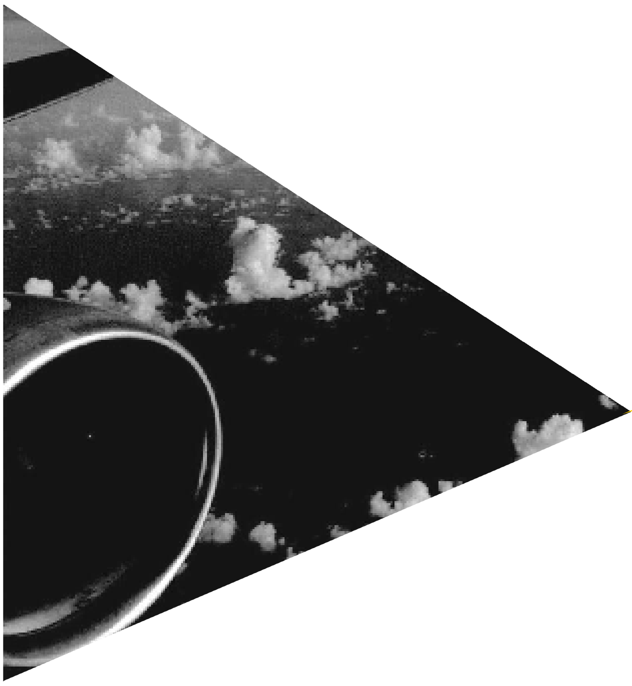

Inclusion of Aviation in the EU ETS: Cases for Carbon Leakage

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Ernst & Young
Quality In Everything We Do

York Aviation

This Study has been conducted at the request of:

AEA
Association of European Airlines
www.aea.be

ECA
European Cargo Alliance
www.eca.web.com

ERA
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This study has been performed by Ernst & Young and York Aviation on the basis of the June 2007 impact study. The theoretical background was reviewed by Professor Jan Keppler (Paris Dauphine University) and Michel Cruciani (Paris Dauphine University); Professor Jean-Charles Hourcade (CIRED – Centre International de Recherche sur l'Environnement et le Développement) and Stéphanie Monjon (CIRED) were associated with the methodology regarding carbon leakage.

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EXECUTIVE SUMMARY

1. BACKGROUND

1.1 In January 2008, in the context of the 'Second Package on Energy and Climate', the European Commission published its proposed Directive to improve and extend the EU ETS. It acknowledged that certain sectors could be exposed to a loss of market share and competitive disadvantage leading to carbon leakage.

1.2 In an effort to identify those sectors at risk of carbon leakage, a questionnaire has been sent to all ground sources covered by the EU ETS. On the basis of the replies received, the Commission will determine which sectors qualify for a special regime (from 0% up to 100% of auctioning). The results will be announced in June 2010.

1.3 In May 2008 the aviation sector received the same questionnaire, to which it replied in August 2008. However, some decisions have already been made for the sector. Indeed, the new aviation legislation stipulates that "*from 1 January 2013 15% of allowances shall be auctioned.* ***This percentage may be increased as part of the general review of this Directive***".

1.4 The aviation industry has substantial concerns about the design of the scheme in general and about the level of auctioning in particular, since it is proposed to increase progressively to 100% by 2020.

1.5 **The aviation sector has commissioned this study to assess the impact of high levels of auctioning on the costs of the industry and whether it will become subject to significant carbon leakage.**

2. OBJECTIVE OF THE STUDY

2.1 The primary objective of the study is to examine the extent to which the airline sector may be subject to carbon leakage under the combined effects of ETS costs and high levels of auctioning.

2.2 In considering the airline sector's potential exposure to carbon leakage as a result of high levels of auctioning, we have adopted the approach developed by the Climate Strategies Report[1] which addressed four key questions.

1. ***Would auctioning lead to a substantial increase in production costs for the airline sector and would it have an impact on profitability?***
2. ***How will the EU ETS impact the market, price and demand?***
3. ***What is the risk of transfer of activities to non-EU operators or to routes not covered by the EU-ETS?***
4. ***To what extent would the sector be able to reduce emissions levels, for instance through more efficient technology?***

2.3 The study also investigates the impact of ETS and increasing levels of auctioning on the wider EU economy.

1 Climate Strategies (2007): J.C. Hourcade, K. Neuhoff, D. Demailly and M. Sato, Differentiation and dynamics of EU ETS industrial competitiveness impacts

3. FIRST FINDING

Auctioning will lead to a substantial increase in production costs for the airline sector and will affect the profitability of the sector

3.1 4 scenarios have been set out based on 2 different levels of CO_2 costs combined with 2 auctioning options:

- Scenario 1: CO_2 at €30/t with a flat rate of auctioning of 15% from 2012 to 2020
- Scenario 2: CO_2 at €30/t with an auctioning rate increasing from 15% in 2012 to 100% in 2020
- Scenario 3: CO_2 at €50/t with a flat rate of auctioning of 15% from 2012 to 2020
- Scenario 4: CO_2 at €50/t with an auctioning rate increasing from 15% in 2012 to 100% in 2020

3.2 Over the trading period 2012-2020, the costs by scenario are as follows:

Period 2012 - 2020	Scenario 1 €30/t CO_2 auctioning 15% 2012 - 2020	Scenario 2 €30/t CO_2 auctioning 15% 2012 to 100% 2020	Scenario 3 €50/t CO_2 auctioning 15% 2012 - 2020	Scenario 4 €50/t CO_2 auctioning 15% 2012 to 100% 2020
Cost – Purchasing	€31.4 billion	€30.7 billion	€51.0 billion	€49.1 billion
Costs - Auctioning	€8.4 billion	€32.2 billion	€14.0 billion	€53.7 billion
Total costs	€39.8 billion	€62.9 billion	€65.0 billion	€102.8 billion

3.3 The table above gives rise to the following remarks:

- The difference between the total cost in Scenarios 3 and 4 is €37.8 billion, which represents an increase of **58%.**

- In Scenario 3, auctioning represents **21.5%** of the total cost of ETS whereas in Scenario 4 it represents **52%** of the total and is evidently the main cost component.

In order to highlight the importance of the ETS impact, it seems appropriate to compare its cost to the airline industry's operating profits and investments in fleet renewal.

3.4 The prospects of air transport returning to 'normal business profitability', i.e. earning a consistent average operating margin of 4%, during the next 5-6 years is greatly over-optimistic.

Worldwide airline results during the period 2001-2006 (since the tragic events of '9/11') recorded losses in each year, aggregating to a loss for the entire period of USD42 billion. IATA estimates results for 2007, 2008 and 2009 to be a profit of USD5.6 billion and losses of USD 5.2 billion and USD4.1 billion respectively. Most industry analysts believe that the effects of the worldwide economic downturn will last longer and be more far-reaching than the more transitory effects of '9/11'.

However, even though the current financial crisis and the continuation of an economic downturn means that an assumption of an operating margin of 4% for network airlines is over-optimistic, this study uses it in order to be consistent with the previous 2007 study. In order to calculate these operating profits it has been assumed that:

- Operating profit is the profit made on all flights arriving at or departing from an EU airport, regardless of the nationality of the operator.

- Profitability on these routes reflects the overall profitability of airlines across all their operations.

- A "business as usual" operating margin for network airlines is 4%, for leading low fares airlines 14%, for other low fares/leisure airlines 2% and for cargo airlines 4%.

3.5 On this basis, we estimate that the projected operating profit of the airline industry during the period 2012-2020 would amount to €106.4 billion, namely **€12 billion per year.** Even this over-estimated operating profit would practically disappear in Scenario 4, simply due to the high level of auctioning.
We have calculated the amount of investment to be made by airlines to renew their fleet based on ICAO FESG (Forecast and Economic Analysis Support Group) data and more particularly on the fleet renewal forecast at 2006 prices in the 15-year period 2006-2020. Airlines operating to/from Europe are expected to spend **€525 billion** on fleet renewal during the period 2006-2020, namely **€35 billion per year**.

3.6 As shown in the Table below, aviation's inclusion in the EU ETS will have a significant financial and economic impact on airlines' profit and investments. The EU-based carriers will be more affected as the totality of their traffic will be covered by the ETS.

	ETS TOTAL COSTS 2012 - 2020	ETS ANNUAL AVERAGE COSTS	% ANNUAL AVERAGE PROFITS €12 billion	% ANNUAL AVERAGE FLEET INVESTMENTS €35 billion
Scenario 3 €50 with auctioning at 15%	€65.0 billion	€7 billion	60%	21%
Scenario 4 €50 with auctioning at 15% -100%	€102.8 billion	€11 billion	95%	33%

- In Scenario 3, the annual cost of ETS will be **€7 billion** and will represent **60%** of the airline industry's annual profits and **21% (i.e one fifth)** of its annual fleet investment.
- In Scenario 4, the annual cost of ETS will be **€11 billion** and will represent **95%** of the airline industry's annual profits and **33%** of its annual fleet investment.

With a high level of auctioning, even taking a largely overestimated profit assumption, ETS would practically remove the industry's overall profits and would deprive the sector of one third of its financial capacity to invest in new technologies.

3.7 As shown in the Table below, the importance of the financial and economic impact is strongly related to the level of auctioning applied to the sector.

	AUCTIONING COSTS ALONE 2012 - 2020	AUCTIONING ANNUAL AVERAGE COSTS	% ANNUAL AVERAGE PROFITS €12 billion	% ANNUAL AVERAGE FLEET INVESTMENTS €35 billion
Scenario 3 €50 with auctioning at 15%	€14.0 billion	€2 billion	13%	4%
Scenario 4 €50 with auctioning at 15% -100%	€53.7 billion	€6 billion	50%	17%
Scenario 3 versus 4	€39.6 billion	€4 billion	37%	13%

- In Scenario 3, the annual cost of auctioning alone will be **€2 billion,** representing **13%** of the airline industry's annual profits and **4%** of its annual fleet investment.
- **I**n Scenario 4, the cost of auctioning alone will be **€6 billion,** representing **50%** of the airline industry's annual profits and 1**7%** of its annual fleet investment.
- The difference in monetary terms between the moderate and high levels of auctioning is **€39.7 billion, namely €4 billion per year.** This represents an increase of **284%** between the two levels.

Auctioning is the driving factor for cost increases arising from ETS. If set at a high level, auctioning alone will remove half of the industry's overall profits and will deprive the airline industry of 17% of its financial capacity to invest in new technologies.

4. SECOND FINDING

The EU ETS will significantly impact the market

4.1 In order to determine the impact of the EU ETS on the market, and more particularly on price and demand, the theoretical assumptions which were used in the previous study published in June 2007 have been revisited. A detailed analysis of these theoretical assumptions and demonstrations on cost pass through and windfall profits can be found in Section II of this study.

The level of auctioning has a significant impact on operating profits. The study estimates that, all other things being equal, for the period 2012 to 2020 :

- **Network airlines** would experience a decline globally from the assumed operating margin of 4% to between **2.4% and -1.2%;**
- **Low fares/leisure airlines**: the market leaders would see a decline from the assumed operating margin of 14% to between **12.9% and 9.5%**. For other low fares/leisure airlines, there would be a decline from the assumed operating margin of 2% to between **0.9% and -2.4%.**
- **Cargo airlines** would face a decline from the assumed operating margin of 4% to between **-0.8% and -9.1%.**

4.2 It should be underlined that this is an overall assessment for the whole industry. The reaction and adaptation to market changes depend on the financial situation of individual airlines, their exposure to competition and on cost pass through and price elasticity over time. If the level of auctioning increases, it becomes harder for airlines to assimilate the associated costs. Ultimately, this results in significant losses or even a total erosion of operating margins.

In the short/medium term, there will be capacity reduction in Europe. In the longer term, this is likely to affect EU operators' ability to invest in new technologies and fleet renewal. Furthermore, as EU-based airlines will be more affected than non-EU based carriers this would result in competitive imbalances.

4.3 The economic and financial impact as described in Paragraphs 3.6 and 3.7 will result in a loss of traffic, with differentiated effects on routes and markets:

- we estimate that with Scenario 3, the number of passengers lost would range from 11 million in 2012 to 22 million in 2020, an average annual loss of 18 million.

- in Scenario 4, the range would be between 11 million in 2012 and 47 million in 2020, an average annual loss of 29 million.

Although these numbers seem relatively low (between 1% and 4% of total traffic), the impact on specific markets could be severe. Some routes may become unviable and could be withdrawn, with major economic and social consequences on regional connectivity and local employment.

5. THIRD FINDING

There is a risk of transfer of activities to non-EU operators or to routes not covered by the EU ETS

5.1 For ground based sectors the concept of carbon leakage covers two types of situation: either the EU manufacturer moves its activities outside the EU to avoid EU ETS costs (**supply driven carbon leakage**) or it loses its market share/competitiveness due to high EU ETS costs and demand then shifts to a non-EU manufacturer (**demand driven carbon leakage**). In both cases, greenhouse gases will continue to be emitted into the atmosphere by operators not covered by the EU ETS.

5.2 There are important differences between aviation and ground based sectors:

- Aviation, as a mobile source, emits CO_2 all along the air route, crossing national borders and different geographical regions. This international dimension is its main feature;
- Aviation provides a service and does not manufacture a product. Its product (a seat offered on a given flight) cannot be stocked. An unsold seat is definitively lost;
- Given the existing constraints of the bilateral traffic rights system and national ownership restrictions, EU carriers cannot realistically switch their activities away from the EU and move their fleet (centre of production) outside the EU;
- However, there is nothing to stop passengers from changing their behaviour, shifting to non-EU carriers or using alternative routings.

In contrast to ground sources, carbon leakage in aviation is linked neither to a product nor to the place of production. Carbon leakage for airlines is better defined as the risk of traffic being deviated from EU operators to the benefit of non-EU operators. In other words, it is not the production facilities (supply driven carbon leakage) but demand (i.e. passengers and goods) that generates carbon leakage.

5.3 The study has identified the following main channels for carbon leakage:

- Case study 1: In intercontinental markets between two non-EU airports: 8%[2] of passenger traffic arriving at EU airports from non-EU origins is connecting to non-EU destinations. Those passengers (and possibly some cargo traffic) could bypass the EU and fly to their final destination via a non-EU hub, located for example in the Middle East, which faces no EU ETS costs. The result would be less activity for European carriers and their home airports but an increase in unregulated emissions around the world;

- Case study 2 and 3: In intercontinental markets between EU and non-EU airports: passenger or cargo traffic could be lost, to the benefit of operators offering connections at hubs close to the borders of the EU and which face lower ETS costs. In such a scenario, there will be increased competition between direct long-haul routes and indirect services. Therefore, the competitive balance will shift in favour of operations that are less affected by ETS costs, namely indirect routes via a hub outside the EU;

- Case study 4: In intercontinental markets between EU and non-EU airports where no direct flight is available. Those passengers do not have the option to choose a direct long haul flight from their departure airport and will have to hub either at an EU or a non-EU airport to reach their non-EU destination. Since these passengers care little about their connection points, unless it adds significant time to the journey, they will be highly sensitive to price and could easily switch to non-EU connecting hubs. The potential risk for traffic to be diverted to non-EU hubs is high.

- Case study 5: Cargo airlines could choose to add a stopover outside the EU in order to reduce the distance covered by the EU ETS. The possibilities on routes from Asia, South America and Africa are greater than on services between North and Central America and Europe. Russia, non-EU countries in Eastern Europe, Central Asia, the Middle East and North Africa could become potential stops. In some cases these points may be on the great circle route, but in other cases they may represent a

2 Source UNWTO (passenger figures by mode / purpose) and IATA (connecting traffic)

diversion from the great circle route and, consequently, may generate higher emissions than a direct route.

- Around 25%[3] of passenger traffic at EU airports is generated by non-EU residents travelling into the EU for leisure. Rising prices caused by the EU ETS could result in some of these inbound tourists being diverted to non-EU destinations, thereby causing carbon leakage. The likelihood of this type of carbon leakage occurring is particularly high considering the sensitivity to price of this segment of the market;

- Case study 6 and 7: For intra-EU markets, increased carbon emissions will be caused by the diversion of short-haul air passengers to surface transport modes which are not subject to the EU ETS or not covered by other restrictions on carbon emissions. This channel for leakage will particularly affect regional routes where prices rises will lead to passengers to switching to car. In some cases, where services remain viable, additional journeys by car will simply result in additional carbon emissions. Alternatively, where the EU ETS undermines the viability of a service, it could stop operating and its passengers would in the main still travel. In these circumstances, on some routes, the additional car journeys involved would create carbon emissions over and above those created by the flight. The examples show that on a typical route, the loss of an air service could lead to a 47% increase in CO_2 emissions compared to keeping the air route in order to satisfy travel demand.

5.4 The Table below analyses the risk of carbon leakage on the types of routes described above. It shows that there is a high risk within a number of markets, and that non-EU carriers are likely to enjoy a competitive advantage as a result of this leakage. However, the importance of these markets to the airlines concerned needs to be considered. In many cases, carbon leakage centres on long-haul movement of either passengers or freight, which are among the most profitable activities for the operating carriers. Therefore, EU carriers' potential loss of market share to non-EU carriers is not just about erosion of volumes; it is about erosion of volumes on their most profitable routes.

Types of Flights / **Types of Diversion**	**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)	Not leakage
Switch to ground transport modes	No Leakage	No Leakage	**Leakage** (Case studies 6 & 7)
Tourism diverted from the EU	**Small Leakage**	**Leakage**	**Leakage**

5.5 In order to illustrate the different types of carbon leakage we have detailed a number of case studies which are described hereafter.

3 Source UNWTO (passenger figures by mode / purpose) and IATA (connecting traffic)

6. FOURTH FINDING

Fleet renewal remains the most efficient way to reduce emissions. It depends on airlines' financial capacity, on manufacturers' industrial capability to construct aircraft in sufficient numbers and on manufacturers' ability to produce steady technological improvements.

6.1 Aviation's abatement opportunities are very limited as the sector is heavily reliant on a single fuel source, with little prospect of technological change in the short to medium term. Improvements to existing aircraft through retrofits, engine upgrades and the use of alternative ground power sources do offer a few opportunities for airlines to reduce their emissions and hence to limit the costs associated with the EU ETS.

6.2 The primary avenue for abatement remains fleet renewal and the introduction of more efficient aircraft or technology - but this will take time and require investment. The imposition of major additional costs through high levels of auctioning will further limit the industry's ability to invest in new technology. The sector has already achieved the quickest renewal that the manufacturers can provide and the fleet operated by European carriers is on average young, relatively modern and efficient compared to what the manufacturers can offer for replacement. This means that the sector has limited technological means to further limit its emissions' growth in the short to medium-term.

6.3 Research into alternative fuel sources is ongoing and involves a number of leading airlines. Central to the success of the strategy will be the development of 'drop in' replacement fuels that can be used with existing aircraft, engines and distribution and storage systems. However, it will be some time before the products resulting from this research can be brought to the market.

6.4 Improvements to air traffic management (ATM) are also expected to bring emissions savings. This is particularly valid for the Single European Sky policy, the implementation of which is outside the control of air carriers. Here again, it will be some time before any tangible results can be achieved. It has been estimated that an efficient ATM system could lead to a 12% reduction in CO_2 emissions. ATM improvements will require significant investment in new airborne and ground technologies. Similarly to fleet investment the additional costs associated with increased levels of auctioning will limit the industry's ability to invest in this area.

7. FIFTH FINDING

The implementation of ETS and, in particular, an increased level of auctioning will impact the competitiveness of the EU, tourism and social mobility.

7.1 As aviation will be the first transport sector to be included in the EU ETS, the impacts will not only affect airlines but will have far-reaching consequences for the wider EU economy. Indeed, by their very nature transport services are inextricably linked to the wider economy and even to society as a whole.

7.2 In this respect we estimate that damage to the air transport industry will directly affect:

- the EU's single market goals, EU cohesion and social mobility;
- the global competitiveness and attractiveness of key centres and regions;
- tourism, where falls in demand are likely to endanger the economic prosperity of regions that are either highly tourism intensive or that have nascent tourism products built around the recent rapid expansion of connectivity within Europe;
- high value added sectors throughout Europe that rely on air connections to enable them to access markets, to source the best and most cost effective components, to interact with other parts of their organisations and extend their presence in the global economy.

8. CONCLUSION

Our analysis shows that:

1. **Aviation's inclusion in the EU ETS will have a significant financial and economic impact on airlines and particularly on EU-based carriers.**
2. **The importance of the financial and economic impact is strongly related to the level of auctioning applied to the sector.**
3. **The economic and financial impact would result in a loss of traffic, with differentiated effects on routes and markets.**
4. **High levels of auctioning combined with international competition would entail risks of carbon leakage and would result in demand (passenger or cargo) shifting to non-EU carriers or alternative routes without necessarily reducing carbon emissions, or even leading to an increase in global CO_2 emissions (see case studies).**

SECTION I: CASES FOR CARBON LEAKAGE IN THE AVIATION SECTOR

1. INTRODUCTION

1.1 Background

In the context of the so-called 'Second Package on Energy and Climate', the European Commission published its proposal for a Directive to improve and extend the EU ETS.

The proposal states that:

"*Taking into account their ability to pass through opportunity costs, full auctioning should be the rule from 2013 onwards for the power sector, refineries and carbon capture and storage. (…) For installations in other sectors, a gradual transition is appropriate, starting with free allocation at a level of [….] % of their share in the total quantity of allowances to be issued, decreasing by equal amounts each year, arriving at zero free allocation by 2020. (…) Overall, it is estimated that at least two thirds of the total quantity of allowances will be auctioned in 2013*."[4]

However, the Commission has acknowledged that certain sectors could be exposed to carbon leakage, which would lead to a loss of market share and competitive disadvantage. It is therefore considering specific measures to protect the international competitiveness of energy intensive industries.

So far, three categories of sectors have been defined:

1. Sectors subject to 100% auctioning from 2013 onwards (power sector)
2. Sectors subject to 100% auctioning in 2020 (and an increasing rate from 2013 until then)
3. Sectors subject to potential carbon leakage for which the auctioning rate will be discussed further.

In an effort to identify those sectors at risk of carbon leakage, a questionnaire has been sent by the Commission to all ground sources falling within the scope of the ETS. On the basis of the replies received, the Commission will determine which sectors would qualify for a special regime (up to 100% of auctioning). The results will be announced in June 2010.

This questionnaire was also sent to the aviation sector in May 2008. However, some decisions have already been made regarding the sector. Indeed, the new aviation legislation already stipulates that *"from 1 January 2013 15% of allowances shall be auctioned. This percentage may be increased as part of the general review of this Directive*".

The aviation industry has major concerns about the design of the scheme and particularly about the proposed level of auctioning which starts at 15% in 2012 and is set to increase to 100% in 2020.

4 Proposal for a Directive of the European Parliament and of the Council amending Directive 2003/87/EC so as to improve and extend the greenhouse gas emission allowance trading scheme of the Community (COM(2008)0016 – C6-0043/2008 – 2008/0013(COD))

1.2 Objectives

This study examines **to what extent aviation may be subject to carbon leakage** and the **consequences of auctioned allowances** for the sector.

In addressing these issues, the study examines the following key questions drawn from the Carbon Strategies Report criteria[5]:

- **Would auctioning lead to a substantial increase in production costs for the aviation sector? (see Chapter 2)**
- **How will the EU ETS affect the market, in terms of price and demand? (see Chapter 3)**
- **What is the risk of transfer of activities to non-EU operators or to routes not covered by the EU-ETS? (see Chapter 4)**
- **To what extent would the sector be able to reduce emissions levels, for instance thanks to more efficient technology? (see Chapter 5)**

We have also considered how aviation's inclusion in the EU ETS will have wider effects, for example how changes in the air transport market will affect economic and social development in the EU (see Chapter 6).

1.3 What is Carbon Leakage?

Definition applied in the context of annex B/non-annex B countries in the Kyoto protocol:
Carbon leakage corresponds to the increase in GHG emissions in non-abating countries due to the implementation of a climate policy in some countries that abate GHG emissions. It is the global effect of a local policy.

Application to ground sources in the EU ETS:
The primary concern surrounding carbon leakage for ground-based emissions sources is whether production from activities based in Europe could be relocated to other parts of the world in response to a unilateral and stringent climate policy in Europe. The results of such relocation would be (1) emissions in the rest of the world would increase, and (2) the "perimeter" of the EU ETS would become narrower, thereby reducing its effectiveness. This underlines that carbon leakage must be thought of in terms of the efficiency of European climate policy.

In examining how carbon leakage might occur for ground sources, several types of company decision have been identified that could be significantly altered by the effect of different carbon costs being applied to direct emissions:

- New investment: when a company is contemplating new investment, greenfield production units could be shifted to regions where carbon prices are lower or where there is no carbon pricing scheme;
- Reduced production: as a result of costs related to its carbon emissions, a company could simply reduce production. Demand would then have to be met by other sources, potentially from outside the scope of the carbon pricing scheme;
- Closure of plants: if carbon costs of production and fixed annual costs are important, then producers could decide to close production units in the short term. This again would leave demand to be satisfied by other sources of production, potentially outside the scope of the carbon pricing scheme.

At present, there is no consensus on the potential importance of the international reallocation of capital stemming from carbon leakage. However, in the longer term after 2012, it could become highly significant as the cost of auctioning rises and the timeframe for investments that would allow carbon leakage is reached.

5 Climate Strategies (2007): J.C. Hourcade, K. Neuhoff, D. Demailly and M. Sato, Differentiation and dynamics of EU ETS industrial competitiveness impacts

The risk of carbon leakage in the aviation sector:
In the case of the aviation sector, carbon leakage is not directly caused by closure or relocation of plants outside the EU. Due to the constraints of the existing traffic rights system and national ownership restrictions, it is simply not realistic for European-based operators to move their activities outside the EU. For the aviation sector, carbon leakage is about changes in the patterns of passenger and cargo demand as consumers respond to distortions in the market caused by the cost of emissions on flights to and from the EU.

There are a **number of scenarios** through which carbon leakage can occur in the aviation sector:

- In intercontinental markets between non-EU origins and non-EU destinations: 8%[6] of passengers arriving at EU airports from non-EU origins are connecting to non-EU destinations. Those passengers (and possibly some cargo traffic) could bypass the EU and fly to their final destination via a non-EU hub, located for example in the Middle East, which faces no EU ETS costs. The result would be less activity for European carriers and their home airports but an increase in unregulated emissions around the world;
- In intercontinental markets between EU and non-EU airports: passenger or cargo traffic could be lost, to the benefit of airline operators offering connections at hubs close to the borders of the EU and which face lower ETS costs. In this scenario, there will be increased competition between direct long-haul routes and indirect services. In fact the balance will shift in favour of operations that are less affected by ETS costs, namely indirect routes via a hub outside the EU;
- Around 25%[7] of passenger traffic is generated by non-EU residents travelling into the EU for leisure. Inbound tourists could be diverted to non-EU destinations, as they constitute a highly price-sensitive part of the aviation sector, with an estimated route level elasticity of -1.4. The impacts on fares resulting from the EU ETS could incite them to switch to alternative leisure destinations outside the EU, thus causing carbon leakage.
- For intra-EU markets, increased carbon emissions could be caused by the diversion of short-haul air passengers to surface transport modes which are not subject to the EU ETS or not covered by other restrictions on carbon emissions.
- Cargo airlines could choose to add a stopover outside the EU in order to reduce the distance covered by the EU ETS. The possibilities on routes from Asia, South America and Africa are greater than on services between North and Central America and Europe. Russia, non-EU countries in Eastern Europe, Central Asia, the Middle East and North Africa could become potential stops. In some cases these points may be on the great circle route, but in other cases they may represent a diversion from the great circle route and, consequently, may generate higher emissions than a direct route.

These risks are heightened by aviation's reliance on a single fuel source and a single technology. This implies that there are very few options for substitution and abatement costs are high. The abatement opportunities are, therefore, very limited. The fleets operated by Europe's airlines are already modern and are regularly renewed, a process driven particularly by the price of fuel. This reliance on a single fuel source seems likely to continue for the foreseeable future, as alternative technologies are currently anticipated only in the research and development phase.

These scenarios make it more difficult to achieve the agreed target of reducing overall CO_2 emissions. The EU ETS may result in a shift of emissions from within the EU to outside, while still imposing an extra burden on the EU economy by raising transportation costs and disadvantaging EU operators to the advantage of non-EU competitors.

Ultimately, in the long term, the continuing competitive disadvantage faced by EU-based airlines could lead to a lack of future investment compared to their non-EU rivals. This could lead to a further type of carbon leakage as markets increasingly move away from Europe and expansion of capacity follows this lead. This type of leakage would be more akin to the definitions of carbon leakage for ground based emissions sources.

6 Source UNWTO (passenger figures by mode / purpose) and IATA (connecting traffic)
7 Source UNWTO (passenger figures by mode / purpose) and IATA (connecting traffic)

It should be noted that these leakages are identified assuming all non-EU operators comply with the EU regulation. If their third party States were to challenge the EU regulation, increased deviation of traffic and therefore of carbon leakage would take place.

1.4 Methodology

1.4.1 Overall approach

A well-regarded methodology for analysing the likelihood of carbon leakage for a sector has been developed in the recent Climate Strategies Report on Differentiation and Dynamics of EU ETS Industrial Competitiveness Impacts (hereafter referred to as the CS Study). This report represents the current best practice approach.

The CS study analysed industry data on the following key parameters:

- Carbon intensity, defined as the cost of buying allowances to cover all CO_2 emissions as a proportion of Gross Value Added (GVA). GVA is defined as revenues minus non-labour and non-capital inputs;
- Cost of CO_2 abatement measures that would reduce the need to buy allowances, in other words, what could be referred to as the value of the elasticity of technical substitution;
- The extent to which final product prices would have to rise to offset the cost of buying these allowances. This depends on the cost pass-through capacity of the operator;
- The size of price elasticities of demand that determine the extent to which demand would be suppressed in the event of such a price rise;
- The size of ‘trade’ elasticities of supply that would cause business activity to be diverted to non-EU producers in the event of such a cost increase.

1.4.2 Adaptation of the methodology to the aviation sector

Since the aviation sector differs from the other sectors so far examined (different cost structure, mobile emission sources, etc), adaptation of the above methodology is required, particularly in the following areas:

- **Cost pass through**: for reasons discussed in the report, we believe that cost pass-through in the aviation sector is complex and it is therefore not possible to simply assume 100% cost pass-through;
- **Gross value added (GVA):** as explained in the report, we believe that operating margin provides a more appropriate indicator of the financial impact on airlines than GVA.

We would also emphasise at this stage that in many cases, market exposure to competition from non-EU operators is very high. In such circumstances, the fact that carbon leakage in the aviation sector is linked to the loss of market share for EU airlines/airports through changes in consumer choice rather than the physical relocation of production facilities, greatly increases the likelihood of carbon leakage occurring. In order to demonstrate this point we have supplemented the CS approach with a series of illustrative case studies.

2. COST OF THE EU ETS

Auctioning will lead to a substantial increase in production costs for the airline sector and will affect the profitability of the sector

KEY FINDINGS

Four scenarios have been set up based on two selected future prices for carbon allowances combined with two auctioning levels – a fixed rate at 15% over the period to 2020 and a rate increasing from 15% in 2012 to 100% in 2020. The cost to the aviation sector is as follows:

	M€	Scenario 1 €30/tCO_2, 15% auctioning	Scenario 2 €30/tCO_2, increasing auctioning	Scenario 3 €50/tCO_2, 15% auctioning	Scenario 4 €50/tCO_2, increasing auctioning
2012	Cost of purchasing	2 040	2 040	3 295	3 295
	Cost of auctioning	**953**	**953**	**1 588**	**1 588**
	Total cost	2 993	2 993	4 883	4 883
2020	Cost of purchasing	4 963	4 818	8 089	7 687
	Cost of auctioning	**933**	**6 221**	**1 555**	**10 368**
	Total cost	5 896	11 039	9 644	18 056
2012-2020	Cost of purchasing	31 380	30 709	50 998	49 134
	Cost of auctioning	**8 418**	**32 213**	**14 030**	**53 688**
	Total cost	39 798	62 922	65 028	102 822

Operating Profit[8] of the airline industry across the period 2012-2020 is expected to be €106.4 billion, consequently **auctioning alone** would represent:

- In Scenario 1: **8%** of **Operating Profit**
- In Scenario 2: **30%** of **Operating Profit**
- In Scenario 3: **13%** of **Operating Profit**
- In Scenario 4: **50%** of **Operating Profit**

Airlines operating to/from Europe are expected to spend €525 billion on fleet renewal during the period 2006-2020, namely €35 billion per year.[9]

	ETS TOTAL COSTS 2012 - 2020	ETS ANNUAL AVERAGE COSTS	% ANNUAL AVERAGE FLEET INVESTMENTS €35 billion	AUCTION. COSTS ALONE 2012 - 2020	AUCTION. ANNUAL AVERAGE COSTS	% ANNUAL AVERAGE FLEET INVESTMENTS €35 billion
Scenario 3 €50 auction. at 15%	**€65.0 billion**	**€7 billion**	**21%**	**€14.0 billion**	**€2 billion**	**4%**
Scenario 4 €50 auction. at 15% -100%	**€102.8 billion**	**€11 billion**	**33%**	**€53.7 billion**	**€6 billion**	**17%**

- Scenario 3: annual cost of ETS will represent **21%** of annual fleet investment. Annual cost of auctioning alone will represent **4%** of annual fleet investment.

- In Scenario 4: annual cost of ETS will represent **33%** of annual fleet investment. **C**ost of auctioning alone will represent 1**7%** of its annual fleet investment.

8 Operating profit is assumed to be the operating profit made on all flights arriving to or departing from an EU airport regardless of the nationality of the operator. It has been further assumed that profitability on these routes reflects the overall profitability of airlines across all their operations. For the purposes of this assessment, we have assumed a business as usual operating margin for network airlines of 4%, for leading low fares airlines of 14%, for other low fares airlines of 2% and for cargo airlines of 4%.

9 We have calculated the amount of investment to be made by airlines to renew their fleet based on ICAO FESG (Forecast and Economic Analysis Support Group) data and more particularly on the fleet renewal forecast at 2006 prices in the 15-year period 2006-2020.

2.1 Allowance Prices for 2012-2020[10]

In the Ernst & Young and York Aviation Study of 2007[11], allowance prices were estimated at between €6/tCO_2 and €30/tCO_2. Since then, two recent developments have changed these assumptions:

1. The publication of some stringent allocations in the second National Allocation Plans (NAP II);
2. The "Second Package on Energy and Climate" that sets a goal of a unilateral 20% reduction in emissions by 2020, increasing to a 30% reduction if international agreement is reached.

As a result, in this study we have assumed allowance prices of €30/tCO_2 for the low scenario and €50/tCO_2 for the high scenario. However, it should be noted that there remains a high degree of uncertainty around these estimates as no global policy has yet been established. In particular, figures for 2013-2020 are based on assumptions regarding a market for which the rules are currently unknown.

In terms of the level of auctioning, the current design of the EU ETS for the aviation sector assumes that 15% of allowances will be auctioned in 2012. In undertaking our analysis, we have used two scenarios to describe the future evolution of auctioning:

- the rate of auctioning remains constant at 15% over time
- the rate of auctioning increases over time, reaching 100% in 2020.

2.2 Number of Allowances to be purchased

Based on our assessment of future traffic demand[12] and assuming an annual efficiency gain of around 1%, we have estimated the number of allowances to be purchased in relation to four scenarios:

- Scenario 1: allowances purchased at €30 and a flat rate of auctioning (15%);
- Scenario 2: allowances purchased at €30 with auctioning increasing from 15% to 100% in 2020;
- Scenario 3: allowances purchased at €50 and a flat rate of auctioning (15%);
- Scenario 4: allowances purchased at €50 with auctioning increasing from 15% to 100% in 2020.

Based on the design elements of the ETS applied to aviation:

- In 2012 the emissions cap for the sector would amount to 211.7 MtCO_2 (average of 2004 – 2006 historical emissions[13] - 3%).
- For 2013-2020 the emissions cap for the sector would amount to 207.4 MtCO_2 for 2013-2020 (average of 2004 – 2006 historical emissions - 5%).

Moreover, it should be noted that a 3% special reserve is included in the level of the cap.

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10 For further detail, see Appendix A: CO2 markets and aviation

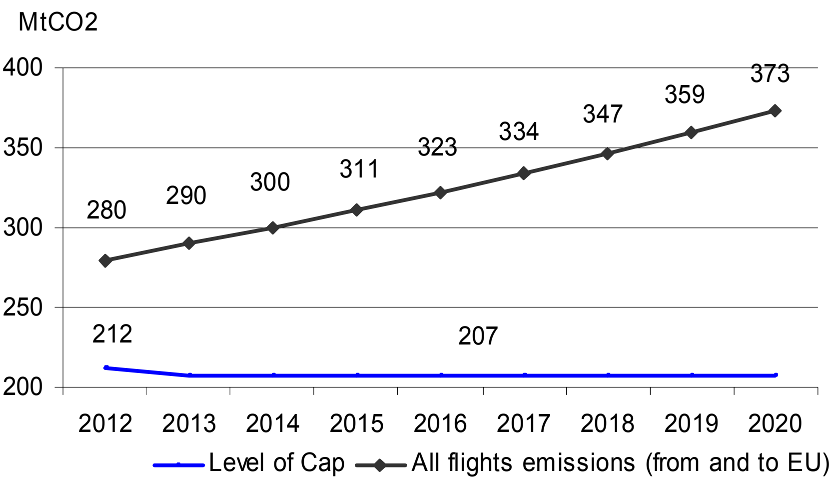
11 Ersnt & Young and York Aviation 2007, Analysis of the EC Proposal to Include Aviation Activities into the Emission Trading Scheme

12 We discuss future demand and the impact of the EU ETS in more detail in Section 4 and Appendix F.

13 2004 CO2 emissions from CE Delft (EC draft proposal, Giving wings to emissions trading : Inclusion of aviation under the European emissions trading system (ETS): design and impacts, Report for the European Commission, DG Environment No. ENV.C.2/ETU/2004/0074r, Delft, July 2005), 2005 emissions estimated with a 4,3% growth based on 2004 emissions (growth of intra EU flights according to AEA data for 2004 and 2005), 2006 emissions estimated with a 4,9% growth based on 2004 emissions (total RTK growth).

Figure 2-1 presents the evolution of CO_2 emissions for the period 2012-2020 and shows that the number of allowances to be purchased by the sector to meet the assumed traffic growth would correspond to 166 $MtCO_2$ in 2020.

Figure 2-1: Evolution of CO_2 emissions for the period 2012-2020



The aviation sector's CO_2 emissions are bound to increase until 2020, since there is no alternative energy or technology which can provide significant improvement before then (see Chapter 5).

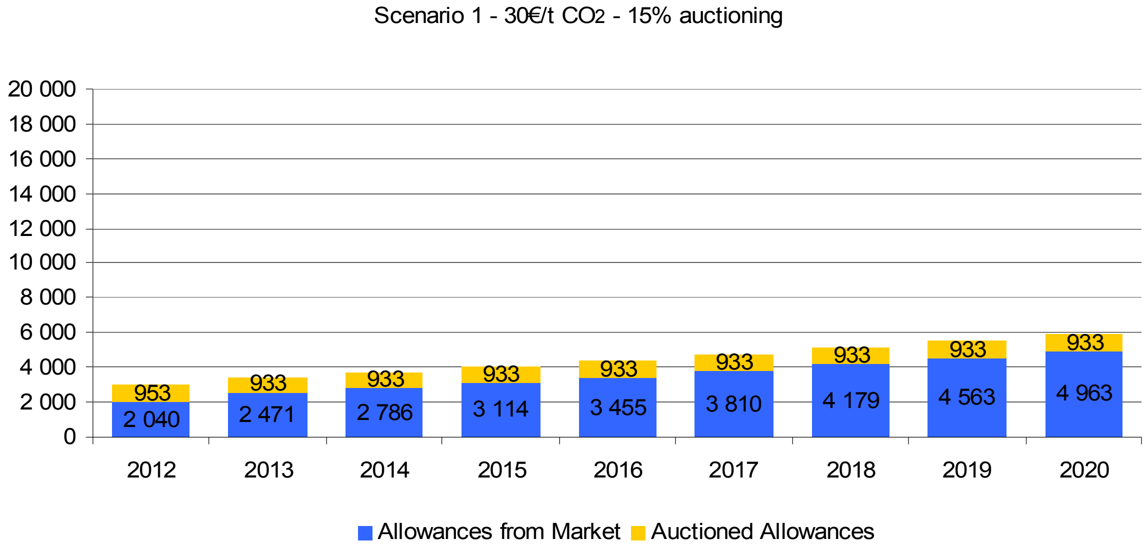
2.3 Cost of purchasing/auctioning allowances

Based on the assumptions described above regarding allowance costs and the growth in emissions, the estimated cost of purchasing allowances under our four scenarios is set out hereafter. It should be noted that these costs reflect the total number of allowances to be purchased in an ETS scheme covering all flights to and from EU airports. These costs therefore include those incurred by both EU and non-EU airlines.

Scenario 1

Figure 2-2 below presents the cost to the aviation sector of buying allowances and of acquiring 15% of auctioned allowances at €30/tCO_2.

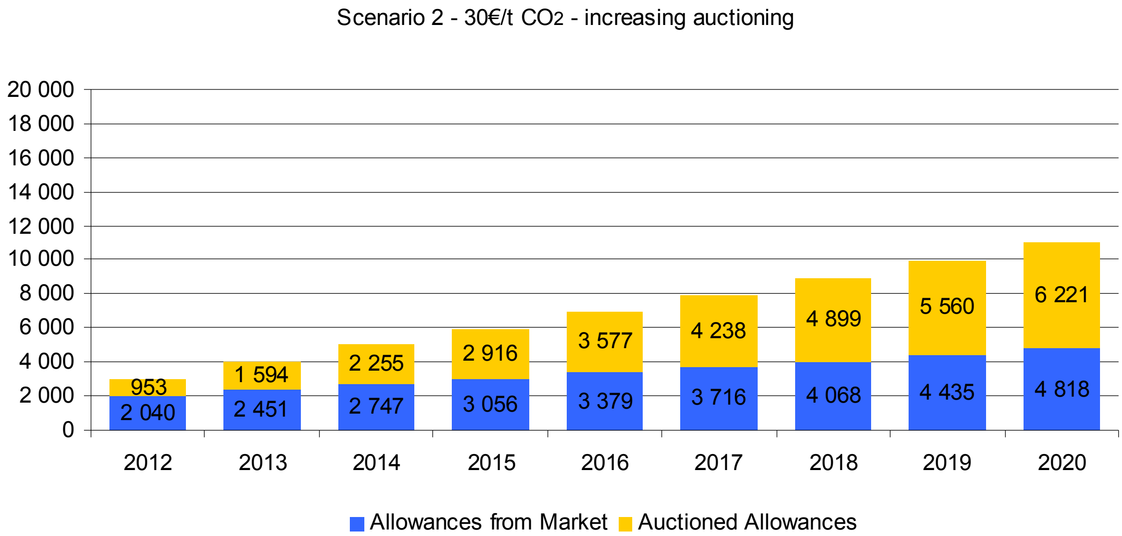
Figure 2-2: Yearly cost of allowances - Scenario 1



Scenario 2

Figure 2-3 below presents the cost to the aviation sector of buying allowances and of acquiring auctioned allowances (15% in 2012 and 100% in 2020) at €30/tCO_2.

Figure 2-3: Yearly cost of allowances - Scenario 2

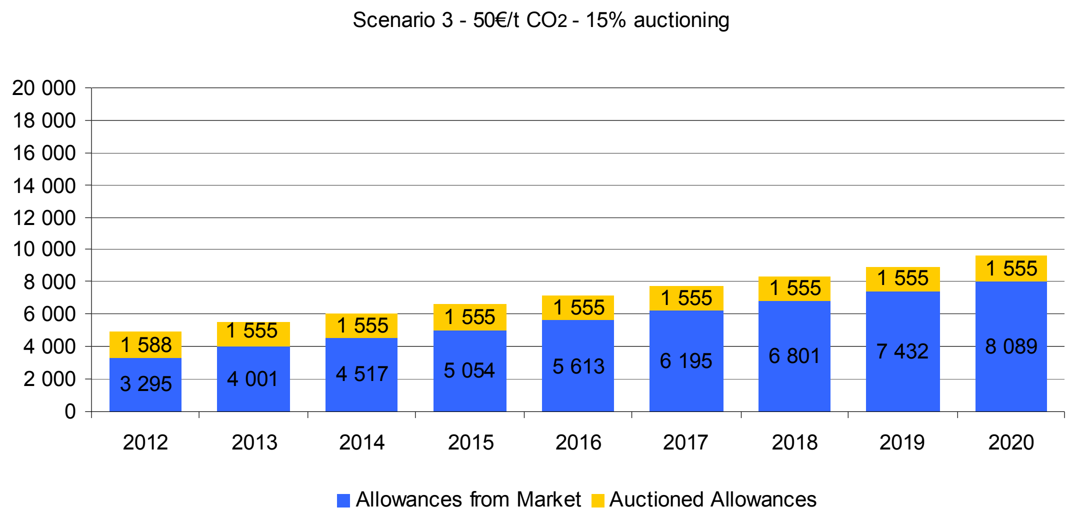


In this scenario, the demand is lower than in the previous one, because the proportion of the cost of the EU ETS passed through to customers is higher. This only affects the number of allowances purchased on the market (blue block), since we assume companies will auction all possible allowances (yellow block) before purchasing them on the market.

Scenario 3

Figure 2-4 below presents the cost to the aviation sector of buying allowances and of acquiring 15% of auctioned allowances at €50tCO_2.

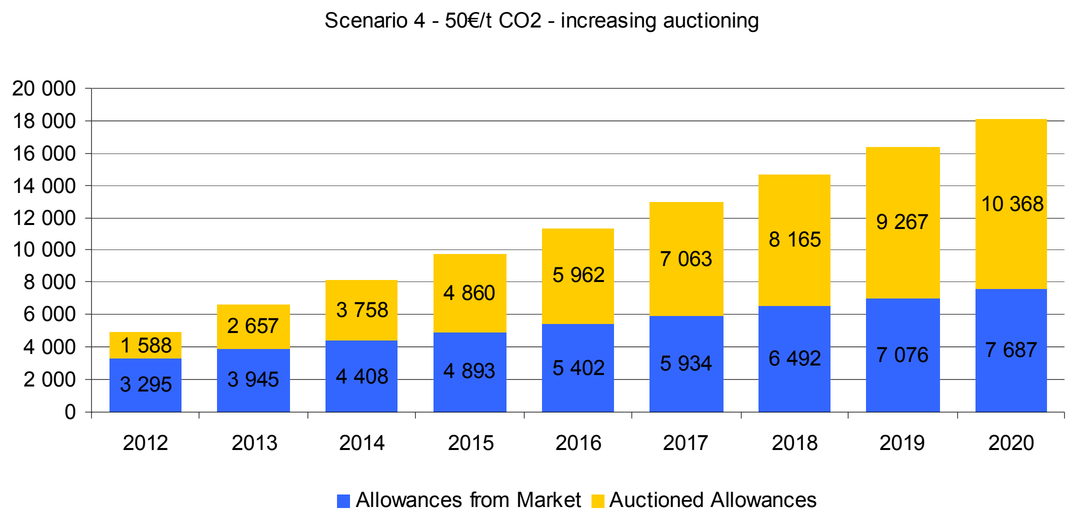
Figure 2-4: Yearly cost of allowances - Scenario 3



Scenario 4

Figure 2-5 below presents the cost to the aviation sector of buying allowances and of acquiring auctioned allowances (15% in 2012 and 100% in 2020) at €50/tCO_2.

Figure 2-5: Yearly cost of allowances – Scenario 4



2.4 Conclusion

- The cumulative total cost to the aviation sector between 2012 and 2020 is estimated to be between €40 billion and €103 billion, depending on the level of auctioning.
- The level of auctioning is extremely important as it determines the cost impact of the EU ETS on the sector. The cumulative impact of auctioning is between €8 billion and €54 billion depending on whether auctioning remains constant at 15% or increases over time to 100% by 2020.

3. IMPACT OF THE EU ETS ON THE AVIATION MARKET, PRICE AND DEMAND

The EU ETS will significantly impact the market

KEY FINDINGS

- Considerable overall effects of the EU ETS on airlines' operating margins over the period 2012 to 2020 assuming other things remain equal:
  - **Network airlines**: a decline from the assumed operating margin of 4% to between 2.4% and -1.2%.
  - **Low fares airlines/Leisure airlines**: for the market leaders, a decline from the assumed operating margin of 14% to between 12.9% and 9.5%. For other low fares/leisure airlines, a decline from the assumed operating margin of 2% to between 0.9% and -2.4%.
  - **Cargo airlines**: a decline from the assumed operating margin of 4% to between -0.8% and -9.1%.
- In the short/medium term: **capacity reduction** in the EU airline industry.
- In the long term: restrictions on EU airlines' **ability to invest** in new technologies and fleet renewal and amplified **distortion of competition** between EU and non-EU airlines.

This chapter considers how the airlines will deal with the increase in costs stemming from aviation's inclusion in the EU ETS and its impact on airline profits. The four scenarios described in Chapter 2 are applied to a simplified market with three types of carriers: network airlines, low fares/leisure airlines and cargo airlines. It should be noted that such segmentation does not exist in reality. Individual airlines may operate in a number of these segments and, indeed, within a range of segments that are variants on those described. However, it is not practical within an exercise such as this to seek to reflect the full range of diversity present in the market.

Prior to presenting this analysis, we need to examine two key issues that have a significant influence on the results:

- Windfall profits in the aviation sector;
- Cost pass-through in the aviation sector.

3.1 Windfall Profits in the Aviation Sector[14]

In our 2007 study we clearly demonstrated that airlines could not derive windfall profits from an allocation of free allowances as part of their inclusion in the EU ETS[15]. However, some studies still debate this issue, such as the study undertaken by Vivid Economics (2008)[16] for Defra[17]. In Section 2 we reply to some key topics raised by those studies. We restate and reinforce our position.

Windfall profits are a highly sensitive subject. It is sometimes claimed that certain sectors have benefited from such profits as a result of their inclusion in the EU ETS. However, the circumstances and characteristics of the aviation sector are quite different: (i) tariff liberalisation means that prices are already adjusted by airlines in order to meet their specific objectives and (ii) airlines cannot switch to alternative fuels in the short-term in order to emit less carbon. It is these differences that make windfall profits unachievable within the sector. The aviation sector's inclusion in the EU ETS will divert airlines from meeting their financial objectives and lower their profits.

Although aviation allowances can be sold to other sectors, they cannot be used by the other sectors to offset their emissions. Therefore, the aviation sector as a whole would not make a profit from selling allowances.

3.2 Cost pass-through in the Aviation Sector

Where air transport markets are only partially covered by the EU ETS, pass-through of costs will not be possible without loss of market share to competitors that are not fully (or at all) covered by the ETS.
In last year's study, we challenged the idea that the costs incurred by airlines through their inclusion in the EU ETS could simply be passed on to consumers. We outlined how a wide range of factors needs to be considered in identifying likely rates for cost pass-through. Particularly, we emphasised the need to consider:

(i) the capacity constraints at airports and the relative market power of airlines;
(ii) the number of competitors on a specific route;
(iii) the shape of the demand curve.

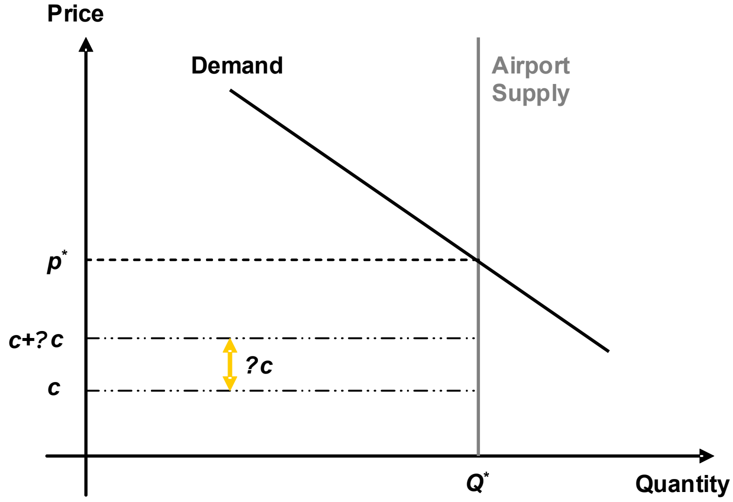
We present hereafter the main assumptions we have used to determine the impact of the EU ETS. A more detailed justification is provided in Section 2 of this report.

3.2.1 The range of cost pass-through rates in the aviation sector in Europe

In the previous study we built upon work undertaken by Oxera which suggested that at congested airports, as potential demand is greater than the actual capacity of the airport, airlines will be unable to pass on cost increases and consequently the number of passengers/amount of goods and the price will remain unchanged. This position is illustrated in **Figure 3-1** which shows how the price of air tickets/transporting goods is related to the number of flights.

14 Further explanation can be found in Section II of this report.
15 "Analysis of the EC Proposal to Include Aviation Activities in the Emissions Trading Scheme" – Ernst & Young, York Aviation – June 2007
16 "A Study to Estimate Ticket Price Changes for Aviation in the EU ETS" – Vivid Economics – November 2007
17 Department for Environment Food and Rural Affairs (UK Government)

Figure 3-1: Demand at Congested Airports



Source: Oxera 2003

The graph presents the demand curve, the marginal cost function of the airlines (assumed to be constant whatever the number of flights), and the constraint capacity at congested airports where the supply is fixed at Q^*. At such airports regardless of the level of marginal cost c, whether or not it is subjected to an increase of Δc due to the cost of allowances, the optimal price will remain equal to p^*. Therefore, at congested airports, the EU ETS will have a negative impact on airlines' financial performance as costs will increase while income will remain the same. This means that airlines will bear the full cost of ETS.

In response to this approach, some commentators have suggested that congestion at airports does not actually imply any restriction on the number of passengers/amount of goods. We do not consider this suggestion to be credible and have provided a detailed response in Section II.

Derivation of the cost pass-through rate from the number of competitors on a specific route
The number of competitors in a market is a central determinant of the cost pass-through rate. According to a study by Ten Kate and Niels, in the general case of an oligopoly under Cournot quantity competition, the cost pass-through rate, with a linear demand function in a market where n competitors are present, is equal to:

$$\sigma = \frac{n}{n+1} \quad \text{(E1)}$$

We have termed this rate the "central cost pass-through rate" not because that rate should be central according to economic theory but because such a rate is our central assumption. It is a balanced assumption as a linear function is both concave and convex (see paragraph below).

Equation (E1) demonstrates that when there are a large number of competitors, the cost pass-through rate increases to almost one, meaning that all the costs are passed through to the customer. This is in line with general economic theory which states that the cost pass-through rate is around 100% in a perfectly competitive market. However, it is also clear that the rules of pure and perfect competition cannot be applied to the aviation sector.

The shape of the demand curve
Equation E1 in the next paragraph is based on the assumption that the demand curve is linear. The cost pass-through rate is actually higher or lower depending on the actual shape of the demand curve, if it is convex or concave. Since publication of our last report, there have been suggestions that the shape of the demand curve used should be convex rather than concave. Not only is there no empirical evidence to

support these statements, but there are several arguments to suggest that this cannot be the case in the aviation sector. In Section II, we provide evidence that the linearity of the demand curve is a very balanced assumption even if, in fact, it is more credible to assume that the demand curve would be concave.

3.2.2 Conclusion on the range of cost pass-through rates in the aviation sector in Europe

The following table indicates the cost pass-through rates adopted, depending on the type of competition.

Table 3-1: Pass-Through Rates by Type of Competition

Competition	Cost pass-through rate
Congested airports	0%
Route operated by one company	50%
Route operated by a small number of companies	75%
Route operated by a large number of companies	90%

What we mean here by a route operated by a small number of companies is a standard situation where the number of competitors is equal to 3. We have, however, also considered the case of a route operated by a large number of companies, in this case where there are 9 competitors. These assumptions lead to cost pass-through rates in the aviation sector in Europe of between 0% and 90%. The average rate across the market will depend on the proportion of each ‘type’ of route in the market and the proportion of traffic at congested airports. Our work is based on the modelling of competition at route level, where the number of competitors is obviously reduced, which does not preclude the intensity of overall competition on the European market in the airline industry.

3.2.3 Distribution of the cost pass-through rates

The market structure, in particular the percentage of congested airports and the assumed level of competition, is therefore a key issue in estimating the cost pass-through rate. We consider each in turn below. We also discuss briefly the shape of the demand curve, a subject that has been addressed by several commentators.

Percentage of congested airports

A study carried out by Mott Macdonald in 2005 determined the level of congestion at a basket of airports, based on certain variables including slot availability. According to this study, 30% of passengers were handled by heavily congested airports in 2005, but this figure is predicted to rise to 50% by 2025. Based on these figures, we have assumed a linear increase in congestion between 2005 and 2025. As a result, the effective cost pass-through rate depends on the point in time that the assessment is made.

Table 3-2: Airport Congestion for Network Airlines

Assumptions for Network airlines[18]	2005	2020
Percentage of congested airports	30%	45%
Percentage of uncongested airports	70%	55%

Table 3-3: Airport Congestion for Low Fares Airlines

Assumptions for Low Fares airlines	2005	2020
Percentage of congested airports	-	-
Percentage of uncongested airports	100%	100%

18 These assumptions are similar for network airlines and cargo airlines.

We have taken as a basic assumption that only network airlines operate from congested airports. Some low fares airlines do operate from airports with a significant level of congestion, but there is a much greater focus on less congested airports with lower costs.

Level of competition
Based on a study of routes operated by some representative airlines and taking into account comments relating to our previous study, we have assumed the following levels of competition at route level for each of our market segments.

Table 3-4: Type of Competition for Network Airlines

Assumptions for network airlines[19]	2005	2020
% of routes operated by one company	15%	15%
% of routes operated by a small number of companies	75%	75%
% of routes operated by a large number of companies	10%	10%

Table 3-5: Type of Competition for Low Fares Airlines

Assumptions for Low Fares airlines	2005	2020
% of routes operated by one company	10%	10%
% of routes operated by a small number of companies	60%	60%
% of routes operated by a large number of companies	30%	30%

Fixed costs and variable costs
The cost pass-through question is closely related to the question of marginal costs. At first glance, in the aviation sector the marginal cost of one extra passenger on a specific flight is close to zero. The fact that one passenger joins the flight does not increase the costs. However, in order to evaluate fixed and variable costs effectively, it is important to consider the dimension of time.

For example, for time periods of one season the cost of operating a flight is fully fixed. Indeed, over such a short time it is difficult for airlines to adjust supply in response to a change in demand or to a variation in costs. The most significant change in our study is therefore that we have considered that absolutely no fixed costs would arise from the ETS.

Table 3-6: Fixed cost Assumption

	Network airlines	Low fares airlines
Overall Fixed costs	60%	50%
ETS fixed costs	0%	0%

For the purpose of this modelling, the percentage of fixed cost over a period of one year is assumed to represent more than half the costs incurred by airlines. This assumption is also retained in some studies that commented on our approach, so we have aligned our view on that assumption.

3.3 Impact on demand

Below we describe how we have estimated the impact of aviation's entry into the EU ETS on traffic demand. This process is central to our estimates of the financial impact on airlines. This discussion includes an examination of our assumptions of the price elasticity of demand and a description of the methodology used to translate increases in tariffs stemming from ETS into changes in business as usual demand.

19 These assumptions are similar for network airlines and cargo airlines.

3.3.1 Price Elasticity

Any increase in price will lead to a decrease in demand. The relationship between that increase in price and the subsequent decrease in demand is evaluated by a price elasticity of demand that describes the relationship between changes in quantity demanded of a good or a service and changes in the price of that good or service. If the price increases by 1% and the quantity demanded decreases by 2%, the price elasticity of demand would be -2% ÷ 1%, or -2. Any number above 1 indicates relatively elastic demand, whereas numbers between 0 and 1 indicate relatively inelastic demand.

We have assumed the following price elasticity of demand for the different segments in our simplified market:

Table 3-7: Price Elasticity Assumptions

	Business	Leisure
Network airlines (short haul)	-0.8	-1.5
Network airlines (long haul)	-0.8	-1.0
Low fares airlines	-1.5	-1.5
	Express	Standard
Cargo airlines	-0.8	-1.6

These assumptions about consumer behavior, which are identical to those used in our previous study, were based on a review of a range of existing studies, as described in Table 3-8.

Table 3-8: Existing Research on Elasticity of Demand for Passenger Airlines

Study	Elasticity of demand
OXERA	-0.8 (business) and -1.5 (leisure)
CE DELFT	-0.2 to -1.0
TRUCOST	-1.0 to -1.5
Dresdner Kleinwort Wasserstein	-0.5 to -1.4
Government of Canada	-0.7 to -1.5
IATA	-0.6 to -1.4

As before, we believe that the estimates set out in the OXERA Study continue to provide a sensible mid-point assumption[20] for passenger services. However, we have used a lower estimate for long-haul leisure passengers, as this market is generally perceived to be less elastic and this market segment was not specifically considered by the OXERA study.

Information on the price elasticity of demand for cargo airlines and their services is scarcer. However, research undertaken by the World Bank, which summarises the results of a range of studies[21], suggests that the elasticity of demand for cargo services is between -0.8 and -1.6. For the purposes of this impact assessment, we have assumed that express freight services have an elasticity of demand in line with the bottom end of this range, and that standard air cargo services are at the top end of the range.

3.3.2. Impact on Prices and Demand

Our assessment of business as usual demand has been drawn from an analysis of a number of forecasts of global passenger and cargo demand, such as the Boeing World Market Outlook 2007 and the Airbus Global Market Forecast, combined with market information from sources such as AEA, ELFAA, Eurostat and IATA. This analysis results in a business as usual annual average growth rate for RTKs of 4.7%, with long-haul (5.1%) growing slightly faster than the market as a whole and intra-European traffic somewhat below the market average at 3.5%.

20 It should also be noted that the OXERA work draws on 37 other studies to identify its estimates of the Price Elasticity of Demand.
21 “A Survey of Recent Estimates of Price Elasticities of Demand for Transport – Infrastructure and Urban Development Department”, World Bank (1990).

Inclusion of aviation in the EU ETS: Cases for Carbon Leakage

The impact of ETS on demand was modelled by reference to a series of routes. For each market segment, we have identified the typical characteristics of a domestic, short haul and long haul route, including:

- a typical aircraft type;
- sector length;
- number of seats/total payload;
- average load factor;
- average yield per RPK or RTK;
- fuel consumption and corresponding CO_2 emissions.

Data has been drawn from a range of sources to define these sample routes, but comes mainly from AEA's STAR 2007 report and the CORINAIR EMEP report. These routes are used as a basis for examining the change in ticket price stemming from aviation's inclusion in the EU ETS and the consequent impact on demand, based on the price elasticities set out above. More details of this approach and the assumptions used can be found in Appendix F: Calculating the Impact on Demand.

3.4 Impact on Airlines' Profitability and Competitiveness

Below we consider how the costs of ETS and the changes in demand stemming from changes in ticket price will impact on airlines' financial health. We have examined two main indicators in this analysis:

- the impact on GVA is a measure used in the CS Report to consider the extent to which a sector is exposed to carbon leakage. It is used in a similar way here;
- the effect on operating margins, which we feel provides a better indicator of the overall impact on airlines' financial health and, more importantly, their ability to invest.

3.4.1 Impact on GVA

Table 3-9 below shows data from the CS study on the industries found to be significantly exposed to carbon leakage. The first five were found to be so exposed as to warrant free allocation of allowances. The last three would need some free allocation in the event of high carbon prices. For the aviation sector, we used an analysis of aviation data provided by AEA based on the 2007 annual reports of nine companies: Lufthansa, Air France-KLM, Finnair, British Airways, Aer Lingus, Austrian, Iberia, SAS, TAP and Cargolux.

To enable comparison with the CS study, for the purposes of this exercise we have assumed an allowance price of €20/tCO_2. As stated earlier in this report, we believe this assumption to be low considering the latest information available.

The analysis demonstrates that aviation is potentially significantly exposed to carbon leakage, with between 6% and 23% of Gross Value Added at stake. This puts the sector firmly amongst those sectors considered to warrant free allocation of allowances and significantly above those that would need some free allocation in the event of high carbon prices.

Table 3-9: Comparative GVAs across sectors

Sector	Gross Value Added at stake at € 20/t CO_2	
Cement	33.9%	*Source: CS study*
Iron & steel	26.4%	“
Aluminium	10.4%	“
Basic Chemicals	9.0%	“
Pulp & paper	8,8%	“
Glass	4.9%	“
Rubber tyres	4.6%	“
Copper	3,9%	“
Aviation	6-23%	*source: AEA*

3.4.2 Why is operating margin a more effective indicator than GVA for aviation?

Different methods can be used to show the impact of EU ETS on the competitiveness of European airlines. The first methodology involves estimating the cost of EU ETS as a percentage of a company's GVA, as shown above. GVA is a helpful macroeconomic indicator for measuring the performance of a sector. This demonstrates the maximum value at stake for the aviation sector and shows the potential costs of EU ETS within the context of airline operations.

However, GVA depends on the characteristics of each sector. Therefore, considerable care needs to be taken in making comparisons across sectors solely on the basis of Gross Value Added. In this case, aviation is the only service industry on the list, albeit a service industry with significant capital and labour costs. Added value mainly reflects the contribution of labour and capital to raising the value of a product. High capital and labour costs therefore imply high added value. However, this is not an indicator of operating margins and the long term sustainability of a sector's financial performance.

Operating margins in the aviation sector are historically low, making additional costs harder to assimilate. On this basis, we have focussed our assessment of the financial impact on airlines of the effect of EU ETS on operating margins.

3.4.3 Operating margins in the aviation sector

Our assumptions in relation to the operating margins[22] of different market segments were based on the operating margin of representative airlines over the last three fiscal years (2004-2007). The assumed operating margin rate was obtained by taking the average operating margin of several airlines, weighted by their operating revenues. The low fares' segment has been divided into two groups in order to reflect the substantial diversity in current financial performance in this segment of the market. There is a clear group of market leaders, with high market shares and high margins, and a second group of much smaller airlines with low market shares and low margins. This does not imply that the other segments are homogenous, but the range in other sectors is less extreme and it is not possible to identify groups in the same way. Our assumptions for the purposes of this analysis are set out in Table 3-10.

Table 3-10: Financial Assumptions for Airlines

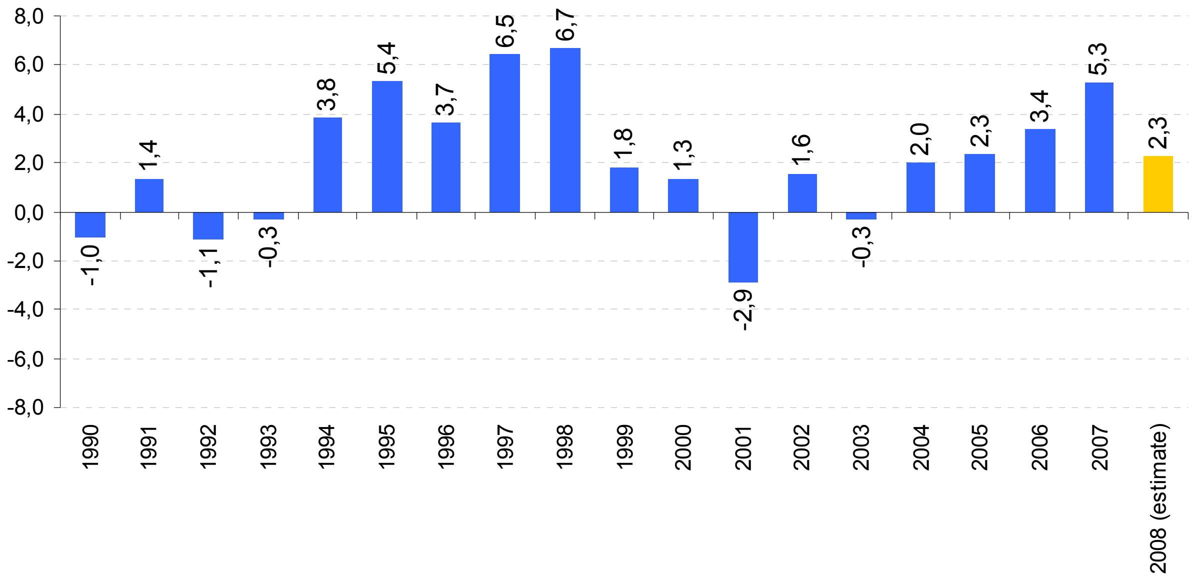
	Network airlines	Low Fares airlines Market Leaders	Low Fares airlines Others	Cargo airlines
Operating margin	4%	14%	2%	4%

- Figure 3-2 provides further justification for our assumption in relation to **network airlines**. The chart shows yearly average operating margins for AEA airlines over the past 17 years. This data suggests that the assumed 4% operating margin, which is based on figures for 2004-2007, is an optimistic assumption of long-term operating margins. It also demonstrates that there is considerable volatility in the average operating margin over time. As a result of recent high fuel prices and the current global economic slowdown, the average operating margin for 2008 is expected to be substantially lower than in recent years. This will put further pressure on airlines seeking to assimilate the additional costs of ETS. It should be noted that while the data displayed only covers AEA carriers, a similar pattern is likely to be seen across the industry.

- **Worldwide airline results** during the period 2001-2006 (since the tragic events of '9/11') recorded losses in each year, aggregating to a loss for the entire period of USD42 billion. IATA estimates results for 2007, 2008 and 2009 to be a profit of USD5.6 billion and losses of USD 5.2 billion and USD4.1 billion respectively. Most industry analysts believe that the effects of the worldwide economic downturn will last longer and be more far-reaching than the more transitory effects of '9/11'.

22 The operating margin is the ratio of operating profit divided by operating revenues.

Figure 3-2: Evolution of the operating margin[23] of network airlines 1990-2008



Source: AEA

Below, we consider the impact of the increasing costs of EU ETS and the corresponding loss of demand on the profits of each of our operating segments. It should be noted that the figures presented below look at the impact of the EU ETS assuming that all other factors remain equal. Since the scope of the analysis is all flights to/from an EU airport, consequently these impacts cover both EU and non-EU airlines.

3.4.4 Network Airlines

Based on an assumed business as usual operating margin of 4%, Table 3-11 shows the impact of our various ETS scenarios on the operating profits of network airlines. The loss of margin is a result not only of the cost of the EU ETS but also the decrease in demand caused by higher ticket prices.

Table 3-11: Impact on Network Airlines' Operating Profits (€ millions)

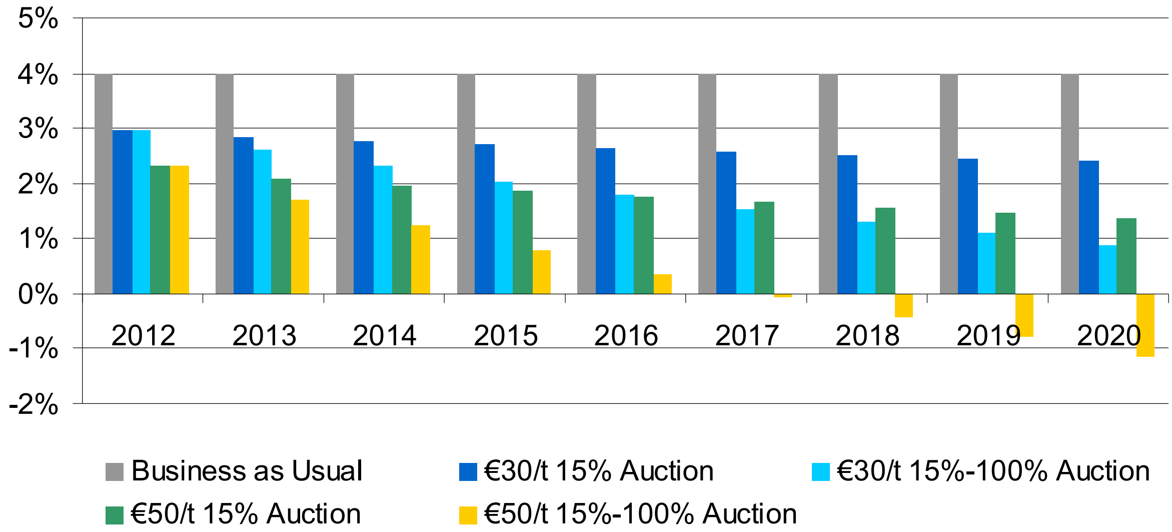
Operational profits Network	Business as Usual (€ Mill.)	€30/tonne 15% Auction (€ Mill.)	€30/tonne 15%-100% Auction (€ Mill.)	€50/tonne 15% Auction (€ Mill.)	€50/tonne 15%-100% Auction (€ Mill.)
2012	6 756	-1 751	-1 751	-2 870	-2 870
2013	7 015	-2 051	-2 460	-3 365	-4 039
2014	7 285	-2 253	-3 078	-3 696	-5 059
2015	7 565	-2 464	-3 713	-4 044	-6 110
2016	7 855	-2 686	-4 366	-4 411	-7 191
2017	8 157	-2 920	-5 037	-4 796	-8 304
2018	8 470	-3 124	-5 685	-5 133	-9 379
2019	8 795	-3 381	-6 392	-5 558	-10 554
2020	9 131	-3 652	-7 117	-6 004	-11 760
Total	**71 030**	**-24 281**	**-39 600**	**-39 876**	**-65 265**

Source: Ernst & Young and York Aviation

[23] Operating margin before interest, source: AEA

The impact of ETS on network airlines' operating margins is shown in Figure 3-3.

Figure 3-3: Impact on Network Airlines' Operating Margins



Source: Ernst & Young and York Aviation.

Based on this analysis, inclusion in the EU ETS will result in a loss of operating profit for network airlines of between €24.3 billion and €65.3 billion over the period 2012 to 2020. In 2020, the loss of annual operating profit would be between €3.7 billion and €11.8 billion. This corresponds to a decline in network airlines' operating margins to between 2.4% and -1.2%, compared to the assumed operating margin of 4%.

The main determinant of the level of impact is the extent of auctioning within the design of the EU ETS. As the level of auctioning increases airlines' exposure to EU ETS increases and this is reflected in a significantly greater impact on profitability. The extent of this difference is best illustrated by comparing scenarios with the same allowance price. For instance, if allowances are priced at €50 per tonne, the scenario where auctioning increases to 100% by 2020 would result in an additional loss of operating profit between 2012 and 2020 of around €25 billion over and above the scenario where auctioning remains constant at 15%.

The implications of this erosion of profitability for network airlines are potentially severe, particularly if 100% auctioning is introduced. The impact assessed here is an average; but across the segment different airlines will be affected to a greater or lesser degree. Some companies will cease to be profitable, resulting in significant restructuring within the industry. The extent of such a restructuring process will depend particularly on the level of auctioning, which is the primary determinant of the financial impact. Networks are likely to be rationalised, with low volume spoke routes and marginal long haul services particularly at risk. However, it seems likely that in many cases this rationalisation is likely to take the form of reduced frequency rather than a total loss of connections, as airlines continue to try to realise the benefits of their network model. There is also likely to be a degree of capacity reduction as airlines seek to focus on their cost base. Airlines will also find it more difficult to invest in new aircraft, making future improvements in fuel efficiency harder to achieve.

It is also important to consider that the EU ETS will affect EU and non-EU airlines differently. All the activities of Europe's network airlines will be covered by the EU ETS, whereas only a relatively small proportion of non-EU airlines' activity will be affected. Therefore, it seems reasonable to assume that most of the impact of inclusion in the EU ETS will fall upon EU-based carriers. This has considerable implications for the competitive balance between these groups, particularly, in terms of their ability to invest. We have already noted the potential difficulties for airlines to invest in new aircraft, but there are also more general issues, notably the ability to invest in areas such as product development, training, and research and development of new technologies.

3.4.5 Low Fares/Leisure Airlines

The low fares' market is more segmented. For the purposes of this analysis we have considered two groups within this segment: high market share/high margin market leaders (Low fares 1) and low market share/low margin other low fares/leisure carriers (Low fares 2).

Market Leaders

Based on an assumed business as usual operating margin of 14%, we have set out in Table 3-12 the impact of our various EU ETS scenarios on the operating profits of low fares airlines' leaders.

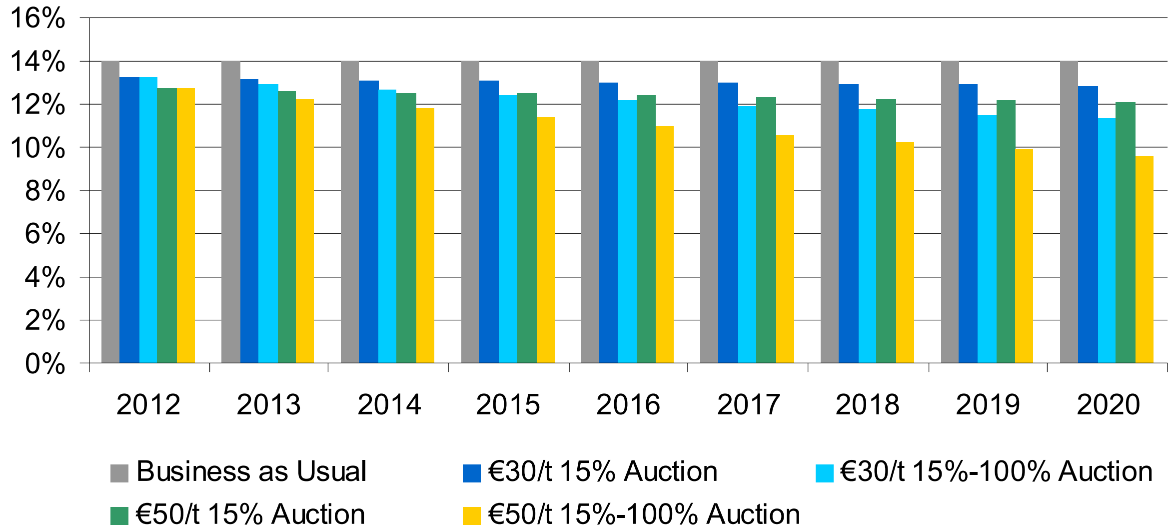
Table 3-12: Impact on Low Fares 1 Airlines' Operating Profit (€ millions)

Operational profits Low Fares 2	Business as Usual (€ Mill.)	€30/tonne 15% Auction (€ Mill.)	€30/tonne 15%-100% Auction (€ Mill.)	€50/tonne 15% Auction (€ Mill.)	€50/tonne 15%-100% Auction (€ Mill.)
2012	2 088	-121	-121	-198	-198
2013	2 227	-143	-181	-235	-297
2014	2 376	-161	-239	-264	-394
2015	2 534	-180	-303	-295	-499
2016	2 703	-200	-372	-329	-613
2017	2 883	-223	-446	-366	-737
2018	3 076	-247	-526	-406	-870
2019	3 281	-273	-613	-449	-1 014
2020	3 500	-302	-706	-496	-1 169
Total	**24 668**	**-1 849**	**-3 507**	**-3 039**	**-5 791**

Source: Ernst & Young and York Aviation

The impact of ETS on the operating margins of low fares airlines' leaders is shown in Figure 3-4.

Figure 3-4: Impact on Low Fares 1 Airlines' Operating Margins



Source: Ernst & Young and York Aviation.

Between 2012 and 2020, we estimate that the high market share/high margin group will suffer a loss of operating profit of between €1.8 billion and €5.8 billion depending on the design of the ETS. The annual loss of operating profit is estimated to reach between €0.3 billion and €1.2 billion by 2020. This corresponds to a decline in low fares 1 airlines' operating margins from the assumed operating margin of 14% to between 12.9% and 9.5%. Again, the primary determinant of the extent of losses is the level of auctioning.

Other Low Fares/Leisure Airlines
Based on an assumed business as usual operating margin of 2%, we have set out in Table 3-13 the impact of our various EU ETS scenarios on the operating profits of other low fares airlines.

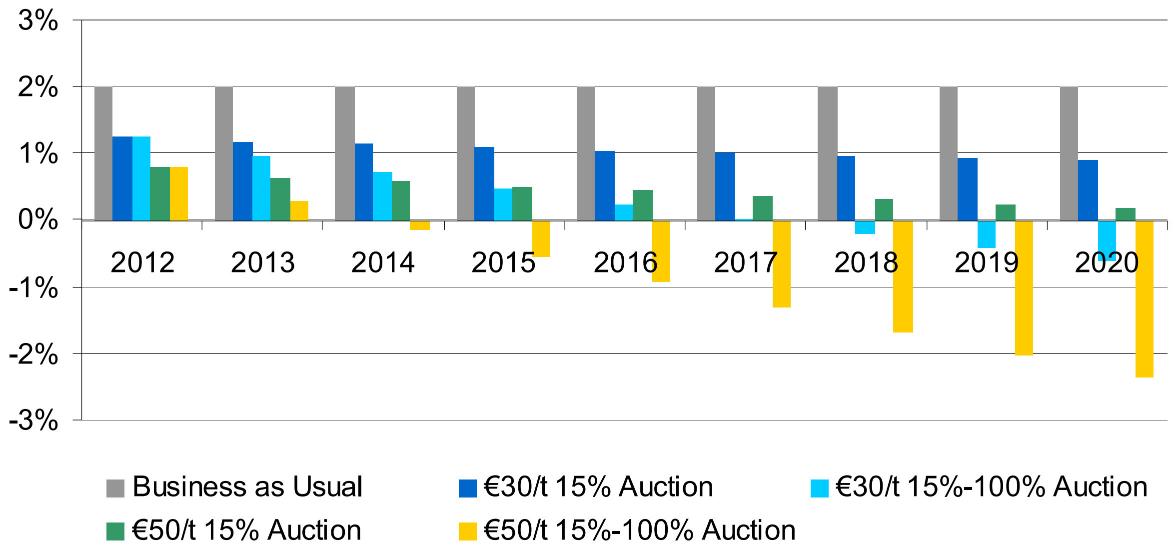
Table 3-13: Impact on Low Fares 2 Airlines' Operating Profit (€ millions)

Operational profits Low Fares 2	Business as Usual (€ Mill.)	€30/tonne 15% Auction (€ Mill.)	€30/tonne 15%-100% Auction (€ Mill.)	€50/tonne 15% Auction (€ Mill.)	€50/tonne 15%-100% Auction (€ Mill.)
2012	298	-111	-111	-183	-183
2013	318	-132	-167	-216	-274
2014	339	-148	-221	-243	-363
2015	362	-166	-279	-272	-460
2016	386	-185	-343	-303	-565
2017	412	-205	-411	-337	-678
2018	439	-228	-485	-374	-801
2019	469	-252	-565	-414	-934
2020	500	-278	-650	-457	-1 076
Total	**3 524**	**-1 704**	**-3 232**	**-2 800**	**-5 334**

Source: Ernst & Young and York Aviation

The impact of ETS on the operating margins of other low fares' airlines is shown in Figure 3-5.

Figure 3-5: Impact on Low Fares 2 Airlines' Operating Margins



Source: Ernst & Young and York Aviation.

Between 2012 and 2020, we estimate that the low market share/low margin low fares/leisure airlines will suffer a loss of operating profit of between €1.7 billion and €5.3 billion, depending on the design of the EU ETS. The annual loss of operating profit is estimated to reach between €0.3 billion and €1.1 billion by 2020. This corresponds to a decline in low fares 2 airlines' operating margins from the assumed operating margin of 2% to between 0.9% and -2.4%. Again, the primary determinant of the extent of losses is the level of auctioning.

Implications for Low Fares/Leisure Airlines

The implications of these results for low fares' airlines are subtly different from those of network airlines. As we have seen, while operating margin rates among the leaders of low fares' airlines are strong, there are substantial variations in the market place. The level of impact indicated here is likely to result in the exit from the market of some weaker carriers and a general consolidation.

Unburdened by network considerations, the stronger low cost companies are likely to withdraw from routes that have become unprofitable and weaker low cost airlines will probably have to leave the market. In other words, the expansion of connections within the EU that has been driven by low fares' airlines in recent years is likely to slow, or perhaps even cease. Under higher impact scenarios, there is a real possibility of reductions in the number of routes served, which could have particular implications for new Member States. We discuss this issue in more detail below.

3.4.6 Cargo Airlines

Based on an assumed business as usual operating margin of 4%, we have set out in Table 3-14 the impact of our various EU ETS scenarios on the operating profits of cargo airlines.

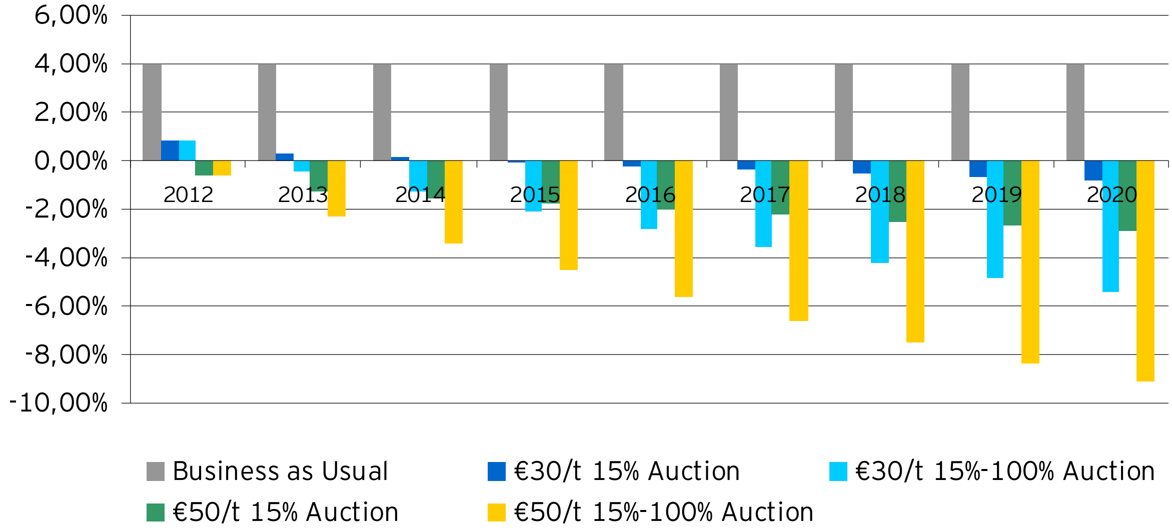
Table 3-14: Impact on Cargo Airlines' operating profit (€ millions)

Operational profits Cargo	Business as Usual (€ Mill.)	€30/tonne 15% Auction (€ Mill.)	€30/tonne 15%-100% Auction (€ Mill.)	€50/tonne 15% Auction (€ Mill.)	€50/tonne 15%-100% Auction (€ Mill.)
2012	649	-522	-522	-739	-739
2013	682	-630	-752	-898	-1 063
2014	716	-693	-942	-988	-1 323
2015	751	-760	-1 138	-1 083	-1 593
2016	789	-831	-1 342	-1 184	-1 872
2017	828	-906	-1 555	-1 291	-2 163
2018	870	-985	-1 776	-1 404	-2 465
2019	914	-1 069	-2 005	-1 524	-2 778
2020	960	-1 158	-2 244	-1 651	-3 103
Total	**7 159**	**-7 554**	**-12 276**	**-10 760**	**-17 099**

Source: Ernst & Young and York Aviation

The impact of EU ETS on cargo airlines' operating margins is shown in Figure 3-6.

Figure 3-6: Impact on Cargo Airlines' Profit Margins



Source: Ernst & Young and York Aviation.

Our analysis suggests that cargo airlines constitute the most vulnerable segment of the market. All the scenarios described result in significant losses for cargo airlines and a total erosion of operating margins. Between 2012 and 2020, it is estimated that cargo airlines will lose between €7.6 billion and €17.1 billion in operating profits, with operating margins falling from the assumed operating margin of 4.0% to between -0.8% and -9.1%.

This particularly severe impact stems from the generally higher proportion of fuel costs in cargo airlines' overall operating costs. This is due to the fact that the cargo sector is considerably less labour intensive (no cabin crew, fewer ground and service staff) than network and low cost airlines. Hence, cost impacts related to fuel, such as emissions, have a greater effect.

The impact of such losses within the market will undoubtedly be significant, leading to substantial restructuring and consolidation within the segment. With their focus on long-haul traffic, there will also be a strong incentive for cargo airlines to move hub activities away from Europe and to add intermediate stops to routes, thereby limiting their exposure to ETS. Within Europe, low volume routes are likely to be withdrawn and there could be a further significant shift towards increased trucking of goods. However, EU cargo airlines' ability to shift their hub operations outside of Europe will be substantially limited by the availability of traffic rights. The segment's ability to invest in new technology to improve its fuel efficiency is also likely to be eroded.

3.5 Conclusion

In this chapter we have identified a number of key points:

- Windfall profits are not achievable in the aviation sector. The nature and characteristics of the industry and the market in which it operates are quite different from other sectors where such profits are assumed to have occurred;
- Cost pass-through is a complex issue and it cannot be assumed that airlines will be able to simply pass on all their costs to consumers. The level of competition on routes and the congested nature of a significant part of the air transport infrastructure in Europe means that in reality cost pass-through rates are likely to be substantially below 100%;
- The EU ETS will have a severe impact on the financial health of airlines.

The extent of this impact is primarily determined by the level of auctioning:

Table 3-15: Financial impact of the EU ETS

	M€	Business as usual operating margin	Impact scenario 1: €30/tCO2, 15% auctioning	Impact scenario 2: €30/tCO2, increasing auctioning	Impact scenario 3: €50/tCO2, 15% auctioning	Impact scenario 4: €50/tCO2, increasing auctioning
Network	2012	6 756	-1 751	-1 751	-2 870	-2 870
	2020	9 131	-3 652	-7 117	-6 004	-11 760
	2012-2020	**71 030**	**-24 281**	**-39 600**	**-39 876**	**-65 265**
Low fares (1+2)	2012	2 386	-232	-232	-381	-0 381
	2020	4 000	-580	-1 356	-954	-2 245
	2012-2020	**28 192**	**-3 554**	**-6 739**	**-5 839**	**-11 125**
Cargo	2012	649	-522	-522	-739	-0 739
	2020	960	-1 158	-2 244	-1 651	-3 103
	2012-2020	**7 159**	**-7 554**	**-12 276**	**-10 760**	**-17 099**
Total	2012	9 791	-2 505	-2 505	-3 989	-3 989
	2020	14 091	-5 390	-10 717	-8 609	-17 109
	2012-2020	**106 380**	**-35 388**	**-58 614**	**-56 475**	**-93 489**

While the inclusion of the aviation sector in the EU ETS has a marked effect on airline profitability in all scenarios, this effect is magnified severely in those scenarios with 100% auctioning. The loss of profitability that 100% auctioning brings about is highly significant and is likely to lead to restructuring in the airline market which will, in turn, have a knock-on effect on users. Rationalisation of networks, reduced capacity and a focus on higher yield routes will change the way in which air services play their role in the EU. These issues are considered further later in this report.

It should also be noted that we have adopted assumptions in relation to the operating margins of airlines based on performance in recent years. These years have been relatively good years for the airline industry. With rising fuel prices and a slowing global economy, operating margins in the near future are likely to be substantially lower. This means that airlines will find it harder to assimilate the costs of ETS and invest for the future.

It is also important to consider the balance of these impacts between EU and non-EU airlines. EU-based airlines will suffer considerably greater impacts than non-EU based carriers simply because all of their activities will be affected by the EU ETS, compared to only a relatively small proportion of the activities of non-EU based carriers. It is therefore reasonable to assume that the majority of these losses will be felt by EU airlines, particularly with regard to their long-term ability to invest and to compete with non-EU carriers in global markets.

4. CASE STUDIES

There is a risk of transfer of activities to non-EU operators or to routes not covered by the EU ETS

KEY FINDINGS

Examination of four case studies to illustrate different forms of traffic deviation/carbon leakage:

- **Case study 1** – Passenger/cargo by-passing the EU on international long-haul flights between two cities located outside the EU, thus completely avoiding the EU ETS cost.
- **Case studies 2 and 3** – Passenger/cargo flying via a non-EU airport rather than using the direct flight on international long-haul flights between two cities, one located within and the other outside the EU, thus avoiding part of the EU ETS cost.
- **Case study 4** – Passenger/cargo flying via a non-EU airport rather than an EU airport on international long-haul flights between two cities, one located within and the other outside the EU, thus reducing the EU ETS cost.
- **Case study 5** – Creation of additional intermediate stops outside the EU on international long-haul flights to and from the EU, thus reducing the EU ETS cost.
- **Case studies 6 & 7** – Carbon leakage to car

4.1 The particular characteristics of the aviation sector

The concept of carbon leakage for ground-based sectors covers two scenarios: either the EU manufacturer moves its activities outside the EU to avoid ETS costs (supply-driven carbon leakage), or it loses its market share/competitiveness because of high EU ETS costs and demand shifts to a non-EU manufacturer (demand-driven carbon leakage). In both cases, greenhouse gases from operators not covered by the EU ETS will continue to be emitted into the atmosphere.

However, it is important to recall some basic differences between aviation and ground-based sectors:

- Aviation, as a mobile source, emits CO_2 all along the air route, crossing national borders and different geographical regions. This international dimension is its main feature;
- Aviation provides a service and does not manufacture a product. Its service (a seat offered on a given flight) cannot be stocked. An unsold seat is definitively lost;
- Given the existing constraints of the bilateral traffic rights system and national ownership rules, EU carriers cannot realistically switch their activities away from the EU and move their fleet (centre of production) outside the EU;
- However, there is nothing to stop passengers from changing their behaviour and shifting to non-EU carriers and to alternative routings.

Therefore, carbon leakage for airlines is better defined as the risk of traffic being deviated from EU operators to the benefit of non-EU operators. In other words, it is not the production facilities but demand (i.e. passengers and goods) that generates carbon leakage. However, the consequences are quite similar to those for ground sources, since rather than reducing overall CO_2 emissions, the EU ETS would in some cases shift aviation emissions from within the EU to outside the EU.

4.2 Main types of carbon leakage in the aviation sector

The avenues through which carbon leakage could occur in the aviation sector can be broadly summarised as follows:

- ***In intercontinental markets between non-EU origins and non-EU destinations***: 8%[24] of passenger traffic arriving at EU airports from non-EU origins is connecting to non-EU destinations. Those passengers (and possibly some cargo traffic) could bypass the EU and fly to their final destination via a non-EU hub, located for example in the Middle East, which faces no EU ETS costs. The result would be less activity for European carriers and their home airports but an increase in unregulated emissions around the world.

- ***In intercontinental markets between EU and non-EU airports:*** passenger or cargo traffic could be lost, to the benefit of airline operators offering connections at hubs close to the borders of the EU and which face lower ETS costs. In that scenario, there will be increased competition between direct long-haul routes and indirect services. In fact the balance will shift in favour of operations that are less affected by ETS costs, namely indirect routes via a hub outside the EU. It is estimated that 30%[25] of passengers arriving at EU airports are connecting at an EU hub to an EU origin or destination. Although these passengers could not avoid the EU, they care little about the intermediate airport at which they connect, unless it adds significant time to the journey. In such circumstances it is very likely that passengers will be highly sensitive to price and could easily switch to a non-EU hub in the event of price distortion in the market.

- ***Inbound tourists*** could be diverted to non-EU destinations, as they constitute the most price-sensitive part of the aviation sector, with an estimated route level elasticity of -1.4. It is estimated that around 25%[26] of passenger traffic is generated by non-EU residents travelling into the EU for leisure. The changes in fares resulting from the EU ETS could incite them to switch to alternative leisure destinations outside the EU, thus causing carbon leakage.

- ***Cargo airlines*** could choose to add a stopover outside the EU in order to reduce the distance covered by the EU ETS. The possibilities on routes from Asia, South America and Africa are greater than on services between North and Central America and Europe. Russia, non-EU countries in Eastern Europe, Central Asia, the Middle East and North Africa could become potential stops. In some cases these points may be on the great circle route, but in other cases they may represent a diversion from the great circle route and, consequently, may generate higher emissions than a direct route.

- ***For intra-EU markets***, increased carbon emissions could be caused by the diversion of short-haul air passengers to surface transport modes which are not subject to the EU ETS or not covered by other restrictions on carbon emissions.

A further possibility, which has not been examined in depth, is that non-European companies could also choose to use less efficient aircraft outside Europe and reserve their most modern, fuel efficient aircraft for sectors within the EU. This would be equivalent to relocating CO_2 emissions outside Europe without changing either the level or pattern of activity.

One issue worthy of further comment prior to our analysis is the position of Switzerland. Switzerland is not part of the EU ETS and in theory could be an outlet for carbon leakage. However, on 1 January 2008 Switzerland initiated its own emissions trading scheme. The linking of the two systems is currently under discussion. Consequently, for the purposes of this study, we do not consider that Switzerland (and more especially Zurich airport) represents a risk of carbon leakage.

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24 Source UNWTO (passenger figures by mode / purpose) and IATA (connecting traffic)
25 Source UNWTO (passenger figures by mode / purpose) and IATA (connecting traffic)
26 Source UNWTO (passenger figures by mode / purpose) and IATA (connecting traffic)

4.3 Case Study 1: Bypassing EU on international long-haul flights between non-EU cities

The example relates to a one-way flight from New York (JFK) to Bombay (BOM) either via Amsterdam (AMS, option A) or via Dubai (DXB, option B).

Figure 4-1: Case study 'Bypassing the EU on international long-haul flights between two non-EU cities

For the purposes of this analysis we have not included the difference in fuel and landing costs associated with each routing, assuming that the networks that bypass Europe are already developed (e.g. Middle East) and that the change in the system will give these carriers an additional pricing advantage. We have also assumed a 100% auctioning rate.

Table 4-1: Case study 'Bypassing the EU on international long-haul flights between two non-EU cities'

	Length (km)	kg CO_2 per passenger	EUETS Cost 100% auctioning €30/tCO_2 per passenger
Option A: JFK ➔ AMS	5 845	408	€ 12
Option A: AMS ➔ BOM	6 854	441	€ 13
Option B: JFK ➔ DXB	10 992	817	€ 0
Option B: DXB ➔ BOM	1 928	144	€ 0
Option A	12 699	849	€ 25
Option B	12 920	961	€ 0
Difference B-A	**+221**	**+112**	**-€ 25**

Source for distances and carbon emissions: ICAO Calculator

This type of traffic deviation/leakage affects the intercontinental market for passengers flying between two cities located outside the EU. These journeys could be made either via an EU or a non-EU hub. Any rise in price due to high levels of auctioning will diminish the attractiveness of the EU routing and will encourage passengers/cargo to simply bypass the EU. They may either use a direct flight, if any, or go via a non-EU hub. As illustrated in our case study the intermediate point is of little consequence to the vast majority of passengers. Hence, there is likely to be little consumer 'loyalty' to the EU routing.

The traffic deviation/carbon leakage via a non-EU hub will result in an additional 112 kg CO_2 per passenger. This represents 13% extra CO_2 per passenger compared to the flight via AMS. This type of traffic deviation/carbon leakage is not only environmentally harmful but also economically detrimental. These markets are particularly important for the EU carriers as they are key drivers of profitability and are also central to their networks, which concentrate and consolidate intercontinental demand at their European home base hubs.

4.4 Case Study 2: Direct vs indirect routes on international long-haul flights between EU and non-EU cities: passengers

The example relates to a one-way flight from Paris (CDG) to Beijing (PEK) either direct (CDG, option A) or via Dubai (DXB, option B).

Figure 4-2: Case study 'Direct versus indirect routes on international long-haul flights between two EU and non-EU cities: passengers'

Again, for the purposes of this analysis we have not included the difference in fuel and landing costs associated with each routing, assuming that the networks that bypass Europe are already developed (e.g. Middle East) and that the change in the system will give these carriers an additional pricing advantage. We have also assumed a 100% auctioning rate.

Table 4-2: Case study 'Direct versus indirect routes on international long-haul flights between two EU and non-EU cities: passengers'

	Length (km)	kg CO_2 per passenger	EUETS Cost (100% auctioning €30/tCO_2 per passenger)
Option A: PAR ➔ PEK	8 185	572	€ 17
Option B: PAR ➔ DXB	5 232	371	€ 11
Option B: DXB ➔ PEK	5 843	416	€ 0
Option A	8 185	572	€ 17
Option B	11 075	787	€ 11
Difference B-A	**+2 890**	**+215**	**-€ 6**

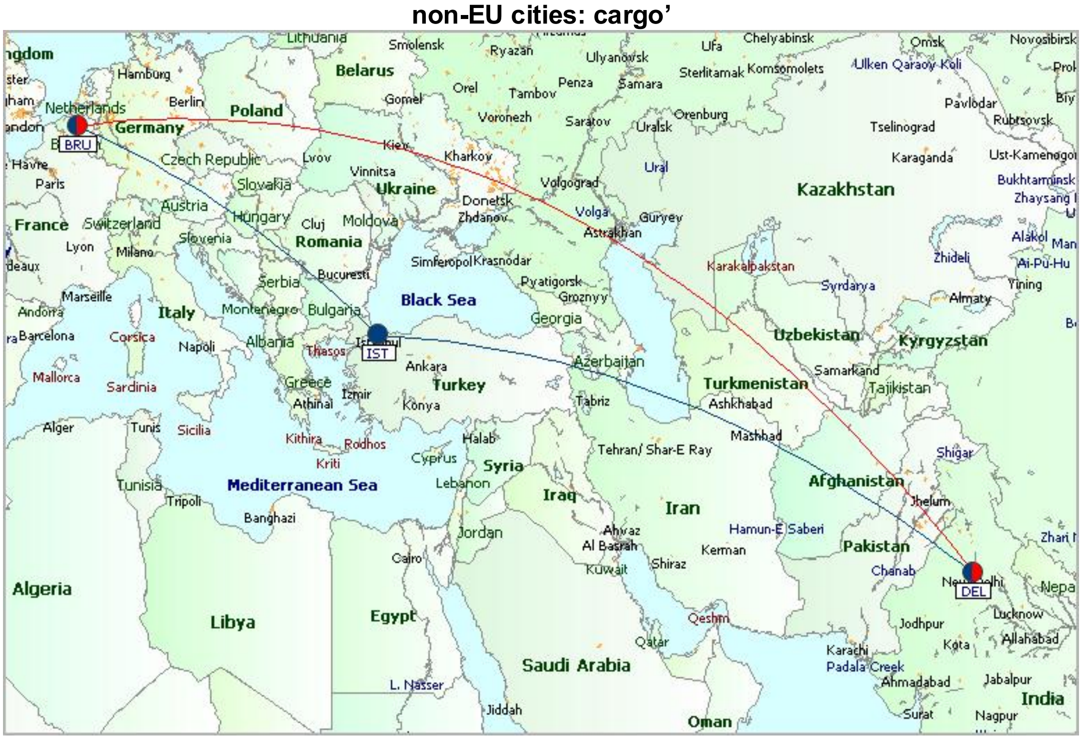
Source for distances and carbon emissions: ICAO Calculator

This type of traffic deviation/leakage affects the intercontinental market for passengers flying between two cities, one located within and the other outside the EU. These journeys could be made either directly or via a non-EU hub. The direct flight will incur additional costs of €6 per passenger but the indirect route via Dubai will result in an additional 215 kgCO_2 per passenger being emitted. This represents 38% more CO_2 per passenger compared to the direct flight. It is obvious that in this case there will be no environmental benefit.

4.5 Case Study 3: Direct vs indirect routes on international long-haul flights between EU and non-EU cities: cargo

The example mentioned above is also bound to occur on some cargo routes. Cargo traffic could be diverted to indirect routes that would become cheaper for Cargo clients. We have set out the case of a one-way flight from Delhi (DEL) to Brussels (BRU, option A) direct or via Istanbul (IST, option B).

Figure 4-3: Case study 'Direct vs indirect routes on international long-haul flights between EU and non-EU cities: cargo'



Again, for the purposes of this analysis we have not included the change in fuel and landing costs associated with each routing, assuming that the networks that bypass Europe are already developed (e.g. Middle East) and that the change in the system will give these carriers an additional pricing advantage. We have also assumed a 100% auctioning rate.

Table 4-3: Case study 'Direct vs indirect routes on international long-haul flights between EU and non-EU cities: cargo'

	Length (km)	CO_2 emissions ($t\ CO_2$)	Costs of CO_2 emissions under EU ETS (hyp.: €30/tCO_2)	Payload (tonnes)	Cost of CO_2/tonne transported
Option A: DEL - BRU	6 482	277	€ 8 310	119.3	€ 70
Option B: DEL - IST	4 663	201	€ 0	119.3	€ 0
Option B: IST - BRU	2 208	94	€ 2 817	119.3	€ 24
Option A	6 482	277	€ 8 310	119.3	€ 70
Option B	6 871	295	€ 2 817	119.3	€ 24
Difference B-A	**+ 389**	**+ 18**	**- € 5 493**	**0**	**- € 46**

Source: EEA (European Express Association)

In the example quoted, the indirect route will cost € 46/tonne less than the direct one, although it will emit an additional 18tCO_2 (i.e. 6% of the CO_2 emissions of the direct flight).

4.6 Case Study 4: Intercontinental flights between EU and non-EU airports where no direct flight is available

The example relates to a one-way flight from Nice (NCE) to Tokyo (NRT) either via Frankfurt (FRA option A) or via Istanbul (IST, option B).

Figure 4-4: Case study 'Intercontinental flights between EU and non-EU airports where no direct flight is available'

Again, for the purposes of this analysis we have not included the difference in fuel and landing costs associated with each routing, assuming that the networks that bypass Europe are already developed (e.g. Middle East) and that the change in the system will give these carriers an additional pricing advantage. We have also assumed a 100% auctioning rate.

Table 4-4: Case study 'Intercontinental flights between EU and non-EU airports where no direct flight is available'

	Length (km)	CO_2 emissions (kg CO_2) per passenger	Costs of CO_2 emissions under EUETS (hypothesis: €30/tCO_2) per passenger
Option A: NCE ➔ FRA	715	93	€ 3
Option A: FRA ➔ NRT	9 356	623	€ 19
Option B: NCE ➔ IST	1 794	193	€ 6
Option B: IST ➔ NRT	8 985	695	€ 0
Option A	10 071	716	€ 21
Option B	10 779	888	€ 6
Difference B-A	**+708**	**+172**	**- € 15**

Source for distances and carbon emissions: ICAO Calculator

The flight with a stop in Frankfurt will cost €15 per passenger more than the one through Istanbul. Any increase in the ticket price resulting from this increase in costs will lead some passengers to switchi from the routing via FRA to the routing via IST. However, this alternate routing will result in 172 kgCO_2. This represents an additional 24% CO_2 per passenger compared to the flight via FRA.

4.7 Case Study 5: Addition of an intermediate stop outside the EU on international long-haul flights to/from the EU

For cargo airlines, there is a further possibility that is worth mentioning at this stage. Indeed, for cargo airlines, in certain circumstances it would be rational to avoid part of the cost of the EU ETS by adding an intermediate stop to existing long-haul routes. We have set out the case of a one-way flight from Shanghai (PVG) to Frankfurt (FRA, option A) direct or via Moscow (SVO, option B).

Figure 4-5: Case Study 'Addition of an intermediate stop outside the EU on international long-haul flights to/from the EU'

In this case fuel and landing costs are relevant and have been included in the analysis. Cargo carriers are able to sensibly add a stop to their existing schedules where passenger airlines cannot since this would impact customer service. We have assumed a 100% auctioning rate.

Table 4-5: Case Study 'Addition of an intermediate stop outside the EU on international long-haul flights to/from the EU'

	Length (km)	CO_2 emissions ($t\ CO_2$)	Landing charges	Cost of Fuel	Costs of CO_2 emissions under EU ETS (hyp.: €30/tCO_2)	Total cost
Option A: PVG - FRA	9 034	380	€ 1 632	€ 77 371	€ 11 413	€ 90 415
Option B: PVG - SVO	7 091	304	€ 3 610	€ 61 818	€ 0	€ 65 429
Option B: SVO - FRA	2 069	88	€ 1 632	€ 17 809	€ 2 627	€ 22 067
Option A	9 034	380	€ 1 632	€ 77 371	€ 11 413	€ 90 415
Option B	9 160	392	€ 5 242	€ 79 627	€ 2 627	€ 87 496
Difference B-A	**+126**	**+12**	**+€ 3 610**	**+€ 2 256**	**-€ 8 786**	**-€ 2 919**

Source: EEA (European Express Association)

In the example quoted, the flight with a stopover will cost 3% less than the direct one, although it will emit an additional 12tCO_2 (i.e. 3% of the CO_2 emissions of the direct flight). This suggests that such an indirect routing could make operational sense for a cargo carrier.

4.8 Case Studies 6 & 7: Carbon leakage to car travel

Below, we consider two cases whereby aviation's entry into the EU ETS leads to an increase in CO_2 emissions as passengers are forced to switch modes to car travel. In each case, we have considered two scenarios:

- First, a situation in which price increases stemming from ETS lead to reduced passenger numbers on an air service that stills flies, where the displaced passengers then travel to their destination by car;
- Second, a scenario whereby the costs of ETS undermine route viability to such an extent that the service no longer flies and its passengers therefore have to travel to their destination by car.

In each case, we have assumed that:

- Purpose of travel for passengers reflects domestic air traffic in the UK and this purpose determines the number of passengers per car;
- Car journeys are made using a typical family car emitting 185g of CO_2/Km;
- Cost pass-through assumptions, price elasticity, load factor and yield are in line with those for domestic flights set out in Chapter 3 of the main report.

In the Table below we have examined a domestic route operating between Aberdeen and Teeside operated by a Jetstream 41.

Table 4-6: Case study 'Carbon leakage to car Aberdeen to Teeside'

	Aberdeen to Teeside	**Aircraft**	**Car**	**Total**	**% Change**
	Journey Distance (km)	304	469		
Scenario 1	Passengers without ETS	19.5	0.0	19.5	
	Emissions without ETS (CO_2 tonnes)	0.89	0.00	0.89	
	Passengers with ETS	19.1	0.4	19.5	
	Emissions with ETS (CO_2 tonnes)	0.89	0.02	0.91	**2%**
Scenario 2	Passengers without ETS	19.5	0.0	19.5	
	Emissions without ETS (CO_2 tonnes)	0.89	0.00	0.89	
	Passengers with ETS	0.0	19.5	19.5	
	Emissions with ETS (CO_2 tonnes)	0.00	1.32	1.32	**47%**

Source: York Aviation

This demonstrates that, if the service continues to fly, the rise in price resulting from the EU ETS will result in an increase in total carbon emissions of around 2%. If, however, the service becomes unviable and passengers are forced to make their journeys by car, total emissions could increase by as much as 47%.

The following Table shows a further example of this type of leakage on a route between Leeds and Southampton operated by a Dash 8 Q400.

Table 4-7: Case study 'Carbon leakage to car Leeds to Southampton'

	Leeds to Southampton	**Aircraft**	**Car**	**Total**	**% Change**
	Journey Distance (km)	325	379		
Scenario 1	Passengers without ETS	50.4	0.0	50.4	
	Emissions without ETS (CO_2 tonnes)	2.34	0.00	2.34	
	Passengers with ETS	49.5	0.9	50.4	
	Emissions with ETS (CO_2 tonnes)	2.34	0.04	2.38	**2%**
Scenario 2	Passengers without ETS	50.4	0.0	50.4	
	Emissions without ETS (CO_2 tonnes)	2.34	0.00	2.34	
	Passengers with ETS	0.0	50.4	50.4	
	Emissions with ETS (CO_2 tonnes)	0.00	2.76	2.76	**18%**

Source: York Aviation

This demonstrates, again, that if the service still operates there is an increase of around 2% in carbon emissions with aviation's introduction into the EU ETS as some passengers shift to car. If, however, the service becomes unviable and passengers are forced to make their journeys by car, total emissions could increase by as much as 18%.

As far as Cargo is concerned, such a leakage seems highly unlikely as trucks offer advantages for the overall operating model and are generally already used for journeys of this type.

4.8 Risk of occurrence

In Table 4-8 below, we summarise the main scenarios for carbon leakage relating to aviation and the risk of occurrence on each type of route.

Table 4-8: Main carbon leakage risks per type of route

Types of Flights / Types of Diversion	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)	Not leakage
Switch to ground transport modes	No Leakage	No Leakage	**Leakage** (Case studies 6 & 7)
Tourism diverted from the EU	**Small Leakage**	**Leakage**	**Leakage**

4.9 Conclusion

Our analysis demonstrates that there is a risk of carbon leakage in a number of markets, meaning that non-EU carriers are likely to develop a competitive advantage as a result of this leakage. For the airlines concerned, these markets often involve long-haul sectors which are amongst their most profitable activities. Therefore, EU carriers' potential loss of market share to non-EU carriers is not just about erosion of volumes; it is about erosion of volumes on their most profitable routes.

5. AVIATION EMISSION ABATEMENT OPPORTUNITIES

Fleet renewal remains the most efficient way to reduce emissions. It depends on airlines' financial capacity, on manufacturers' industrial capability to construct aircraft in sufficient numbers and on manufacturers' ability to produce steady technological improvements.

KEY FINDINGS

- Aviation's emissions abatement opportunities remain limited as no spectacular technological leap is expected in the short to medium term.
- Marginal improvements to operating aircraft are unlikely to offer significant relief.
- Thanks to continuous fleet renewal, European carriers' fleet is on average young, relatively modern and efficient.
- In longer term, new aircraft, new engines and improved Air Traffic Management may contribute to further limit aircraft emissions.
- The fundamental problem of the industry is its reliance on kerosene.
- Realistic and cost-effective alternative fuels are not available at present. Certification of blending of bio fuels will take time to ensure compliance with required specifications.

In this chapter we consider the issue of aviation's abatement costs. In other words, in the light of aviation's inclusion in the EU ETS, to what extent will airlines be able to reduce their emissions and, consequently, lessen their exposure to the scheme and limit their vulnerability to carbon leakage? This analysis examines the potential for both short to medium term emissions reductions, with an approximate timescale for implementation of up to 2015 or 2020, and the possibilities for the longer term.

5.1 Short and Medium Term Reductions (up to 2015-2020)

5.1.1 Improvements to operating aircraft.

In the very short term, few technical adaptations exist that would produce significant reductions in emissions. One example of such a programme has been the addition of blended winglets - wing tip extensions - which, according to the manufacturers, reduce block fuel burn by around 3.5 to 4.0 percent on sectors of more than 1,000 nautical miles. These retrofits have also been made available for some out-of-production models[27]. This technology is now in the process of being certified for a range of other aircraft (both passenger and freight models). Certification is expected by late 2008 or early 2009.

A further option for currently operating aircraft is engine upgrades. On average, upgrading programs provide just over a 1% improvement in fuel consumption[28].

5.1.2 Electrical supply during ground stand-by

If the electrical supply was provided by the airport, aircraft would not need to run their Auxiliary Power Units (APU) to provide air-conditioning, lighting, actuation systems, etc during embarkation and disembarkation operations. Although CO_2 emissions from APUs may be negligible compared to the total emissions of a standard Landing & Take Off Cycle, the figures are really only significant for short haul operations with long stand-by times. Furthermore, only large airports can provide the appropriate electricity supply and the decision to develop such facilities does not rest with the aircraft operator. Therefore, the benefit of possible reductions is not considered in the present study.

27 Source: Boeing
28 Source: CFM

5.1.3 Replacement of ageing aircraft fleet

Continuous improvement in airframes, engines and computer systems has led to improved fuel efficiency over time. For example, the evolution of the CFM56-3 engine has reduced specific fuel consumption by 7% in 10 years, while at the same time increasing engine thrust and extending the flight range. Boeing's newest airplane, the 787 Dreamliner, is expected to bring about a 20% improvement in fuel consumption according to the manufacturer[29], compared to the consumption of the Boeing 767 which it replaces.

In a survey conducted by Avinor, the CO_2 emissions of new generation aircraft (available around 2015) are expected to be approximately 30% lower per seat-kilometer than the current generation[30]. This figure does, however, seem optimistic. Aircraft and engine manufacturer estimates are more conservative. Moreover, fleet renewal is an ongoing and incremental process and as such significant improvements through this route will take time.

In August 2008, the European airline fleet (AEA members) included 2,528[31] aircraft. At the same time, a further 909 aircraft were on order with various manufacturers, equivalent to around 36% of the fleet. Assuming an average of four years between order and delivery, these figures suggest a high replacement rate. With demand forecast to grow at around 4.6% per annum, roughly 500 aircraft will be required to meet the growth in demand in the coming years. This leaves around 400 aircraft for replacement of existing equipment. This assessment is supported by fact that 770 aircraft are currently on option, which could replace a further 30% of the current fleet.

In the medium term, significant CO_2 emission reductions can only be achieved through investment in new aircraft. However, current levels of investment in fleet replacement are already very high, driven particularly by the rising cost of fuel. It therefore seems unlikely that significant additional investment can be made in this area, especially in light of the additional costs imposed by inclusion in the EU ETS. For example, the list price for an aircraft such as the Airbus A320, Boeing's 737 or Embraer's ERJ 190 is roughly $50 million (€35.2 million). In broad terms, a 10% reduction in CO_2 emissions amounts to a saving of 10 000 tCO_2 or €500,000 per year, assuming an allowance price of €50/tCO_2. In the current environment, where investment is already high, any additional order has a capital cost considerably greater than the return provided by the CO_2 reduction alone (around 0.8 %).

In the present study, emission reductions stemming from retrofits, upgrades and replacement of aircraft is assumed to provide an annual efficiency gain of 1% until 2020[32]. This figure may seem conservative but it must be remembered that, even with the relatively high current replacement rate, older aircraft types will still be in service for some time to come and will slow down the overall efficiency gains.

5.2 Long term Reduction (2020 onwards)

5.2.1 New aircraft, new engines, better air traffic management

The Advisory Council for Aeronautics Research in Europe (ACARE) has produced a Strategic Research Agenda (SRA) containing high level targets, including a 50% reduction in CO_2 emissions for aircraft entering service in 2020 relative to year 2000 aircraft. The aviation sector decided to commit to these targets and the EU effort is being driven by the ‘Clean Sky’ initiative.

Contributions to this CO_2 reduction target are expected to come from:

- Airframe technologies including aerodynamic improvements, weight reduction and replacing the Auxiliary Power Unit (APU) with a fuel cell. Such improvements should lead to around a 20% CO_2 emission reduction;

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29 Source: Boeing, quoted in IEA 'Energy Technology Perspectives', July 2008 (page 461)
30 Source: Avinor, Aviation in Norway Sustainability and Social Benefit, January 2008
31 Source: AEA
32 1% annual energy efficiency is also the estimate which is used in the Baseline Scenario for 2008-2025 in IEA 'Energy Technology Perspectives', July 2008, (page 460). While more ambitious rates – up to 1.2 % - are being considered in other scenarios (BLUE and ACT) for 2008-2050, the Baseline scenario fits the period 2012-2020 with the highest likeliness.

- Engine technologies relating to increased combustor temperature, higher engine pressure ratios and improved control systems. These are expected to result in emissions reductions of between 15% and 20%;
- Air Traffic Management involves in-flight, ground operations and air traffic control. Improvements can reduce inefficiencies, including taxiing and delays. Better Air Traffic Management could lead to a 5% - 10 % reduction in CO_2 emissions[33].

There is considerable expectation that these programmes will be successful but it is unlikely that significant progress will be made prior to 2020.

Research is currently underway within the EU to improve the efficiency of Air Traffic Management through the SESAR programme. However, the results of this project are to a large extent out of the control of aircraft operators. It should also be noted that a similar programme, NEXT GEN, is currently being undertaken in the USA, which will be important for transatlantic flights.

5.2.2 Alternative fuels

A number of the main aircraft and component manufacturers, including Airbus, Boeing, CFM and Rolls Royce and several air transport companies, have launched alternative fuel research programs. These are primarily focused on finding replacements for kerosene that can be used as a 'drop in replacement'. In other words, fuels compatible with existing aircraft, engines and fuel delivery/storage systems.

Provided the feedstock can be produced without significant greenhouse gas emissions, bio fuels could produce fewer CO_2 emissions than kerosene. There are, however, certain problems to overcome. To be sustainable, feedstock should be produced without deforestation, new demand for fresh water or competition with food. Finally, the cost of the feedstock must be such that the derived bio fuel is a cost competitive alternative to kerosene. In the short term plants such as jatropha, which are resistant to drought and pests and can be grown easily on non-arable land, will not provide sufficient volumes of bio fuels to allow the replacement of kerosene. Also, a large part of the feedstock produced is likely to be diverted to biodiesel, which offers higher prices.

For the longer term, early experiments with halophytes (plants that can be grown in salt water) or algae look promising. However, there are significant challenges in scaling up production and the environmental impact needs further investigation. The certification and blending of bio fuels to ensure compliance with required specifications will also take time.

Based on the evidence available[34], we do not consider that bio fuels will provide significant emissions reductions before 2020.

5.3 Conclusion

Aviation's abatement opportunities are very limited. It is heavily reliant on a single fuel source and at present there is little prospect of this situation changing in the short to medium term.

Improvements to existing aircraft through retrofits, engine upgrades and the use of alternative ground power sources offer some marginal benefits but would not provide the wholesale opportunities for abatement that would be required to significantly impact the costs associated with the EU ETS.

33 Source: All the figures in the paragraph "Contributions" come from ACARE.
34 Sources: SBAC Briefing paper on alternative aviation fuels and IATA Report on alternative fuels.

6. IMPACT ON THE WIDER EU ECONOMY

The implementation of ETS and, in particular, an increased level of auctioning will impact the competitiveness of the EU, tourism and social mobility.

KEY FINDINGS

- Aviation is the first transport sector and hence the first mobile source to be included in the EU ETS.
- By their very nature, air transport services are inextricably linked to the wider economy and even to society as a whole.
- Aviation contributes to the overall economic development and social cohesion of Europe, notably by:
    - Ensuring people's mobility and movements of goods;
    - Offering greater connectivity to remote/peripheral regions;
    - Supporting the tourism industry;
    - Improving the global attractiveness of Europe as a business place;
    - Connecting Europe to the rest of the world.
- The design of the EU ETS in general and high levels of auctioning in particular expose aviation to carbon leakage which in turn will lead to more extreme effects on society and the wider economy.

6.1 The holistic effects

Ultimately, the impact of aviation's entry into the EU ETS will not only affect air carriers. Airlines are intertwined with almost every aspect of life within the EU, allowing people to travel for either business or leisure and moving mail and freight quickly throughout the world. The connectivity provided by air services is an essential element in:

- social cohesion;
- regional development;
- supporting quality of life;
- economic prosperity.

As we have demonstrated, the EU ETS will have a substantial negative impact on airlines and their ability to provide transport to the communities of the EU, particularly in more extreme scenarios with high levels of auctioning. Carbon leakage will weaken the competitive position of EU airlines compared to their non-EU counterparts, further damaging these airlines' ability to provide the air transport infrastructure that is so important to life in the EU. It is therefore important to consider how the impact on the aviation sector will affect the wider EU.

To a large extent these impacts on the economy and society of the EU are not quantifiable in terms of employment or GVA; they are more subtle but potentially highly significant. Below, we examine a number of ways in which a weakened European aviation sector will affect the EU as a whole.

6.2 Economic Development in the EU

The EU is the largest single market and trading bloc in the world and air services play a key role in facilitating the economic activity that this implies:

- air services move business people from their home regions to destinations inside and outside of Europe to trade and invest;
- equally, air services bring business people from around the world to the EU;

- air services are a vital component of the tourism industry, connecting EU tourism destinations to their markets inside and outside of Europe;
- air freight is an increasingly important part of 'doing business' in Europe, transporting components and finished products rapidly throughout the world in a way that no other mode can.

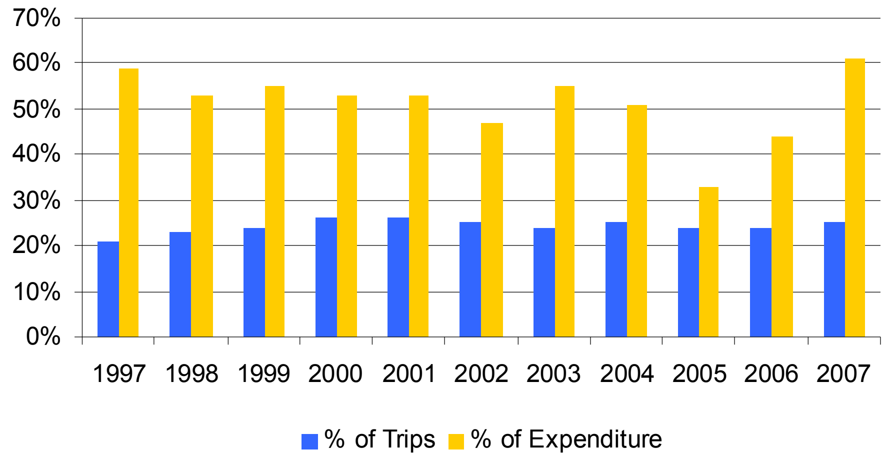
In articulating the extent and effect of aviation's inclusion in the EU ETS on economic development, we have focused on four examples:

- impact on the EU tourism economy;
- impact on advanced supply chains;
- impact on EU cohesion and the single market;
- impact on Business and Employment.

6.2.1 Impact on the EU Tourism Economy

Tourism is a major economic sector within the EU. The sector directly accounts for around 4% of EU GDP and around 4% of EU employment (around 8 million people). It is a sector dominated by SMEs, with an estimated 2 million enterprises[35] in 2004. If the sector's supply chain links are included, these figures rise to around 11% of EU GDP and 12% of employment. The contribution of air services to the tourism economy is significant. **Figure 6-1** shows the proportion of total holiday trips and expenditure by tourists whose main mode of travel was air.

Figure 6-1: Proportion of Holiday Trips and Expenditure by Air Passengers



Source: Eurostat

While there is some volatility with regard to the quality of data for each year, these figures demonstrate that air travel is used by around 25% of people travelling on holiday and that these trips generally account for between 50% and 60% of total expenditure. In other words, in general air passengers spend more than those travelling by other modes and are therefore commensurately more important than their numbers alone would suggest. This reflects the fact that air passengers tend to travel further, where other modes are not a realistic alternative, will stay longer and will often use more or higher quality services and amenities at their destination. This is a general point that needs to be borne in mind throughout our consideration of how the inclusion of aviation in the ETS will impact on tourism in Europe.

While it is illuminating to consider this issue at an EU level, to a large extent this hides the real effect on the EU economy. The decline in demand caused by aviation's inclusion in the EU ETS will not be uniform. Some routes will see greater falls in passenger numbers than others and some services will simply cease, particularly on routes with less total demand. Also, the reliance of different regions on

35 DG Enterprise and Industry website - http://ec.europa.eu/enterprise/services/tourism/index_en.htm

tourism for the health of their economy varies, so the loss of tourism will be more important for some regions than for others.

Below, we consider two cases which illustrate the potential damage to regional economies:

- a traditional tourism destination with high volumes of visitors and an economy largely based on tourism;
- a newer tourism destination with smaller visitor numbers and a growing tourism sector.

Impact on a High Volume Tourism Destination

A range of regions, primarily around the Mediterranean, are traditionally regarded as major tourist economies. These areas, which include the Balearic Islands, the Canary Islands, the Algarve, Catalonia, the Greek Islands and Southern Spain, are considered to be major, well established mass tourism markets.

The potential for a slowdown in these markets, stemming from a decline in demand following the inclusion of aviation in the EU ETS, could be high. Even if cost pass through is not 100%, it is not zero and high elasticity of demand would imply a decrease in demand. While the seat capacity in these markets is high and consequently it is unlikely that they would suffer significant erosion of their overall connectivity to key markets, the numbers of visitors to these destinations is such that relatively small percentage changes in total demand can be significant in terms of trips and expenditure in the local economy. The World Travel and Tourism Council (WTTC) estimates that in the Algarve around 60% of employment and 66% of GDP is dependent upon tourism. In this context, important reductions in demand, even in such a high volume market, are likely to have a significant impact on employment levels in the region and on overall prosperity.

The Algarve is only one example of such a region. There are a large number of highly tourism intensive regions within the EU, particularly amongst the island economies, and these are likely to be at least as at risk as the Algarve.

Specific mention should also be made of the potential impact on some EU overseas territories and the potential for distortion in the market. Island territories in general are likely to be amongst the most affected regions, as there is little chance that travellers can easily switch to other modes of transport to reach these destinations and their economies are often significantly based on tourism. Moreover, some destinations, for instance the French overseas territory of Martinique, will be competing with near neighbours that are not subject to the EU ETS, and hence will be placed at a price disadvantage. This is an example of the third type of carbon leakage described above, the diversion of inbound tourists, operating on a local scale.

Impact on a New Tourism Destination

In recent years the rapid growth of air travel in Europe has seen a significant increase in the number of city pairs served by European airlines, particularly with expansion to the new member states in Central and Eastern Europe. One of the main consequences of this has been the development of a series of ‘new’ tourism destinations, which have in turn developed tourism economies to service this new demand.

Broadly, these can be split into two categories:

- City and short break destinations in the new member states, such as Krakow, Tallinn, Pula and Constanta.
- Secondary destinations in ‘old’ Europe that service a different type of visitor, perhaps less focused on major tourist attractions, and sun destinations. These are often more rural regions, for example Limoges in the Limousin region in France and Santander in Northern Spain.

In these areas the growth of tourism is an important element in wider economic development and regeneration. Tourism is helping these localities to manage the transition from heavily agrarian economies or economies based on declining industries to more service orientated, higher value added activities.

Tourism is bringing new skills, new investment and an injection of expenditure that enables renewal and improvement of local amenities and services, to the benefit of residents and visitors alike.

The risk to both types of destination from the inclusion of aviation in the EU ETS stems from the nature of their connectivity. In both cases these destinations are relatively low passenger volume routes with relatively low yields, as there is little business traffic to push up average prices. As such, these routes are often operated by only one airline, with relatively low frequencies and sometimes only seasonally. In this climate, airlines are heavily reliant on achieving high load factors, and relatively small changes in total demand can result in the scaling back of frequencies or total withdrawal of a service. Inclusion in the ETS could potentially have a significant impact on these markets, particularly as the relatively low yields means that costs passed on to passengers are likely to have a disproportionately greater effect.

Silesia in Poland provides a prime example. The region is served by Katowice Airport, which has grown ten-fold since 2002 and currently handles around 2.1 million passengers annually. The new services that have been developed are bringing new visitors to the region and are also enabling residents to travel. Tourism in the region is now booming, with hotel occupancy rates improving from around 30% to 80% in recent years, even with a significant investment in and expansion of hotel capacity.

Overall, the impact of aviation’s inclusion in the EU ETS may not be uniform and will not be felt significantly in all regions. However, in those areas particularly reliant on tourism or that are emerging tourism destinations the impacts could be substantial, with significant losses in employment, GDP and investment.

6.2.2. Impact on advanced supply chains

One area of particular concern is the potential impact on advanced supply chains from damage to the air cargo industry in Europe. Research undertaken by Oxford Economic Forecasting[36] found that cargo is a €35 billion a year industry in the EU and that around 40% of firms surveyed made use of express carriers to support just-in-time production.

In recent years advanced manufacturing industries have increasingly focused on the development of ‘just-in-time’ processes for their facilities. This term refers to a manufacturing process by which component parts are delivered to the assembly plant as soon as possible prior to their integration into the finished product. This allows companies to minimise inventory stocks, hence streamlining the manufacturing process and minimising costs. This mode of operation has become the norm in many industries and is essential to competitiveness in the global market.

Central to operations of this type is a highly complex logistics chain that ensures that the component parts arrive in the right order at precisely the right time from wherever in the world they have been sourced. Cargo airlines and their partners play an essential role in this process. Their global networks and speed of delivery make them ideal for transporting high value components between points both within Europe and further afield.

The impact of ETS in this case is both subtle and potentially highly significant. Higher prices will, obviously, make these services more expensive for factories based in European locations but it is the potential disruption to supply chains that is probably of greater importance. Again, there are two main potential effects to be considered:

- The loss of cargo spoke services – cargo airlines operate on a similar model to network airlines, feeding a series of hubs via spoke services. Spoke services are used on relatively low volume routes to enable consolidation at the hub. However, if a spoke ceases to be viable despite its contribution to the wider network, it could be withdrawn. Freight will then have to be trucked either to another airport with a spoke service or directly to the hub;
- a shift of hub activity away from EU airports – cargo operators have a number of hubs within Europe, such as Leipzig, Cologne, Paris, Liege and Luxemburg, and also have significant operations at many of the EU’s major airports. While it is unlikely that such bases would be completely removed, certainly

36 ‘The Economic Impact of Express Carriers in Europe’ – Oxford Economic Forecasting (2004).

in the short to medium term, it is quite possible that growth could be shifted elsewhere. For example, routings could be changed for non-EU to non-EU flights as described in our carbon leakage examples, thereby limiting options for connections and capacity, or intermediate stops could be added to schedules to reduce exposure to ETS.

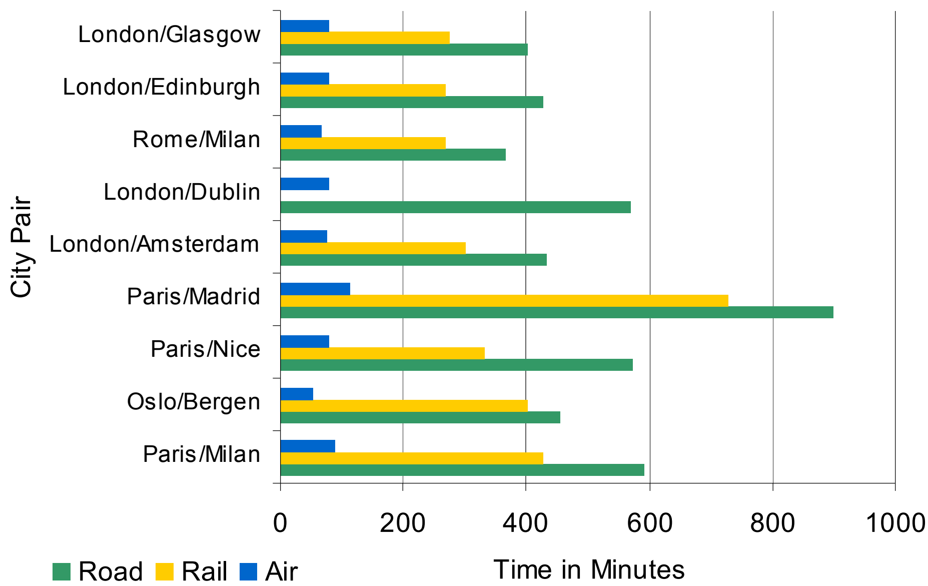
In terms of the end user both scenarios have a similar effect. It adds time into the supply chain and, critically, will change cut off points for deliveries and pick-ups. It is this latter effect that is the primary issue. With additional time required to move packages, delivery times will be later and, more importantly for those companies that are themselves part of a supply chain or that are required to deliver time sensitive products to market, the pick-up times at the end of the day will become earlier. In practice, this means that the assembly plant's working day will be shortened, meaning that it cannot be operated as efficiently and inventories will, by necessity, have to increase. This will put existing facilities within the EU at a competitive disadvantage compared with regions in other parts of the world and will affect decisions on future investment in both existing and new facilities.

It is difficult to identify which regions might be particularly subject to these issues as very little data is available on freight flows and the use of such services. However, it seems reasonable to assume that most regions with strong industrial bases will be affected to some extent.

6.2.3 Impact on EU Cohesion and the Single Market

The EU is a substantial land mass and is increasing in size with the adhesion of new member states. The distances involved in travel, for instance between key centres and between peripheral regions, can often be material. Therefore, it is essential for the European single market ideal that capital and labour can move effectively throughout the single market area. Air services play an essential role in this movement. The distances between points within the EU are, in many cases, such that air travel is the only sensible option for travel with any level of time sensitivity. This can easily be demonstrated by considering the relative journey times between air and surface modes for some of the busiest air routes within the EU[37], as set out in **Figure 6-2.**

Figure 6-2: Travel Times by Mode – Top 10 Air Routes in the EU



Source: RAC RoutePlanner, Train Timetables and Expedia

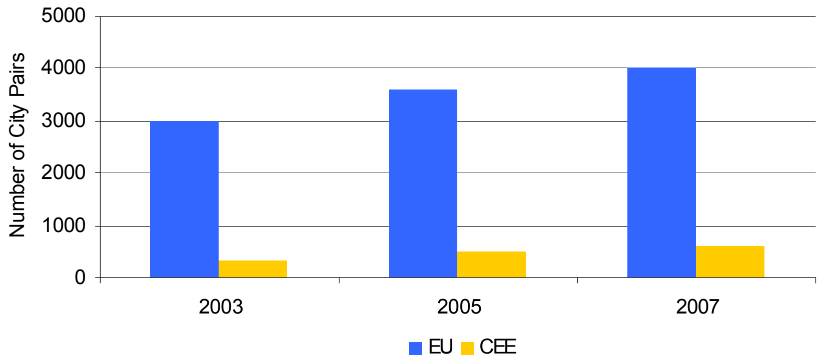
37 It should be noted that many of these routes are between major centres, often within the same country, that are in European terms relatively close to each other. There are many other journeys that would yield a much greater differential. These routes have been identified on the basis of available seat capacity from OAG.

Inclusion of aviation in the EU ETS: Cases for Carbon Leakage

In recent years intra-EU air travel has grown considerably. In 2000, Boeing estimated that Europe to Europe travel accounted for around 440 billion RPK. By 2006, this had risen to around 594 billion RPK, a 35% increase in only six years. In the same year, airlines moved over 2.5 million tonnes of freight around Europe.

There is also substantial evidence to suggest that this growth has not simply been about more people flying but also about different parts of the EU being served more effectively by airline networks. **Figure 6-3** shows the number of EU city pairs served by airlines in recent years. While RPKs have been growing at around 5% per annum, the number of city pairs served has expanded by nearly 8% per annum as airlines have continued to extend the internal connectivity of the EU. This chart also shows the number of city pairs with an origin or destination point within Central and Eastern Europe (CEE). This demonstrates the particular role airlines have played in enabling new member states to connect to their EU partners. In this market, the number of city pairs served has grown by nearly 16% per annum since 2003.

Figure 6-3 : Number of City Pairs Served in the EU



Source: OAG

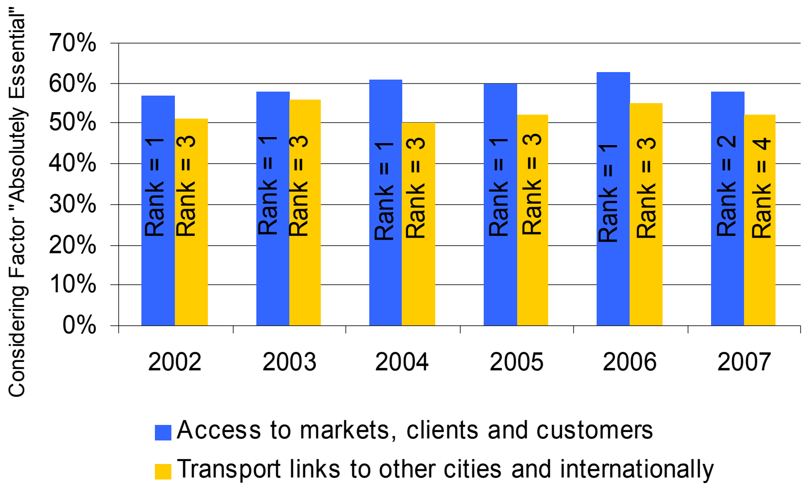
With EU enlargement and the increasing integration of the economies of Member States, the need for effective transport infrastructure is growing. Air transport is a vital part of that infrastructure. Damage to the industry can only harm air transport's ability to play its role in developing greater cohesion. Furthermore, the operating economics of air transport mean that the regions of Europe most reliant on air transport to provide links to the economic heart of the EU are most at risk. It is the new member states and the most peripheral areas, where markets are smaller and yields are lower, that are likely to be most affected as airlines seek to use their fleets more efficiently in areas where revenues and profitability are stronger.

6.2.4 Impact on Business and Employment

The regions and cities of the EU are operating in an increasingly global market place to attract and retain economic activity. In the past, Europe enjoyed considerable success in this area but the future outlook appears more challenging. The world's economic centre of gravity is moving east, away from Europe, particularly as regards manufacturing industries but increasingly also for service industries. In other words, in the future the EU is going to have to compete harder for the investment that will fuel prosperity, growth and employment.

The role air services play in influencing company location decisions and patterns of investment is well established. Accessibility, be it to markets or to other corporate offices, is one of the key drivers of location choice. This is perhaps best demonstrated by the results of the annual Cushman & Wakefield Healey & Baker European Cities Monitor. Each year this research analyses the responses of around 500 senior decision makers in European companies to questions about business location and the factors that make particular locations attractive. Consistently, *access to markets, clients and customers* and *transport links with other cities and internationally* are amongst the main factors seen as essential for a business location (see **Figure 6-4**).

Figure 6-4: European Cities Monitor 'Absolutely Essential' Location Factors



Source: Cushman & Wakefield Healey & Baker European Cities Monitor 2002 to 2007.

It is against this background that the impact of aviation's inclusion in the EU ETS and the growth of carbon leakage need to be considered. If we consider Europe's major cities as proxies for competitiveness across the EU, we can analyse the impact of the EU ETS.

Europe has a significant number of what have been termed 'world cities'. These are centres for business and finance that have a global presence and are key drivers of their own national economies. The Globalisation and World Cities network based at Loughborough University identified London, Paris, Frankfurt and Milan as being in the leading tier of world cities, with others such as Brussels and Madrid in the next tier down[38]. The danger to these cities from the inclusion of aviation in the EU ETS comes from the potential damage to European carriers, either by burdening the airlines with unsustainable additional costs or by putting them at a competitive disadvantage compared to their non-EU counterparts, thereby reducing connectivity to these key economic sectors.

London provides a good example of this problem. For many years London and New York have been competing to be the world's leading financial centre, but in recent years London has achieved a degree of ascendency. However, there are increasing concerns amongst London's business community about its international connectivity, in particular the capacity issues and consequent problems at London Heathrow. Companies are keen to point out that air services are only one factor in their decision to be in London, but the problems at Heathrow are resulting in individual decisions to move investment and growth away from London. Each decision is not particularly significant in itself, but in total and over time they will be. Many senior figures in the City of London now believe that the problems of air access are such that long term damage is being done to London's economy.

This process provides a model for what could happen across Europe's major cities. Impaired connectivity or more expensive air connections will lead to a slow shift in economic activity from the EU's major cities to locations where the air service offer is more competitive. This will not be a dramatic change, and it will not happen in the short term. However, the danger in the medium to longer term, particularly considering the world's changing economic geography, is very real. The knock-on effects of these changes for business and employment in the wider EU economy are potentially significant, with many sectors increasingly less tied to particular locations and able to locate wherever suits their needs.

38 'Introducing GaWC: Researching World City Network Formation' by P.J. Taylor, D.R.F Walker and J.V. Beaverstock.

6.3 Social Development in the EU

So far, we have focused primarily on potential economic impacts of a weakened aviation sector in the EU. However, the ability to travel and to transport mail and freight also has an important social function in the EU:

- 'Outbound' tourism or the ability of EU residents to travel for pleasure is increasingly seen as essential to quality of life;
- In an increasingly global labour market travelling to visit friends and relatives, known as VFR travel, is essential for social cohesion and for maintaining family ties and cultural links throughout the world;
- Air services connect the most peripheral points of the EU, such as its island territories, to its main centres. This is not only vital for economic development but important for cultural reasons and for providing access to essential services, for example healthcare;
- Despite the rise of electronic communications, mail remains central to the fabric of EU society for many reasons and few transport modes can match air services for transporting mail quickly and efficiently across an area as large as the EU;
- Conversely, the rise of the internet has enabled European consumers to shop in markets around the world. Again, air cargo often plays an essential role in the prompt and reliable delivery of these products.

These few examples demonstrate how air services are currently and increasingly very much an essential part of everyday life in the EU. As with economic development, a weakened aviation sector within Europe, damaged by the additional costs of EU ETS and the skewing of competition within the market towards non-EU carriers inherent in carbon leakage, will lose the ability to play its part in the social structure of the EU. Again, these effects cannot be readily quantified but they are likely to have a disproportionate impact on peripheral regions, for which the benefits are perhaps most critical.

6.4 Conclusion

Air transport will be the first transport sector to be included in the EU ETS. By their very nature transport services are inextricably linked to the wider economy and society as a whole. Therefore, any consideration of the impact of this inclusion and the potential for carbon leakage needs to examine the implications of these changes in the market for society and other economic sectors.

Damage to the air transport industry will directly affect the EU's single market goals and the global prominence of key centres and regions. However, the most obvious effect is likely to be on tourism, where falls in demand would endanger the economic prosperity of highly tourism intensive regions or of areas with a nascent tourism product built around the recent rapid expansion of connectivity within Europe. Also, the more subtle impacts on high value added service and manufacturing sectors should not be ignored. These sectors rely on air connections to enable them to access markets, to source the best and most cost effective components, to interact with other parts of their organisations and to reinforce their presence in a global economy where growth is increasingly shifting to the East.

Reduced mobility within the EU will also impact airlines' ability to support the social benefits offered by air travel, for instance by reducing access to travel opportunities or making such opportunities more expensive, by making VFR travel more costly with consequent impacts on culture and diversity, by limiting the role aviation can play in providing access to essential services for peripheral or island regions, and by impairing communication links across the EU.

The extent of the impact on the wider EU will depend on the final design of the EU ETS and the consequent impact on airlines.

SECTION II: ECONOMIC ANALYSIS ON WINDFALL PROFITS AND COST PASS-THROUGH

7. WINDFALL PROFITS IN THE AVIATION SECTOR

7.1 Background

In our 2007 Study we presented evidence which clearly demonstrated that airlines would not be able to derive windfall profits from an allocation of free allowances accompanying their inclusion in the EU ETS[39]. This conclusion has received some support since its publication, though with different arguments. However, there is still some debate on this issue in relation to the aviation sector, most notably in the study undertaken by Vivid Economics (2008)[40] for Defra[41]. We have, therefore, set out below some further thoughts on this issue and a further explanation of our position.

Windfall profits are a highly sensitive subject. It is sometimes claimed that certain sectors have benefited from such profits upon their inclusion in the EU ETS. However, the circumstances and characteristics of the aviation sector are quite different and these differences mean that windfall profits are not achievable within the sector. Those who defend the potential for windfall profits in the aviation sector suggest that airlines will have a two step reaction to their inclusion in the EU ETS:

1. they will first set new prices for their services based on the full cost of the EU ETS. In other words, they would seek to pass through to consumers not only the cost of allowances that have to be purchased, but also the equivalent cost of allowances allocated free of charge - the so-called 'opportunity cost' of free allowances;
2. therefore, when they receive their free allocation of allowances, airlines will make a windfall profit equal to the notional opportunity cost of allowances passed through to customers, either by selling them on the market or avoiding buying them on the market.

This assumed two-step reaction by airlines to the EU ETS should be challenged.

7.2 A simple case study: the single operator

Below, we set out a case study for an airline being the single operator on a given route. We assume that this airline will seek to maximise its profit in line with standard economic theory. This is of course a highly simplified example but it provides valuable lessons for considering more complex situations.

The formula below expresses a profit function for a profit maximising single operator (on a given route) selling one homogenous good prior to inclusion in the EU ETS:

$$\Pi = (p - c) \times D(p) - F \qquad \textit{(E)}$$

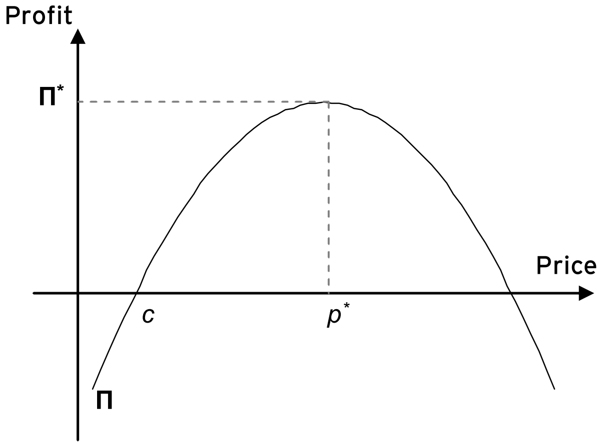
where p is the price of an air ticket, c the marginal cost, $D(p)$ the demand curve depending on the price and F the fixed cost incurred by the company. The profit is the difference between two terms: firstly the *gross profit* of the company – that is to say the margin made on each service unit multiplied by the demand – and secondly the fixed costs. In this case, the company will determine the price of its service units in order to maximize its profit. The profit-maximizing price prior to the inclusion in the EU ETS is written as p^* whereas the maximized profit is written as Π^*.

$$\Pi^* = (p^* - c) \times D(p^*) - F$$

39 Analysis of the EC Proposal to Include Aviation Activities in the Emissions Trading Scheme – Ernst & Young, York Aviation – June 2007
40 A Study to Estimate Ticket Price Changes for Aviation in the EU ETS – Vivid Economics – November 2007
41 Department for Environment Food and Rural Affairs (UK Government)

Before inclusion in the EU ETS, the profit function of the company is represented by Π in the following graph (for convenience and simplicity we will assume that fixed costs F are equal to zero from now on).

Figure 7-1: Profit curve in the general case of a monopoly



This graph represents the company's profits depending on the price of the service it sells. When the price is set at the marginal cost (noted c on the chart), the profit is zero as the company's margin on each service unit sold is nil. If the price increases slightly above the marginal cost, the margin on each unit will become slightly positive and consequently so will the company's profit. In reality, any price increase will have two different effects on profit: (i) a positive effect as the margin made on each unit increases and (ii) a negative effect as the increase in price will result in a decrease in demand and a fall in the volume of sales. If the price increases slightly above the marginal cost then the first effect will be the most important. As the price continues to rise, initially the first effect will remain more important than the second. However, there will be a price at which the second effect will become the most important one. This particular price is the profit maximizing price noted p^* in the above chart.

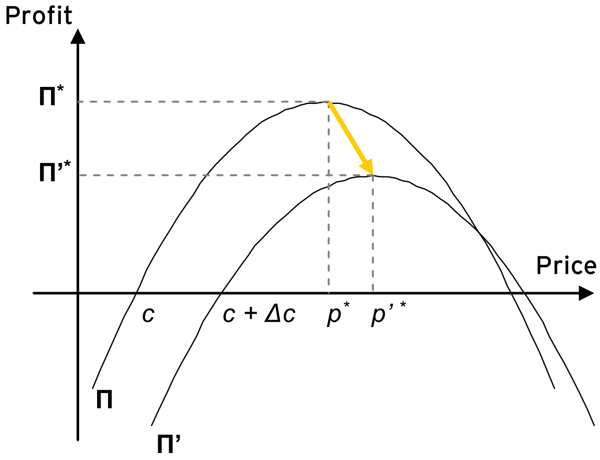
After inclusion in the EU ETS, we assume that the company will react in two steps as suggested in the literature on the matter:

1) The company will adjust its price by taking into account the additional cost of the EU ETS (the "opportunity cost"). This results in a new profit function, Π'. Π' can be written as

$$\Pi' = \left(p - \left(c + \Delta c\right)\right) \times D(p) - \left(F + \Delta F\right)$$

where the opportunity cost of allowances leads to an increase in the marginal cost by Δc and of the fixed cost by ΔF (we assume that ΔF is equal to 0 as well as F to simplify). The new function is represented in the following graph, as well as the choice of the new price p'^* which leads to a new maximized profit of Π'^* under the new profit function.

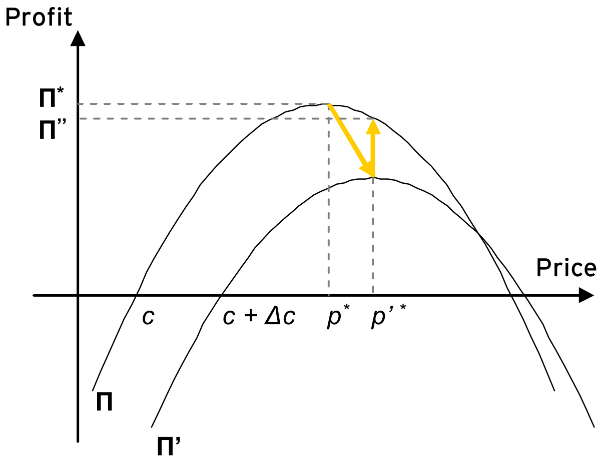
Figure 7-2: Effects on profits of an increase in cost due to EU ETS



We insist on the fact that the new profit function after the inclusion in the EU ETS is necessarily below the profit function before the inclusion, and the profit-maximizing price after the inclusion is necessarily equal to or higher than the profit-maximizing price before the inclusion, so that this graph is representative of all possible situations of our case study

2) However, in the second step, the impact of free allowances has to be considered. In such a case, the "opportunity cost" on which the company has based its new price is actually not a real cost since allowances are free. The actual profit function of the company due to these free allowances (to the extent that those allowances are *exactly* equal to the ones necessary for its activity) switches from Π' to Π again, but with one difference, i.e. the price remains at the level set in the first step, that is to say p'^{*}. The corresponding profit is noted as Π''. The following graph demonstrates what happens to the company's profit after it receives the free allowances.

Figure 7-3: Effects on Profits of free ETS allowances



The company's profit after the introduction to the EU ETS – noted Π'' – is in fact lower than before the imposition of the EU ETS – noted Π^{*}, even if all allowances are granted for free.

The rationale for this result is that after inclusion into the EU ETS – and assuming the allocation of free allowances – the company will determine its price based on a theoretical new profit function, whereas its actual profit function remains similar after and before the ETS. The impact on profitability for the company then depends entirely on the rationale and constraints for determining the price, and in particular on the degree of liberalization in the industry.

We will now provide a numerical example of this and explain with the same graphs and in the same simplified situation why other industries can experience windfall profits within the EU ETS.

7.3 A numerical example

To make our point easier to understand, we consider the following illustrative numerical example. Let us assume that the demand function is linear and could be expressed as: $D(p) = D_0.(1 - a.p)$ where D_0 and a are parameters that can take several values and let us assume that fixed cost are equal to zero. On this basis, the profit maximising function prior to the EU ETS can be set out as in equation *(E)*:

$$\Pi = (p - c) \times D_0.(1 - a.p)$$

The optimal price for the profit-maximizing single operator (on one given route) would be:

$$p^* = \frac{1}{2a} + \frac{c}{2}$$

Let us assume that $c = 10$, $a = 0.05$ and $D_0 = 100$, then $p^* = 15$ and $\Pi^* = 125$ whereas the demand based on this price is equal to $D(15) = 25$.

After the EU ETS, c becomes $c + \Delta c$ and it is easy to see that the optimal price of the new maximization program is equal to:

$$p^* = \frac{1}{2a} + \frac{c + \Delta c}{2}$$

With the same values as set out above and $\Delta c = 2$, then $p'^* = 16$ and $\Pi'^* = 80$ whereas the demand based on this price is equal to $D(16) = 20$. The decrease in profit is therefore equal to (45).

If we assume that allowances were allocated for free, the company will then receive an amount of allowances that can be valued at $D(16).\Delta c$, that is to say $20 \times 2 = 40$. This amount is lower than the loss of profit of (45), which suggests that even with all its all its allowances allocated for free, the company will not only have no windfall profits but will suffer a real profit loss of (5).

We summarize this example in the following table:

Table 7-1: Impact of free EU ETS allowances on Profits (Numerical Example)

Profits before ETS	125
Step 1 – Loss of profit with increase in price due to opportunity cost	(45)
Step 2 – Values of free allowances	40
Profits after ETS	120
Loss of profit due to ETS	(5)

Other parameters and other shapes of the demand curve could be considered in a numerical example but there is no case in which it is possible to generate windfall profits.

7.4 Why can windfall profits occur in certain other sectors?

In some sectors, windfall profits would be possible based on the increase in consumer prices and the free allocation of EU ETS allowances. Two factors would make this possible:

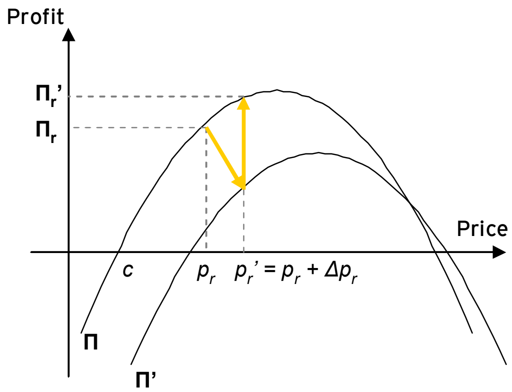
1. The degree of tariff-liberalization of these markets differs from that of the aviation sector;
2. Some sectors would receive more allowances than they actually need.

We examine each of these issues in more detail below.

- **Windfall profits are possible in a regulated market**

The above example considered a company that was able to decide freely on the price of its services. Let us now consider a different degree of market liberalization, where the company has to limit its prices because of a regulator. The company is compelled by the regulator to price at p_r which does not maximize its profit, noted as Π_r on the chart. After inclusion in the EU ETS, the company will increase its price by Δp_r. In a second step, with all allowances granted for free, the actual cost function will be the same as before the EU ETS, as will the profit function. The difference is, now that the price is set at a higher level, the company is closer to the profit-maximizing price. This is shown in the figure below.

Figure 7-4: Effects on Profits of an Increase in Price on a regulated market



EU ETS therefore potentially allows windfall profits for companies that operate in a partially tariff-regulated market. These windfall profits do not exist in tariff-liberalized sectors, such as the aviation sector, even when all allowances are allocated for free.

- **Windfall profits are possible if free allowances outnumber requirements**

There are few situations where windfall profits could occur. However, it is possible if a company receives more free allowances than are necessary to cover its activities. In this case, the company can use free allowances to maintain its prices and profits at the same level as before its inclusion in the EU ETS and sell the extra allowances on the market. This could occur in the following cases:

- If the EU ETS is not well designed and results in a surplus of free allowances compared to requirements, these extra allowances can then be sold on the market at a profit and can be considered as windfall profits. However, it is unlikely that the aviation EU ETS will be designed in this way since the number of free allowances granted to airlines will be below previous years' emissions. In addition, airlines will not be allowed to sell their surplus emissions in the EU ETS to other sectors;
- If technological improvements, and in particular the ability to switch to another fuel (for example from coal to gas) enable companies to reduce carbon emissions to such an extent that the initial amount of free allowances exceeds their needs, they could be able to sell the surplus allowances on the EUA market.

None of these situations is particularly credible in the aviation sector. Airlines are already doing their utmost to reduce fuel consumption, driven both by high fuel prices and by inclusion in the EU ETS, and it seems highly unlikely that sufficient improvements could be made by 2020 to make these options possible.

7.5 Conclusion: no windfall profits in the aviation sector

These examples clearly demonstrate that no windfall profits could occur in the aviation sector upon its inclusion in the EU ETS. The situation that is supposed to have been experienced in other sectors is completely different from that of the aviation sector. The two main differences are: (i) the high level of tariff liberalization in the aviation sector, meaning that prices are already adjusted by companies in order to meet their specific objectives and (ii) any switch to fuel that could be less carbon-intensive is not realistic except in the very long term. Inclusion in the EU ETS will prevent airlines from meeting their financial objectives and lower their profitability.

8. ANALYSIS OF COST PASS-THROUGH IN THE AVIATION SECTOR

8.1 Main drivers of the cost pass-through rate

Another aspect of our previous work that has been discussed in other studies is the cost pass-through rate. The cost pass-through rate can be defined as the rate at which a cost increase (or decrease) is passed on to consumers. In our previous study, we outlined that several factors have to be considered in order to derive a cost pass-through rate, the most significant of which are (i) airport capacity constraints and the relative market power of airlines, (ii) the number of competitors on a specific route and (iii) the shape of the demand curve.

Capacity constraints and relative market power
Based on a study by Oxera[42], we identified that at cost pass-through at congested airports – where it is not possible to completely satisfy demand due to supply constraints – will be zero, all other things being equal.

The number of competitors on a specific route
Ten Kate and Niels outlined[43] that the cost–pass-through rate depends on the number of competitors in the market. In the aviation sector, as the number of competitors is generally low in any given market the cost pass-through rate should, therefore, be lower than in other sectors.

The shape of the demand curve
The last and perhaps most important parameter for considering cost pass-through is the shape of the demand curve rather than price elasticity itself. The cost pass-through rate is lower when the price elasticity increases because of higher ticket prices, that is to say if the demand-curve is concave.

In the main these arguments were found to be sensible, but some commentators have made specific comments. The most significant of these are as follows:

- The market power at congested airports outlined by Oxera may have been overemphasized since slot congestion may not imply restrictions for passengers;
- The Cournot model that we have used is not adapted to the aviation sector and the results of contestability theory should have been considered;
- The implicit demand function that we have used is a linear shape whereas the most common shape is a convex function;
- Some econometric studies suggest that the cost pass-through rate will be equal to 100% in the aviation sector, with some evidence that it could be even higher.

We will examine these comments below. It is important to note that market structure, and in particular the number of competitors, is a key variable. This has been acknowledged by most of the more recent studies. The Vivid Economics study mentions that, on most routes, the number of competitors is between 2 and 4, which is in line with our view of the market structure.

42 Assessment of the Financial Impact on Airlines of Integration into the EU Greenhouse Gas Emissions Trading Scheme – Oxera – October 2003
43 To what extent are Cost Savings passed on to Consumers? An oligopoly approach – European journal of law and economics – A. Ten Kate and G. Niels - 2005

8.2 Analysis of key discussion points

Response to Comment 1 – Slot congestion does imply restrictions for passengers

One comment on our previous research concerned the use of the work performed by Oxera on congested airports in order to demonstrate that airlines benefit from a so-called "scarcity rent", stemming from limits in supply combined with high levels of demand. This means that airlines can price air tickets relatively independently of their costs. The two main arguments used in existing studies against this premise are as follows:

- First, some commentators come back to a study performed in 2005 by PwC[44] in which they would claim that the cost pass-through rate was equal to 100% even at congested airports. Beyond the fact that we found no explicit reference to congested airports in the PwC study, this study is challengeable for other reasons, as we discuss below (Examination of Comment 4).
- The second argument is that slot congestion does not imply restrictions on the number of passengers. It is clear that congested airports extract a "scarcity rent" from airlines, but this should not mean that airlines are able to pass this on to passengers, whose number is assumed not to be restricted. It is argued that airlines could increase their load factors or use larger aircraft to get around slot constraints and increase passenger numbers.

In reality, these two options for airlines to serve more demand (increasing the load factor and changing the size of aircraft) are already being used. The success of the new Airbus A380 clearly shows that airlines are willing to increase the size of their aircraft, and the existence of yield management proves that airlines are already doing their best to increase load factors. The fact that capacity is restricted at congested airports implies that the number of passengers that can transit through them is restricted.

Furthermore, such an argument does not consider the organization of airlines at hub airports, which include the most congested airports in Europe. One of the main objectives of a hub is to feed long-haul flights with passengers flying into the hub via short-haul flights. The fact that short-haul flights are operated with smaller aircraft than long-haul flights cannot reasonably be seen as proof that demand is limited for those short-haul flights, thus leading to the conclusion that the number of passengers is unrestricted at congested airports. The economics of the aviation sector are more complex and there is a relationship between long-haul and short-haul flights. In seeking to contest that the number of passengers at such congested airports is restricted, it is not sensible to argue that not all flights starting from or arriving at congested airports are operated with A380 aircraft with a load factor of 100%.

44 Aviation Emissions and Policy Instruments – PwC – September 2005

Response to Comment 2 – The use of the Cournot model is appropriate in the airline industry and application of the theory of contestable markets is not

Some comments were related to the fact that the airline industry is a pure and competitive market, meaning that airlines price at marginal cost (and thus the cost pass-through rate would be equal to 100%).

In our previous study, we assumed that competition in the aviation sector is close to a Cournot model, that is to say a model where competitors compete mainly on the quantity of service to put on the market. The main alternative model is the Bertrand model where the competitors are able at any time to adjust the quantity of services on the market and then compete only on price, which will ultimately arrive at marginal cost due to the fact that competitors try to undercut each other. The Bertrand model is closely linked to the theory of contestable markets. We examine below why the theory of contestable markets is not fully adapted to the aviation sector.

The concept of pure and perfectly competitive markets is purely theoretical, and economists agree that it bears little relation to reality. However, it is possible to apply the rules of pure and perfect competition in certain markets, known as contestable markets. Contestable markets are markets in which the potential competition, that is to say the threat of a new entrant coming in, guarantees competitive prices, even if in reality the number of competitors is small.

The conditions for a market to be contestable are as follows:

- There are no barriers to entry
- There are no barriers to exit, in other words there are no sunk costs
- The existence of a firm wishing to enter the same market.

This theory claims that the pressure exercised by the possibility of new entrants (the potential competition) maintains prices at the level of marginal cost (and therefore zero profit), even when real competition is low. If significant profits are made in a contestable market, then a competitor will enter the market, offer a lower price, take the profit and leave the market. This is known as “hit and run behaviour”. That is why, in contestable markets, competitors have to use the rules of pure and perfect competition even if few competitors are present.

The aviation sector cannot be considered as a contestable market for a number of reasons.

For **network airlines** the situation in the market is such that “hit and run behaviour” does not seem realistic because:

- The market structure of network airlines is mainly based on hub airports. Without a hub, a network airline will find it hard to fill a plane. A new entrant will not be able to compete with the current airlines as the creation of a hub is costly and takes time and there is no evidence that a hub is a liquid asset;
- A network airline cannot reasonably rent all of its planes and as a consequence only have variable costs. It takes time to build up a large fleet, which also cannot be sold in the very short term;
- Airport slots are not easily available at congested airports, so there are some barriers at the airports for new entrants to enter the market in a significant manner;
- A new entrant will lack brand image and experience, two components necessary to gain the confidence of network airlines’ passengers;
- Network airlines often have a loyalty program or an efficient booking system that is a component of the value for customers and that cannot easily be replicated;
- Legal barriers exist, depending on the countries where airports are based, which also constitute a barrier for opportunistic entrants.

Cargo airlines can be compared to network airlines with regard to competition and market conditions. Even if marketing arguments (especially brand image necessary for passengers’ safety) are less applicable for cargo flights, cargo carriers face the lack of slots available at congested airports as well as high fixed costs and legal barriers. These are all significant barriers for potential newcomers.

For **low fares' airlines** some of the above reasons are also valid. It could be said that the low cost market is contestable in the sense that low cost airlines created this specific market with point to point routes. It could then be possible for a firm to enter the market with leased aircraft over a short period to compete with current low cost carriers. However, we would argue that barriers are still present so that some systematic "hit and run behaviour" is excluded. These barriers are:

- In order to extract favourable terms from airports, it is common practice for low fares' carriers to enter into medium or long term deals which limit their ability to exit from a market;
- The existence of sunk costs, such as advertising and the development of a distribution platform. Even if these costs are limited compared to those borne by network airlines, they still exist and have to be recovered over a certain period of time;
- The need for costly infrastructure: while it might be possible for competitors to enter the market using leased aircraft and to avoid fixed costs in some instances, to do so on a significant scale would require both time and substantial financing.

The global aviation market cannot be treated as a perfectly contestable market, implying that the rules of pure and perfect competition cannot be applied to this sector. In light of this, the aviation sector is therefore best described, at route level, as a market where the number of operators on each route is low, where there are barriers to entry and where profits are possible. However, this does not mean that huge profits exist in the aviation sector. Airlines have to sell air tickets at a price that guarantees a comfortable gross margin rate compared to their marginal cost because they incur significant fixed costs that must be covered in the longer term.

Why is Cournot preferable to the Bertrand model?

Vivid Economics have developed very sensible arguments on why the Cournot model should be used in the airline industry:

"The logic of the Cournot model has been criticised for relying on the assumption that firms compete in terms of the quantity of output when competition on price is so commonly observed in practice, particularly in the aviation sector. Therefore, an additional important justification for adopting the Cournot model is that its predictions remain valid where firms choose production capacities followed by price competition (…). This is likely to be a reasonable characteristic of the aviation market where the establishment of new routes and the purchase or leasing of new aircraft are medium-term decisions taken by the firm, with prices adjusting to short-term influences."

The rationale for using a Cournot model is that competition on price in the airline industry is only a second step in the industrial strategy, the first one being the decision to enter the market with a certain level of supply. The assumption that a Bertrand model could be used is not realistic, especially at congested airports where quantity of supply is restricted but the level of fixed costs and the impossibility of "hit and run" behaviour prevents an instantaneous adjustment of the supply, except in some specific circumstances.

Why would airlines maximize their profit?

Another argument concerns the criticism of the profit-maximizing strategy of airlines. Airlines could indeed employ other strategies such as the maximization of market shares or maximization of their turnover. Generally speaking, these arguments are sensible but we do not believe that they are completely appropriate:

- The stated objective of airlines is to make a profit, and one cannot reasonably expect a company to have any other objective than creating wealth (and thus implicitly profits) for its shareholders in the long-run. In the shorter-term, we do not deny the existence of some secondary objectives such as a higher turnover. However, such secondary objectives are always related to the long-term primary objective of generating profits, either by acquiring a leading position in the market and thereby achieving higher margins than competitors, or through economies of scale which increase profitability. Profit maximization is a necessary objective for airlines.

- A second argument is more specific to the airline industry, particularly in Europe where managers could not easily adopt other objectives than maximizing the profit in order to increase their own salaries. Airlines have lost significant amounts of money over the last decade, as highlighted previously in the study. Secondary objectives such as increased market shares are theoretically possible, but they are only plausible in an industry where wealth creation is high. Indeed, such secondary objectives should not divert from immediate wealth creation to the extent where the financial position of the company is significantly impaired. At present the financial situation of European airlines is not healthy enough for them to put off to a longer-term the need to make a profit. Profit-maximization is therefore a sensible assumption for airlines.

After examining the main comments concerning the market and industry characteristics of the airline industry that would contradict the use of a Cournot model with an assumption of profit maximisation, we consider that we have proven its reliability for the purpose of this study.

Response to Comment 3: The argument that demand in the aviation sector could be convex cannot be accepted

Some studies point out that the shape of the demand curve is a critical parameter for the cost pass-through rate and that the linear demand curve used in our previous study is a particular situation. This is perfectly true, as we clearly stated in our previous study. However, the choice of a linear demand curve was dictated by (i) the fact that no study exists on the actual shape of the demand curve in the aviation sector and (ii) that the cost-pass-through rate is completely different depending on whether the demand curve is concave or convex. A linear demand curve, which is neither concave nor convex, is then a situation that we considered to be “central”.

Deciding if the demand curve is convex or central is not easy and is not an issue that is often discussed in economic literature. Most of the time constant price elasticity, and therefore a convex demand curve, is assumed. However, the main argument for this is that such an assumption considerably simplifies the economic equations. The choice of a convex demand curve is often ad hoc and is rarely supported by econometric evidence or economic considerations.

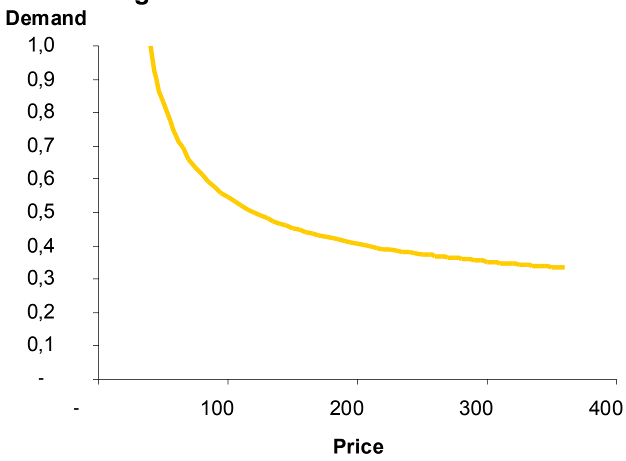
We propose to examine, based on a simple example, some of the drivers of the convexity or concavity of the demand curve. We have chosen a very simple situation (described in more detail via equations below) where customers have the choice between travelling by train or plane for a certain journey. The choice between the train and the plane is based on two different factors and consumers’ preference for one factor or the other:

- a monetary factor which is the price of the journey
- a non-monetary factor which is linked to the means of transport.

In some cases, the plane could have a higher non-monetary value than the train, for example if the duration of the journey by plane is considerably shorter than the journey by train. In other cases, the train could have a higher non-monetary value than the plane, for example because of the time lost in passenger processing, transportation to and from the airport, low frequency of flights, etc. The shape of the demand curve will be determined by the assumptions regarding consumers’ preferences for the monetary and non-monetary factors.

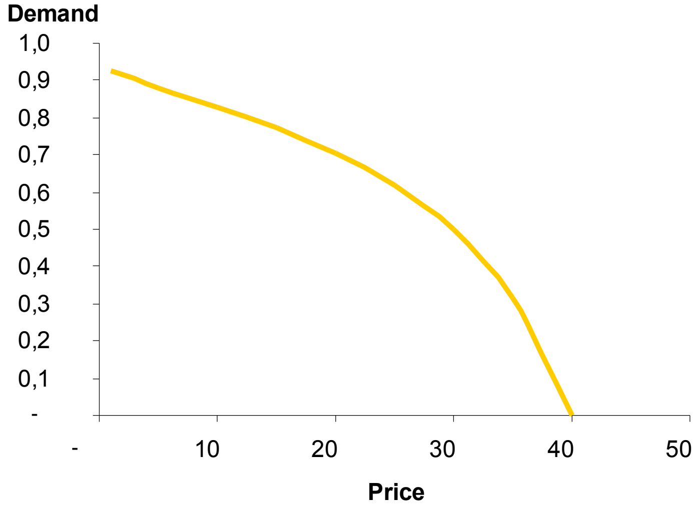
If the plane has a non-monetary advantage, then the shape of the demand curve will be convex. This can be explained by the fact that there are always customers for whom price is not an issue and for whom the non-monetary aspect is the most important.

Figure 8-1: Convex demand curve



If the plane has a non-monetary disadvantage, then the situation is completely different. Travellers who are not concerned about the price will take the train in most cases and the only people using the plane will be those who consider price to be the most important factor. In this case, the shape of the demand curve is likely to be concave.

Figure 8-2: Concave demand curve



This very simplistic situation has the advantage of showing that a concave demand curve is not a purely theoretical assumption. On the contrary, if there are substitute services to the journey by plane, and if the journey by plane does not present a non-monetary advantage for some customers, then there is a high probability that the demand curve will be concave. Note that the non-monetary factor is not necessarily related only to the duration of the journey but may cover various other aspects. Note also that the model used to represent the demand curve for different conditions does not take into account the potential reservation utility of the passengers; that is to say the choice not to use any means of transport. Including the reservation utility would result in an even more concave demand curve. Below we give some examples of the kind of qualitative disadvantage a journey by plane could have compared to other options.

For short haul flights (mainly domestic flights), the most obvious substitute is competing ground transport, such as the train or car for passenger carriers and trucks and ships for cargo carriers. An extreme example is the route between Paris and Brussels on which there are now no flights since the arrival of the high-speed train, Thalys. The combination of high air fares and high overall travel time led to a dramatic decrease in demand for air services. Such situations are realistic where there is a certain price above which demand can be considered to be nil. However, other less obvious substitutes also need to be considered. Leisure passengers, for example, may consider that a journey by plane has a non-monetary disadvantage compared to alternative leisure activities.

For long haul flights the same substitution argument can be used. For leisure passengers, the choice of a different, closer destination can be a substitute if the prices increase or if there is a choice of different leisure activities that have a higher non-monetary benefit. For business passengers - especially for short journeys - the substitute could be the use of new media technology such as teleconferences. Companies could even choose to increase the presence of their firm on site through the development of local teams in subsidiaries (for example with expatriates) rather than having employees from headquarters travelling frequently on airlines.

Furthermore, considering that constant elasticity would imply that there is always someone willing to pay for a ticket, no matter what the price, is unrealistic. This assumption means that airlines are always profitable, because even if they raise the ticket price dramatically, there will always be someone prepared to buy it. However, substantial losses and even bankruptcy have been seen amongst airlines in the last few years, which contradicts Vivid's assumption that it would always be possible to find one passenger willing to pay the whole cost of the flight.

Response to Comment 4: The cost pass-through rate is below 100%; there is in fact not evidence showing a 100% cost pass-through rate.

➢ *Econometric estimation of cost pass-through rates in the aviation sector*

The only study that presents an econometric estimation of a cost-pass-through rate in the aviation sector equal to 100% is the study performed by PwC in 2005[45] and reconfirmed by CE Deft in 2008. In this study, PwC analysed cost pass through for the aviation sector in UK markets and measured how the price of air tickets evolved over the period from 1966 to 2003 compared to the price of fuel. PwC concluded that the cost pass-through rate was equal to 100%. However, it should be underlined that the methodology used by PwC includes some grey areas, which do not allow a clear understanding of the methodology. Three main methodological points should be raised:

1) The way in which the evolution of demand during the period was treated: the study seems to consider that the change in costs was the only driver of the changes in the price of air tickets. Changes in demand were dramatic over such a large period of time from 1966 to 2003 and do not seem to be taken into consideration.
   - First, demand increased significantly over the period, which necessarily brought reactions from airlines in terms of the price of air tickets, independent of any increase in costs and the adaptation of supply. Any change in the demand curve will actually lead to a corresponding change in the "objective-maximizing" price of the airline. This effect does not seem to be considered in the study.
   - Secondly, the nature of demand may also have changed over the period. For instance, the balance between short-haul and long-haul and the balance between leisure and business passengers may have changed significantly, which can lead to changes in the price of air tickets as well, independent of the increase in costs. Again, the study does not explicitly address this issue.

2) How changes in supply were treated over the period: the study does not seem to have analyzed the changes in supply over the period either. Evolution of aircraft, multiplication of routes and the development of tourism and of package tours, for example, are not explicitly addressed. The evolution of the market structure over the period, and in particular the mergers between European airline companies, is recognized by most studies as being a key component of pricing, but this is not addressed either. These factors will have had an impact on the price of air tickets over the period.

3) How the increase in other costs and general inflation was treated: fuel is not the only source of costs for airlines, although it is important. Many other costs have also increased over the period and their impact cannot be considered as negligible. The only cost considered in the study is the cost of fuel. This appears limited.

In addition to these elements not considered in the study, the conclusions do not really appear to be directly derived from the results. We reproduce hereafter the table presented in the report:

	Regression result	Lower bound	Upper bound
Coefficient	4.12	2.13	6.11
Full-service pass-through	105%	44%	156%
Low cost pass-through	90%	46%	133%

Source: *Aviation Emissions and Policy Instruments – PwC – September 2005*

The first line of the table represents the regression coefficients for the annual difference in the travel price index by the annual difference in the kerosene price index. The figure of 4.12, which is referred to as the coefficient for the regression result, seems to indicate that a change in the kerosene price of £1 would lead to an increase in the price index of £4.12, that is to say a cost pass-through of 412%. However, the study concludes that the cost-pass-through rate would be between 90% and 105% which is a completely different range of figures. There is no information within the study that helps to explain these issues.

Overall, it seems that the results are highly contestable and do not provide a significant input to discussions.

45 Aviation Emissions and Policy Instruments – PwC – September 2005

➢ *Econometric study on cost pass-through rates in other industries*

The Vivid Economics study comes to the conclusion that the cost pass-through rate in the aviation sector is likely to be close to 100%. As in our previous study, Vivid assumes that the cost pass-through rate is closely related to the structure of the market (level of competition, type of products, and the possibility of substitution…). In order to support such a level of cost pass-through, Vivid suggests that some other products in different markets have already experienced 100% cost pass-through. However, these products cannot be compared to airline services:

- Vital commodities, such as bread or milk, have no real substitutes so the shape of the demand curve is obviously convex and thus it is not surprising that the level of cost pass-though is high in these cases. Some studies have even shown that consumption of certain goods increases with the price. Indeed, the increase in the price of a vital commodity will decrease the level of disposable revenue and thus the consumption of a more expensive substitution commodity will be reduced. Paradoxically, consumers will switch from the expensive good to goods where the price is increasing but which are still less expensive than the other good. This is an illustration of what is commonly known as the cross elasticity of demand.
- Addictive products, such as tobacco and alcohol, are very specific in the sense that the consumers of these products have a particular behaviour in terms of demand: their utility functions give low importance to the price of the products compared to the addictive benefit that they receive from them. It is likely that for this type of products, the strength of addiction can be so high that the companies can transfer all the additional costs to the customers. This is certainly not the case for the airline market where demand is mostly driven by price and time and not by addictive behaviour.
- Products for which the markets are very competitive cannot be considered similar to airline services. Let us consider the example of clothes, used by Vivid in order to illustrate the fact that conclusions drawn for the clothing industry are not applicable to the aviation sector. Clothes can be considered as relatively vital commodities and, overall, the number of clothing manufacturers and clothes' shops is very high. The clothes market can even be considered as a contestable market since (i) the market is not particularly capital intensive, (ii) fixed costs are low, and (iii) knowledge and experience are not needed in many areas. However, as we have proven above, the theory of contestable markets cannot be applied to the airline market, which makes the comparison with the clothing industry irrelevant.

The Vivid study also mentions the cost pass-through rate in the electricity industry. We have been informed of some claims that windfall profits have occurred in the electricity sector, but received no evidence of this, so that we will not dispute or comment on this. However, we have already dealt with the subject earlier in relation to the possibility of windfall profits. The electricity industry cannot be compared with the airline industry for two reasons: (i) the market for electricity is not fully tariff-liberalized so that the effect of price increases will not have the same effect on profitability as in the airline industry, where actual prices are already profit-maximizing, and (ii) the substitution of fuels (from coal to gas) is sometimes possible in the electricity sector, whereas this is absolutely not the case in the airline industry in the short-term. It should also be noted that the consumer cannot switch away from electricity so that the electricity demand curve is convex rather than concave.

The comparisons used by Vivid in order to support the conclusion that the cost pass-through rate is close to 100% in the aviation sector are not pertinent since it is not possible to compare sectors that have such different features.

8.3 Conclusion

Although some of the comments regarding our previous study do not appear relevant, some of them are valid, at least to some degree, and have necessitated some changes in our approach. However, most of these changes are relatively minor and concern assumptions that we used rather than the structure of our model. We remain confident that our approach to cost pass-through is an accurate reflection of market realities.

SECTION III: APPENDICES

9. APPENDIX A: CO2 MARKETS AND AVIATION

CO_2 Spot Market and Futures Market

EU ETS spot market: 2005-2007

Figure 9-1 below shows the historical prices of EUAs on the ECX spot market, where 90% of the CO_2 European Union Allowances (EUAs) trading takes place. Since July 2007, EUAs have no remaining price on the ECX spot market as they are not transferable to the 2008-2012 period.

Figure 9-1: EUAs Prices on the ECX Spot Market

Source: www.europeandclimateexxhange.com

EU ETS Futures Market

European CO_2 derivatives markets (for example, ECX and Nord Pool) can provide a first approximation of the CO_2 allowance price available between 2008 and 2012.

Figure 9-2 below shows the evolution of December 2012 futures over time. The evolution of 2008-2011 futures is similar.

Figure 9-2: EUAs Futures Prices on the ECX Market

Source: www.europeandclimateexxhange.com

EC impact assessment hypotheses

In its impact assessment[46], the EC states the carbon price ETS (EUA) in 2012 should be between €30 and €47/tCO_2, as shown in the table below:

Table 9-1: Scenarios of the EC Impact assessment

Scenario	1	2	3	4
	Cost efficient reference scenario	Redistribution of Non ETS targets, no CDM	Redistribution of Non ETS targets, but with CDM	Redistribution of the Non ETS targets, no CDM + Redistribution of the renewables targets, no RES trade.
Carbon price ETS (€/tCO2)	39	43	30	47
Carbon price non-ETS (€/tCO2)	39	37	Max. 30	37
Renewable value (€/MWh)	45	44	49	51

Source: EC impact assessment

NAP II allocations

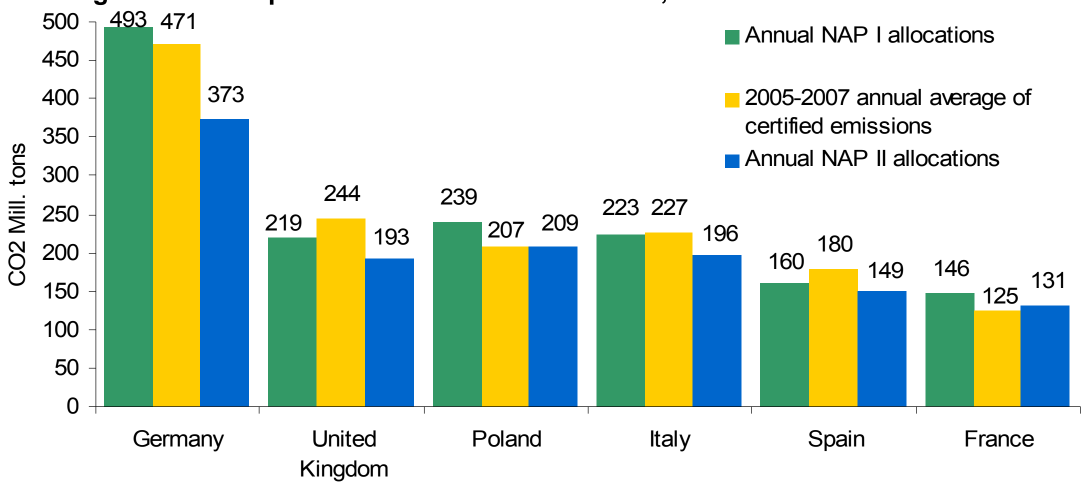
The allocations for the second period are significantly below those for first period. They are even lower than the real 2005-2007 emission levels, as Figure 9-3 and Figure 9-4 show.

All NAP II have not been published yet. However, the 2005-2007 certified emissions of the six countries included in the figures - those that have already published their NAP- cover around 71% of total 2005-2007 European certified emissions.

The data has been rebased to obtain a similar perimeter for NAP I and NAP II to allow comparison. All installations only included in one of the two NAPs have been extracted (the installation has either closed or opened between NAP I and NAP II, the sectors –or subsectors- that were only included in one of the two NAPs). Only the Spanish and British NAPs were validated. The data for the other countries is based on proposed NAPs.

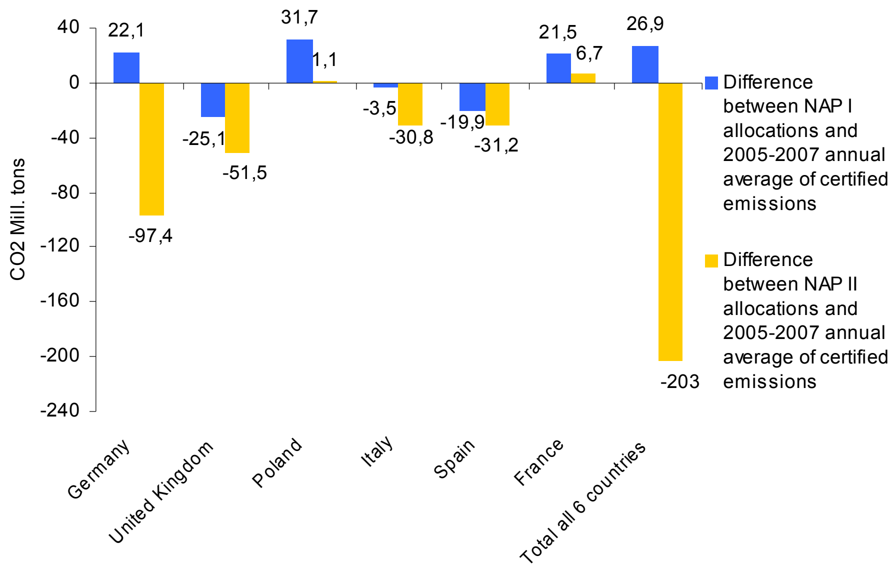
46 Impact Assessment, Document accompanying the Package of Implementation measures for the EU's objectives on climate change and renewable energy for 2020, EC, January 2008.

Figure 9-3: Comparison between real emissions, NAP I and NAP II allocations



Source: Ernst & Young

Figure 9-4: Difference between real emissions and NAP I and II allocations



Source: Ernst & Young

This analysis suggests that the price of allowances is bound to be higher because of the NAP II allocations, which appear below the needs.

Aviation allowances (AA)

The agreed characteristics of the aviation allowances are as follows:

- Instead of separate emissions caps for each of the 27 Member States, one EU-wide cap will be set for aviation based on historical emissions levels in 2004-06
- The 2012 emissions cap is set at 97% of the average 2004-06 EU aviation sector emissions
- There is a reserve (new entrants) of 3%
- From 2013 onwards, the emissions cap is set at 95% of the average 2004-06 emissions, although this is still being discussed under wider EU negotiations
- Aircraft operators receive 85 percent of AAs for free in 2012
- The remaining 15 percent are to be auctioned by government - this percentage may change from 2013 as part of the general vision of the EU ETS Directive
- Aircraft operators can use EUAs, the credits traded under the EU ETS, for compliance, but ground sources participating in the EU ETS cannot use AAs

Kyoto credits

In addition to the cap and trade system, the Kyoto Protocol proposed two mechanisms: Clean Development Mechanisms (CDM) and Joint Implementation (JI).

The CDM defined in Article 12 of the Kyoto Protocol provides for Annex I Parties (the European Union, Japan, Canada, Russia, etc.) to implement project activities that reduce emissions in non-Annex I Parties, in return for certified emission reductions (CERs). The CERs generated by such project activities can be used by Annex I Parties to help meet their emissions targets under the Kyoto Protocol.

The Protocol provides for Annex I Countries to implement policies and measures jointly with other Parties. In order to build experience and ‘learn by doing’, COP 1 (Berlin, March/April, 1995) launched a pilot phase of jointly implemented activities under which Annex I Parties may implement projects in other countries that reduce emissions of greenhouse gases or enhance their removal through sinks.

The sponsoring governments will receive Emissions Reduction Units (ERUs) that may be applied to their emissions targets; the recipient nations will gain foreign investment and advanced technology (but not credits toward meeting their own emissions caps).

There are several ways to obtain project-based credits:

- develop a CDM or JI project on one’s own;
- contract with a trader or a company specialized in finding CDM or JI projects;
- participate in a carbon fund.

According to the UNFCCC, at August 5, 2008, more than 3,000 CDM projects were being prepared or assessed, representing more than 2 700 mill. tCO_2, 80 were in the process of registering (40 mill. tCO_2) and 1 133 were registered (1,290 mill. tCO_2).

Together with the expected ERUs from JI projects, the total amount of Kyoto credits available until year-end 2012 would reach 4 000 mill. tCO_2, if all of the projects followed through to completion. This would be a very optimistic assumption. Other assessments suggest that between 150 mill. tCO_2/year and 300 mill. tCO_2/year could be originated from CDM/JI project development.

The estimated expected demand for CERs and ERUs in 2012 is 900 mill. tCO_2/year, of which:

- European Union: 400 mill. tCO_2/year;
- Japan: 270 mill. tCO_2/year;
- Canada: 200 mill. tCO_2/year.

Figure 9-5 below shows the evolution of the price of CERs, which is significantly lower than that of EUAs.

Figure 9-5: CER prices on the OTC

Source: Point Carbon

Inclusion of aviation in the EU ETS: Cases for Carbon Leakage

Aircraft operators may have more difficulties developing CDM/JI projects than other actors already included in the EU ETS for the following reasons:

- Emissions abatement opportunities are low in the aviation sector. Activities commonly used for CDM and JI project development are less linked to the aviation sector than to other sectors where the implementation of such projects is far less expensive. Aircraft operators will not have access to projects in their core business whereas many other actors do.
- Subsidiaries of aircraft operators in an Annex II countries will not have the required size and skills to develop CDM/JI themselves whereas this in more in line with regular activities in other sectors (cement, energy).

Therefore, if the price of CERs/ERUs is lower than the EUAs price, aircraft operators will be net buyers of those credits once they are validated and issued.
In addition to AAs and EUAs, aircraft operators can use CERs or ERUs to cover 15 percent of their emissions - this may change from 2013 as part of wider EU negotiations.
CDM and JI cost less than EUAs, but the prices will be pulled up by the EUA and AA prices.

Based on the price of EUA futures and on the EC scenarios, and considering the consequences of the NAP II, we have assumed a low price scenario of €30/tCO_2 and a high price scenario of €50/tCO_2. We have kept these assumptions constant until 2020, reflecting that in reality the price will probably be between the two all through the period. However, it should be noted that there is considerable uncertainty about future prices and it is quite possible that prices could exceed the upper bound set out here.

10. APPENDIX B: ADDITIONAL CONSIDERATION ON WINDFALL PROFITS

Arguments regarding the possible occurrence of windfall profits in the aviation sector in a situation where allowances are granted to aircraft operators have been presented in Section 2. The aim of this appendix is to examine the issue further in more detail with more theoretical examples.

- **Examination of windfall profits for a single operator on one given route**

To start with, we assume a single operator that maximizes its profit by selling one single homogeneous good and whose profit Π before the introduction of the ETS may be written as follows:

$$\Pi = (p - c) \times D(p) - F \qquad (E)$$

where p is the price of an air ticket, c the marginal cost, $D(p)$ the demand curve depending on the price and F the fixed cost incurred by the company. The profit may be seen as the difference between two terms, the first being the *gross profit* of the company – that is to say the margin of each unit of service multiplied by the demand – and the second being the fixed costs. In this case, the company will determine the price of its units of service in order to maximize its profit. The profit-maximizing price prior to the introduction of the ETS is written as p^* whereas the maximized profit is written as Π^*.

$$\Pi^* = (p^* - c) \times D(p^*) - F$$

After the introduction of the ETS, the structure of cost will change since the company will now have to incur costs related to allowances (at this stage, we do not consider whether the allowances are free of not): the marginal cost increases by Δc and the fixed cost by ΔF so that the maximisation program changes and become the following:

$$\Pi' = (p - (c + \Delta c)) \times D(p) - (F + \Delta F)$$

The operator will then decide to adopt the new price that will maximize its new profit function. We note that this new price is p'^* and we note $\Delta p = p'^* - p^*$ the increase in price following the increase in costs and we also note $\Delta p = \sigma.\Delta c$ where sigma is the cost pass-through rate. The new equilibrium demand will also be different and will be equal to $D(p'^*)$ and we note $\Delta D = D(p^*) - D(p'^*)$ the decrease in demand. The new *net profit* for the aircraft operator just after ETS can be defined as:

$$\Pi'^* = (p'^* - (c + \Delta c)) \times D(p'^*) - (F + \Delta F)$$
$$\Pi'^* = ((p^* + \Delta p) - (c + \Delta c)) \times (D(p^*) - \Delta D) - (F + \Delta F)$$
$$\Pi'^* = ((p^* - c) + (\Delta p - \Delta c)) \times (D(p^*) - \Delta D) - (F + \Delta F)$$
$$\Pi'^* = (p^* - c) \times D(p^*) - F + (\Delta p - \Delta c) \times D(p^*) - (p^* - c) \times \Delta D - \Delta F$$
$$\Pi'^* = \Pi^* + (\Delta p - \Delta c) \times D(p^*) - (p^* - c) \times \Delta D - \Delta F$$

We note that $\Delta p = \sigma.\Delta c$ where σ is the cost pass-through rate and using the price elasticity of demand ε. We then have:

$$\Pi'^* = \Pi^* - \Delta c \times (1 - \sigma) \times D(p^*) - (p^* - c) \times \varepsilon.D(p^*).\frac{\Delta p}{p^*} - \Delta F$$

This expression shows the different effects on the operator's profitability. The profit after ETS is equal to the profit before ETS less three different terms:

1. The first term is the increase in the variable cost that is not passed through to customers which reduces the gross margin for the airlines: *the variable cost not passed through*;
2. The second term is the loss of gross margin due to the reduction of demand (implied by the price increase): *the decrease in demand due to price increase*;
3. The third term is equal to the fixed costs of ETS that cannot be passed through to customers and thus reduces the profit margin of the airline: *the additional fixed costs*.

Using the well-known Lerner equation $\frac{p-c}{p}=\frac{1}{\varepsilon}$, the above equation becomes:

$$\Pi'^{*} = \Pi^{*} - \Delta c \times (1-\sigma) \times D(p^{*}) - D(p^{*}).\Delta p - \Delta F$$

At the first order – i.e. for a small variation of the cost – and using $\Delta p = \sigma.\Delta c$, this equation can be rewritten in the following manner :

$$\Pi'^{*} = \Pi^{*} - \left(\Delta c.D(p^{*}) + \Delta F\right)$$

The second term of this equation is exactly equal to the cost of allowances. This means that at the first order, the profit of the operator will decrease exactly by the cost of allowances. This means that windfall profits are impossible in such a situation. Studies that suggest that an airline will increase the price of air tickets because of the new cost of emissions and benefit from the “value” of free allowances completely ignore the fact that the potential “value” of these free allowances would at best cover the loss of profits due to the increase of costs.

- **Preliminary justification of the use of a Cournot Model**

The Cournot model assumes that firms compete on output/capacity (here the number of seats) whereas the Bertrand model assumes that firms compete on price.

The Cournot equilibrium is reached when firms anticipate correctly the level of production of their competitors and thus maximize their profits. The economic model of Cournot competition for an oligopoly is characterized by the following features:

- All firms on the market produce homogeneous products
- No collusion between firms
- Fixed number of firms
- Firms choose quantities simultaneously
- The firms respect the Nash equilibrium (each firm chooses its best strategy given the strategies followed by other firms)

Retaining the Cournot model means that we assume that airlines’ products are homogeneous. This is not completely accurate as in reality factors such as brand image, service quality, loyalty program, and the carrier’s nationality will mean there are differences between products. However, we can assume that most of the passengers, especially leisure passengers, are indifferent to the airlines they are flying with and therefore consider that the offers are homogeneous.
Cournot competition is an appropriate model for the aviation sector as airlines are likely to fix their capacity first and then adjust the price.

Other models have been studied but we came to the conclusion that they were not applicable to the airlines industry and especially the Bertrand model that assumes that competition is on prices and that prices are chosen simultaneously. This implies that in the case of homogeneous products, the price is equal to the marginal cost, which results in zero profits. Price competition means that when the price is fixed, it is easy for the firm to adjust the output. The Bertrand model is not properly suited because the capacity of airlines cannot be easily changed.

- **Examination of windfall profits for a limited number of operators on one given route**

This situation is similar to that of a single operator, although some differences do exist. In examining the case of a limited number of operators, we use the Cournot duopoly model. We assume that the price function for both aircraft operators will be $p(q_1, q_2)$, where q_1 and q_2 are the supply of services provided by operators 1 and 2. The profit of operator 1 before the introduction of the ETS can be rewritten as follows:

$$\Pi_1(q_1, q_2) = [p(q_1, q_2) - c]q_1 - F$$

After the introduction of the ETS and with the additional cost, profit may be written as:

$$\Pi'_1(q_1, q_2) = [p(q_1, q_2) - (c + \Delta c)]q_1 - (F + \Delta F)$$

This equation can be rewritten as follows:

$$\Pi'_1(q_1, q_2) = \Pi_1(q_1, q_2) - [\Delta F + \Delta c\ q_1]$$

This equation shows that the profit after ETS is equal to the profit before ETS less the cost of allowances. This equation is similar to the profit maximization formula for a single operator, with the exception that it is necessary to take into account the change in supply of operator 2 relating to the introduction of the ETS, which may have an effect on the profit of operator 1. In order to examine the impact on the profitability of operator 1, we identify q_1^* and q'^*_1, quantities which maximize the profit of the company before and after the introduction of the ETS respectively. The same notation is used for company 2.

The difference in profit for operator 1 before and after the introduction of the ETS may be noted as:

$$\Pi'_1(q'^*_1, q'^*_2) - \Pi_1(q_1^*, q_2^*) = [\Pi_1(q'^*_1, q'^*_2) - \Pi_1(q_1^*, q_2^*)] - [\Delta F + \Delta c\ q'^*_1]$$

We first resolve the first term. First order Taylor development leads to the following equation:

$$\Pi_1(q'^*_1, q'^*_2) - \Pi_1(q_1^*, q_2^*) = \frac{\partial \Pi_1}{\partial q_1}(q_1^*, q_2^*)(q'^*_1 - q_1^*) + \frac{\partial \Pi_1}{\partial q_2}(q_1^*, q_2^*)(q'^*_2 - q_2^*)$$

The first term of this equation will be close to zero since the operator maximized his profit before the ETS so that the first order condition is driven only by the second term.[47]

$$\frac{\partial \Pi_1}{\partial q_2}(q_1^*, q_2^*) = \frac{dp}{dq}(q_1^* + q_2^*)\ q_1^*$$

At this stage, we consider that dp could be considered as a small change in price and we consider that dp may be interchanged with Δp whereas dq may be interchanged with Δq.

We also assume that the market share of operators 1 and 2 will remain unchanged after the introduction of the ETS and if we define $q_1^* = \alpha_1 .Q$ then $q'^*_1 = \alpha_1 .Q'$, where α_1 is the market share of operator 1.

$$\Pi_1(q'^*_1, q'^*_2) - \Pi_1(q_1^*, q_2^*) = \Delta p.q_1^*.(1 - \alpha_1),$$

The impact of the introduction of the ETS on profits can be rewritten as the sum of the two terms rearranged:

$$\Pi'_1(q'^*_1, q'^*_2) - \Pi_1(q_1^*, q_2^*) = \alpha_2.\Delta p.q_1^* - (\Delta F + \Delta c.q'^*_1)$$

47 Note that a second development would lead to a negative term which means that the decrease in profit will be more significant if the impact of the ETS is not marginal.

At the first order, the following expression can be determined:

$$\Pi'_1\,(q'^*_1, q'^*_2) - \Pi_1\,(q^*_1, q^*_2) = -\,(\Delta F + (1-(1-\alpha_1).\sigma).\Delta c.q'^*_1\,),$$

where σ is the variable cost pass-through rate. This expression means that there is, in any case, a financial loss for the operators even if this loss is lower than for a single operator, as the increase in costs leads to a decrease in the quantities supplied by both operators, thus a decrease in competition and as a consequence a relatively higher increase in fares.

The preceding equation shows that the decrease in profits for the aircraft operators depends, at the first order and assuming that the duopoly is of Cournot-type, on (i) the cost pass-through rate (the higher the cost pass-through rate the lower the financial impact on the aircraft operator since the cost is passed through to customers), and (ii) the market share of the aircraft operator (the lower the market share, the lower the financial impact since the operator benefits from the reduction in supply of its competitor).

The main conclusions of this analysis are the following:

- in the case of a single operator ($\alpha_1 = 1$), we find the same result as described in the preceding chapter, that is to say the financial loss is at least equal to the additional costs, just as if there were no cost pass-through;
- in the case of pure and perfect competition ($\alpha_1 = 0, \sigma = 1$), the financial impact on aircraft operators would be reduced to the fixed part of the additional cost of the ETS that cannot be passed-through to customers;
- If the cost-pass-through rate is equal to 0 (e.g. at congested airports where price are set at a level that equals the demand and the capacity of the airport), the financial impact is equal to the whole additional cost with no regard to the market share.

Two issues have to be taken into account when interpreting these results:

- The financial impact is lower for aircraft operators with a low market share than for others. However, this is no longer true if we talk about relative financial impact. Small aircraft operators will be less affected by variable costs than larger ones, but their financial position may be dramatically affected by the increase in fixed costs that in certain cases could not be offset by their relatively low gross margin. For larger aircraft operators, the additional fixed costs may be absorbed more easily due to the volume effect;

- The impact that we have determined is a first order impact and we have not sought to examine second order impacts that would have shown that the negative financial impact on aircraft operators is higher, since all second order terms are negative and thus would lead to a further reduction in the profits of aircraft operators.

11. APPENDIX C: ADDITIONAL CONSIDERATIONS ON COST PASS-THROUGH

Below we seek to provide more information and more detail in relation to a number of key elements of the analysis regarding cost pass-through presented in Section 2 of this report.

- **The Shape of the Demand Curve**

The purpose of this example is to demonstrate with a numerical example the possibility that the demand curve could either be convex or concave and, therefore, that the linear demand curve we have used in our work is a sensible middle ground assumption.

We consider a simplistic case, where consumers must choose between the train and the plane to go from one place to another. This case is only sensitive to the price and the duration of the journey. His corresponding utilities are the following:

Train: $U_1 = t_1^{-\alpha} \times p_1^{\alpha-1}$

Plane: $U_2 = t_2^{-\alpha} \times p_2^{\alpha-1}$

Where t_1 and t_2 are the duration of the trip by train and by plane respectively, p_1 and p_2 the prices, and α is a parameter that represent the weight put on the duration of the journey whereas $1-\alpha$ represents the weight put on the price. α is different for various types of customers and could range between 0 and 1. We assume that α is uniformly distributed in that range. We note α_m the marginal consumer who is indifferent to use the plane or the train given the durations and prices for these two means of transportation, so that the demand for the plane is equal to: $\begin{cases} \alpha_m & if \quad t_2 > t_1 \\ 1-\alpha_m & if \quad t_2 < t_1 \end{cases}$

In order to get the shape of the demand curve for the plane, we will focus on the need to obtain a relation between α_m and p_2. The equality of the two utility functions gives us:

$$U_1 = U_2$$
$$\Leftrightarrow t_1^{-\alpha_m} \times p_1^{\alpha_m-1} = t_2^{-\alpha_m} \times p_2^{\alpha_m-1}$$
$$\Leftrightarrow \left(\frac{p_1}{p_2}\right)^{\alpha_m-1} = \left(\frac{t_2}{t_1}\right)^{-\alpha_m}$$
$$\Leftrightarrow \alpha_m.\ln\left(\frac{p_1.t_2}{p_2.t_1}\right) = \ln\left(\frac{p_1}{p_2}\right)$$
$$\Leftrightarrow \alpha_m = \frac{\ln\left(\frac{p_1}{p_2}\right)}{\ln\left(\frac{p_1.t_2}{p_2.t_1}\right)}$$

Fixing the value for t_1, t_2, and p_1 will give us the value of α_m or $1-\alpha_m$ depending on the value of p_2. The following examples will show that not only can the demand curve be convex, but it can also be concave.

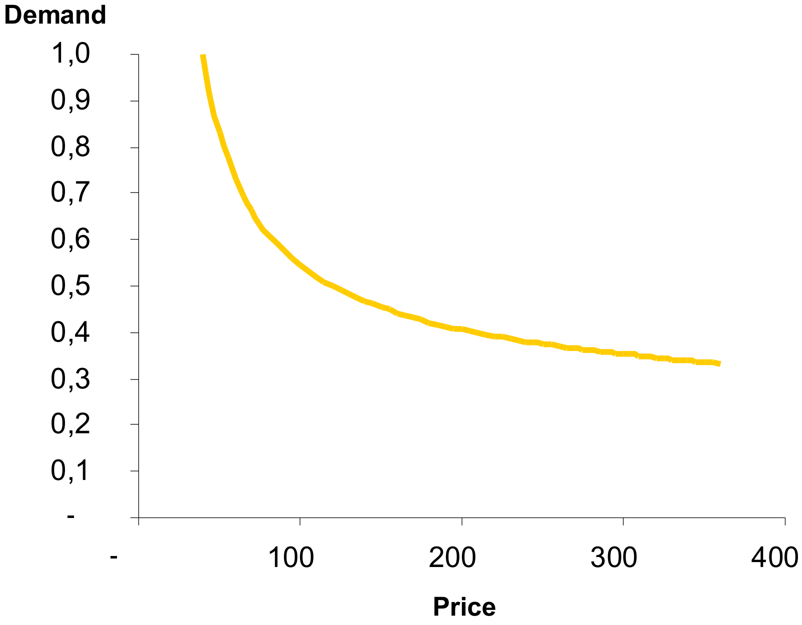
The assumptions taken for our first example are summarized in the table below:

Table 11-1: Assumptions in order to obtain a convex demand curve

Train	t1 p1	3 40
Plain	t2 p2	1 ?

The shape of the demand curve, given by $1-\alpha_m$, is the following:

Figure 11-1: Shape of the Demand curve when the plane has a qualitative advantage



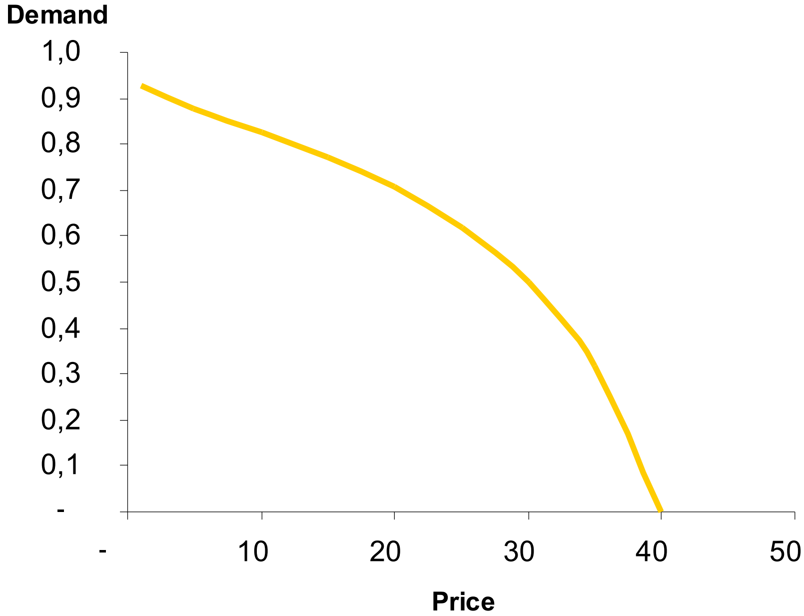
The demand curve is convex, which is due to the non-monetary advantage of the plane compared to the train: trip duration is lower in the case of the plane. This is a kind of demand curve that we find commonly in the theory. The next example will show that we cannot assume that the demand curve is always convex.
The assumptions taken for our second example are summarized in the table below:

Table 11-2: Assumptions in order to obtain a concave demand curve

Train	t_1 p_1	3 40
Plain	t_2 p_2	4 ?

The shape of the demand curve, given by α_m in this case, is the following:

Figure 11-2: Shape of the Demand curve when the plane has a qualitative disadvantage



The demand curve is now concave, which is due to the non-monetary disadvantage of the plane compared to the train as the trip duration is higher in the case of the plane.

This simplistic example shows that it is possible to find concave demand curve with a limited set of assumptions. We have considered here two means of transport and that the consumer would only focus on the price and the duration of the journey. Actually, extension is possible by comparing the utility of the journey by plane with any other type of service like for example a leisure activity at home for leisure passengers, and also by considering other non-monetary considerations of the consumers.

- **Congested Airports**

In its Worldwide Scheduling Guidelines, IATA[48] classifies airports in to two categories: (i) schedule-facilitated airports, where aircraft operators have to explain in advance their requirements to land and take off and (ii) coordinated airports where aircraft operators cannot arrive or depart until they have been allocated specific slots by a coordinator appointed for the airport. According to a study carried out by Mott MacDonald for the European Commission[49], airports could be classified in to three categories based on their level of congestion: (i) un-congested, (ii) partially congested and (iii) heavily congested. This study was based on 35 airports selected from the 73 coordinated airports and 55 schedule-facilitated airports in the Community. These airports include all the heavily congested airports, a large proportion of all the reasonably congested airports, a small proportion of the larger number of lightly congested airports and a small number of schedule-facilitated airports. Classification was based predominantly on the ratio of slots made available by airports and the number of slots allocated during the summer 2005 IATA Slot allocation meetings. Slots made available by airports are the slots that may be bid on by aircraft operators. Other criteria were developed in the Mott MacDonald study in order to qualify the level of congestion of an airport, and the results for 2005 are presented in the following table.

48 International Air Transport Association
49 Study on the impact of the introduction of secondary trading at Community airports – European commission - Mott MacDonald – November 2006

Table 11-3: Slot Availability During Summer 2005

Summer 2005	Town	Airport	Allocated slots / available slots
Heavilly congested	Amsterdam	Amsterdam	111%
Heavily congested	London	Gatwick	102%
Heavily congested	Milan	Linate	101%
Heavily congested	Paris	Orly	100%
Heavily congested	London	Heathrow	99%
Partially congested	Paris	Charles de Gaulle	88%
Partially congested	London	Stansted	83%
Un-congested	Brussels	Brussels	79%
Partially congested	Zurich	Zurich	78%
Partially congested	Rome	Fiumicino	75%
Un-congested	Lisbon	Lisbon	70%
Un-congested	Milan	Malpensa	67%
Partially congested	Copenhagen	Copenhagen	64%
Un-congested	Geneva	Geneva	59%
Un-congested	Stockholm	Arlanda	53%
Un-congested	Milan	Bergamo	52%
Un-congested	Budapest	Budapest	47%
Un-congested	Oslo	Oslo	41%
Un-congested	Stockholm	Bromma	37%
Un-congested	Rome	Ciampino	34%

Data was not available or not requested for seven airports, three of which have been considered as heavily congested airports. Eight airports are considered to be heavily congested by this study.

According to Mott MacDonald, 30% of passengers were handled by heavily congested airports in 2005, but this figure is expected to rise to 50% by 2025. We have assumed that these figures prepared for the European Commission represent the percentage of demand at heavily congested airports. This is actually an underestimate since it is reasonable to assume that the average revenue from a passenger at a heavily congested airport is higher than for an average passenger at a less heavily congested airport. Heavily congested airports are hubs for the network airlines, handling long-haul flights with higher prices than short-haul flights. We propose the following percentages:

Table 11-4: Percentage of Congested Airports

	Percentage of congested airports
2005	30%
2020	45%

- **Unlimited Supply and Competition**

The situation is different at un-congested airports since the absence of supply limits allows for a more traditional form of competition between aircraft operators.

However, such competition cannot be considered systematically perfect, and its actual nature depends on point-to-point markets. On some point-to-point markets, competition is closer to an oligopoly, and in some cases even a monopoly. We will first examine these different cases by assuming that no changes occur on the supply side.

- **Pricing under perfect oligopolies**

Cost pass-through approach in an oligopoly is an issue that has been considered in a paper by Ten Kate and Niels[50]. They examine the case of cost savings in a monopoly and in an oligopoly, and the way in which such savings are passed on to consumers. They consider the different situations for a monopoly and an oligopoly according to the nature of cost and demand. They conclude that cost pass-through in the case of an oligopoly does not only depend on the elasticity of demand, but also on the number of assumed equally-sized competitors and on the convexity or concavity of the demand function at the equilibrium point. This result may be surprising, since a well-known result in the case of a monopoly is the Lerner equation:

$$\frac{p - mc}{p} = \frac{1}{\varepsilon}$$

where p is the single price of the goods or services provided by the monopoly, mc the marginal cost and ε the elasticity of demand. By assuming that the demand is iso-elastic, such an equation is often solved by giving the following result:

$$p = \frac{\varepsilon . mc}{\varepsilon - 1}$$

This result means that the cost pass-through can be higher than 100%, or in other words, that the monopoly may decrease or increase its price much more significantly than the decrease or increase in costs it faces (proportionally in relative). However, as outlined by Ten Kate and Niels, the use of an iso-elastic demand result is nothing more than the choice of a particular shape of demand, and we note on top of that that this shape of demand is fairly unrealistic in the airline market. Kate and Niels then determine the cost pass-through rate by assuming no particular shape of the demand function and discuss how such a cost pass-through rate depends on the actual shape of the demand function and not only on the elasticity at the equilibrium point. The case in point is one of linear demand for which the cost pass-through rate is determined only by reference to the number of competitors:

$$\sigma = \frac{n}{n + 1}$$

This analysis of the cost pass-through rate can also be applied to perfect competition, which leads to cost pass-through results of 100% if the number of competitors is infinite, which corresponds to the assumption made in the EC impact assessment. However even a situation where nine aircraft operators compete, leads to a cost pass-through rate lower than 100% and equal to 90%.

50 To what extent are Cost Savings passed on to Consumers? An oligopoly approach. – European journal of law and economics - A. Ten Kate and G. Niels - 2005

12. APPENDIX D: ETS ADMINISTRATIVE COSTS

We studied in the body of the report the cost of purchasing allowances. Implementation of the EU ETS also generates administrative costs for the operators covered by the scheme. These costs can be classified as follows:

- Internal costs, i.e. costs borne by operators through the working hours of their personnel for calculating historical yearly emissions and annual emissions, submitting requests to competent authorities, following up on annual verification and legal support.
- External verification costs, i.e. the costs of verification performed by the accredited verifier appointed by the aircraft operator.
- Costs related to registration fees and allowances trading.

We have calculated the costs for three different types of aircraft operators:

- ‘Large companies’: companies operating a high number of destinations, already reporting their CO_2 emissions, with trading resources inside the company and all aircraft equipped with Digital Flight Data Recorders (DFDR);

- ‘Medium-size companies’: companies operating several destinations, but with no detailed report of fuel consumption, without internal resources for trading or for monitoring and reporting the CO_2 emissions;

- ‘Small-size companies’: companies not already reporting fuel consumption by destination, with no internal resources for trading or for monitoring and reporting CO_2 emissions.

Table 12-1: Minimum Administrative Costs Related to the Inclusion in the EU ETS

Type of cost (k€)	Large companies	Medium-size companies	Small-size companies
Internal costs	79	64	49
External verification	75	56	43
Registration	33	30	25
Total	**187**	**149**	**116**

We estimate that administrative costs will range from k€116 to k€187 per annum when all the monitoring, verification and trading mechanisms will be in place. Based on the assumption that the allowances distributed to a company may range from 50,000 tCO_2 to 5 mill. tCO_2 per year, the administrative costs borne will range from €0.04 per allowance for large companies to €2.33 per allowance for the smallest aircraft operators. The relative cost can thus be 60 times higher for small aircraft operators than for large companies. Sectors like business aviation, where 85% of the companies have less than five aircraft will be penalized.
For some aircraft operators, these costs could easily be multiplied by a factor of two or three during the first year when companies will have to adapt their reporting tools and become familiar with the trading system.

The administrative costs are not significant in comparison to the cost of purchasing allowances and consequently this analysis is not included within the main body of the report.

13. APPENDIX E: RESULTS OF SENSITIVITY TESTING

In this Appendix, we present the results of three key sensitivity tests that have been undertaken in relation to the impact of the EU ETS on the airlines profitability. The purpose of these tests was to examine the impact of varying certain core assumptions made as part of this assessment and to examine whether these could significantly alter the conclusions drawn.

The three tests undertaken focussed on:

- the Price Elasticity of Demand Assumptions – while the literature relating to the price elasticity of demand is extensive, we tested the sensitivity of the models developed to our assumptions by reducing each of the assumed elasticities by 10%;

- the Rate of Cost Pass-through – we have identified a series of theoretical models that demonstrate the likely extent of cost pass-through by segment. However, again, we felt it would be prudent to assess the overall sensitivity of the models to our assumptions. To do this, we have increased the fixed cost of ETS by 10% in each case, reducing the rate of cost pass-through.

- the Market Structure (Level of competition & Level of congested airports) – even if these assumptions were chosen regarding market information, we felt it would be prudent to assess sensitivity to this assumption. A greater proportion of routes operated by one company has been tested (+15%), offset with a decrease of routes operated by a small number of companies (-5%) and routes operated by a large number of companies (-10%). This has been naturally mixed with a greater proportion of congested airports in 2020 (55% against 45% initially).

Our assessment of the results is that, while these assumptions obviously do change the results of the impact assessment, it is in a relatively small range. The core assumptions presented within the main body of the report represent the most appropriate basis for assessing the impact on the aviation sector.

Below, we have set out the financial impact on airlines of these tests for the period 2012 to 2020.

Sensitive Tests on Elasticity (10% variation)		Business as Usual (€ Mill.)	€30/tonne 15% Auction (€ Mill.)	€30/tonne 15%-100% Auction (€ Mill.)	€50/tonne 15% Auction (€ Mill.)	€50/tonne 15%-100% Auction (€ Mill.)
Network Airlines	Study's Assumptions	71 030	-24 281	-39 600	-39 876	-65 265
	Test's New Assumptions	71 030	-25 098	-40 914	-41 207	-67 401
	Sensitivity	0.0%	3.4%	3.3%	3.3%	3.3%
Low Fares 1 Airlines	Study's Assumptions	24 668	-1 849	-3 507	-3 039	-5 791
	Test's New Assumptions	24 668	-1 986	-3 766	-3 263	-6 219
	Sensitivity	0.0%	7.4%	7.4%	7.4%	7.4%
Low Fares 2 Airlines	Study's Assumptions	3 524	-1 704	-3 232	-2 800	-5 334
	Test's New Assumptions	3 524	-1 827	-3 463	-3 001	-5 715
	Sensitivity	0.0%	7.2%	7.2%	7.2%	7.2%
Cargo Airlines	Study's Assumptions	7 159	-7 554	-12 276	-10 760	-17 099
	Test's New Assumptions	7 159	-7 773	-12 588	-11 115	-17 598
	Sensitivity	0.0%	2.9%	2.5%	3.3%	2.9%

Sensitive Tests on Market Structure (Level of competition & Level of congested airports)		Business as Usual (€ Mill.)	€30/tonne 15% Auction (€ Mill.)	€30/tonne 15%-100% Auction (€ Mill.)	€50/tonne 15% Auction (€ Mill.)	€50/tonne 15%-100% Auction (€ Mill.)
Network Airlines	Study's Assumptions	71 030	-24 281	-39 600	-39 876	-65 265
	Test's New Assumptions	71 030	-24 627	-40 189	-40 453	-66 262
	Sensitivity	0.0%	1.4%	1.5%	1.4%	1.5%
Low Fares 1 Airlines	Study's Assumptions	24 668	-1 849	-3 507	-3 039	-5 791
	Test's New Assumptions	24 668	-1 839	-3 490	-3 023	-5 766
	Sensitivity	0.0%	-0.5%	-0.5%	-0.5%	-0.4%
Low Fares 2 Airlines	Study's Assumptions	3 524	-1 704	-3 232	-2 800	-5 334
	Test's New Assumptions	3 524	-1 688	-3 202	-2 774	-5 288
	Sensitivity	0.0%	-1.0%	-0.9%	-0.9%	-0.9%
Cargo Airlines	Study's Assumptions	7 159	-7 554	-12 276	-10 760	-17 099
	Test's New Assumptions	7 159	-7 572	-12 322	-10 791	-17 182
	Sensitivity	0.0%	0.2%	0.4%	0.3%	0.5%

Sensitive Tests on Fixed Costs (10% increase)		Business as Usual (€ Mill.)	€30/tonne 15% Auction (€ Mill.)	€30/tonne 15%-100% Auction (€ Mill.)	€50/tonne 15% Auction (€ Mill.)	€50/tonne 15%-100% Auction (€ Mill.)
Network Airlines	Study's Assumptions	71 030	-24 281	-39 600	-39 876	-65 265
	Test's New Assumptions	71 030	-25 579	-41 714	-42 016	-68 772
	Sensitivity	0.0%	5.3%	5.3%	5.4%	5.4%
Low Fares 1 Airlines	Study's Assumptions	24 668	-1 849	-3 507	-3 039	-5 791
	Test's New Assumptions	24 668	-2 057	-3 902	-3 380	-6 447
	Sensitivity	0.0%	11.2%	11.3%	11.2%	11.3%
Low Fares 2 Airlines	Study's Assumptions	3 524	-1 704	-3 232	-2 800	-5 334
	Test's New Assumptions	3 524	-1 941	-3 682	-3 190	-6 081
	Sensitivity	0.0%	13.9%	13.9%	13.9%	14.0%
Cargo Airlines	Study's Assumptions	7 159	-7 554	-12 276	-10 760	-17 099
	Test's New Assumptions	7 159	-7 913	-12 813	-11 352	-17 990
	Sensitivity	0.0%	4.8%	4.4%	5.5%	5.2%

14. APPENDIX F: CALCULATING THE EFFECT ON DEMAND

In this Appendix, we set out the methodology and assumptions that have been used to calculate the impact on demand for the aviation sector. This Appendix should be considered in conjunction with Chapter 3, which discusses the issue of cost pass-through in the aviation sector, and includes information on the price elasticity of demand used. We do not revisit these issues here.

Calculating the Impact on Demand
It should be noted at the outset that, in quantitative terms, our approach focuses on the impact on passenger airlines, divided into the two principal business models; network and low fares airlines, and on cargo carriers. We consider that the impact on charter or regional airlines will fall within the spectrum of the impacts of the principal carrier types considered.

Establishing Business as Usual Demand
Within the scope of this study we have not sought to undertake detailed modelling of the future demand for air transport. We have, instead, drawn upon existing work undertaken by a number of organisations to develop a business as usual demand position. The sources used for this analysis were:

- Eurostat which provided a base for 2005 and 2006 for both passenger and cargo demand;
- Boeing Current Market Outlook 2007 which provided details of RPKs for 2006 and forecast growth rates;
- Airbus Global Market Forecast 2007 to 2026 provided information on RTKs for cargo in 2006 and forecast growth rates;
- AEA and ELFAA information on the market share of low fares airlines based on passengers flown and seats offered.

Based on an assessment of the growth rates identified in these publications for different market segments, we have identified a business as usual (BAU) demand scenario that reflects forecast growth without the extension of the EU ETS to cover the aviation sector. The results of this analysis separated into business model and sector length are set out in Table 14-1 below.

Table 14-1: Business as usual demand scenario

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
PASSENGERS (MILL.)																
NETWORK AIRLINES																
DOMESTIC	127	131	134	138	141	145	148	152	155	159	162	166	169	173	176	180
INTRA EU	234	251	258	264	271	278	284	291	298	305	311	318	325	332	338	345
EXTRA EU	245	250	263	276	290	305	321	337	354	372	391	411	432	454	477	501
TOTAL	606	632	655	678	702	727	753	780	807	835	865	895	926	958	991	1 025
LOW FARES AIRLINES																
DOMESTIC	35	36	39	41	44	47	50	53	57	61	65	69	74	79	84	90
INTRA EU	65	70	74	79	85	90	96	103	110	117	125	133	142	151	161	172
EXTRA EU	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	100	106	113	121	129	137	146	156	167	178	190	202	216	230	245	262
CARGO (MILL. TONNES)																
DOMESTIC	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
INTRA EU	2	2	2	2	2	2	2	2	3	3	3	3	3	3	3	3
EXTRA EU	9	9	10	10	11	11	12	12	13	14	14	15	16	17	18	18
TOTAL	11	12	12	13	14	14	15	16	17	17	18	19	20	21	22	23
REVENUE PASSENGER KILOMETRES (BILLION)																
NETWORK AIRLINES																
DOMESTIC	116	122	125	129	132	135	138	142	145	148	151	155	158	161	164	168
INTRA EU	324	343	352	361	370	379	388	397	406	415	425	434	443	452	461	470
EXTRA EU	999	1 062	1 115	1 172	1 231	1 294	1 359	1 428	1 501	1 577	1 657	1 741	1 830	1 923	2 021	2 124
TOTAL	1 439	1 527	1 592	1 661	1 732	1 807	1 885	1 967	2 052	2 140	2 233	2 330	2 431	2 536	2 647	2 762
LOW FARES AIRLINES																
DOMESTIC	32	34	36	39	41	44	47	50	53	57	61	65	69	74	78	84
INTRA EU	90	95	101	108	115	123	131	140	149	159	170	181	193	206	220	235
EXTRA EU	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	122	129	138	147	157	167	178	190	203	216	231	246	262	280	299	318
REVENUE TONNE KILOMETRES (CARGO OPERATORS)																
DOMESTIC	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1
INTRA EU	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2
EXTRA EU	54	56	59	62	65	68	72	75	79	83	87	91	96	101	106	111
TOTAL	55	58	60	63	66	70	73	77	81	85	89	93	98	103	108	114

Calculating the Impact on Demand

In order to examine the impact on demand for the aviation sector, we have identified a series of sample routes that can be used to illustrate of the impact of ETS on fares or cargo tariffs for different business models and markets.

Below, we set out three tables containing the assumptions used in developing these sample routes (Table 14-2 Network Airlines, Table 14-3 Low fares Airlines, Table 14-4 Cargo Operators).

Table 14-2: Assumptions for "typical routes": Network Airlines

ASSUMPTION	SOURCE	DOMESTIC	SHORT HAUL/INTRA-EU	LONG HAUL/EXTRA EU
AIRCRAFT	YALLP ASSUMPTION	AIRBUS A320	AIRBUS A320	BOEING 777
TOTAL SEATS	AIRCRAFT MANUFACTURER WEBSITE	150	150	340
SECTOR LENGTH (KM)	AEA STAR06	450	902	6452
AVERAGE PASSENGER LOAD FACTOR	AEA - STAR06	67.20%	69.30%	81.30%
AVERAGE PASSENGER YIELD PER RPK (€)	AEA - STAR06	€ 0.17	€ 0.13	€ 0.07
FLIGHT RPK		45 360	93 763	1 783 462
REVENUE (€)		€ 7 622	€ 12 246	€ 116 469
ONE WAY YIELD PER PAX (€)		€ 75.62	€ 117.81	€ 421.35
LTO CYCLE FUEL USAGE	EMEP/CORINAIR DATABASE	802.3	802.3	2 562.8
FUEL USAGE PER KM IN CRUISE	EMEP/CORINAIR DATABASE	3.7	3.1	7.4
FUEL USAGE IN KG PER SECTOR		2 467.3	3 598.5	50 307.6
CO2 EMISSIONS IN KG	BASED ON FUEL USAGE AND CARBON FACTOR OF 3.15	7 772.0	11 335.3	158 468.9

It should also be noted that our estimates of the additional costs of ETS are based on the load factors and fuel consumption described above.

Table 14-3: Assumptions for 'Typical' Routes: Low Fares Airlines

ASSUMPTION	SOURCE	DOMESTIC	SHORT HAUL/INTRA-EU	LONG HAUL/EXTRA EU
AIRCRAFT	YALLP ASSUMPTION	BOEING 737-800	BOEING 737-800	N/A
TOTAL SEATS	AIRCRAFT MANUFACTURER WEBSITE	189	189	N/A
SECTOR LENGTH (KM)	AEA STAR06	450	902	N/A
AVERAGE PASSENGER LOAD FACTOR	ELFAA KEY STATISTICS	83.00%	83.00%	N/A
AVERAGE PASSENGER YIELD PER RPK (€)	TRL AIRLINE PERFORMANCE INDICATORS	€ 0.09	€ 0.07	N/A
FLIGHT RPK		70 592	141 497	N/A
REVENUE (€)		€ 6 630	€ 10 329	N/A
ONE WAY YIELD PER PAX (€)		€ 42.26	€ 65.85	N/A
LTO CYCLE FUEL USAGE	EMEP/CORINAIR DATABASE	825.4	825.4	N/A
FUEL USAGE PER KM IN CRUISE	EMEP/CORINAIR DATABASE	3.1	3.0	N/A
FUEL USAGE IN KG PER SECTOR		2 220.4	3 531.4	N/A
CO2 EMISSIONS IN KG	BASED ON FUEL USAGE AND CARBON FACTOR OF 3.15	6 994.3	11 123.9	N/A

Table 14-4: Assumptions for 'Typical' Routes: Cargo Operators

ASSUMPTION	SOURCE	DOMESTIC	SHORT HAUL/INTRA-EU	LONG HAUL/EXTRA EU
AIRCRAFT	YALLP ASSUMPTION	BOEING 737 FREIGHTER	BOEING 737 FREIGHTER	BOEING 747 FREIGHTER
TOTAL CAPACITY	AIRCRAFT MANUFACTURER WEBSITE	18	18	114
SECTOR LENGTH	AEA STAR06	450	902	6452
AVERAGE FREIGHT LOAD	AEA STAR06	38.40%	60.10%	71.00%
AVERAGE YIELD PER FREIGHT TONNE KILOMETRE (€)	AEA STAR06	€ 0.16	€ 0.50	€ 0.21
FLIGHT TONNE KILOMETRES		3 110	9 758	522 225
YIELD (€)		€ 492.95	€ 4 856.96	€ 108 133.97
ONE WAY YIELD PER KILOGRAMME (€)		€ 0.07	€ 0.45	€ 1.34
LTO CYCLE FUEL USAGE	EMEP/CORINAIR DATABASE	825.4	825.4	3 402.2
FUEL USAGE PER KM IN CRUISE	EMEP/CORINAIR DATABASE	3.1	3.1	10.3
FUEL USAGE IN KG PER SECTOR		2 220.4	3 621.6	69 857.8
CO2 EMISSIONS IN KG	BASED ON FUEL USAGE AND CARBON FACTOR OF 3.15	6 994.3	11 408.0	220 052.1

The information in the tables above is then used to examine the impact of ETS on air fares and cargo tariffs, which can in turn be used to make an assessment of the impact on overall demand. This process needs three further inputs discussed in other chapters in this report:

- the assumed allowance price;
- the average rate of cost pass-through for the market segment;
- the price elasticity of demand for the market.

In Table 14-5 below, we have illustrated this process for a low fares, short haul/intra EU route where the allowance price is assumed to be €30/tCO_2 in 2022 and auctioning is set at 15%. For the purposes of this illustration, we have examined the impact on passenger demand.

Table 14-5: Impact of ETS on Demand: Low Fares Airline, Short Haul/Intra EU Route

ALLOWANCE PRICE OF €30/TCO_2	
AVERAGE ONE-WAY FARE (€)	65.85
CO_2 EMITTED BY FLIGHT	11
COST OF ALLOWANCES AT €30/TCO_2 (€)	€ 334
COST PER PASSENGER FLOWN (NUMBER OF SEATS X LOAD FACTOR) (€)	€ 2.13
AVERAGE COST PASS-THROUGH RATE	77%
COST PASSED TO PASSENGER (€)	€ 1.64
NEW AVERAGE ONE-WAY FARE (€)	€ 67.48
% RISE IN FARE	2.5%
PRICE ELASTICITY FOR THE MARKET SEGMENT	-1.5
RESULTING CHANGE IN DEMAND	-3.7%
BASELINE PASSENGERS IN 2020	172 074 617
TOTAL INTRA EU EMISSIONS IN 2020	76.4
CAP APPLYING TO INTRA-EU FLIGHTS	51.7

Our assessments of the impact on demand are an extension of this process. The impact is assessed for each year, for each carrier type, for each sector length and for each allowance price scenario. This percentage impact is then applied to the different measures of demand shown in Table 14-1.

For ease of reference, we have set out in Table 14-6 to Table 14-10 the impact on fares and tariffs for the various market segments and sector lengths based on the process and assumptions shown above, including the elasticity of demand assumptions (Table 14-9) and the cost pass-through assumptions (Table 14-10) set out in chapter 3 and the proportion of demand affected by prices rises caused by the EU ETS, which is determined by total emissions for each market segment, the portion of the cap assumed to apply to that market segment and the extent of auctioning (Table 14-11). It should be noted that we have presented here the average cost-pass through rates for the different market segments. In reality, the rate of cost pass-through is determined by the level of competition on each route but, for the purposes of modelling the impact on demand, it is necessary to apply an average rate.

Table 14-6: Changes in One Way Air Fares and Tariffs Resulting from the Introduction of the EU ETS: Domestic Routes

€	NETWORK BUSINESS/LEISURE		LOW FARES		CARGO	
AVERAGE FARE/ TARIFF PER KG	€143.67/ €68.06		€42.26		€0.07	
ALLOWANCE COST NEW PRICE €	30 €/T	50 €/T	30 €/T	50 €/T	30 €/T	50 €/T
2012	144.73/ 69.11	145.44/ 69.82	42.75	43.07	0.08	0.09
2013	144.72/ 69.10	145.41/ 69.80	42.78	43.20	0.08	0.09
2014	144.70/ 69.08	145.39/ 69.77	42.80	43.33	0.08	0.09
2015	144.68/ 69.07	145.36/ 69.74	42.82	43.47	0.08	0.09
2016	144.67/ 69.05	145.33/ 69.71	42.84	43.60	0.08	0.09
2017	144.65/ 69.03	145.30/ 69.68	42.83	43.60	0.08	0.09
2018	144.63/ 69.02	145.27/ 69.65	42.82	43.60	0.08	0.09
2019	144.62/ 69.00	145.25/ 69.63	42.81	43.60	0.08	0.09
2020	144.60/ 68.98	145.22/ 69.60	42.80	43.60	0.08	0.09

Table 14-7: Changes in One Way Air Fares and Tariffs Resulting from the Introduction of the EU ETS: Short-Haul Routes

€	NETWORK BUSINESS/LEISURE		LOW FARES		CARGO	
AVERAGE FARE/ TARIFF PER KG	€192.03/€109.56		€65.85		€0.45	
ALLOWANCE COST PRICE INCREASE €	30 €/T	50 €/T	30 €/T	50 €/T	30 €/T	50 €/T
2012	193.53/ 111.06	194.53/ 112.06	66.63	67.12	0.46	0.47
2013	193.51/ 111.04	194.49/ 112.02	66.66	67.34	0.46	0.47
2014	193.48/ 111.01	194.45/ 111.98	66.70	67.55	0.46	0.47
2015	193.46/ 110.99	194.41/ 111.94	66.73	67.76	0.46	0.47
2016	193.43/ 110.97	194.37/ 111.90	66.76	67.97	0.46	0.47
2017	193.41/ 110.94	194.33/ 111.86	66.74	67.97	0.46	0.47
2018	193.39/ 110.92	194.29/ 111.82	66.73	67.97	0.46	0.47
2019	193.36/ 110.90	194.25/ 111.78	66.71	67.97	0.46	0.47
2020	193.34/ 110.87	194.21/ 111.74	66.70	67.97	0.46	0.47

Table 14-8: Changes in One Way Air Fares and Tariffs Resulting from the Introduction of the EU ETS: Long-Haul Routes

€	NETWORK BUSINESS/LEISURE		LOW FARES		CARGO	
AVERAGE FARE/ TARIFF PER KG	€1217.69/€332.86		N/A		€1.34	
ALLOWANCE COST PRICE INCREASE €	30 €/T	50 €/T	30 €/T	50 €/T	30 €/T	50 €/T
2012	1 225.57/ 340.75	1 230.83/ 346.00	N/A	N/A	1.36	1.38
2013	1 225.45/ 340.62	1 230.62/ 345.79	N/A	N/A	1.37	1.39
2014	1 225.32/ 340.50	1 230.41/ 345.58	N/A	N/A	1.37	1.39
2015	1 225.20/ 340.37	1 230.20/ 345.38	N/A	N/A	1.37	1.39
2016	1 225.07/ 340.25	1 230.00/ 345.17	N/A	N/A	1.37	1.39
2017	1 224.95/ 340.12	1 229.79/ 344.96	N/A	N/A	1.37	1.39
2018	1 224.82/ 340.00	1 229.58/ 344.75	N/A	N/A	1.37	1.39
2019	1 224.70/ 339.87	1 229.37/ 344.54	N/A	N/A	1.37	1.39
2020	1 224.57/ 339.75	1 229.16/ 344.33	N/A	N/A	1.37	1.39

Table 14-9: Price Elasticity of Demand Assumptions

	Business	Leisure
Network airlines (short haul)	-0.8	-1.5
Network airlines (long haul)	-0.8	-1.0
Low fares airlines	-1.5	-1.5
	Express	Standard
Cargo airlines	-0.8	-1.6

Table 14-10: Average Cost Pass-through Rate (% Costs Passed to Consumer)

	2012	2013	2014	2015	2016	2017	2018	2019	2020
NETWORK AIRLINES	46%	45%	44%	44%	43%	42%	41%	41%	40%
LOW FARES AIRLINES	77%	77%	77%	77%	77%	77%	77%	77%	77%
CARGO	46%	45%	44%	44%	43%	42%	41%	41%	40%

Table 14-11: Proportion of Traffic Affected by the EU ETS

Year	€30/tonne 15% Auction		€30/tonne 15%-100% Auction		€50/tonne 15% Auction		€50/tonne 15%-100% Auction	
	Intra-EU	Extra-EU	Intra-EU	Extra-EU	Intra-EU	Extra-EU	Intra-EU	Extra-EU
2012	28.5%	37.7%	28.5%	37.7%	28.1%	37.2%	28.1%	37.2%
2013	31.6%	41.3%	40.0%	48.5%	31.2%	40.8%	39.6%	48.0%
2014	33.3%	43.5%	49.7%	57.5%	32.9%	43.0%	49.2%	57.0%
2015	34.9%	45.7%	59.0%	65.9%	34.5%	45.2%	58.6%	65.4%
2016	36.5%	47.8%	68.0%	73.7%	36.1%	47.3%	67.6%	73.3%
2017	38.1%	49.8%	76.5%	81.0%	37.6%	49.3%	76.2%	80.7%
2018	39.6%	51.7%	84.7%	87.8%	39.1%	51.2%	84.5%	87.6%
2019	41.1%	53.6%	92.5%	94.1%	40.6%	53.1%	92.4%	94.0%
2020	42.5%	55.3%	100.0%	100.0%	42.1%	54.9%	100.0%	100.0%

The results of this process are set out in **Table 14-12** for the € 30/tonne constant 15% auctioning scenario, in **Table 14-13** for the € 30/tonne 15% to 100% auctioning scenario, in **Table 14-14** for the € 50/tonne constant 15% auctioning scenario and **Table 14-15** for the 50 €/tonne 15% to 100% auctioning scenario.

Table 14-12: 30 €/ton and 15% constant auctioning scenario

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Passengers (mills.)																
Network Airlines																
Domestic	127	131	134	138	141	145	148	151	154	158	161	165	168	171	175	178
Intra EU	234	251	258	264	271	278	284	289	296	303	309	316	323	329	336	342
Extra EU	245	250	263	276	290	305	321	334	351	369	387	407	427	449	472	496
Total	**606**	**632**	**655**	**678**	**702**	**727**	**753**	**774**	**801**	**829**	**858**	**887**	**918**	**950**	**982**	**1 016**
Low Fares Airlines																
Domestic	35	36	39	41	44	47	50	53	56	60	64	68	73	78	83	88
Intra EU	65	70	74	79	85	90	96	102	108	115	123	131	140	149	159	169
Extra EU	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	**100**	**106**	**113**	**121**	**129**	**137**	**146**	**154**	**165**	**175**	**187**	**199**	**213**	**227**	**242**	**258**
Cargo (mill. tonnes)																
Domestic	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Intra EU	2	2	2	2	2	2	2	2	2	3	3	3	3	3	3	3
Extra EU	9	9	10	10	11	11	12	12	13	14	14	15	16	16	17	18
Total	**11**	**12**	**12**	**13**	**14**	**14**	**15**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**
Revenue Passenger Kilometres (bills.)																
Network Airlines																
Domestic	116	122	125	129	132	135	138	141	144	147	150	154	157	160	163	166
Intra EU	324	343	352	361	370	379	388	395	404	413	422	431	440	449	458	467
Extra EU	999	1 062	1 115	1 172	1 231	1 294	1 359	1 416	1 487	1 562	1 641	1 724	1 811	1 903	2 000	2 101
Total	**1 439**	**1 527**	**1 592**	**1 661**	**1 732**	**1 807**	**1 885**	**1 952**	**2 035**	**2 122**	**2 213**	**2 309**	**2 408**	**2 512**	**2 621**	**2 734**
Low Fares Airlines																
Domestic	32	34	36	39	41	44	47	49	53	56	60	64	68	72	77	82
Intra EU	90	95	101	108	115	123	131	139	148	157	168	179	191	203	217	231
Extra EU	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	**122**	**129**	**138**	**147**	**157**	**167**	**178**	**188**	**200**	**213**	**228**	**243**	**259**	**276**	**294**	**313**
Freight Tonne Kilometres (bills.)																
Domestic	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1
Intra EU	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2
Extra EU	54	56	59	62	65	68	72	74	77	81	85	89	94	99	104	109
Total	**55**	**58**	**60**	**63**	**66**	**70**	**73**	**76**	**79**	**83**	**87**	**91**	**96**	**101**	**106**	**111**

Table 14-13: 30 €/ton and 15% to 100% increasing auctioning scenario

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Passengers (mills.)																
Network Airlines																
Domestic	127	131	134	138	141	145	148	151	154	157	160	163	167	170	173	176
Intra EU	234	251	258	264	271	278	284	289	295	302	308	314	320	327	333	339
Extra EU	245	250	263	276	290	305	321	334	350	368	386	405	425	446	468	492
Total	**606**	**632**	**655**	**678**	**702**	**727**	**753**	**774**	**800**	**826**	**854**	**882**	**912**	**942**	**974**	**1 007**
Low Fares Airlines																
Domestic	35	36	39	41	44	47	50	53	56	60	64	68	72	76	81	86
Intra EU	65	70	74	79	85	90	96	102	108	115	122	130	138	146	156	166
Extra EU	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	**100**	**106**	**113**	**121**	**129**	**137**	**146**	**154**	**164**	**174**	**185**	**197**	**210**	**223**	**237**	**252**
Cargo (mill. tonnes)																
Domestic	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Intra EU	2	2	2	2	2	2	2	2	2	3	3	3	3	3	3	3
Extra EU	9	9	10	10	11	11	12	12	13	13	14	15	15	16	17	18
Total	**11**	**12**	**12**	**13**	**14**	**14**	**15**	**15**	**16**	**17**	**18**	**18**	**19**	**20**	**21**	**22**
Revenue Passenger Kilometres (bills.)																
Network Airlines																
Domestic	116	122	125	129	132	135	138	141	144	147	150	153	156	159	162	164
Intra EU	324	343	352	361	370	379	388	395	403	412	420	429	437	446	454	462
Extra EU	999	1 062	1 115	1 172	1 231	1 294	1 359	1 416	1 485	1 557	1 634	1 715	1 800	1 889	1 984	2 083
Total	**1 439**	**1 527**	**1 592**	**1 661**	**1 732**	**1 807**	**1 885**	**1 952**	**2 031**	**2 116**	**2 204**	**2 296**	**2 393**	**2 494**	**2 600**	**2 710**
Low Fares Airlines																
Domestic	32	34	36	39	41	44	47	49	52	56	59	63	67	71	76	81
Intra EU	90	95	101	108	115	123	131	139	147	156	166	177	188	200	212	226
Extra EU	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	**122**	**129**	**138**	**147**	**157**	**167**	**178**	**188**	**200**	**212**	**226**	**240**	**255**	**271**	**288**	**307**
Freight Tonne Kilometres (bills.)																
Domestic	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Intra EU	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2
Extra EU	54	56	59	62	65	68	72	74	77	81	85	89	93	97	102	107
Total	**55**	**58**	**60**	**63**	**66**	**70**	**73**	**76**	**79**	**83**	**86**	**90**	**95**	**99**	**104**	**109**

Table 14-14: 50 €/ton and constant 15% auctioning scenario

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Passengers (mills.)																
Network Airlines																
Domestic	127	131	134	138	141	145	148	150	153	157	160	164	167	171	174	177
Intra EU	234	251	258	264	271	278	284	288	295	301	308	315	321	328	334	341
Extra EU	245	250	263	276	290	305	321	332	349	366	385	404	425	446	468	492
Total	**606**	**632**	**655**	**678**	**702**	**727**	**753**	**771**	**797**	**825**	**853**	**882**	**913**	**944**	**977**	**1 010**
Low Fares Airlines																
Domestic	35	36	39	41	44	47	50	53	56	60	64	68	72	77	82	87
Intra EU	65	70	74	79	85	90	96	101	107	114	122	130	138	148	157	168
Extra EU	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	**100**	**106**	**113**	**121**	**129**	**137**	**146**	**153**	**163**	**174**	**185**	**198**	**211**	**224**	**239**	**255**
Cargo (mill. tonnes)																
Domestic	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Intra EU	2	2	2	2	2	2	2	2	2	3	3	3	3	3	3	3
Extra EU	9	9	10	10	11	11	12	12	13	13	14	15	15	16	17	18
Total	**11**	**12**	**12**	**13**	**14**	**14**	**15**	**15**	**16**	**17**	**18**	**18**	**19**	**20**	**21**	**22**
Revenue Passenger Kilometres (bills.)																
Network Airlines																
Domestic	116	122	125	129	132	135	138	140	143	146	150	153	156	159	162	165
Intra EU	324	343	352	361	370	379	388	393	402	411	420	429	438	447	456	465
Extra EU	999	1 062	1 115	1 172	1 231	1 294	1 359	1 408	1 478	1 552	1 630	1 712	1 799	1 890	1 985	2 086
Total	**1 439**	**1 527**	**1 592**	**1 661**	**1 732**	**1 807**	**1 885**	**1 942**	**2 023**	**2 110**	**2 200**	**2 294**	**2 393**	**2 496**	**2 604**	**2 716**
Low Fares Airlines																
Domestic	32	34	36	39	41	44	47	49	52	56	59	63	67	72	76	82
Intra EU	90	95	101	108	115	123	131	138	146	156	166	177	189	201	214	229
Extra EU	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	**122**	**129**	**138**	**147**	**157**	**167**	**178**	**187**	**199**	**212**	**226**	**240**	**256**	**273**	**291**	**310**
Freight Tonne Kilometres (bills.)																
Domestic	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1
Intra EU	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2
Extra EU	54	56	59	62	65	68	72	73	77	80	84	88	93	97	102	107
Total	**55**	**58**	**60**	**63**	**66**	**70**	**73**	**75**	**78**	**82**	**86**	**90**	**95**	**99**	**104**	**110**

Table 14-15: 50 €/ton and increasing 15% to 100% auctioning scenario

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Passengers (mills.)																
Network Airlines																
Domestic	127	131	134	138	141	145	148	150	153	156	159	162	165	168	171	174
Intra EU	234	251	258	264	271	278	284	288	294	300	306	312	318	323	329	335
Extra EU	245	250	263	276	290	305	321	332	348	364	382	401	420	441	462	485
Total	**606**	**632**	**655**	**678**	**702**	**727**	**753**	**771**	**795**	**820**	**847**	**874**	**903**	**932**	**963**	**994**
Low Fares Airlines																
Domestic	35	36	39	41	44	47	50	53	56	59	63	66	70	75	79	84
Intra EU	65	70	74	79	85	90	96	101	107	113	120	127	135	143	152	161
Extra EU	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	**100**	**106**	**113**	**121**	**129**	**137**	**146**	**153**	**162**	**172**	**183**	**194**	**205**	**218**	**231**	**246**
Cargo (mill. Tonnes)																
Domestic	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Intra EU	2	2	2	2	2	2	2	2	2	3	3	3	3	3	3	3
Extra EU	9	9	10	10	11	11	12	12	13	13	14	14	15	16	17	17
Total	**11**	**12**	**12**	**13**	**14**	**14**	**15**	**15**	**16**	**16**	**17**	**18**	**19**	**20**	**20**	**21**
Revenue Passenger Kilometres (bills.)																
Network Airlines																
Domestic	116	122	125	129	132	135	138	140	143	146	148	151	154	157	160	162
Intra EU	324	343	352	361	370	379	388	393	401	409	417	425	433	441	449	457
Extra EU	999	1 062	1 115	1 172	1 231	1 294	1 359	1 408	1 474	1 544	1 619	1 697	1 780	1 867	1 959	2 056
Total	**1 439**	**1 527**	**1 592**	**1 661**	**1 732**	**1 807**	**1 885**	**1 942**	**2 018**	**2 099**	**2 184**	**2 273**	**2 367**	**2 465**	**2 568**	**2 676**
Low Fares Airlines																
Domestic	32	34	36	39	41	44	47	49	52	55	58	62	66	70	74	79
Intra EU	90	95	101	108	115	123	131	138	146	154	164	174	184	195	207	220
Extra EU	0															
Total	**122**	**129**	**138**	**147**	**157**	**167**	**178**	**187**	**198**	**209**	**222**	**236**	**250**	**265**	**281**	**299**
Freight Tonne Kilometres (bills.)																
Domestic	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Intra EU	1	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2
Extra EU	54	56	59	62	65	68	72	73	76	80	83	87	91	95	100	104
Total	**55**	**58**	**60**	**63**	**66**	**70**	**73**	**75**	**78**	**81**	**85**	**89**	**93**	**97**	**102**	**106**

15. GLOSSARY

AAU	Assigned Amount Unit
CCS	Carbon Capture and Storage
CDM	Clean Development Mechanism
CER	Certified Emission Reduction
CO_2 e	Carbon dioxide equivalent
COP	Conference of the Parties
EC	European Commission
ERU	Emission Reduction Unit
ETS	Emissions Trading System
EU ETS	European Union Emissions Trading Scheme
EUA	European Union Allowance
GVA	Gross Value Added
ICAO	International Civil Aviation Organization
JI	Joint Implementation
Mt	Million tonne
NAP	National Allocation Plan
Operating profit	Net profit or loss before income tax and financial income and expenses
Operating margin	Operating profit or loss expressed in percentage of revenue
RPK	Revenue Passenger Kilometer
RTK	Revenue Ton Kilometer
UNFCCC	United Nations Framework Convention on Climate Change

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