Trade and Sustainable Energy Series

The Inclusion of Aviation in the EU Emissions Trading System

An Economic and Environmental Assessment

By Jasper Faber
   Linda Brinke

ICTSD Global Platform on Climate Change, Trade and Sustainable Energy

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International Centre for Trade
and Sustainable Development

Issue Paper No. 5

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ICTSD welcomes feedback on this document. These can be forwarded to Joachim Monkelbaan, jmonkelbaan@ictsd.ch

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LIST ABBREVIATIONS AND ACRONYMS

AEUA	Aviation European Union Allowance
CBDR	Common but Differentiated Responsibilities
CDM	Clean Development Mechanism
ETS	Emissions Trading System
EU	European Union
EUA	European Union Allowance
GHG	Greenhouse Gas
ICAO	International Civil Aviation Organization
JI	Joint Implementation
MTOW	Maximum Takeoff Weight
Mton	Megaton
PSO	Public Service Obligations
RTK	Revenue Tonne Kilometre
UNFCCC	United Nations Framework Convention on Climate Change

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FOREWORD

Tackling climate change and energy security successfully will require a fundamental transformation of our economies and of the ways in which we generate and use energy. This in turn will impact significantly the transport sector, as today the transport sector is responsible for 25 percent of global CO_2 emissions from fossil fuel combustion. If international co-operation on climate change is to be effective, international regulatory frameworks will need to address transport emissions.

One example of a regulatory framework that addresses transport emissions is the European Union's Emissions Trading System (ETS), which will include aviation from 2012 onward. The EU has decided to unilaterally impose emissions trading on aircraft flying to and from EU airports due to disagreements on global measures to reduce aviation emissions. This paper discusses the economic and environmental consequences of the inclusion of aviation in the EU ETS.

The study shows that the impact on net emissions covered by the EU ETS could be large, as with growing aviation emissions, operators will have to buy allowances from other sectors in the EU ETS. This, in turn, will drive down emissions in these other sectors. There may also be changes in competitiveness and tourism. The impact on trade between Europe and developing countries is likely to be small, though this may vary between products and regions.

The incorporation of aviation into the EU ETS is, however, the first instance of imports being included into a domestic carbon pricing strategy, and should therefore be seen as part of a bigger picture. Indeed the inclusion of aviation in the EU ETS is an example of a 'response measure' to climate change that may impact the opportunities that trade has for contributing effectively to sustainable development. A clear understanding of the inter-linkages between response measures and their possible socio-economic impacts on developing countries in particular is, therefore, crucial. This paper aims to add to the information available to countries and stakeholders regarding the breadth and scope of response measures, as well as their potential implications for development.

The authors are leading experts in the field of climate policy and international transport modes. Jasper Faber is the co-ordinator of CE Delft's work on aviation and maritime transport. The focus of his work is on climate policies with respect to international transport modes. Dr Faber has led and assisted in numerous consultancy projects on the inclusion of aviation in the EU ETS, including the impact assessment for the European Commission. Linda Brinke, MSc is a researcher in the field of transport economics, also at CE Delft. She is currently working on fiscal measures for the transport sector in the Netherlands and reviewing a social cost benefit analysis for the construction of a new airport. She is also conducting research on the link between economic growth and transport volume and the cost effectiveness of environmental policies.

This paper is part of a series of issue papers published as part of ICTSD's Global Platform on Climate Change, Trade and Sustainable Energy. The Global Platform mobilizes technical and political expertise to foster strong multilateral regimes on trade and climate change that effectively promote a transition to a low-carbon economy and a sustainable energy future. We hope that you will find the paper to be both stimulating and informative, and that it proves useful for your work.

Ricardo Meléndez-Ortiz
Chief Executive, ICTSD

EXECUTIVE SUMMARY

The EU Emissions Trading System (ETS), which was launched in 2005, is one of Europe's main policy instruments for reducing its greenhouse gas emissions. The ETS currently covers all major land-based installations in the EU. From 2012 onward, emissions from aircraft flying to and from EU airports will also be included in the scheme. One of the reasons for this addition is that the international community has not been able to agree on a global measure to reduce aviation emissions.

The regulation on aviation in the EU ETS is non-discriminatory and treats all airlines (EU and non-EU) the same. This increases the system's environmental effectiveness by covering more flights; it also avoids a distortion of competition, since otherwise non-EU airline flights to and from EU Member States would become cheaper than those of EU airlines. The EU ETS does, however, allow exemptions for airlines that run few flights, including several airlines from small developing countries.

In this paper, the economic and environmental consequences of the EU ETS are evaluated on the basis of existing literature. From this, it can be concluded that the EU ETS will have a small impact on ticket prices and aviation demand. Since emissions abatement in the aviation industry is generally expensive, the impact on aviation emissions will be small as airlines would rather buy allowances from other industries than to implement expensive measures in their fleet. The impact on net emissions covered by the EU ETS, in contrast, could be large because aviation emissions are projected to grow strongly. The airlines, therefore, will have to offset an increasing share of their emissions by purchasing allowances from other sectors within the EU ETS or Kyoto project credits.

While the inclusion of aviation in the EU ETS is being implemented in a way that limits distortion of competition, some changes in competitiveness may nevertheless occur. The competitiveness of hub airports just outside the EU, along with the non-EU airlines that serve these airports (including airlines from developing countries), may increase on some routes, due to the hub effect. There might also be a switch to alternative transport modes and a diversion of tourism away from the EU. Therefore, some carbon leakage is likely to take place, meaning that the reduction of aviation emissions within the EU is partly compensated for by an increase of emissions outside of the EU ETS.

The impact on trade between Europe and developing countries is likely to be small because of the low increase in aviation costs, but impacts may vary between products and regions. For the same reason, the impact on tourism is likely to limited on average because transport costs are a small share of total tourism expenditures; however, some destinations with high cross-price elasticities of demand might experience a greater impact.

Along with these small negative impacts, there may also be some small positive impacts on developing countries. The impact of revenues from auctioning allowances depends on how Member States decide to use these revenues. However, there is a large chance that at least part of these revenues will benefit developing countries, e.g. when they are spent on adaptation in developing countries. Demand for credits from CDM projects is likely to increase, which will have a positive impact on some developing countries because of the increased foreign direct investment.

Together with this economic analysis of the inclusion of aviation in the EU ETS, ICTSD will be publishing a legal analysis on this issue.

1. INTRODUCTION

1.1 Background

The EU Emissions Trading System (EU ETS), which was launched in 2005, is one of Europe's main policy instruments for reducing its greenhouse gas emissions.

The EU ETS works off of the "cap and trade" principle. This means that there is a cap, or limit, on the total amount of carbon dioxide (CO_2) that actors in the system can emit. Emission allowances can be traded among actors; the flexibility that such trading brings ensures that emissions are cut in the most cost-effective way.

Initially, the EU ETS covered only stationary sources in Europe. However, in 2008, it was decided that the aviation sector would be included as well. Aviation accounts for approximately 4% of manmade CO_2 emissions in the EU and the sector's emissions are growing very rapidly.

Aviation will be included in the EU ETS from 2012 onward. In Directive 2008/101/EC on the inclusion of aviation in the EU ETS, all airlines (both EU based and non-EU based) are to be treated equally. This increases the system's environmental effectiveness by covering more flights. It also avoids distorting competition, since without this requirement non-EU airline flights to and from EU Member States would become cheaper than those of EU airlines.

1.2 Policy Context

The Kyoto Protocol states the following in Article 2.2:

"The Parties included in Annex I shall pursue limitation or reduction of emissions of greenhouse gases (…) from aviation (…), working through the International Civil Aviation Organization …"

Although there have been various interpretations of this article, it is clear that the burden of reducing emissions lies on Annex I countries, and that ICAO must be engaged in this process. Herein lies one of the main reasons for the current deadlock regarding aviation emissions.

The United Nations Framework Convention on Climate Change (UNFCCC) makes a clear distinction between Annex I and non Annex I countries.[1] Under the Kyoto Protocol, only Annex I countries have quantitative targets and legally-binding commitments, while other countries have no quantitative targets of any kind. This differentiation originates in the principle enshrined in the Framework Convention that countries have 'common but differentiated responsibilities (CBDR) and respective capabilities'.

By contrast, ICAO's policies are generally non-discriminatory, since they are equally applicable to all aircraft regardless of their nationality. Regional differentiation is possible, but these policies still apply to all aircraft. Individual ICAO members may set higher standards for airlines in their jurisdiction, but these rules only apply to these airlines and are not ICAO policies. Within ICAO, many non-Annex I countries have argued that it would not be in line with current global climate policies to impose mitigation measures on their aircraft and ships (CE et al., 2004; CE et al., 2006; Stochniol, 2008).

In 2008, citing a lack of progress on global measures addressing aviation's greenhouse gas emissions, the European Union agreed to include aviation in its emissions trading scheme. In order to avoid carbon leakage, the EU included all aircraft operators, regardless of their nationality. This was justified on the basis of the Chicago Convention, which governs civil aviation globally, and which recognises expressly the right of each Contracting Party to apply on a non-discriminatory basis its own

air laws and regulations to the aircraft of all States (2008/101/EC).

1.3 Outline of the Paper

Aviation provides important transport links between countries. By including aviation in the EU ETS, the costs of aviation are likely to rise, which will affect both airlines and the wider economy. This inclusion will also have environmental consequences. In this paper, both types of impacts will be discussed. Furthermore, this paper also briefly examines the impacts of this measure on developing countries.

Chapter 2 discusses the most important design elements of the inclusion of aviation in the EU ETS. Chapter 3 elaborates on the mechanism through which the emissions allowance price affects both the economy and the environment. A brief overview of the literature on impact assessment is also presented. The impacts on the competitiveness of airlines and airports, along with carbon leakage, are discussed in Chapter 4. Chapter 5 analyses the impact on developing countries' economies, particularly through trade (in goods), tourism, the use of EU ETS revenues, and CDM projects. Conclusions from this analysis will be presented in Chapter 6.

2. THE INCLUSION OF AVIATION IN THE EU ETS: DESIGN ELEMENTS

2.1 The EU Emissions Trading System

The EU Emissions Trading System was launched in 2005. The system consists of a cap on the total level of emissions allowed from the covered entities, along with permits for emitting greenhouse gases below this cap. These permits can be freely traded. Capping CO_2 emissions at a level lower than that which would take place in a business as usual scenario creates scarcity, thereby putting a price on the emissions. An emission allowance can therefore represent a value to large emitters, if the cap is sufficiently strict.

Currently, the EU ETS applies mainly to large installations in the EU. Installations need to report greenhouse gas emissions annually and surrender an equivalent amount of allowances; otherwise, they are subjected to heavy fines. A certain percentage of the allowances in the system are allocated for free, with the percentage differing per sector. In the early phases of the ETS, the absolute majority of the allowances were allocated for free. In the coming phase, the practice of allocating allowances for free will gradually diminish in favour of auctioning.

If a company reduces its emissions, it can either keep the spare allowances to cover its future needs or sell them to another company that is short on allowances. Furthermore, companies can buy credits through the Joint Implementation (JI) or Clean Development Mechanism (CDM). The former represents emissions abatements in other Annex I countries, the latter for non Annex I countries. The amount of JI or CDM credits that can be bought is limited, and is governed by Directive 2009/29/EC.

2.2 Design Elements of the Inclusion of Aviation

The inclusion of aviation in the EU ETS is regulated by Directive 2008/101/EC. The most important design elements of this inclusion are presented here.[2]

In 2012, the total quantity of aviation emission allowances that will be allocated to the aviation sector (the cap) is set at 97 percent of the average total emissions in the years 2004-2006. In subsequent years, this percentage will be gradually lowered.

The regulator will allocate a certain amount of emission allowances for free to each aircraft operator. This amount will be determined on the basis of historic output. All airlines or aircraft operators - regardless of where they are based - will be obliged to surrender allowances for intra-EU flights, as well as all flights to and from the EU. When an aircraft operator needs more emission allowances, because it has emitted more, it has two options. Depending on the airline's cost of emissions abatement, the airline can decide to either reduce its emissions, or buy an allowance from elsewhere:

- Buy from the regulator at auction;

- Buy from other airlines, installations, or intermediaries;

- Buy CDM or JI credits.

Aircraft emissions are determined on the basis of monitored fuel consumption, which is then translated into CO_2 emissions. Emission allowances have to be surrendered for the amount of CO_2 emitted during the whole flight to and from the EU. Aircraft flying through EU airspace without making a stop do not have to surrender their allowances.

While there is an equal treatment of airlines in the EU ETS, there are some exceptions to the obligations imposed by the scheme. If a non-EU country has 'equivalent' climate measures in place, then flights from this country to the EU can be excluded from the EU ETS. The EC Directive states that such equivalent measures must have an environmental impact that is

at least equivalent to that of the EU scheme and that these measures must reduce the climate impact of flights to the EU. Therefore, building a hydropower installation with a similar climate impact as the EU ETS does not appear to constitute an 'equivalent measure'. In the Directive, the linking of the EU ETS to other trading schemes that cover aviation is mentioned as an example of future co-operation between the EU and other countries that take their own 'equivalent measures'.

Allowances must be submitted for flights with fixed-wing aircraft that have a maximum takeoff weight (MTOW) of 5,700 kg or more. An exception is made for rescue flights and a proportion of flights with public service obligations (PSO), among others. PSO flights are flights "which are vital for the economic development of the region they serve" and that are economically not viable to carry out.[3]

The 'de minimis' provision ensures that commercial aircraft operators which perform less than 243 flights in four months for three four-month periods in a row (which means on average less than two flights a day) are excluded from the scheme. Furthermore, the exception holds for operators that emit less than 10,000 tonnes of CO_2 per year. Hence, airlines which are very small and/or do not operate many flights to Europe are excluded from the scheme.

From the total amount of allowances allocated to aviation, 15 percent will be auctioned; it is up to the Member States to decide how to use the auction revenues. However, the Directive states that these revenues *should* be used for climate change adaptation, mitigation, and R&D (see Section 5.3).

Furthermore, 82 percent of allowances are allocated for free, according to a harmonised EU method that involves an aviation specific benchmark. The total number of emissions allowances to be given out for free is divided by the total verified tonne-kilometre data of relevant flights, which were monitored in 2010. In this way, a benchmark value of CO_2 per tonne kilometre is obtained. Each operator receives an amount of allowances that equals the number of tonne-kilometres multiplied by the benchmark value.

A share of the allowances (three percent) is reserved for new entrants to the market and/or fast-growing airlines. The last category is defined as operators whose tonne-kilometre data increases more than 18 percent annually on average. An operator can only apply for allowances from this reserve fund if its activities are not (partly) a continuation of aviation activity that was previously performed by another operator.

The aviation industry will have a 'one way' link to the EU ETS, meaning that allowances allocated to aircraft operators will be valid within the aviation industry only. However, airlines are allowed to buy allowances from other sectors in the EU ETS, as well as credits through the Joint Implementation and Clean Development Mechanism. The reason for this 'one way' trading barrier is that aviation emissions are not covered by the Kyoto Protocol and the Commission does not want to undermine the Kyoto goals.[4]

3. ECONOMICS AND ENVIRONMENTAL EFFECTS

3.1 Introduction to the CO_2 Price Mechanism

Airlines incur two types of costs as a result of the inclusion of aviation in the EU ETS First, there is the 'carbon cost': the cost of purchasing allowances. In this paper, the term CO¬2 price is used interchangeably with allowance price, since the allowance represents a right to emit CO_2. Second, there are system costs; these include joining the EU ETS, the cost of monitoring and reporting emissions, and the verification thereof by an external verifier. The cost of trading allowances is also included in the system costs.

As portrayed in Figure 1, the impact of the CO_2 price works through different channels: efficiency improvement and demand impact. In the case of the former, the CO_2 price provides an incentive for airline operators to increase their efficiency as long as marginal abatement costs are lower than the CO_2 price plus the fuel price¬. In the aviation industry, fuel efficiency measures are already commonplace because fuel costs represent one of the major operating costs of airlines. The measures include the installation of winglets, weight reduction, fleet renewal, and the optimisation of flight paths, among others. There is still scope for emission reductions, but some of these reductions will only be profitable in the case of a high CO¬2 price and in some cases (e.g. fleet renewal) these reductions may take a long time. It should be noted that fuel efficiency improvements can be costly and therefore also influence the profit margin.

Besides influencing fuel efficiency measures, the CO_2 price also has an upward effect on ticket prices, which, in turn, has an impact on demand. The extent to which airline operators can pass costs through to customers determines the ticket price increase. The possibility for pass through depends on the price elasticity of demand for aviation, which depends on factors such as location and the existence of alternatives (i.e. competition from other airlines or modes). Price elasticity estimates range from -0.6 to -1.4.[5] This means that if the price of aviation increases by 10 percent, then the quantity demanded will decrease by 6 to 14 percent. The lower the price elasticity, the less sensitive passengers are to price changes and the more likely it is that airlines will increase prices. How strongly demand falls influences the profit margin of airlines, as well as absolute profits.

Demand in the aviation sector influences both the CO_2 emissions from aviation and the amount of CO_2 emitted by other sectors, because airlines can buy as many allowances from stationary sources as they like. As mentioned previously, the total cap on emissions in the EU ETS (aviation and non-aviation) is limited. Therefore, from an environmental point of view, it does not matter where the reductions take place. On the other hand, it does matter from a financial point of view. In this chapter we will take a closer look at some of these effects.

Figure 1. Effects of CO_2 price on profit margin and CO_2 emissions
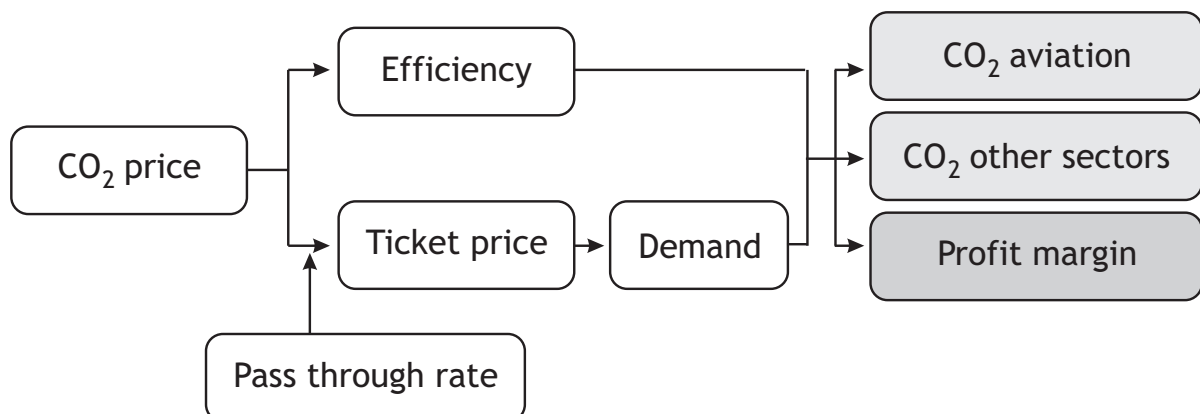
3.2 Economic Impacts

In the current trading period (2008-2012), the European Union Allowance (EUA) prices in the EU ETS have varied from €7.96 to €28.73. The daily volatility of allowance prices is similar to the volatility of oil prices (CE Delft et al., 2010). Projections for the next trading period (2013-2020) are highly uncertain, mainly because of the banking of allowances that have not been surrendered during the recession. Infras et al. (2008) project prices between €17 and €70 for 2020, but these projections were made before the current recession. The price of aviation emissions allowances (AEUA) is expected to be very close to the EUA price, because airlines are indifferent between buying an EUA or AEUA and will keep buying either one until the price evens out. However, since the AEUA is less liquid, given that it can only be used in the aviation industry, its price could lie somewhat lower than that of the EUA.

The impact on the aviation industry can be estimated through the use of different models, such as the AERO model that was specifically designed to model the impact of policy measures on aviation emissions.[6] Discussing the technicalities of such models is outside of the scope of this paper, as there are many assumptions underlying these models. These assumptions include projections on the demand for aviation (depending on economic growth, etc.), the cost of aviation, the share of allowances allocated for free, the cost of pass through rates, and price elasticities.

It is not clear how large the pass through rate in the aviation sector will be in the case of the CO_2 price, because this depends on the extent to which airlines are exposed to competition.[7] Although a large share of the allowances is allocated for free, this does not mean that cost pass through is low, which is a common misconception. It has been shown that companies have been passing on not only the actual cost of allowances, but also the opportunity costs of the allowances they have received for free.[8] The opportunity cost is the value of a free allowance when sold on the market instead of being used by an airline to cover emissions. Windfall profits occur if businesses pass through the opportunity costs of free emission allowances to customers, which has been the case in some sectors, such as electricity generation, under the EU ETS (CE Delft, 2010).

In this section, we discuss some of the studies that have modelled the impact of including aviation in the EU ETS. Table 1 summarises the impact of the EU ETS on ticket prices, output measured in revenue tonne kilometres (RTK), and the profit margin.

Table 1. The effect of the EU ETS on ticket prices, output and operating results

Study	Ticket price (€ round trip 2020)	Output in RTK	Profit margin (2011-2022)
CE Delft (2007)	+2 to 4 (SH) +3 to 8 (MH) +10 to 30 (LH)	-0.3 to -1.5% (2012)	Uncertain
York Aviation (2007)	N.A.	N.A.	-0.3 to -1.6 % (FSA)* -0.9 to -1.9 % (LFA)*
Frontier Economics (2006)	N.A.	-7.5 to -12% (LFA) -2 to -3% (FSA)	N.A.

SH=short haul, MH=medium haul, LH=long haul

FSA= full service airlines, LFA = low fares airlines

* Reference scenario includes a profit margin of 3 percent

Effect on ticket prices

CE Delft (2007) estimates the impact of the EU ETS, with an allowance price of €15 to €45, on ticket prices in 2020 based on AERO model calculations, assuming a full pass through of EUA costs and opportunity costs (see Table 1). For a short haul flight of 480 km, the ticket price increase is between €2 and €4; for a medium haul flight of 1,400 km it is between €3 and €8, and for a long haul flight of 6,400 km it is between €10 and €30.

In addition to evaluating existing studies, we have carried out a back-of-the-envelope calculation with a more recent fuel price. This analysis does not take into account possible changes in fuel efficiency, but it does have the advantage of being more transparent in its methodology. According to AEA (2009), fuel represented 25 percent of total operating expenses of airlines in Q3-2009. Every litre of jet fuel contains 2.49 kg CO_2/l (CarbonMetrics, IPCC). The average jet fuel price of the last year has been US$2.43 per gallon, which is equal to €0.47 per liter (assuming an exchange rate of 1.35 US$/€).

Combining this information with different allowance prices yields the results on ticket price shown in Table 2; these calculations assume that both the expenditures and opportunity costs of allowances are fully passed on to customers. These results show that the ticket price increase will be in the range of 1.3 to 6.5 percent.

Table 2. The impact of the carbon price on ticket prices and demand

Price of CO_2 emission allowance	€ 10	€ 30	€ 50
Fuel price/l increase (€)	0.025	0.075	0.12
Fuel price % increase	5.3%	16%	26%
Ticket price increase	1.3%	4.0%	6.5%
% change in demand	-0.5%	-2.4%	-2.6%

Source: own calculations

Effect on output

It is useful to take the analysis from Table 2 one step further towards demand/output, which is generally expressed in revenue tonne kilometres (RTK). Pearce (2008) has established that at the European Union level price elasticity of demand for air travel is -0.6. With an allowance price of €30, corresponding to a ticket price increase of 4% (see 2) this means that demand will fall by 2.4 percent.

We also know from the literature (Table 1) that the impact of the EU ETS on demand (revenue tonne kilometre, RTK) is small, around -0.3 to -1.5 percent (CE Delft, 2007). This study also illustrates that the effect on CO_2 emissions is generally slightly larger than on RTK, due to the fact airlines have an incentive to increase load factors and fuel efficiency. This incentive has an impact on CO_2 emissions, but not on RTK.

Making a distinction between full service airlines (FSA) and low fare airlines (LFA) is useful in determining ETS's effect on output because of the different business models these airlines employ (Frontier Economics, 2006). FSAs compete on price, the quality of their network, service, and comfort. LFAs compete much more on price; therefore, consumer demand is also much more responsive to price. Therefore, the output of FSAs (-2 to -3 percent) is expected to decline less than that of LFAs (-7.5 to -12 percent).

Effect on operating result

The impact of the ETS on the operating result (e.g. profit) is uncertain, as it depends on the cost pass through rate and the demand effect. Some studies indicate that the impact on operating revenues is small, assuming that cost pass through does take place.

If, however, the value of freely obtained allowances are passed through, profits may go up. Under the assumption of full opportunity cost pass through, the operating result of EU

carriers could increase from 3.1 to 5.4 percent (CE Delft, 2007). Vivid Economics (2008) estimates that if free allowances account for more than 20% - 40% of emissions, which is likely in the coming years, profit margins are likely to increase. York Aviation (2007), on the other hand, puts forward that profit margins will undoubtedly go down because windfall profits cannot occur.

3.3 Reduction of Emissions in the Aviation Sector and Other Sectors

The extent to which CO_2 emissions will be reduced in the aviation sector depends on the CO_2 price and marginal abatement costs, as well as on the pass through rate. As previously mentioned, the EUA price currently moves at around €12 (August 2011). Table 3 shows estimates of marginal abatement costs in the aviation industry in 2020, expressed in Euro per tonne of CO_2 abated. The table shows that in 2020, only 10 Mton of CO_2 can be abated for a lower price than the EUA price of €12. Furthermore, a marginal abatement cost curve would show a very steep increase in these costs. The most expensive abatement measure (early retirement of aircraft) costs €1,666/tCO_2, which is more than 100 times the current EAU price. Therefore, emissions abatement will mainly take place in other EU ETS sectors.

Table 3. Marginal abatements costs and emission reduction potential for aviation in 2020

Abatement option	Marginal abatement cost €/tCO_2 (2020)	Possible emissions abated in Mton (2020)
Improve load factor	-105.6	7.3
Cyclic engine Wash	-18.4	0.8
Reduction of contingency fuel	-5.9	1.9
New aircraft: Turboprop development	0	0.0
Polishing instead of painting	19.8	0.2
Current fleet: Lightweighting	81.1	1.8
Air Traffic Management improvement: SESAR system	109.2	21.9
Taxi-in/out: Single Engine Taxi	162.4	0.7
Refit: Winglets	203.8	1.3
Reduction of Auxiliary Power Unit use	223.7	0.9
New aircraft: Lightweighting	415.9	6.6
Biofuels (20% blend)	576.2	3.0
Refit: Engine upgrades	789.4	0.1
Refit: Engine replacement	964.3	0.5
New aircraft: Early retirement of aircraft	1656.8	12.2

Source: Köhler (2010).

Furthermore, the lower the share of costs that is being passed through, the lower the reductions, since there is a smaller fall in demand. The extent to which CO_2 emissions are reduced also depends on whether the reduction in demand results in a reduction of the number of flights. As the overall cap on both aviation and non-aviation emissions is fixed, where these reductions take place is merely a distributional issue.

Table 4 shows the impact of the EU ETS on (total) CO_2 emissions. The difference in the model results is mainly explained by the choice of the base year (2012 or 2020), as well as different assumptions on carbon prices. There are reductions in the aviation sector (13 Mton in 2020), but the reduction in emissions in other sectors is much larger (170 Mton in 2020), because emissions abatement is cheaper in other sectors than in the aviation sector.

Also, aviation emissions are projected to grow strongly, which means that airlines will have to offset an increasing share of their emissions through buying allowances from other (stati-onary) sectors in the EU ETS. Therefore, the impact of the inclusion of aviation in the EU ETS on CO_2 emissions is substantial (-183 Mton in total in 2020).

Table 4. Overview of the impact of EU ETS on CO_2 emissions

Source	CO_2 emissions aviation	CO_2 emissions bought from other EU ETS sectors	Total CO_2 reduction
CE Delft (2007)	-0.4 to -3.2% (2012)	N.A.	N.A.
CE Delft et al. (2005)	-2 to -9 Mton (2012) *	-17 to -23 Mton (2012)	-19 to -32 Mton (2012)
CE Delft et al. (2007)	-13 Mton (2020) **	-170 Mton (2020)	-183 Mton (2020)

* Reference scenario for aviation emissions is 155-180 Mton in 2012.

** Reference scenario for aviation emissions is 401 Mton in 2020.

4. EFFECTS ON COMPETITION AND CARBON LEAKAGE

4.1 Introduction

One of the common arguments in the debate on climate policy is the effect of emissions trading on competition and carbon leakage. When a country or group of countries takes unilateral action, the related costs to industry may affect the competitiveness of industries in these countries. The risk of carbon leakage stems from this effect. Carbon leakage is defined as an increase in carbon dioxide emissions in one country as a result of a strict emissions reduction policy in a second country. This leakage effect undermines the climate policy objective. In this chapter, we will discuss competition and carbon leakage in the context of the inclusion of aviation in the EU ETS.

4.2 The Effect on Competition

The non-discriminatory principle that lies beneath the inclusion of aviation in the EU ETS aims to limit competition distortion, and thus carbon leakage (EC, 2005). However, even though the measure is applied non-discriminatorily, regional schemes inevitably suffer from some changes in competitiveness.

In the discussion on the inclusion of aviation in the EU ETS, three arguments on a possible distortion of competition between EU airlines and non-EU airlines have been brought forward:

1. The competitiveness of airlines could be affected by differences in possibilities for cross-subsidisation.

2. The competitiveness of airlines could be affected by a volume effect.

3. The competitiveness of airlines could be affected by differences in the location of hubs.

This chapter analyses each of these three elements and finds that only the hub effect is likely to have an impact on the competitiveness of airlines and airports.

Cross-subsidisation

One possible channel through which competitiveness is affected is cross-subsidisation. The argument is as follows: American airlines, for example, would have to surrender emission allowances for up to 10 percent of their flights, based on the share of their total flights that land in and depart from the EU Member States. For European airlines, on the other hand, which for natural reasons perform an important share of their flights within European territory, this figure is 80 percent or higher. The cost of these emission allowances will to a large extent be passed on to customers. American airlines could then use the profits of the other 90 percent of the flights to prevent price rises on flights to and from the EU. European airlines have less opportunity to do the same.

This line of reasoning was discussed in CE Delft and MVA (2007), which concluded that there is no scope for cross-subsidisation on a city pair (the combination of a departure city and an arrival city). If non-EU carriers in general are considered to be profit maximising – and there is no reason to assume that they are not seeking to maximise profits – they would have no immediate incentive to engage in cross-subsidising their routes to/from the EU. Cross-subsidisation in this case would mean that they use part of the revenues of higher prices on other flights to lower the price on flights to/from the EU and thereby gain market share at the expense of other airlines.

There are two reasons why cross-subsidisation is not likely. First, under a profit-maximising strategy, prices are set at a level at which any price change will lead to lower profits. For

example, if the price is raised, then the loss of revenues due to a lower demand is larger than the gain in revenues due to a higher price. Therefore, the airline will not change its prices. Secondly, by transferring costs to routes completely outside the EU, they would reduce their competitiveness against that of the airlines that do not any have flights falling under the EU ETS.

Volume effect

The volume effect relates to the share of the revenue base that is subject to the EU ETS. As this differs between airlines, the competitiveness of European airlines might be affected (Ernst & Young and York Aviation, 2007). Some airlines are more exposed to the EU ETS than others, depending on their route network. As already discussed, European airlines have to surrender allowances for at least 80 percent of their flights, American airlines for 10 percent.

The first category will therefore see its output decline more than the second, due to the demand effect. Some may seem this disparity and argue that this is 'unfair' competition. However since in aviation, markets are city pairs and all flights between city pairs are treated in the same way (with the exception of the hub effect – see below), this is not a distortion of competition. After all, there is no competition between networks, but there is competition between airlines on specific routes.

Hub effect

Finally, the hub effect should be taken into consideration when discussing the competitiveness of airlines under the EU ETS. In the context of journeys between EU and non-EU cities, the impact of the EU ETS on EU carriers and (some) non-EU carriers will be different, because of the location of their hub airports (CE Delft and MVA, 2007).

For most major city-pairs there are direct flights, in many cases operated in competition between carriers based at the two cities concerned. Other carriers, however, will offer alternative routings via their own hubs, where passengers must transfer (interchange) between flights. This is usually at a lower fare than for the direct flights, to compensate for the additional time and inconvenience of the indirect journey. Consequently, passengers between major cities typically have a choice between direct flights, transferring at an EU hub, or transferring at a non-EU hub.

The importance of hub location is as follows. For passengers who transfer at EU hubs, both flights that they use will be subject to the EU ETS. In contrast, none or only one of the flights used by passengers who transfer at non-EU hubs will be subject to the

EU ETS. In terms of EU ETS costs, the different choices for a flight from Amsterdam to Los Angeles are as follows (Table 5).

Table 5. EU ETS costs for the flight Amsterdam-Los Angeles

	EU ETS costs per flight (€, CO_2 price=€ 30)
Direct flight Amsterdam-Los Angeles	28.10
Flight via London	32.63
Flight via Newark, New Jersey	17.59

Source: Author Source: CE Delft and MVA, 2007

It becomes clear from Table 5 that the flight via London is slightly more expensive than the direct flight in terms of carbon costs, due to the indirect routeing. The flight via Newark is the most attractive in terms of EU ETS costs. Obviously, other factors also play a role in the decision of passengers which flight to take. It

must be noted that transferring at a non-EU hub instead of taking a direct flight could lead to increased emissions, because a transfer flight generates more emissions than a direct flight (all other factors such as load factor being equal). Also, transferring at a non-EU hub instead of transferring at an EU hub could lead to increased

emissions if the non-EU hub involves making a detour. This means that carbon leakage is taking place (see Section 4.3).

If carriers pass on their EU ETS costs to customers, there will be an overall reduction in the total number of passengers travelling between each pair of EU and non-EU cities. In light of the previous discussion, it can be expected that transfers at EU hubs will decrease more than proportionately, and passengers on direct flights less than proportionately. It is also possible that transfers at some non-EU hubs will fall less than proportionately, or even increase, if the reduction in exposure to the EU ETS (compared to using direct flights) more than compensates for the additional time and inconvenience of using an indirect route.

Since transfers at EU hubs are overwhelmingly with EU carriers and vice versa, it follows that the hub effect is most likely to benefit non-EU carriers. Expert opinion suggests

that EU carriers are unlikely to re-locate hub activities to non-EU airports (CE Delft and MVA, 2007).

Table 6 shows the impact of the EU ETS on passenger numbers between Amsterdam and North American and Asian/Pacific cities (CE Delft and MVA, 2007). An allowance price of €30 is assumed for allowances that are bought at auction, of which the costs are fully passed on to customers. It follows that the competitiveness of EU airlines performing transfer flights to North America is harmed the most, as shown by a 10.5 percent decline in passenger numbers. In the case of transfer flights, non-EU carriers suffer more on the route to Asia/Pacific (-10.0 percent) than EU carriers

(-8.4 percent), which has to do with the specific location of their hubs. Taking all carriers together, the effect on passenger numbers is close to -5 percent.

Table 6. Impact of the EU ETS on passenger numbers to/from Amsterdam

Cities	All carriers	EU carriers		Non-EU carriers		
	Total	Total	Direct	Transfer	Total	Direct	Transfer
North America	-4.7%	-5.0%	-4.3%	-10.5%	-4.4%	-4.2%	-5.8%
Asia/Pacific	-5.1%	-5.0%	-3.8%	-8.4%	-5.2%	-3.9%	-10.0%

Source: CE Delft and MVA (2007).

Which hubs are likely to benefit from the EU ETS depends mainly on geographical factors. The most obvious candidates for improved competitiveness would be hubs just outside Europe: hubs in the Middle East and North Africa, and east coast US. In the Gulf region, for example, there are two fast growing airports: Abu Dhabi and Dubai (CE Delft, 2009). Dubai especially has witnessed rapid growth. These new hubs can only attract passengers travelling from Europe to South East Asia by having low prices or a high quality services. On the route to Australia, the hubs have a larger chance of attracting passengers, as a stopover is always necessary and passengers will be largely indifferent in which city the stopover takes place.

4.3 Carbon Leakage

Carbon leakage occurs when there is an increase in carbon dioxide emissions in one country as a result of an emissions reduction policy in another country (AEA and CE Delft, 2011). In general, the term carbon leakage is used to describe undesirable side-effects of climate policies that undermine the initial emission reduction target. More precisely, carbon leakage is defined as the change in emissions in the rest of the world as a percentage of domestic emission reductions.

Carbon leakage has economic and environmental implications. The *economic* implication is that carbon leakage may be associated with a job

and welfare losses in countries with unilateral climate policies, as a result of the distortion of competition discussed in Section 4.2.

The main *environmental* consequence is that the effectiveness of the unilateral climate policy is undermined. Carbon leakage results in an underachievement of intended emissions savings because rather than being mitigated from the global atmosphere, emissions are simply transferred across borders to countries with less stringent standards and carbon intensive technologies.

Three types of channels are distinguished in the literature: investment leakage, trade leakage, and energy price leakage. In the context of aviation, the first channel means that airports/ airlines will invest in non-EU countries, such as by setting up a new subsidiary in such a country. This is highly unlikely, given bilateral agreements and ownership restrictions, (Ernst & Young and York Aviation, 2008). Trade leakage means that the EU ETS creates a competitive disadvantage for EU companies because of higher production costs. The market shares of these companies will fall, as is the case when considering the hub effect (see Section 4.2). Energy price leakage occurs if the demand for kerosene – which is used as aircraft fuel – decreases in the EU due to the EU ETS, putting a downward pressure on the worldwide kerosene price. This, in turn, raises the demand for aviation in the rest of the world.

For the aviation industry, we can conclude that carbon leakage is not driven by supply effects (investment leakage) but by demand effects (trade leakage, and to a lesser extent energy price leakage).

Table 7 shows for which flights carbon leakage is a risk (Ernst & Young and York Aviation, 2008). The first two horizontal lines 'connecting at a non-EU airport' and 'additional intermediate stop outside the EU' have been referred to as the 'hub effect' in Section 4.2. It also follows from Table 8 that there might be a switch to ground transport modes. This leads to carbon leakage when road transport, water transport or *diesel* rail transport is used. However, high speed electric rail transport is also covered by the EU ETS (more precisely, the ETS covers electricity generation), so this particular switch does not lead to carbon leakage. Note that the carbon leakage takes place outside of the EU ETS but not outside of the EU, whereas in this paper we have mainly taken a geographical approach. Finally, carbon leakage may also occur when tourism is diverted away from the EU and the new destination is further away than the original one. On the other hand, European citizens may decide to stay close to home, which would have a positive impact on overall emissions.

Table 7. The risk of carbon leakage for different routes

Types of Diversion / Types of Flights	Flights between 2 non-EU points – Direct or indirect	Flights between EU and non-EU points – Direct or indirect	Intra-EU flights
Connecting at a non-EU airport	Leakage (bypassing the EU) (case study 1)	Leakage (Case studies 2, 3 & 4)	No leakage
Additional intermediate stop outside the EU	No Leakage	Leakage for cargo (Case study 5)	No leakage
Switch to ground transport modes	No leakage	No leakage	Leakage (Case studies 6 & 7)
Tourism diverted from the EU	Small Leakage	Leakage	Leakage

Source: Ernst & Young and York Aviation (2008).

5. IMPACTS ON DEVELOPING COUNTRIES

There are a few channels through which non-EU countries - including developing countries - are impacted by the inclusion of aviation in the EU ETS: imports and exports, tourism, and the use of revenues. The costs of the emission allowances are at least partly passed on to customers, who then adjust their demand to this new price. Generally, this means that customers buy in lower quantities, impacting exports. Also, a higher cost of transport means higher costs of food and other imports. We will discuss these issues in the following chapter, focussing on the EU ETS's impacts on developing countries.

5.1 Trade

In general, the trade impact of including aviation into the EU ETS depends on:

- The transport cost increase, which is likely to be small;

- The share of transport costs in the consumer price of the product, which varies per product;

- Import substitution possibilities, which vary per product.

Costs incurred due to a climate policy could, and generally would, directly or indirectly be passed on to customers, thereby leaving most of the profit margin of producers intact. However, climate policies that increase the costs of transport may result in lower demand for exports from these countries, and thus in their lower overall profit. This is supported by evidence that the elasticity of trade with respect to the freight cost factor lies somewhere in the range of -1.3 to -3.5, which means that trade is quite responsive to transport costs (Behar and Venables, 2010).

The higher cost of transport that results from the inclusion of aviation in the EU ETS will be more significant for countries that rely heavily on exports and imports and are vulnerable to transportation costs, such as small island developing states and landlocked countries.[9] In terms of food imports and exports, the importance of aviation for small island developing states is small, as they depend to a large extent on maritime transport for their food imports and exports. Air transport consists mainly of perishables, although this may change with new cooling techniques that enable perishables to be transported by sea and other methods. Furthermore, perishables are generally high value products, therefore the share of transport costs in the total production process is likely to be low. Therefore, a small increase in air transport costs will not make a large difference on actual final consumer price. This means that demand remains fairly stable, as does trade.

In terms of other traded goods, the impact on trade is heavily dependent on circumstances, such as geography, access to maritime transport and other transport modes, competition in the market, and consumer preferences.

The extent to which import substitution could increase as a result of the EU ETS depends on the economic structure of the country and the availability of inputs. In any case, import substitution will be stimulated by higher transport costs of imports. All in all, it is not possible to estimate the impact of the EU ETS on trade quantitatively.

5.2 Tourism

Some tourism destinations are much more dependent on air travel than others; examples of this include European islands such as the Canaries, Malta, and Cyprus. This holds true even more for tropical island states in the Caribbean, as well as countries at a long distance from rich countries, such as Tanzania and Nepal. Since flights to destinations that are further away will experience a larger absolute price increase than flights to nearer destinations, tourists may choose for a destination within the EU over a destination outside the EU.

Section 3.2 established that ticket prices will rise by a few percentage points, for instance 4 percent. Assuming a price elasticity of -0.6, the demand for air travel would decrease by 2.4 percent. The total price of holidays increases even less, because transport constitutes only one part of total holiday costs. Therefore, the effect on the demand for holiday packages will be smaller.

Furthermore, the EU ETS effectively raises fuel prices; research has shown that historical increases in fuel prices have not resulted in any noticeable reduction in total air traffic demand. Figure 2 shows total traffic demand for the major European airlines of the Association of European Airlines and developments in jet fuel prices in the period 2000-2005. Despite a strong increase in kerosene prices, the demand for air travel has risen in this period. The reason for this is that air travel demand in this period was also determined by other factors, such as household income growth and the liberalisation of the aviation market.

Figure 2. Fuel price increases and air travel demand within Europe
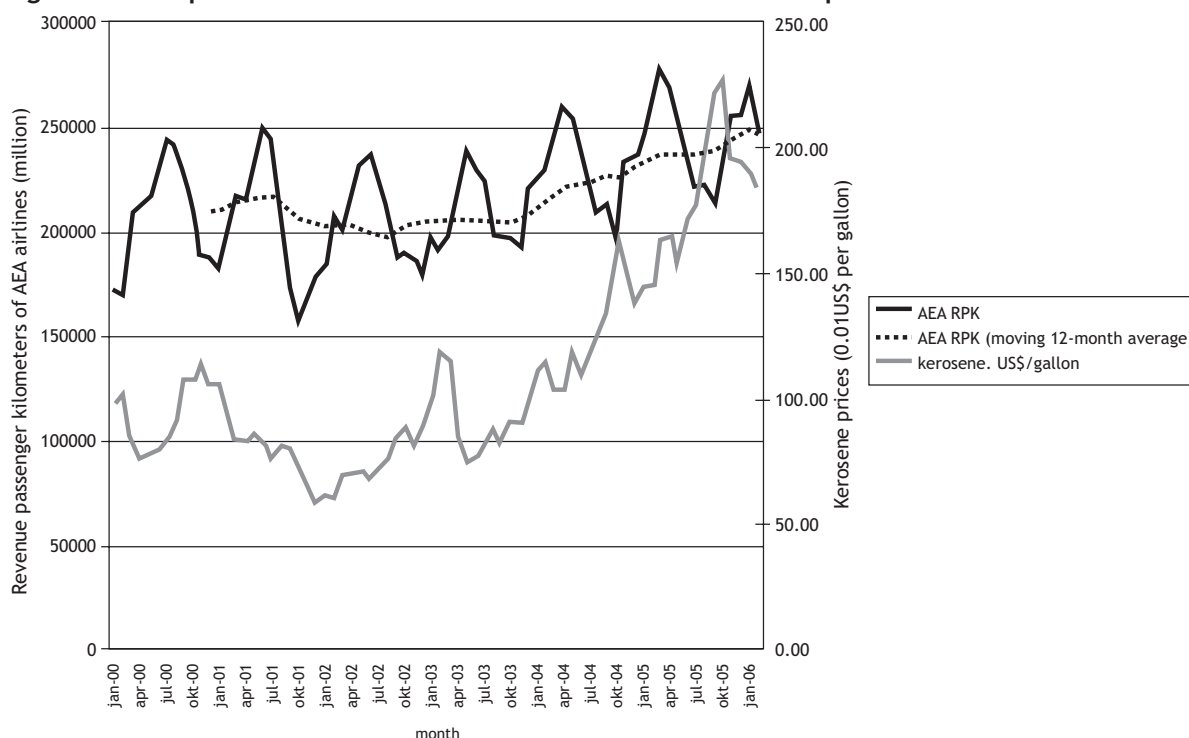
Source: CE Delft et al., 2007.

In fact, many countries experience sharp increases and decreases in tourism on a year-to-year basis. Some destinations suddenly become 'fashionable', and reputation effects resulting from media coverage can be strong. The fluctuations are typically larger than the expected decrease in aviation tourism coming from the inclusion of aviation in ETS.

While some countries will be more affected than others, in general the overall effect is small and should be viewed in the context of general tourism trends. Tourism demand is growing so strongly that it will most likely override any adverse effects stemming from the introduction of aviation in ETS.

5.3 Use of Revenues from ETS

Because a share of the allowances will be auctioned, including aviation in the EU ETS raises revenues. Directive 2008/101/EC affirms the right of Member States to determine the use of these revenues, which is why they are not earmarked. On the other hand, in the same article states in a non-binding way a number of causes towards which revenue should be directed, such as:

- To tackle climate change in the EU and third countries;

- To adapt to the impacts of climate change

in the EU and third countries, especially developing countries;

- To fund research and development for mitigation and adaptation, in particular in the fields of aeronautics and air transport;

- To fund contributions to the Global Energy Efficiency and Renewable Energy Fund.

Some of these causes could have a positive impact on developing countries' economies, either because of direct investments in developing countries or because of spillovers from R&D.

5.4 CDM Projects

CDM projects are projects in non-Annex 1 countries that generate emission allowances because of the emissions these projects abate. The demand for such CDM credits will rise as a result of the inclusion of aviation, especially since it is fairly expensive to reduce emissions in the industry itself. In the first year, airlines are allowed to surrender CDM and JI credits to cover up to 15 percent of their total emissions, totalling approximately 32.5 million CERs (Standard and Poor's, 2011). In following years, the share will be equal to the share in the rest of the EU ETS.

A CDM project is beneficial for a developing country because it generates both capital for investment projects and employment (depending on the particularities of the project). Not all non-Annex 1 countries have CDM projects, and future development is dependent on current climate negotiations about the possible renewal of the Kyoto Protocol.

6. CONCLUSIONS

The regulation on the inclusion of aviation in the EU ETS is non-discriminatory and treats all airlines (EU and non-EU) the same. There are, however, exemptions for airlines with few flights (including several airlines from small developing countries).

In this paper, the economic and environmental consequences are discussed on the basis of existing literature. From this analysis, it can be concluded that the EU ETS will have a small impact on ticket prices and aviation demand. Since emissions abatement in the aviation industry is generally expensive, the impact on aviation emissions will be small as airlines would rather buy allowances from other industries than to implement expensive measures in their fleet. On the other hand, the impact on net emissions covered by the EU ETS could be large, because aviation emissions are projected to grow strongly. Therefore, the airlines will have to offset an increasing share of their emissions through buying allowances from other sectors in the EU ETS or Kyoto project credits.

While the inclusion of aviation in the EU ETS is implemented in a way that limits distortion of competition, some changes in competitiveness may nevertheless occur. The competitiveness of hub airports just outside the EU and the non-EU airlines that serve these airports (including airlines from developing countries) may increase slightly on some routes due to the hub effect. Also, there might be a switch to alternative transport modes and a diversion of tourism away from the EU. Therefore, some carbon leakage is likely to take place, meaning that the reduction in aviation emissions in the EU is partly compensated by an increase of emissions outside of the EU ETS.

The impact on trade between Europe and developing countries is likely to be small because of the low increase in aviation costs, but impacts may vary between products and regions. For the same reason, the impact on tourism is likely to be small on average because transport costs are only a small share of total tourism expenditures; however, some destinations with high cross-price elasticities of demand may experience a greater impact.

Along with these small negative impacts, there may be some small positive impacts on developing countries. The revenue impact from auctioning allowances depends on how Member States decide to use these revenues, but there is a large chance that at least part of the revenues will benefit developing countries, such as by using this revenue for adaptation. Demand for credits from CDM projects is likely to increase, which will have a positive impact on some developing countries because of higher foreign direct investment.

A way forward

Aviation greenhouse gas emissions are growing rapidly and their rise is offsetting emission reductions in land-based sectors, thus undermining the effectiveness of climate policies. At the same time, the external costs of aviation greenhouse gas emissions are not reflected in the price of aviation, which makes the global economy unsustainably dependent on aviation.

The EU ETS has been designed as a way for the EU to comply with its obligation under the Kyoto Protocol to limit or reduce aviation emissions. Ideally, measures in a global sector like aviation should be global, but it has not been possible to reach a global agreement. One of the main stumbling blocks has been the discussion on how to apply the principle of common but differentiated responsibilities (CBDR) to the aviation sector.

A global measure is unlikely to have more negative impacts on developing countries than inclusion in EU ETS. Since these impacts are small, it appears possible that developing countries can be compensated for the negative impacts that such a measure may have. Several proposals have been made on how this can be done using the revenues of a global tax or ETS, such as by providing developing countries with

a lump sum refund linked to their international trade. In this way, a measure that would affect aviation in a non-discriminatory way could comply with the CBDR principle.

A global non-discriminatory scheme would suffer less from carbon leakage and market distortions. It could open the way for developing countries to reduce their dependence on aviation and improve the sustainability of their development trajectory. At the same time, aviation greenhouse gas emissions would be limited or reduced, thus reducing the impacts of global warming on all countries. It is to be hoped that the inclusion of aviation in the EU ETS is a first step towards such a global measure.

ENDNOTES

1   *Annex I Parties* include the industrialised countries that were members of the OECD (Organisation for Economic Co-operation and Development) in 1992, plus countries with economies in transition (the EIT Parties), including the Russian Federation, the Baltic States, and several Central and Eastern European States. The Annex 1 countries (with a few exceptions such as the US) took on binding reduction targets under the Kyoto Protocol.

     Non-Annex I Parties are mostly developing countries. Certain groups of developing countries are recognised by the Convention as being especially vulnerable to the adverse impacts of climate change or to the potential economic impacts of climate change response measures (UNFCCC, 2011).

2   A thorough overview of design elements is presented in Schaefer *et al.* (2010), as well as Anger and Köhler (2010).

3   European Commission (2011).

4   See Kopsch (2011) for more information on this, as well as its impact.

5   Pearce (2008).

6   See for example Vlek and Vogel (2000).

7   Note that the rate of cost pass through depends on competition, which is influenced by the way slots at airports are allocated. At slot constrained airports (such as London Heathrow), the pass through rate will be zero because airlines are able to determine their own prices. These prices are higher than in a more competitive environment; the airlines are able to obtain a so-called 'scarcity rent'. Airlines cannot increase prices without a loss in profits because prices have already been set equal to the profit-maximising level.

8   CE Delft has published a number of publications on this topic, such as CE Delft (2010).

9   Davidson and Faber (2009).

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ICTSD's project on Trade and Sustainable Energy aims to promote pro-sustainable development perspectives for a transition to sustainable energy production and consumption by brokering new and innovative knowledge on trade-related opportunities and challenges. The project aims to:

- Support the transition to a sustainable energy future by providing relevant stakeholders in different policy processes with innovative analysis regarding opportunities and challenges in the trade and sustainable energy nexus;

- Generate policy-oriented and solutions-focused knowledge on the interface between the multilateral trading system and various regimes and initiatives promoting the transition to a sustainable energy future;

- Expand the knowledge community on trade and sustainable energy by including nontraditional actors and view-points in the debate, including oil producers, climate scientists, agricultural economists, specialists in services trade, labour and consumer organisations; and

- Support existing capacity-building efforts through knowledge outputs and dialogues, particularly for poor countries and disadvantaged communities.

Publications include:

- Feed-in Tariffs for Renewable Energy and WTO Subsidy Rules: An Initial Legal Review. By Marie Wilke, Issue Paper No. 4, 2011.

- International Transport, Climate Change and Trade What are the Options for Regulating Emissions from Aviation and Shipping and what will be their Impact on Trade? By ICTSD, Background Paper, 2010.

- Sectoral Approaches to Climate Change Mitigation: Competitiveness, Trade and Development Issues in Small Developing Countries. By ICTSD, Information Note No. 11, October 2009.

- Climate Change and Trade on the Road to Copenhagen. Policy Discussion Paper, 2009.

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Founded in 1996, the International Centre for Trade and Sustainable Development (ICTSD) is an independent non-profit and non-governmental organization based in Geneva. By empowering stakeholders in trade policy through information, networking, dialogue, well-targeted research and capacity building, the centre aims to influence the international trade system such that it advances the goal of sustainable development.