Executive Summary

The European Commission has issued a proposal for the inclusion of aviation emissions of carbon dioxide (CO_2) in the European Emission Trading Scheme (EU ETS) (COM(2006)818 final). According to the proposal, airlines will have to surrender allowances for CO_2 emissions on flights within the EU (in 2011) and on all flights departing from or arriving at EU airports (from 2012 onwards). Domestic flights and international flights will be treated alike. Like other participants in the EU ETS, airlines will be given a number of free allowances.

Scope of the study

This study was commissioned by the UK Department for Transport and the Environment Agency, and was conducted by Manchester Metropolitan University and CE-Delft. The study sets out to develop a detailed understanding of the implications of different possible allocation methodologies for emissions allowances to participating airlines with regard to economic efficiency, environmental effectiveness and the distributional impacts on the airlines themselves. The study does this by assessing the impacts of different benchmarks on different illustrative airline types, relative to one another. As a result, this research is not intended to assess the impacts on specific airlines. This study has used UK data to analyse generic UK airline types, consequently some of the results may not be directly applicable to the EU as a whole.

Allocation methodologies

In principle, there are three ways to allocate allowances among aircraft operators:

1. *grandfathering*, i.e. free allocation on the basis of an airlines' historical emissions;
2. *auctioning*, i.e. no free allocation;
3. *benchmarking*, i.e. free allocation on the basis of an indicator of the output, efficiency, or fleet characteristics.

Grandfathering has the advantage that every existing airline will face the same relative shortfall but the disadvantage of this method is that it does not reward early action for decreasing emissions. In fact, airlines that have increased their efficiency may have exhausted the cheapest options to reduce emissions and may thus be disadvantaged under grandfathering.

Auctioning can be an efficient non-discriminatory way of allocating permits, is consistent with the 'polluter pays' principle, and can generate revenues for environmental expenditure.

Benchmarking can be a good way to reward early action whilst making free allocation of allowances possible at the same time. It is also the allocation method proposed by the European Commission and supported by most Member States. Therefore, it is the focus of this study.

The European Commission's Proposal

The European Commission has proposed to allocate a large proportion of emission allowances to airlines at no cost, based on a 'benchmark'. More specifically, it proposes to allocate to each airline a share of the total amount of allowances that equals the share of Revenue Tonne Kilometres of that airline within the boundaries of the system (where a Revenue Tonne Kilometre is defined as either one tonne of freight or the equivalent weight of passengers transported over one kilometre).

Modelling approach

Any free allocation of emission allowances to aircraft operators will transfer assets to aircraft operators. Since benchmarks cannot be designed in a way that is neutral to all business models of airlines, benchmarking will inevitably create winners and losers. Therefore, it is important to analyse which types of airlines can be expected to gain and lose, and what the size of these gains and losses is likely to be, so that an informed decision can be taken over the relative merits of the different benchmarking options.

For this purpose, using UK Civil Aviation Authority data on flights to and from the UK, a parameterized spreadsheet model was developed to calculate the emissions and allowances allocated under different benchmarks of ten generic aircraft operator types that represent a cross-section of airline business models. These generic airline types are:

- large network carriers,
- medium sized network carriers,
- low-cost carriers,
- non-EU network carriers,
- regional airlines and
- freight-only airlines.

In defining the airlines, care was taken to mimic typical existing airlines as closely as possible, in order to ensure that the results of this study are representative for the airlines considered. It has not been possible within the scope of this study to model every existing type of airline. Business aviation, for example, is not included from the analysis, as it is a small sector in terms of emissions and number of flights. Charter carriers are not included explicitly, although it could be argued that they are represented by one of the low-cost carriers modelled.

For the different generic airline types, emissions and allowances were calculated for nine different benchmarks. These nine benchmarks can be categorized into three groupings:

- '**Output-based benchmarks**': allocating allowances in proportion to the output generated by an airline. The most common output benchmark parameter is RTK (as defined above). This study has calculated results for this benchmark, as well as several variants in which passengers are assigned higher equivalent weights than

100 kg in order to account for seats, catering, overhead bins, and other items on board for use by the passengers.

- ‘**Input-based benchmarks**’: allocating allowances in proportion to the transport capacity offered by an airline. The most common input benchmark parameter is ATK (available tonne kilometre – the capacity to transport either one tonne of freight or ten passengers over one kilometre). Other input-based benchmark parameters considered in this study were maximum payload kilometres and maximum take-off weight kilometres.
- ‘**Fleet age benchmarks**’: allocating more allowances to airlines with a relatively young fleet. Fleet age benchmarks reward airlines with a fleet younger than average with 1% or 2.5% more allowances per fleet age year. Some parties have argued that a fleet age benchmark would be close to a technology-based benchmark: if technology would constantly improve, i.e. aircraft would get ever more fuel efficient, a younger fleet would mean a more efficient fleet. However, there seems to be very little empirical evidence for this claim.

The results

The results have been evaluated for distributional impacts (the sizes of the gains and losses), rewards for early action (be it load factor improvement, fleet efficiency improvement or technical and operational improvements), and incentives for emission abatement.

The results are presented in terms of percentage variation from the average, resulting in positive (i.e. relative over-allocation) and negative (i.e. relative under-allocation) data. Put differently, the results are represented as if the cap was set at the level of actual emissions. Note that this was done because it makes it easier to identify which airline types win and which lose, not because is was assumed that the cap would be equal to business as usual emissions. It should be noted that an over-allocation in this analysis does not mean that some airlines receive more allowances than they need and therefore have surplus ones to sell; it means that some airline types may receive more than the aviation average as a whole. As aviation emissions will most likely continue to grow, at some point all airline types are expected to face a shortfall of allowances; however, this shortfall is larger for the airlines that are relatively under-allocated whilst the airlines that are relatively over-allocated will need to buy fewer allowances from the market. The analysis showed that different benchmarks varied considerably with respect to their distributional impacts on generic airline types and rewards for early action.

The RTK benchmark with a passenger weight of 150 kg and the fleet age benchmark with an age factor of 1% had the smallest distributional impacts of the different benchmarks considered. It should be noted that the age factor 1% benchmark has the least distributional impacts because it closely resembles grandfathering; without the age factor of 1%, this benchmark would be identical to allocating based on historical emissions. Other benchmarks, such as the RTK with a passenger weight of 100 kg and the ATK benchmarks create larger gains and losses for different airline types. The largest distributional impacts of the benchmarks studied were created by the maximum payload kilometres, the maximum take-off weight kilometres and the age factor of 2.5%.

The main project results are summarised in the table below in terms of percentage deviation from the mean.

ES Table 1: Relative over-allocation and shortfall of generic airline types – static situation

Carrier type	RTK100	RTK150	MPK	MTOWK	ATK/MSCK	ATK/ASK	AF2.5%	AF1%
Large Network Carrier A	3%	1%	4%	9%	1%	-4%	-4%	-1%
Large Network Carrier B	-2%	-2%	-3%	2%	-3%	-2%	-4%	-1%
Mid-sized Network Carrier A	2%	1%	7%	3%	9%	-1%	4%	1%
Mid-sized Network Carrier B	-2%	-2%	-2%	-2%	0%	2%	4%	1%
Low-cost Carrier A	-9%	-4%	-24%	-45%	-6%	7%	11%	4%
Low-cost Carrier B	-7%	-2%	-8%	-34%	9%	25%	11%	4%
Large US based network carrier	13%	9%	21%	23%	6%	-4%	-11%	-4%
Large Far East based network carrier	1%	-1%	0%	26%	-10%	-12%	4%	1%
Regional airline	-33%	-28%	-31%	-53%	-13%	-7%	-11%	-4%
Freight Airline	-1%	-26%	-13%	-5%	-4%	33%	-23%	-9%

Note 1: Benchmark abbreviations can be found in section 3.3.2.

Note 2: For information; if grandfathering were added to this table, it would be represented as 0% for each generic airline.

In considering the impacts on the different generic airline types under the scope of the UK arriving and departing flight data, low-cost carriers were found to be more sensitive to benchmark choice than network-carriers. Network carriers were found to have either small over- or under-allocations under a RTK benchmark, which is principally the result of their long-haul flights, which tend to have high load factors (and thus generate a large amount of RTKs). Such flights are relatively fuel-efficient because of the proportion of time spent in the cruise phase of flight and the large sizes of the aircraft employed.

Freight-only airlines were under-allocated in all benchmarks with the notable exception of an available tonne kilometres benchmark and an RTK100 benchmark. This is due to their relatively inefficient fleet, the assumed load factor, and to the UK situation for which there are a relatively large number of short-haul freight flights.

Regional airlines faced a considerable shortfall under all the benchmarks considered, which partly arises from the fact that this generic airline type tends to travel only short distances. This is likely to be a particular situation for the UK, owing to the nature of its outlying island territories and is likely to be in contrast to the situation for some other EU Member States. Adding a constant to the flight distance in RTK benchmarks would significantly reduce the shortfall of the UK type regional airlines. It would also make some low-cost carriers better off, while non-EU network carriers would be negatively affected. There is some empirical evidence for adding a constant of about 100 km.

Note that in an intra-EU scheme, network carriers would not benefit from the fuel efficiency of their long-haul flights. With such a geographical scope, low-cost carriers would be relatively over-allocated while network carriers would be relatively under-allocated.

In addition to the strongly varying distributional impacts of the technology age factor benchmarks (i.e. for 1% yr^{-1} and 2.5% yr^{-1}), a detailed examination of data and the origin of such a factor could not support improvements of even the lower order rate of 1% yr^{-1}.

Output-based (RTK) benchmarks generated relative over-allocation for airlines with high load factors, especially on their long-haul flights. Input-based benchmarks (be it ATK or other) are less predictable. If they were based on actual seating capacities, they over-allocated airlines with high seating capacities; but if they were based on maximum or standardised seating capacities, they over-allocated airlines with an actual number of seats that is lower than the standard.

A number of sensitivity tests were conducted to ascertain the robustness of the results with regard to the assumptions made in the modelling: changes in the assumptions within boundaries of what might be considered as ‘likely’ resulted in maximum changes of approximately 2%, such that confidence could be placed in the modelling assumptions.

Rewarding early action

When considering these benchmarks against the criterion for rewarding early action, the analysis showed that output-based benchmarks reward load factor improvement, fleet optimisation and operational measures to reduce emissions. By contrast, input-based benchmarks slightly penalise load factor improvement but rewarded fleet optimisation and operational measures to reduce emissions. Fleet age benchmarks only reward fleet optimisation, and only insofar as aircraft efficiency correlates with age.

ES Table 2: Reward for early action

	Output based	**Input based**	**Fleet age**
Load factor improvement	+	0 (-)	0
Fleet optimisation	+	+	+ (-)
Operational measures	+	+	0

Note: '+' = *rewarded,* '*0*' = *not rewarded,* '-' = *penalised*

Conclusion

In summary, this study argues that an output-based benchmarking method is more consistent with encouraging environmental efficiency than other benchmarks. At the same time, the RTK-based metrics had relatively small distributional impacts, with the exception of those on UK-type freight-only carriers and UK-type regional carriers.