impact on climate change than suggested by its output of these gases.

It is more appropriate to introduce local measures to reduce LTO emissions; however, the greenhouse gas element of these are also relevant to the climate change gas stabilisation that is incorporated in the United Nations Framework Convention on Climate Change (UNFCCC) and subsequent Kyoto Protocol. Article 2.2 requires the parties to work towards the limitation in emissions through ICAO, without laying down any timescale (IATA, 2001).

Up to this point, ICAO's involvement in this field had been the encouragement of improved emissions of new aircraft engines. Aircraft are required to meet the engine certification standards adopted by the Council of ICAO. These are contained in *Annex 16 - Environmental Protection, Volume II - Aircraft Engine Emissions* to the

Convention on International Civil Aviation. These were originally designed to respond to concerns regarding air quality in the vicinity of airports. As a consequence, they establish limits for emissions of oxides of nitrogen (NO_x), carbon monoxide, unburned hydrocarbons, for a reference landing and take-off (LTO) cycle below 915 metres of altitude (3 000 ft). There are also provisions regarding smoke and vented fuel.

2.2 Trends and targets

Airlines and their associations have set themselves targets for increased fuel efficiency, which provide proxies for CO_2 efficiency gains. The International Air Transport Association (IATA) adopted a goal of achieving a 26% improvement overall between 1990 and 2012 in litres per 100 Revenue tonne-kms or RTKs (IATA, 2005). This was not especially onerous, since airlines such as British Airways had already achieved a 20% improvement by 2000.

British Airways has a target of a 30% improvement in fuel efficiency between 1990 and 2010 (British Airways, 2004). The metric they use is RTKs per gallon, and they are close to achieving this goal with their 2005 level 27% below the 1990 level (British Airways, 2006).

The first aviation and environment summit convened by the major international air transport airline and airport trade associations highlighted the 70% improvement in fuel efficiency over the past 40 years (ATAG et al, 2005). This study compared today's modern aircraft with fuel consumption of 3.5 litres per 100 passenger-km with similar consumption for a modern compact car. They concluded with a shorter term target of 4 litres per 100 passenger-km in 2008, versus an average of 4.5 in 2002. This is an average annual reduction of 1.9%, significantly higher than recent trends, and achievable through the implementation of improved operational practices.

In the longer term, fuel efficiency (and thus CO_2 efficiency) improvements have been possible of little more than 1% a year, and this is expected to slow in the future (see Table 9-2 in IPCC, 1999). With traffic forecast to grow by 4-5% a year, emissions are clearly set to increase significantly unless further measures can be introduced. Emissions trading provides the means to do this most economically, without resorting to physical controls.

There is a range of existing technologies now available to reduce fuel burn considerably faster than the more recent trend. Green (2005) describe the technologies available for reducing fuel burn and NOx, as well as contrails. For fuel burn, they range from the operational improvements identified in ICAO of 8% to the laminar flying wing with open rotor propulsion that would produce an almost 70% reduction in fuel burn per tonne-km.

Over the past 20-30 years there has been some economic incentive to apply new technologies from intermittent spikes in jet kerosene prices. Airlines may be entering a period of high fuel prices of longer duration, which would by itself give an incentive to technical innovation. This would have a beneficial impact on fuel burn and CO_2, but possibly adverse affect on NOx.

ACARE introduced a target of a 50% reduction in CO_2 emission per tonne-km for an aircraft entering production in 2020 relative to its year 2000 equivalent (Green, 2003). For NOx a target of 80% was specified over the same period (ACARE, 2002).

3 Emissions trading and air transport

Emissions trading schemes are becoming more widespread with the EU ETS started in 2005 and a similar scheme (RGGI) for seven states in the northeast of the US, capping CO_2 emissions at their 1990 level. Voluntary schemes have been launched domestically in the UK (British Airways participate) and Japan.

Introducing an aircraft engine emissions trading scheme has been studied and discussed since the 1990s, both at the world and regional level. Considerable analysis has been applied to an international scheme by ICAO's CAEP mentioned above. The reluctance of the US to be involved and other problems has meant that actually introducing such a scheme is unlikely for the foreseeable future, at least at a world level.

In Europe, the focus switched from a preference for emissions charges and taxes (European Commission, 1999) to emissions trading as the best way forward. A European scheme is now very likely to become reality for air transport in 2011/2012. The European Commission published a study on economic incentives to mitigate greenhouse gas emissions from air transport in 2002 (CE Delft, 2002). Their analysis was limited to two policy options: an environmental charge and a Performance Standard

Incentive (PSI). The latter was based on emissions per unit of output, but did not address the allocation of permits or trading.

The most effective way of meeting the policy objectives are:

- Emissions trading
- Emissions charges

Both the above are economic instruments that would lead to the internalisation of the cost of climate change. Each could, in principle, be designed to achieve the same level of emissions reduction. (European Commission, 2005).

4 The EU ETS scheme

Given the problems in introducing an emissions tax on a regional basis, the EU member countries are generally keen to see aviation brought into the EU ETS which so far has been introduced for a number of other industries. ICAO has been considering aviation emissions trading schemes, and encourages such regional initiatives, given the impossibility of introducing it worldwide at the present time.

A study by CE Delft (2005) for the European Commission examined concepts for amending Directive 2003/87/EC to address the full climate change impact of aviation through emissions trading. This required the consultants to propose options in terms of the scope of an EU scheme, the allocation and surrendering of allowances, and data requirements. They also looked at the impact of these options, including any possible distortions to competition.

The study concluded that aircraft operators would be the best entity upon which to base the system, with allocation at the EU, rather than individual member state level. It also came out in favour of including only CO_2, at least initially. It looked at the possibility of restricting the scope to intra-EU flights, as well as including all flights to/from EU airports.

As to the allowance allocation method, the study reported that 'auctioning appears to be the most attractive option for allocation'. Their second-best option was benchmarking, and the least attractive was grandfathering, although this could be combined with the other methods..

The study evaluated the impact of the various options on short-haul, medium haul and long-haul flights, but did not measure the impact on the different airline business models. This paper attempts to do this, building on some of the assumptions considered in the Delft study.

This paper also seeks to re-assess some of the Delft study's statements on distortion. They stated in their executive summary that '...any carrier operating between eg Paris and Copenhagen will be subject to exactly the same competitive conditions'. This is true for origin-destination passengers, but one carrier (e.g. Air France) may feed a high proportion of the passengers on this sector to long-haul flights, while another (e.g. easyJet) might have no long-haul feed.

Furthermore, Air France (in the above example) will have to find or purchase allowance for its Copenhagen-Paris-Houston traffic, while Continental could fly the same passenger non-stop via Newark with no environmental accountability.

Frontier Economics (2006) is the only detailed airline response so far to the European Commission's study. It agreed with the possibility of airlines having allowance submission responsibility, but also proposed that airports are considered as an alternative, without going into detail. As with slots, airports may not be best placed to encourage the most efficient system. They supported the use of fuel burn as the unit of charge, but came out strongly for a wider scope than just intra-EU flights.

In fact, they estimate that intra-EU coverage would capture just 42 million tonnes of CO_2, compared to a total of 213 million for all flights departing and arriving at EU airports. CE Delft (2005) reported the somewhat different 52 million tonnes intra-EU compared to 162 million tonnes in total based on 2004 Eurocontrol data.

5 Analysis of three airline business models

The three business models selected for analysis are a network carrier, charter or leisure airline and a Low Cost Carrier (LCC). These were all from one country, UK, both to reduce possible distortions and because of greater data availability. The airlines are:

- British Airways (Network carrier)
- easyJet (Low Cost Carrier)
- Britannia/Thomsonfly (Charter/leisure airline)

These three provide some variation in operational characteristics such as average sector length, passenger load factor and the share of RTKs on intra-EU routes.

5.1 Operational characteristics

Table 1 below gives the main traffic and operating data for the three UK airlines selected for the analysis. The key difference between the models are evident: the higher load factors for the LCC and charter models, and their higher density seating. The charter airline uses larger aircraft, some of which are employed outside Europe. Whereas almost all easyJet's RTKs were within the European Economic Area (EEA), Britannia/Thomsonfly operates longer haul charters to the Caribbean, Mexico, Egypt and Asia. British Airways carries the major part of its RTKs on routes to/fom non-EEA countries (although its also carried some traffic on its short-haul subsidiaries, not included in this analysis).

Insert Table 1 here

Any ETS scheme focused entirely on intra-EEA or EU flights/traffic would clearly impose a relatively larger burden on easyJet. It could also hasten the trend by charter airlines to move into longer haul leisure flights, and increase the medium haul focus for all airlines to North Africa and non-EU Eastern Europe.

5.2 Fleets and fuel burn

British Airways' short/medium haul fleet consists of a mixture of A319/320 and B737 aircraft. The latter comprise three different variants, but two engine types. easyJet operate the B737-700 and B737-300 types, and are replacing the latter with A319s of the same capacity. Britannia/Thomsonfly mainly used its B757-200s on European sectors, with some B767s at peak times. However, with the birth of Thomsonfly, B737-500s and A320s have been introduced into the fleet.

Insert Figure 1 here

British Airways is a little below the industry average fuel efficiency in both passenger and seat terms. easyJet perform much better, due both to more seats per aircraft and a higher average passenger load factor (Figure 1). Britannia/Thomsonfly also has high seat density, and even higher load factors, in addition to operating larger aircraft types.

6 Methodology for the analysis of three allocation methods

6.1 Introduction

The method of allocation of ETS allowances is crucial in terms of the scheme's impact on various players. It is assumed here that the relevant entity has been selected to be the airline. There are three main methods:

- Grandfathering allowances
- Auctioning allowances

- Benchmarking

A combination of the first and last has also been proposed (Sentance & Pulles, 2005), and also the first and second (Hewett and Foley, 2000, and Butzengeiger et al, 2001).

6.2 Grandfathering

Grandfathering involves allocating free allowances based on past emissions. Each year, once these were used up airlines would be required to purchase allowance from other airlines or other trading entities. It is intended that the other entities would be those already in the EU ETS, and including these is crucial in obtaining the benefits of limiting CO_2 at least cost. The allocation could be by negotiation or by applying a formula, with the latter preferred because of lower transaction costs (Butzengeiger et al, 2001).

Grandfathering tends to reinforce the status quo, and reward the more polluting airlines with pollution allowance that they do not have to pay for. Any further expansion could only be obtained by more environmentally efficient aircraft, or the purchase of the necessary allocation from others at the market price.

A key question is setting the baseline for past emissions and thus allocation. The existing ETS scheme used an average of the past three years. A five year average is also possible, but that includes the sharp post-9/11 downturn. An average of three or five years historical data would put the LCCs at a serious disadvantage, since they have grown by more than 30% a year since then. New entrants would have to purchase all their allowances.

According to Wang (2005), The UK allocation plan for the EU ETS used an average of emissions for 1998 to 2003 for the baseline. This was considered unacceptable by this study's case study airline, Britannia, because of the inclusion of the heavily 9/11 distorted years 2001 and 2002. For the UK Emissions Trading Scheme (that started earlier) 1998-2000 was chosen as the baseline. British Airways reported exceeding their commitment to reducing emissions by 19% compared to this baseline (Sentance and Kershaw, 2005).

6.3 Auctioning

Auctioning allowances would be undertaken by the administering authority. In the EU context this could be the European Commission. Airlines would need to bid for the CO_2 emissions that they would expect to need for the coming year or season. This is a fair method, especially between incumbents and new entrants, and faster and slower growing airlines. Auctioning can be combined with grandfathering. The major question with auctioning is how to apply the proceeds from the auctions. The money raised should be spent on CO_2 reducing projects, but could also be used as general tax revenue, or returned to airlines in proportion to traffic or through aviation related projects.

6.4 Benchmarking

Benchmarking has the advantage of rewarding airlines that have already introduced efficient aircraft, and those that achieve higher efficiency than their competitors. It is thus favoured by airlines that have high passenger load factors, eg LCCs (Frontier Economics, 2006).

Benchmarking involves the determination of a baseline efficiency measure, say RTKs per tonne CO_2, fixing an overall CO_2 cap, and allocating CO_2 allowances depending on an airline's share of RTKs. This is the most likely EU aviation ETS approach:

$$RTK_{total} = \sum_{i=1}^{n} RTK_i \qquad (1)$$

$$E_{total} = \sum_{i=1}^{n} E_i \qquad (2)$$

$$A_i = \frac{(E_{total})}{RTK_{total}} * RTK_i \qquad (3)$$

n = number of airlines taking part

RTK_{total} = Total RTKs in the base period for those taking part

RTK_i = Total RTKs assigned to airline i in the base period

E_{total} = Emissions assigned to all airlines in the base period

E_i = Emissions assigned to airline i in the base period

A_i = Emission allowances assigned to each airline

First, this method puts a smaller burden on those airlines operating with high load factors and over longer sectors. Second, those airlines flying shorter sectors would tend to be penalised, although Sentance and Pulles (2005) argue that this would encourage passengers to take less polluting forms of transport such as rail.

The above criticisms are addressed by using aircraft kms and flights as the efficiency measures, and not RPKs. This gets closer to penalising higher emitters, removing any reference to passenger loads as being irrelevant.

$$E_{km} = \sum_{i=1}^{n} \sum_{j=1}^{p} E_{ij(km)} \tag{4}$$

$$E_{flights} = \sum_{i=1}^{n} \sum_{j=1}^{p} E_{ij(flights)} \tag{5}$$

$$A_{i(flights)} = \frac{(E_{flights})}{F_{total}} * F_i \tag{6}$$

$$A_{i(km)} = \frac{(E_{km})}{D_{total}} * D_i \tag{7}$$

$$A_i = A_{i(km)} + A_{i(flights)} \tag{8}$$

n = number of airlines taking part

p = number of aircraft/engine combinations

$E_{i(km)}$ = Emissions assigned to airline i in the base period based on kilometres and aircraft type (j) flown

$E_{i(flight)}$ = Emissions assigned to airline i in the base period based on number of flights (LTO) and aircraft type (j) flown

E_{km} = Emissions assigned to all airlines in the base period based on kilometres and aircraft types flown

E_{flight} = Emissions assigned to all airlines in the base period based on flights and aircraft types flown

$A_{i(km)}$ = Emission allowances assigned to each airline based on aircraft km performed

$A_{i(flight)}$ = Emission allowances assigned to each airline based on number of flights (LTOs)

A_i = Total emission allowances assigned to each airline

Fi = Total flights performed by airline i for all EEU fleet

Di = Total departures (LTOs) by airline i for all EEA fleet

The impact of each of the above benchmarking approaches will be analysed in the next section.

7 Results

7.1 Grandfathering

The impact of 100% grandfathering was evaluated for the three types of UK airline (described in Section 5). British Airways has been growing slowly in RTK terms over the past three years (+4% pa) and also over the past five years (+3% pa). There would thus not be a large difference between a three or five year average. They would also not have to purchase too much extra allowance over the next few years, given their paucity of firm aircraft orders and deliveries.

A previous study (Wright, 2004) applied the UK National Allocation Plan approach to three EU network carriers, British Airways, KLM and SAS, taking their latest actual year of 2002. They found that, using the average of the four highest years between 1998 and 2002, British Airways' allocation would be 12% above their 2002 actual emissions, KLM's 3% above, and SAS's 17% below. However, their intra-EU emissions were estimated using revenue shares. This is likely to have significantly exaggerated the EU share of emissions for these airlines.

Britannia is owned by the pan-European tour group, TUI, and has recently set up its own LCC, Thomsonfly. Some of its aircraft have been transferred to this subsidiary, such that its overall growth has also not been large.

The third airline, easyJet, grew by around 30% last year, but this growth is now slowing to 15%. However, even at this rate they would still need to purchase significant quantity of allowance, and the average period is also of vital interest to such an airline.

Table 2 below shows an allocation based on the average of 2003 and 2004 CO_2 emissions, in order not to penalise fast growing LCCs. The 2005 estimates were based on 4% increase in total fuel burn for British Airways, 30% for easyJet and 10% for Britannia/Thomsonfly (based on its faster growing LCC arm). For 2006, the projected changes were 4%, 15% and 10% respectively. These growth rates did not explicitly take into account fleet changes and the likely improvement in fuel efficiency (eg easyJet) or deterioration (eg a greater share of operations for Thomsonfly with smaller aircraft).

Insert Table 2 here

The analysis shows that the LCC would need to purchase the most extra allowance in the market, and at US$40 per tonne CO_2 this would impose an extra charge for 2006 of $2.17 per passenger (or a reduction in profitability of $62 m). The initial premium on the average fare would only be around 3% for easyJet and much lower for the other two airlines. At $100 per tonne the LCC cost would rise to $7.33.

7.2 Auctioning

The analysis in Table 3 is based on the traffic growth rates and fuel burn shown in Table 2. This option assumes that all the required CO_2 emissions will need to be purchased in the open market at $40 per tonne. This is somewhat higher than the market levels that were reached from the existing EU scheme. In support, pressure from higher prices is likely to come from a tightening of the existing scheme, and the fact that aviation, as a net purchase of allowances, would be able to trade with participants from other industries. A closed airline trading system was not considered.

Insert Table 3 here

The above estimate works out as a $5.87 per passenger premium for easyJet, or 9% of the average fare, assuming all of the cost is passed on to the passenger. At $100 per tonne the extra cost would rise to $14.68 per passenger. The total cost would be too large to absorb in profits. On the other hand, British Airways' average European fare was around US$260 in 2004/05, such that the extra $4.18 would only amount to about 1.6%. It could also be covered by network revenues.

7.3 Benchmarking

The benchmarking formulae in 6.3 (Equation 3) above have been applied to the three airlines, assuming that the scheme is restricted to UK airlines and EEA operations. It has also been restricted to passengers, with air cargo excluded. This type of traffic is much less significant on intra-EEA routes than long-haul operations. The total emissions that would need to be purchased in the market would be the actual emissions by all airlines for that year less E_{total}.

The example in Table 4 below assumes that the target or baseline is set at total UK EEA passenger kms in 2003. Other targets would also be possible, but a more recent year penalises LCCs less, and could always be tightened later.

Insert Table 4 here

The cost of the excess allowance needed in 2005 and 2006 is again based on a market price of $40 per tonne, and the growth rates previously adopted. Britannia/Thomsonfly is in credit on this allocation basis, because of its high efficiency relative to the benchmark. This is through a combination of higher loads per flight and longer sectors. The LCC is still penalised most, but, at least initially, not far off the burden on the network carrier.

In order to address the problems associated with the first benchmarking approach (discussed above), the more complex Equation 8 was applied to the three airlines, also using the base year data. These results are shown in Table 5.

Insert Table 5 here

It can be seen that Britannia/Thomsonfly no longer performs as well against the new benchmarks and thus receives insufficient allowance, resulting in a need in 2006 to spend $17 million on purchasing extra in the market. This would not be an excessive amount relative to its average fare or profitability. British Airways is not penalised for flying smaller aircraft and more premium passengers and thus is allocated more allowance than it is expected to need. However, it is the flights and LTOs that cause the emissions and not the passengers, and it would seem unfair to allocate less to an airline that carried a greater percentage of premium passengers (as in the first benchmarking method). Long-haul economy class passengers on intra-EU feeder sectors may also have paid a high total fare and could easily absorb such increases.

8 Summary and conclusions

A number of previous studies have examined the possible impact of various ways of implementing a European ETS. These have highlighted possible distortions, without investigation the impact on specific airlines (apart from the limited Wright, 2004, analysis) or business models. This paper attempts to do this for three UK airlines: the network carrier, British Airways, a major European LCC, easyJet, and one of the largest charter/leisure airlines, Britannia/Thomsonfly (itself part of a pan-EU group). It is argued that this gives a good indication of the *relative* impact on the business models, although a broader sample would be needed to be able to form any robust conclusions on the specific impacts.

The above analysis assumes that an EU ETS for aviation would be only applied to intra-EU flights. This raises significant distortions by itself, but appears at present the most likely approach. The focus has been on the three major types of allocation system: grandfathering/baseline, auctioning and benchmarking.

The analysis has been based on recent data for each of the airlines (2003 and 2004). To examine the impact over 2005 and 2006, traffic growth rates have assumed to be 4% for British Airways for each year, 30% and 15% for easyJet and 10% for Britannia/Thomsonfly for both years. Cargo has been excluded on the basis of the minimum distortion it might cause for shorter haul routes.

The summary in Figure 2 shows that, as expected, the impact is greater on the LCC in all cases, although not by too much. This would be worse if the baseline had been based on less recent emissions. Thus the cap is lenient, the main purpose being to give an incentive to airlines (or other industries) to reduce pollution in the future. The position of Britannia depends to a large extent on how far its LCC (Thomsonfly) grows relative to its tour operator/leisure flights.

Insert Figure 2 here

The baseline or grandfathering approach tends to penalise the faster growing LCC and favour the network carrier. The latter carries both long- and short-haul passengers on its intra-EU feeder services, and the cost could easily be absorbed in the total long-haul ticket price. It would, however, put the EU network carrier at a small disadvantage relative to foreign hub carriers in the same markets.

Auctioning (favoured by the CE Delft, 2005, study) is the most costly option for airlines, and needs further evaluation in terms of how the proceeds are used, and hybrid schemes. Benchmarking is the second choice of the CE Delft (2005) study and a possible approach has been discussed in ICAO's CAEP. An alternative is proposed here of splitting the benchmark into a LTO and distance flown elements. This is more complex in terms of data collection and monitoring, but avoids the sector length distortion and does not penalise low emissions smaller aircraft.

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Table 1

Selected airline traffic and operating data, Domestic & intra-EEA

	2002	*2003*	*2004*
BRITISH AIRWAYS			
Total RTKs million	1,383	1,529	1,196
Total ATKs million	2,257	2,297	2,141
Passengers (000)	16,627	17,265	17,036
Aircraft kms 000)	153,538	152,565	136,014
Flights	202,396	195,523	177,823
Pax load factor (%)	61	67	56
Average sector kms	759	780	765
EEA/Domestic % RTKs	10	11	9
Average pax per flight	82	88	96
EASYJET			
Total RTKs million	628	1,347	1,633
Total ATKs million	817	1,755	2,102
Passengers (000)	8,947	17,626	21,224
Aircraft kms 000)	61,697	132,744	158,498
Flights	75,898	150,538	176,795
Pax load factor (%)	77	77	78
Average sector kms	813	882	897
EEA/Domestic % RTKs	98	97	94
Average pax per flight	118	117	120
BRITANNIA/THOMSONFLY			
Total RTKs million	1,174	1,153	1,264
Total ATKs million	1,304	1,262	1,472
Passengers (000)	6,827	6,697	7,389
Aircraft kms 000)	57,600	57,758	69,945
Flights	28,839	28,837	35,871
Pax load factor (%)	90	91	86
Average sector kms	1,997	2,003	1,950
EEA/Domestic % RTKs	75	72	70
Average pax per flight	237	232	206

Source: UK Civil Aviation Authority

Table 2

Cost impact of Baseline/Grandfathering allocation method

	British Airways	*easyJet*	*Britannia/Thomsonfly*
CO_2 allocations (000t)	1,736	1,553	868
CO_2 emissions projection (000t):			
2005	1,850	2,388	1,000
2006	1,927	3,015	1,099
CO_2 emissions less cap (000t)			
2005	114	835	131
2006	191	1,552	231
Market price of carbon (US$/tonne)	40	40	40
Cost of excess (US$000):			
2005	2,621	33,402	5,253
2006	5,456	62,062	9,251
Excess cost / passenger (US$)			
2005	0.26	2.05	0.39
2006	0.41	2.17	0.63

Source: UK CAA, ICAO Aircraft Engine Emissions DataBank on UK CAA website and Eurocontrol BADA 3.6

Table 3

Cost impact of Auction allocation method

	British Airways	*easyJet*	*Britannia/Thomsonfly*
CO_2 emission projection (000t):			
2005	1,850	2,388	1,000
2006	1,927	3,015	1,099
Auction cost (US$000) @ $40			
2005	73,986	78,437	36,420
2006	77,064	101,968	40,062
Auction cost per passenger (US$)			
2005	4.18	5.87	3.00
2006	4.18	5.87	3.00

Source: UK CAA, ICAO Aircraft Engine Emissions DataBank on UK CAA website and Eurocontrol BADA 3.6

Table 4

Cost impact of Benchmarking method (1)

	UK Industry (operations within EEA)		
Baseline RPKs m (2003)	97,173	97,173	97,173
Baseline RPKs/US gallon	101	101	101
Baseline US gallons (m)	962	962	962
Baseline CO_2 tonnes (000)	9,269	9,269	9,269
	British Airways	*easyJet*	*Britannia/Thomsonfly*
RPKs per US gallon	76.8	117.5	147.6
RPK share in 2003 (%)	12.0	13.6	14.0
CO_2 allowance (000t)	1,114	1,261	1,295
Emissions less allowance (000t)			
2005	735	1,127	-295
2006	812	1,844	-195
Cost of excess (US$000):			
2005	29,417	45,094	-11,818
2006	32,495	73,754	-7,820
Excess cost / passenger (US$)			
2005	1.66	2.77	-0.89
2006	1.76	3.49	-0.53

Source: UK CAA, ICAO Aircraft Engine Emissions DataBank on UK CAA website and Eurocontrol BADA 3.6

Table 5

Cost impact of Benchmarking method (2)

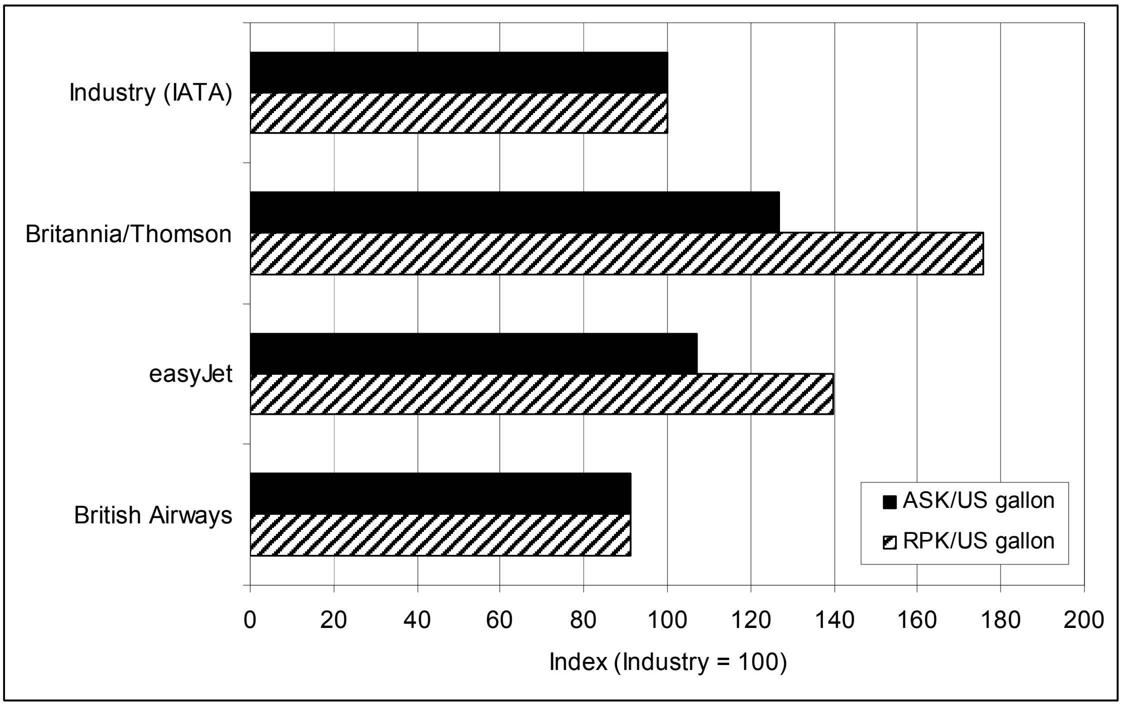
	UK Industry (operations within EEA)		
Baseline aircraft-kms m (2003)	712	712	712
Baseline US gals/1000 a/c km*	1,042	1,042	1,042
Baseline flights 000 (2003)	616	616	616
Baseline US gallons/flight *	346	346	346
Base gallons (cruise: km)	742	742	742
Base gallons (LTO: flights)	213	213	213
Total baseline US gallons (m)	955	955	955
Baseline CO_2 tonnes (000)	9,197	9,197	9,197
	British Airways	*easyJet*	*Britannia/ Thomsonfly*
Aircraft km share %	20.5	18.6	8.1
Flight share %	27.8	24.8	4.7
US gallons (m) allowance -kms	152.1	138.3	60.2
US gallons (m) allowance -flight	59.1	52.7	10.0
US gallons (m) allowance -total	211.2	191.0	160.2
Total CO_2 allowance (000t)	2,035	1,840	676
Emissions less allowance (000t)			
2005	-185	548	324
2006	-108	1,265	424
Cost of excess (US$000):			
2005	-7,417	21,924	12,957
2006	-4,339	50,584	16,955
Excess cost / passenger (US$)			
2005	-0.42	1.35	0.97
2006	-0.24	2.39	1.16

Source: UK CAA, ICAO Aircraft Engine Emissions DataBank on UK CAA website and Eurocontrol BADA 3.6

* average for all UK short/medium haul fleet weighted by aircraft type flights/km flown

Figure 1

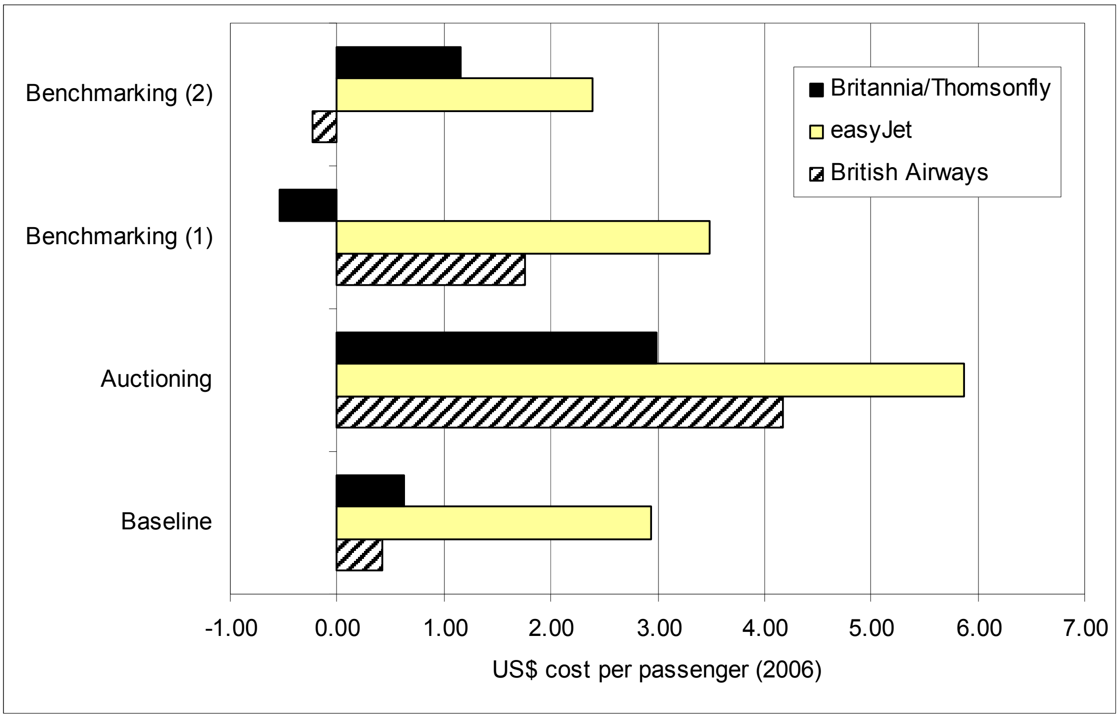
Fleet fuel efficiency for short/medium-haul fleet, 2004



Source: UK Civil Aviation Authority and IATA

Figure 2

Summary of cost impact of allocation options in 2006 (US$ per passenger)



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