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Allocation of allowances for aviation in the EU ETS

The impact on the profitability of the aviation sector under high levels of auctioning

Final report

Report

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Executive summary

At the end of 2006, the European Commission put forward a proposal for inclusion of aviation emissions in the EU ETS. WWF UK asked CE Delft to study one particular aspect of this proposal, namely the initial allocation of allowances to aircraft operators. We have looked specifically at:
- The interaction between allocation method and the likelihood that costs of allowances are passed through.
- How the allocation method may affect emission reductions within the aviation sector.
- The impact of high levels of auctioning on the profitability of the aviation sector.

In this report we list the findings of our study.

Before describing the results of our analysis in detail, note that the use of allowances implies opportunity costs, whether the allowances have been bought or obtained free of charge. In the first case, the opportunity costs are reflected in actual expenditures on allowances either from the purchase of allowances at an auction or at the EU ETS market. Not passing through real expenditures will negatively affect the operating margins. In case of freely obtained allowances, the opportunity costs are not reflected in actual expenditures. If the opportunity costs are passed through nonetheless, this may actually increase the operating margin.

In general, in competitive markets where price setting is based on marginal cost levels, opportunity costs will be passed through fully in air fares, whether they are related to actual expenditures or not. Empirical results for the power sector indicate that pass through of opportunity costs is real. There are however two situations in which these opportunity costs might not accompanied by a (full) corresponding increase in air fares. First, from a theoretical perspective, it may be argued that expenditures on allowances will not be passed through fully in case of congested airports. The empirical data available however point in the direction that also at congested airports additional expenditures are passed through fully.

Second, in addition to opportunity costs there may also be what we call ‘opportunity benefits’. In its proposal for aviation the European Commission put forward so-called repeated or updated benchmarking. The allowances allocated for the next trading period depend on the performance during the current trading period. There may thus be opportunity benefits of producing RTK’s in addition to the opportunity costs. These cancel out largely and it is therefore not expected that these allowances will be reflected in the ticket prices[1]. Actually, if as under the current proposal, one specific year will be used as benchmark year to allocate emissions for the upcoming five year period, there will be a perverse incentive for operators to lower their prices during this benchmark year, so to ensure the

[1] Note that this is not in line with the results reported in previous CE Delft studies. These did not consider in detail the impacts of updated benchmarking.

allocation of more free allowances for the next period. Under one off benchmarking and auctioning, in contrast, there are no opportunity benefits and it may be expected that opportunity costs are fully passed through.

In general, under emissions trading aircraft operators will take all measures that cost less than handing in allowances. These measures may be technical (e.g. purchasing a more efficient aircraft), operational (e.g. increasing the load factor), or may incorporate volume measures. Volume measures are said to occur when the cost pass through in tickets results in lower demand. Since under updated benchmarking, the freely allocated allowances are not fully reflected in ticket prices, the incentive for volume measures is reduced substantially. Therefore the emission reduction within the sector is lower under updated benchmarking then under auctioning or one off benchmarking. In any case, the expected reductions within the sector are in the order of 2 to 10% of the amount of allowances that will be purchased on the EU ETS market.

Table 1 Qualitative comparison of impacts of different allocation methodologies

	Pass through in ticket prices	Windfall profits	Demand effect	Industry measures
Auctioning	++	- -	++	++
Grandfathering	+	+	+	++
Repeated benchmarking	-	-	-	++
One off benchmarking	+	+	+	++

Note: ++: very likely; +: likely; -: unlikely; - -: very unlikely.

Table 1 summarizes the likely impacts under different allocation methods. If it is decided that (part of) the allowances should be allocated free of charge, there will either be windfall profits and a demand effect, or no windfall profits and no demand effect. Only in case of auctioning windfall profits can be avoided while still inducing a demand effect.

The impacts of different allocation methods on the profitability of airlines has been studied by applying the AERO model. We find that the operating margin of airlines is hardly affected, provided that opportunity costs associated with expenditures are passed through and opportunity costs from updated benchmarking are cancelled out by the opportunity benefits this allocation method induces.

If, contrary to the outcome of our analysis, airlines do not pass through the expenditures on allowances, they will incur a loss and the operating margin will decrease. They would have expenditures that would not be met by revenues.

Similarly, if airlines would receive allowances free of charge without future updating, as would be the case under one off benchmarking, airlines could increase air fares while not having expenditures. Consequently, their operating margin would increase and there would be windfall profits.

It should be noted that the AERO model applied is a static model, calculating equilibrium situations. It thus assumes that the aviation industry has fully adapted to the new policy and investments levels have been adjusted accordingly. In the short run there may be fixed costs associated to the investments, and environmental policy that reduces demands may cause excess capacity. This would mean a loss to airlines.

Given the strong growth of the aviation sector and the lead time between the announcement of emissions trading and actual implementation, we expect the potential of overinvestment to be small. However, there may be some years between ordering an aircraft and its delivery, possibly exceeding the lead time of emission trading. In that case, raising the percentage of auctioned allowances over time may further enable airlines to take full account of the influence of emissions trading on their investment decisions.

1 Introduction

1.1 Background

The European Commission brought forward a legislative proposal to include the climate impact of the aviation sector in the EU Emissions Trading Scheme (ETS) in 2006 (EC, 2006). As proposed, the scheme will cover flights between EU airports from 1 January 2011. After one year, the scheme is set to be expanded to cover all flights arriving at or departing from an airport in the Community. The total number of allowances to be allocated to the aviation sector will be set equal to the average emissions from aviation in the years 2004-2006.

The European Commission also proposes to allocate a fixed percentage of the total quantity of allowances free of charge on the basis of a benchmark to aircraft operators which submit an application (the earliest application relating to 2008 data). For the period 2011-2012 this percentage will correspond to the average percentage proposed by the Member States including auctioning in their national allocation plans. Thereafter this will be reviewed in the light of the results of the general review of the emissions trading scheme. The European Parliament (2007) estimates about 3% being allocated by auctioning in the first period (2011-2012).

Experiences in the power sector, however, indicate that allocating allowances free of charge to companies may increase the costs of emission reduction, ultimately resulting in less stringent environmental targets. If this would also hold for the aviation sector, there would be reason to increase the percentage of the total quantity of allowances to be auctioned among airlines. However, increasing the percentage of the total quantity of allowances to be auctioned may also affect the airline profitability and thus the sector's support.

1.2 Aim of this research

In this context the objectives of this study are:

- To assess the degree to which aircraft operators are able to pass through the costs of allowances, and the extent to which this is dependent on the allocation method used (including an assessment of the impact on ticket prices).
- To investigate how the allocation and distribution of allowances (in combination with other design factors) may affect emission reductions within the aviation sector and in other sectors.
- To investigate the impact of high levels of auctioning on the profitability of airlines.

1.3 Reader

Different allocation methods are discussed in chapter 2. We discuss the influence of the allocation method on the probability that expenditures on and opportunity costs of allowances are passed through. Section 2.3 discusses this mainly from a theoretical perspective. First the general theory is presented and next reasons why the general theoretical framework may not apply are discussed. In section 2.4 empirical data on pass through are presented, both related to emissions trading in general, and the pass through of fuel price increases in the aviation industry. Section 2.5 discusses the theoretical and empirical findings.

In this study we have modelled the impacts under different allocation variants. The variants and modelling assumptions are presented in chapter 3.

In chapter 4, we discuss the results from the modelling regarding the impact of the allocation method on the emission reductions within the aviation sector.

Next, in chapter 5 the impacts on airline profitability and ticket prices are presented and discussed.

Finally, chapter 6 discusses the results of this study in light of its objectives.

2 Allocation methods

2.1 Introduction

The main objectives of this study are to assess the impacts of different levels of auctioning on the emission reduction within the aviation sector and the profitability of the sector. Both kinds of impacts depend upon the extent to which different levels of auctioning affect ticket prices. In this chapter, we investigate this first from a theoretical perspective and then we present empirical data on cost pass through.
In the first section (2.2), we introduce the different allocation methodologies available. Next in section 2.3, we discuss the 'ideal' working of tradable emission rights and how the opportunity costs of freely allocated allowances may be reflected in ticket prices. In paragraph 2.3.2 we discuss how the allocation mechanism may affect the incentives for operators, and the potential impacts on the ticket prices. We will argue that the allocation mechanism may give rise to, what we will call, 'opportunity benefits'. These will reduce the net opportunity costs, and thus reduce the impact of emission trading on ticket prices.
In paragraph 2.3.3 we will discuss another factor that affects whether (opportunity) costs are reflected in ticket prices. If there is no full competition, price setting is generally not based on marginal costs, and thus changes in marginal costs need not affect price setting. Section 2.3.4 describes the potential impact of the allocation method on emission reductions within the sector.

In section 2.4.1 empirical results on the extent to which the costs of emission trading are reflected in market prices will be discussed. We will analyse which factors determine the likelihood of pass through, based on results with the current EU ETS. Section 2.4.2 presents results on the pass through of increased expenditures on fuel in the aviation sector. Over the last decade, fuel prices have spiked. The question to be answered is whether airlines were able to pass through these additional expenditures to their clients.

In section 2.5 the theoretical results are compared to the empirical analysis.

2.2 Allocation methods

In the case of an emissions trading system, the total amount of emissions allowed by the operators under the system is capped. At the end of the trading period, emittants / operators are required to hand in a number of allowances equal to their actual emissions during the period. These allowances can be obtained in different ways. They can be allocated to the emittants at the start of the trading period or they can be purchased on the allowance market. In this section we discuss how allowances can be allocated to the emittants, and what the influence of the allocation method on the working of the emission trading scheme may be.

Generally, one distinguishes three methods of allowance allocation:
- Grandfathering.
- Benchmarking.
- Auctioning.

Under grandfathering, allowances are allocated based on the historical emissions. Under benchmarking, the allowances are allocated to the different emittants based on some performance indicator. The advantage over grandfathering is that thus account can be taken of early action. For example, airlines that have invested in fuel efficient aircraft will be allocated relatively generously, thus rewarding them for the investment. Both under grandfathering and benchmarking, allowances are allocated free of charge. This is different with auctioning, where the emittants have the opportunity to buy the allowances at an auction. It is often argued that thus treatment of newcomers is more fair[2]. Often, the emittants are not in favour of auctioning, because they will have more expenses on allowances.

An additional distinction is between updated or repeated benchmarking and what we will call one off benchmarking. Under updated benchmarking, the allocation of allowances for trading period *t+1* is based on the performance during trading period *t*. In case of one off benchmarking, perpetual emission rights are allocated at the beginning of period 1. For all subsequent trading periods, these allowances hold[3].

Burtraw et al. (2005) discuss updated benchmarking in relation with the treatment of closures and newcomers. They state that 'Adjusting allocation upon closure of an installation will have a negative effect on efficiency'. The reason for this is that under updated benchmarking emittants receive allowances for the next period under the condition that they continue operating in the year used for the benchmark. If they do not produce, no allowances are allocated. Continuing production thus delivers marginal benefits in the form of allowances allocated in the next period. This can be regarded as production subsidy.

One off benchmarking[4], or continuing to use a historic year prior to the first trading period for benchmarking, may solve this. One off benchmarking would allocate allowances to operators in the base year, so to compensate them for any financial losses due to the change in environmental regulation. The allocation of allowances does not depend on the continuation of operation, hence there is no longer a production subsidy. Emittants decide on production levels based on

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2 Of course, with benchmarking ways to come around this problem have been proposed and implemented. For example, a reservation of allowances can be made for newcomers. In that case, not all allowances are allocated at the beginning of the period. If newcomers enter the market, they receive allowances from the reservation.

3 A slightly different alternative is historic benchmarking. The benchmarking is based on the historic year prior to the first trading period, but the total number of allowances allocated may differ between trading periods.

4 Note that one off benchmarking with perpetual rights is an extreme possibility. As Burtraw et al. (2005) argue: 'The ten-year rule captures the lion's share of efficiency gains from a stable system of property rights. Yet it addresses the perception of fairness by providing a finite horizon for the potentially infinitively lived property rights that could be created under historic allocation and that have been created in previous systems'.

marginal costs and benefits. Production may be reduced, in which case the allocated allowances (perpetual rights or allowances allocated in future periods based on the historic benchmark) may be sold. They may even decide to cease operations altogether and sell all their allowances. There is no longer a perverse incentive to continue operation, for the purpose of receiving allowances that would otherwise not be allocated.

Given the discussion above, one might ask oneself the question what the reasons for allocation free of charge might be. The main reason is not to present a financial loss to the sector in comparison to the situation prior to the new regulation. The sector might incur a loss, because in their investment decisions the new regulation has not been taken into account.
On the one hand, such a financial loss is of course detrimental in finding a sector's support for new regulation. On the other hand, compensation for unexpected financial losses due to new governmental policy is simply a matter of good governance.

2.3 Opportunity costs of emission allowances and cost pass through

2.3.1 Theory

In emission trading, there are opportunity costs related to the use of emission allowances. Instead of using allowances 'to cover for one's emissions', the allowances could have been sold against the market price. Since the price of products and services are generally determined by the marginal production costs, one would therefore expect the prices to reflect the opportunity costs of emission allowances. If for example, the production of an additional product would require an extra 10 Euros of emission allowances, one would expect the price of the product to be raised 10 Euros as well.

It is important to note that the opportunity costs of emission allowances do not depend upon how they were received, i.e. the allocation method. The emission allowances have the same opportunity costs whether they were received free of charge or bought at auction. The opportunity costs are equal to the market price for the allowance. In well functioning markets, where price setting is based on marginal costs, it is rational to pass through the opportunity costs of allowances. This is independent on whether the opportunity costs relate to actual expenditures, as is the case if the allowances were purchased on the market or at an auction, or not.

2.3.2 Opportunity benefits in the case of benchmarking and ticket prices

Above we explained that the use of emission allowances represents an opportunity cost, irrespective of whether the allowances have been bought at an auction, at the market or received free of charge. However, it should be noted that if emission allowances are allocated free of charge periodically on the basis of an updated benchmark, flying may also induce *'opportunity' benefits*. By carrying out a flight, the benchmark indicator (e.g. the number of RTKs[5]) increases, and an airline will be allocated a larger share of the total allowances in the next period.

To explain this, let us assume for simplicity that each year operators are allocated allowances free of charge based on their share in total RTK performance in the previous year. Furthermore, let us assume that a particular flight requires € 1,000 worth of emission allowances. Then, the emission allowances, which were received free of charge on the basis of performance in the previous year are part of the marginal costs of the flight, since an additional flight requires the purchase of additional allowances. Actually carrying out the flight, however, also results in the operator receiving approximately € 1,000 worth of emission allowances in the next year[6]. These are part of the marginal *benefits* of the flight. In this hypothetical situation, the opportunity costs and benefits associated with the allowances cancel out each other and no change in ticket prices will occur (see also: ILEX, 2003; ILEX, 2004: section 4.12; Sijm et al., 2005: 45; Neuhoff et al., 2006. Grubb and Neuhoff, 2006).

In practice, the situation is more complicated. First, according to the Commission's proposal operators will be allocated allowances free of charge for each five-year period on the basis of their performance in RTK's in the year ending two years before the start of the new period. The result is that in every five years there are four years in which there are only opportunity costs and no opportunity benefits, since the performance during these four years does not influence the benchmark indicator. Therefore, during these four years ticket prices could be adjusted to reflect the marginal opportunity costs of the allowances required for performing the flight, including those which were allocated for free. However, in one of the five years, the year on which the benchmark is based, the marginal opportunity benefits of performing the flight in terms of emission allowances could outweigh the marginal opportunity costs by almost a factor five. Although the flight may require a certain amount of emission allowances, even more allowances[7] can be earned by performing the flight[8]. In this year, ticket prices may actually become *cheaper* than without the EU ETS. The present EU ETS proposal thus offers a perverse incentive for a five-year periodical price stunting 'jubilee year', in which air transport is boosted. Such a perverse incentive may arise, for example, during the upcoming year 2008. In the present EC proposal, operators' shares in total RTKs during the upcoming year 2008 will determine the allocation for the years 2011 and 2012.

A second complicating factor is that the proportion of emission allowances allocated free of charge to the aviation sector will diminish each year in comparison to the total number of allowances required by the aviation sector.

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5 RTKs (Revenue Tonne Kms) reflect the total payload. It is a summation of passenger kms and cargo ton kms.

6 This will actually be slightly lower in this example, because the overall number of RTKs will also increase.

7 Corresponding to the 5 year duration of the next trading period.

8 The number of allowances to be earned is equal to five times the number of allowances required for the flight times the total amount of allowances required by the aviation sector divided by the total amount of allowances allocated free of charge to the aviation sector.

First, aviation is a strongly growing sector, requiring more allowances in the future. In the business-as-usual scenario, aviation's CO_2 emissions covered by the ETS are expected to grow from about 220 Mton in 2005 to 400 Mton in 2020 (see Table 2).

Table 2 Average growth of emissions

	Average growth rates of emissions		
	2005 - 2010	2010 - 2015	2015 – 2020
Intra EEA flight	5.1%	3.9%	3.1%
All departing flight from the EEA	5.2%	3.9%	3.3%

Source: Impact Assessment (EU, The baseline growth in CO_2 emissions was computed by the AERO model on the basis of a set of assumptions about traffic growth produced by ICAO's Forecasting and Economic Analysis Support Group (FESG)).

Since the number of allowances allocated to the aviation sector is for each period about equal to the emissions in 2005, at maximum half of the allowances will be received free of charge in 2020. Second, it is the intention of the European Commission to increase the fraction of auctioned allowances in future periods. Therefore, it can be expected that in 2020 less than half of the total number of allowances required by the aviation sector will be allocated free of charge.

Concluding, while in the case of auctioning ticket prices may be expected to account for the marginal opportunity costs of allowances and thus increase, this might not be the case with repeated benchmarking. With repeated benchmarking, there are also marginal opportunity benefits which may offset the opportunity costs. Since according to the proposal for inclusion of aviation in the EU ETS, only part of the allowances are received free of charge and it is expected that the sector will have to purchase a substantial share of the required allowances on the EU ETS market, ticket prices are expected to increase somewhat nonetheless.

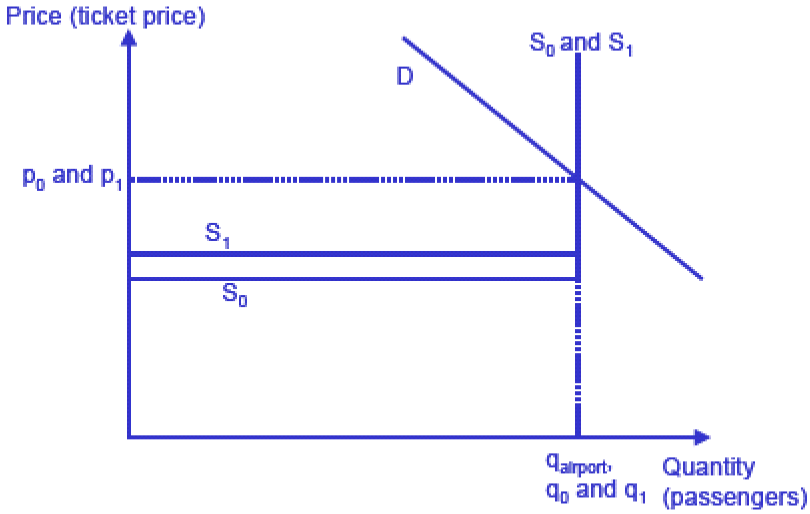
2.3.3 Capacity constrained markets

There is a second reason why costs of emission trading may not be passed through. Generally, if there is no full competition, possibly because of production capacity constraints, prices do not reflect marginal costs. For example, in the case of congested airports there may be constraints to the number of airplanes which can arrive or depart either by limited slot availability or noise regulation. In such capacity constrained markets, the product price is not determined by the marginal costs of production, but simply set at the level which clears the demand at the given supply (OXERA, 2003). This clearing price is higher than the marginal costs of production at the given supply. The difference is the so-called scarcity rent.

Similarly, if there is a monopoly, such as up to recently on the route Amsterdam – Paris Charles de Gaulle, price setting is not based on marginal producer costs. In such situations, cost increases may not be passed through to the client, but may instead decrease the profit (margin) of the operator on the applicable routes. This is explained in the figure below, which has been borrowed from OXERA (2003:

7). The clearing price is equal to the intersection of the demand curve labelled D and the fixed supply S. The marginal production costs in the absence of the ETS are given by the curve S_0. The marginal production costs are raised by the ETS to S_1. So the scarcity profit (P minus S_0) is lowered (to P minus S_1).

Figure 1 Market clearing at congested markets



Source: OXERA.

The relevant question is now to what extent there is full competition in the aviation sector.

There are some airports where capacity is constrained, either physically or due to environmental regulations. Physical constraints may apply only in summer or throughout the year.

OXERA (2003: 11-12) estimates that 25% of intra-EU demand passes through congested airports:

> 'The evidence on this is divided, however. On the one hand, EUROCONTROL argues in its medium-term forecast that only Heathrow Airport can be considered to be a congested airport in the 2008–12 scenario[9]. On the other hand, if the EU's slot coordination rules[10] are used to define which airports within the EU are congested, virtually all major airports are already congested, with more likely to become so by the 2008–12 period.
> The situation becomes even less clear when projecting forward to 2050. One plausible argument is that there will only be a small increase in the provision of airport capacity over that period, perhaps due to complaints from local residents. This could result in an extremely high proportion of demand passing through congested airports. A second plausible argument is that, over such a long timeframe, supply will be substantially more elastic than over short periods, and

9 EUROCONTROL (2003), 'Forecast of Annual Number of IFR Flights (2003–2010)', STATFOR, **1**, section 3.4, February.

10 A congested airport needs to coordinate the allocation of its slots; therefore an airport that is classed by the EU as 'Fully Coordinated' is arguably a congested airport.

> hence it is plausible that only a small proportion of demand will pass through congested airports.
> In the base-case scenario, a figure of 25% of demand passing through congested airports is used. This figure reflects that, although a proportion of air travel demand in Europe passes through congested airports, far from all of it does, particularly since the low-cost carriers (eg, Ryanair) have begun operating primarily from secondary and tertiary airports'.

Despite some airports being congested, Price Waterhouse Coopers (2005: 43), assumes a degree of pass through close to 100%, also at congested airports. They argue that analyses of the airline industry in Europe as well as the world as a whole have shown that profits are extremely cyclical and profit margins are low. The European industry as a whole has created losses of US$ 1.48 billion in 2003. According to PWC, this leaves no room to absorb cost increases in the profit margin.

PWC's view coincides with the opinion expressed by the Competition Commission (2002) in response to a report by the Civil Aviation Authority. According to the Competition Commission, 'The argument that there are significant rents to airlines at Heathrow[11] sits oddly with the lack of profitability of Heathrow airlines. Almost all are currently making little or no profit'. (2002: 53). Furthermore, according to the Competition Commission airlines as well strongly disputed the existence of scarcity rents that would allow them to absorb any increase in costs (2002: 53). Therefore, the Competition Commission concluded that the very strong probability is that fares will rise generally across many, if not most, routes if airport charges or air passenger duties are increased.

2.3.4 Allocation and emission reduction

In theory, systems of tradable emission allowances offer incentives for all measures with which targets can be achieved. These measures do not only include investment in low carbon and energy efficiency technologies, but also other measures such as more efficient operation and demand reduction. In the case of aviation, aircraft operators can reduce their emissions in the following ways[12]:

1 Technical measures:
   a To existing aircraft (short term), such as retrofitting of winglets, riblets and possibly engines.
   b To new aircraft (long term), such as replacement of old aircraft by newer, more fuel-efficient aircraft.
2 Operational measures:
   a At individual flight level (changes of flight path, reduction of empty weight).
   b At network level (such as increases in load factor).
3 Volume measures:
   Reducing the amount of transported ton-kilometres.

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[11] CE Delft: Heathrow is generally regarded as a congested airport.
[12] See also: CE Delft, 2005, Giving wings to emission trading, p. 124-7.

In a completely efficient market for emission allowances, all measures will be taken that cost less than the emission allowances. As discussed in the previous chapter, the free distribution of emission allowances may partly undo the financial incentive to reduce emissions created by a system of tradable emission allowances. In case of updating, allocation of emission allowances free of charge can be considered as a subsidy lowering the production costs[13].

If allowances are allocated free of charge on the basis of a ton-kilometre benchmark, as proposed by the European Commission, the incentives to reduce emissions by either technical or operational measures are left unchanged in comparison to an auction of allowances. After all, by implementing technical or operational measures emissions are reduced without affecting the number of RTKs. Thus less allowances have to be bought or more can be sold, while these measures do not affect the amount of free allowances to be obtained in the next period.

This does not hold, however, in the case of volume measures. If allowances are allocated free of charge on the basis of a ton-kilometre benchmark, the incentives to reduce emissions by volume measures are *reduced* in comparison to an auction of allowances (see also Neuhoff et al., 2006). As explained above, the production of RTKs involves both the opportunity costs of using already owned emission allowances and the opportunity benefits of gaining free emission allowances for the next period. These opportunity costs and benefits partly cancel out each other thus reducing the incentive to take volume measures.

2.4 Practical experience

2.4.1 Experiences with the EU ETS

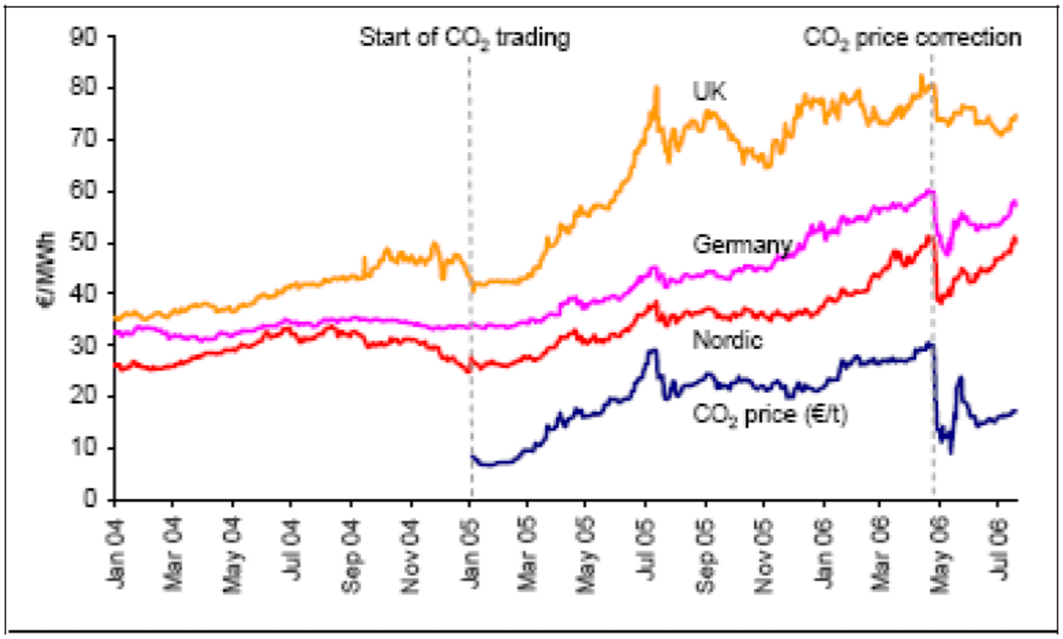
In this section we discuss studies on the pass through of costs in the current EU ETS markets. Few studies have performed empirical *ex post* analysis, however, such as Honkatukia et al. (2006), Sijm et al. (2005), Sijm et al. (2006), Fezzi, 2006, and Bunn and Fezzi (2007). Most studies present theoretical *ex post* estimates, such as OXERA (2004, see also Carbon Trust, 2004; Smale et al., 2006) and ILEX (2004).

Most experience is available for the electricity sector where several surveys have reviewed the pass through of CO_2 allowance prices onto power prices (IEA, 2006). The pass through of CO_2 allowance prices is clearly demonstrated by the response of electricity prices to a sudden change in carbon prices in May 2006. In that period, carbon prices dropped by more than 50% upon reports that the Czech Republic, Estonia, France, the Netherlands and the Walloon region emitted far less CO_2 in 2005 than initially anticipated by the market. Electricity

[13] The only exception would be the case where tradable so-called ‘perpetual permits’ are allocated. (McKibbin and Wilcoxen, 2002; Pezzey, 2003).

prices fell by € 5 to € 10 per MWh in Europe in general on hearing the news[14]. See Figure 2.

Figure 2 Electricity and CO_2 Prices between January 2004 and July 2006



Source: IEA, 2007, p. 27 and primary sources therein.

Empirical analysis of Finnish electricity markets in the first 16 months of the EU ETS indicates that on average about 75% to 95% of a price change in EU ETS is passed through to the Finnish NordPool spot price (Honkatukia et al., 2006). In a study by Sijm et al. (2005) trends in prices of fuels, CO_2 and electricity in Germany and the Netherlands over the period January-July 2005 were analysed. The pass through rates of European CO_2 allowances (EUAs) were found to vary between 40% and 72%, depending on the carbon intensity of the marginal production unit and other, market or technology specific factors concerned. Sijm et al. (2006) update this analysis with a longer observation period and a more refined statistical approach, and find much higher pass through rates. On the basis of its literature survey, the IEA (2007) concludes that the pass through of CO_2 allowance prices onto power prices is real, but also concludes that none of the estimates can be considered accurate enough for quantitative conclusions, partly because the pass through can vary depending on the details about the specific electricity markets. The extent of the pass through of carbon prices into the electricity prices reflects the power generation fuel mix of each country and in particular the fuel burned by the marginal plants, i.e. the ones which set the prices in auction markets (Fezzi, 2006).

14 Source: http://www.euractiv.com/en/sustainability/crashing-carbon-prices-puts-eu-climate-policy-est/article-154873.

2.4.2 Impact of kerosene price increases

Allowances that are auctioned or purchased on the market have a similar economic impact as does for example an increase in kerosene prices. We will discuss the impact of such price increases to analyse the expected impact of increases expenses on emission allowances.

In general, the costs of kerosene are part of the production costs for airlines, and it is very likely that these costs will be reflected in ticket prices. Kerosene prices are part of the marginal costs, and may make of to 50% of the airline costs on intercontinental flights. Airlines that do not reflect these costs in ticket prices will go bankrupt without long.

However, kerosene prices are unpredictable and may fluctuate substantially over time. These fluctuations are not always reflected in ticket prices for two reasons. First of all, airlines apply fuel hedging so to lessen their exposure to fluctuations on the oil market. Second, there are so-called menu costs associated with changing product (i.e. ticket) prices. For these reasons, it may take some time before enduring changes in kerosene prices are reflected in ticket prices.

This is precisely the outcome of research by Price Waterhouse Coopers (2005: 43). PWC regressed changes in annual kerosene prices (with a one period lag) on changes in an annual air travel price index for the UK. The result was calibrated for full service and low cost airlines and confirmed pass through rates that are not significantly different from 100% for both types of carriers. Figure 3 reproduces the results. For full service carriers the level of pass through is estimated at 105%, with the confidence interval ranging from 44% to 156%. For low cost airlines the point estimate is slightly lower, 90%, with the confidence interval ranging from 46 to 133%. The analysis suggested that it takes up to two years for the full impact to become apparent.

Figure 3 Regression results on pass through of fuel price increases

	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: PWC, 2005: 44.

2.5 Discussion

For the analysis of pass through of costs from allowances, we can distinguish between expenditures on allowances and on costs associated with freely allocated allowances. In both cases there are opportunity costs. Depending on the exact form of benchmarking, there may also be ‘opportunity benefits’ in case of free allocation, which influences the potential impact on ticket prices.

It can be expected that expenditures on allowances will be passed through in ticket prices. Airlines that do not pass through their expenditures will end up with cash flow problems and will go bankrupt in the end. PWC (2005) have shown that increases in fuel prices are passed through in ticket prices. There is a theoretical argument to make that at congested airports, airlines receive scarcity rents and price setting is not based on marginal costs. However, this is not substantiated by empirical data. Different sources indicate that there airlines operating from congested airports do not have higher operating revenues than other airlines.

Freely allocated allowances, such as by grandfathering or benchmarking, also have opportunity costs associated. These are however not related to actual expenditures. In the case of updated benchmarking, these opportunity costs may be offset by opportunity benefits. In all other cases, it may be argued that the opportunity costs associated with freely allocated allowances are likely to be passed through, just as in case there had been actual expenditures. Aviation is a competitive sector, and price setting is based on marginal costs. Since opportunity costs are marginal costs, it may be expected that ticket prices reflect these opportunity costs.
In case of updated benchmarking, production during the benchmark year (used for next period's allocation) will also involve opportunity benefits. Producing, or carrying out the flight, will entitle the emittant to more allowances for the next period. Therefore, the emittant may even decide to lower its prices.
Empirical data for the power sector substantiate the claim that opportunity costs will be passed through. IEA (2007) concludes that pass through is real, but that the current empirical results are not accurate enough for quantitative conclusions. on the pass through of opportunity costs.

In Table 3 an qualitative overview is given of the impacts of different allocation methodologies. Note that the scoring in the table only refers to the impacts of the allowances that are allocated to the sector. If the sector has more emissions than the number of allowances allocated, as is expected, it has to purchase allowances. The expenditures associated with these purchases are expected to be passed through the clients in ticket and freight prices, no windfall profits will occur from these purchased allowances, and it will induce a demand effect and also incentivise technical improvements and other measures by the industry.

Table 3 Qualitative comparison of impacts of different allocation methodologies

	Pass through in ticket prices	Windfall profits	Demand effect	Industry measures
Auctioning	++	- -	++	++
Grandfathering	+	+	+	++
Repeated benchmarking	-	-	-	++
One off benchmarking	+	+	+	++

Note: ++: very likely; +: likely; -: unlikely; - -: very unlikely.

3 Modelling

We have applied the AERO model to estimate the impact of different policy variants on the emission reduction within the sector, and on the profit margin and ticket prices. In this chapter we introduce the variants that have been studied. Next, in chapter 4 the impacts on emission reduction will be presented. Chapter 5 discusses the impacts on profit margins and ticket prices.

3.1 General assumptions

We assume for all our analyses that emissions from all departing and arriving flights are brought under the scheme from the start in 2011[15]. For all variants defined in section 3.2 below, the amount of allowances allocated to the aviation sector is set at the 2005 emission level. The main variants are analysed for 2012 and 2020, assuming allowance prices of € 15 and € 45. Sub variants providing sensitivity analysis and some results for particular design issues have been analysed for 2020 assuming an allowance price of € 45.

Table 4 provides an overview of the Business as Usual (BaU) emission levels assumed.

Table 4 Historical and future emission levels of aviation

	2005	2012	2020
Emissions (Kton CO_2)	217,690	307,091	401,016

Annex A lists further data on the business as usual scenario and its underlying assumptions.

3.2 Definition of variants

Making use of the AERO model, we have analysed several allocation variants. The variants differ in the allocation methodology assumed and the level of pass through assumed. The variants studied are presented in Table 5.
Main variant A follows the Commissions proposal. We assume that this will result in 3% of the allowances allocated to the sector being auctioned, and the remainder repeatedly benchmarked based on an operators share in total RTKs for the year ending 24 months before the new trading period[16]. All expenditures (either at the auction or from purchased on the EU ETS market) are passed through. The opportunity costs of freely allocated allowances are not passed through. We thus assume here that under repeated benchmarking, the opportunity costs are offset by opportunity benefits and there are no net opportunity costs to pass through.

15 Note that this is not in line with the proposal by the Commission, which assumes an intra EU scope for 2011.

16 The Commissions proposal allows room for an increase in the share of allowances auctioned.

Under main variant B 100% of the allowances are auctioned. It assumes that all expenditures are passed through. This is in line with the analysis in chapter 2, all actual expenditures will be passed through.

Table 5 Overview of variants

		Pass through		Resulting level of pass through in 2020
		Expenditures	Free allocation	
Main variant A	Commission proposal	100%	0%	47,3%
Main variant B	100% auctioning	100%	Not relevant	100%
Sub variant 1	One off benchmarking	100%	100%	100%
Sub variant 2	Increased auctioning	100%	0%	83,7%
Sub variant 3	100% auctioning	100% at non-congested airports, 0% at congested airports	Not relevant	75%
Sub variant 4	100% auctioning	50% at all airports	Not relevant	50%

Apart from these main variants, we have analysed several sub variants. The first sub variant studies the allocation method of one off benchmarking. Existing operators receive perpetual emission rights based on their share in RTKs in 2008. All opportunity costs are passed through.

Sub variant 2 assumes that the level of auctioning increases over the trading periods. For 2011 and 2012, 10% of the allowances allocated to the sector are auctioned. For the second trading period, 2013-2017, this increases to 40%. In the third trading period, 2018-2022, 70% of the allowances are auctioned. This increases to 100% for the periods thereafter. The remainder of the allowances are allocated by repeated benchmarking. We assume that all expenditures are passed through, the opportunity costs of repeated benchmarking are not passed through.

The third sub variant is based on main variant B, 100% auctioning. It assumes however that 25% of air transport involves congested airports, and that at congested airports expenditures are not passed through.

Finally, sub variant 4 assumes 100% auctioning, and assumes that in general only 50% of all expenditures on allowances can be passed through.

Note that in the last column of Table 5, the resulting levels of pass through are reported. These are based on the assumptions on pass through for expenditures on allowances and freely allocated allowances, but are also influenced by the share of allowances that need to be purchased on the EU ETS market. The resulting levels of pass through for the Commissions proposal and the sub variant with 100% auctioning and a pass through of 50% (sub variant 4) are very similar, but the financial impacts on operating revenue will be very different. The reason is that under sub variant 4 all allowances need to be purchased, and 50% of the costs are passed through, whereas under the Commission proposal, all expenditures are passed through.

4 Impacts on emission reduction

4.1 Introduction

In this chapter we investigate how much additional emission reduction is achieved within the aviation sector if the level of auctioning is increased in comparison to the Commission's legislative proposal. As explained in section 2.3.4. In the level of auctioning does not affect technical and operational measures, but only volume measures. In the aviation sector, however, volume measures are at least as important as technical measures to achieve efficient emission reduction. In section 4.2, we estimate the effects quantitatively following the scenarios and assumptions as described in chapter 3.

4.2 Modelling results

We have estimated the impact of different policy variants on the emission reduction within the aviation sector using the AERO model. An overview of the results is presented in Table 6.

Table 6 Emission reduction within the aviation sector (Mton CO_2)

Year	2012		2020	
Allowance price	€ 15	€ 45	€ 15	€ 45
EC proposal	3.0	8.1	3.5	10.2
100% auctioning	6.0	16.5	6.4	17.7
Sub variant 1				17.7
Sub variant 2				15.7
Sub variant 3				14.3
Sub variant 4				10.8

The impact of a higher allowance price is nearly linear. Possibly somewhat counter intuitively, the emission reductions within the sector hardly increase over time, despite the shortfall[17] of allowances increasing. The reason is that the demand effect (i.e. lesser people willing to buy a ticket at higher ticket prices) is more or less the same in 2020 as in 2012 due to autonomous developments between 2012 and 2020.

The differences in emission reduction within the sector between the different policy options are relatively modest in comparison to the business-as-usual emissions. The lower the share of costs that is being passed through, the lower the reductions within the sector. This reflects that most of the reductions within the sector are caused by a fall in demand due to higher ticket prices. If less costs are passed through, the ticket price increase is lower and the demand effect will be smaller. Hence a smaller reduction within the sector.

[17] The shortfall is defined as the difference between the allocated allowances and the business as usual emission level.

For all policy options, the vast majority of the shortfall of allowances is covered by purchasing allowances from other sectors. Table 7 shows how in the main variants, the shortfall is covered.

Table 7 Coverage of CO_2 emissions in 2020 for main variants

Effect	Unit	Policy variants and assumed allowance prices			
		Main variant A		Main variant B	
		€ 15	€ 45	€ 15	€ 45
Aviation CO_2 emissions					
2005	Mton	217.7	217.7	217.7	217.7
2020 BaU projection	Mton	401.0	401.0	401.0	401.0
Coverage of CO_2 emissions					
Allowances benchmarked	Million allowances	211.2	211.2	-	-
Allowances auctioned	Million allowances	6.5	6.5	217.7	217.7
Reduction within sector	Mton CO_2	3.5	10.2	6.4	17.7
Allowances purchased on EU ETS market	Million allowances	179.8	173.1	177.0	165.6
Total	Mton CO_2	401.0	401.0	401.0	401.0

At higher allowances prices on the market, it becomes less attractive to purchase allowances on the market, and more reductions are achieved within the sector.

In Table 8 the results for the main variants on air transport and CO_2 emissions are presented for 2012. For the intra-EU routes, the reduction in RTKs is slightly smaller than the reduction in CO_2 emissions. This reflects an increase in load factors and fuel efficiency.

Table 8 Coverage of CO_2 emissions in 2012 for main variants

Effect	Policy variants and assumed allowance prices			
	Main variant A		Main variant B	
	€ 15	€ 45	€ 15	€ 45
Intra EU routes				
RTK	-0.3%	-0.9%	-1.0%	-3.0%
CO_2 emissions	-0.4%	-1.1%	-1.1%	-3.1%
Intercontinental routes: EU to non-EU and non-EU to EU				
RTK	-0.5%	-1.5%	-1.6%	-4.5%
CO_2 emissions	-1.2%	-3.2%	-2.2%	-6.2%

5 Impacts on airline profitability and ticket prices

5.1 Introduction

In this chapter we present the impacts on the operating results and ticket prices of the different policy variants. Making use of the AERO model, the impact on the profit margin of airlines have been estimated. The results of this analysis are presented in section 5.2.

It should be noted that the AERO model is a static model, and estimates the impacts of policies, assuming all impacts have worked out fully. This means that it calculated the new equilibrium situation with optimal investment levels after the policy measure has been implemented. In reality, reaching this new equilibrium takes time and will involve costs. A discussion of the share of fixed costs for aircraft operators and how this may affect profit margins over time is included in section 5.3.

Section 5.4 discusses the impacts on ticket prices.

5.2 Impacts on operating results from the AERO model

The operating results are calculated as the difference between the operating revenues and the operating costs. These are then expressed as percentage of the operating revenues, to have an estimate for the impacts on profit margins of airlines. The modelling results indicate that the impact on the profit margins are generally very small.

We have focused on the profit margins instead of the absolute operating results or profit levels for the following reason. The aviation sector is projected to grow substantially over the coming decades. Transport levels will increase, and, assuming stable profit margins, so will absolute profits. Therefore a comparison between the potential decrease in the absolute operating results and current operating results is somewhat nonsensical. According to us, the profit margin is a better indicator.

For the presentation of the results, we have made a split between EU carriers (based in the EU 27, Norway, Iceland or Liechtenstein), and non-EU carriers. The reason for this split is that for non-EU carriers, the impact on operating results will be very small, given that the EU market only constitutes a small share of their total market. Changes in the operating result on the EU market, presented as a percentage of the total operating results of all carriers in the world, will thus be minor. By presenting the results for the EU carriers separately, a better indication of the effects can be achieved.

Table 9 Impact on operating results under main variants (as % of operating revenues)

	Allowance price	Year	EU carriers	Non-EU carriers
Business as Usual	-	2012	2.4%	2.5%
	-	2020	3.1%	3.1%
EC proposal	€ 15	2012	2.4%	2.5%
		2020	3.1%	3.1%
	€ 45	2012	2.4%	2.5%
		2020	3.0%	3.1%
100% auctioning	€ 15	2012	2.4%	2.5%
		2020	3.0%	3.1%
	€ 45	2012	2.3%	2.5%
		2020	2.9%	3.1%
Sub variant 1	€ 45	2020	5.4%	3.7%
Sub variant 2	€ 45	2020	2.9%	3.1%
Sub variant 3	€ 45	2020	2.1%	2.9%
Sub variant 4	€ 45	2020	1.3%	2.7%

Analysing these results we focus on the differences in operating result induced by the policy variants. For 2012, the BaU operating result for EU carriers is estimated at 2.4%. This results is hardly affected by the different policy options under the main variants. Even though airlines may have substantial expenses on allowances, the operating revenues also go up if these costs are passed through. The increased costs will induce higher ticket prices, which will lead to a demand effect. This in itself reduces the operating revenue. Since the AERO model is a static model, it assumes operation costs can be adjusted to reflect the lower demand for air transport at the higher prices. For this reason, the impacts on operating revenues are very small under the main variants.

This is different for the sub variants. The reason is that in the sub variants we assume that:
- Opportunity costs are passed through while airlines do not have expenses (sub variant 1).
- At congested airports, expenses on allowances cannot be passed through (sub variant 3).
- Airlines are only able to pass through 50% of their expenditures on allowances.

These assumptions substantially impact operating revenues. If airlines can pass through more than their actual expenditures, there will be windfall profits. This is reflected in the change in operating result for sub variant 1, where the operating results for EU carriers increases from 3.1 to 5.4% in 2020. Alternatively, if airlines cannot pass through their expenditures on allowances, this has a negative impact on the operating result. Under sub variants 3 and 4, with respectively a pass through of 75 and 50% of all expenditures on allowances, operating results decrease substantially. As we expected, despite the resulting levels of pass through being roughly equal under the Commissions proposal and sub variant 4, the impacts on profitability differ substantially.

The full results of the modelling with the AERO model can be found in Annex C. It also includes a more detailed discussion of the results.

5.3 Fixed costs

As mentioned, the AERO model is a static model. Increases in fuel prices or emissions trading may result in lower demand, and the model then estimates the new equilibrium situation, assuming that airlines have fully adapted to the changed market circumstances. In the short run, there may be fixed costs associated to investments which cannot be reduced if demand falls suddenly. In this section we discuss to what extent this may influence the analysis in section 5.2 on operating margin.

If costs are passed through, there will be some loss of demand, the size of which depends upon the price elasticity of demand[18]. If all costs are variable, the airlines can reduce costs in proportion to the fall in demand, keeping their profit margin constant, but losing some absolute level of profit due to the reduction in the scale of the operation (OXERA, 2003). In the AERO model the operating margin under BaU is estimated at 2.4% of revenue for EU airlines in 2012 and 3.1% in 2020.

Not all costs are variable, however. If all costs are fixed, the airlines cannot reduce costs in the face of reduced demand, resulting in a relatively large loss (of profits). Whether the sector faces such losses depends, however, on the speed with which the sector can respond to the new situation. The sector may face high costs if it has substantial fixed costs on a time scale which is larger than the period between introduction of the system of tradable rights and its announcement by the government. If the costs of emission allowances can be passed through this will result in a loss of demand. If there are substantial fixed costs, this will not only result in a normal loss of profit over the lost demand, but also in a loss of investments in fixed costs. Since demand is reduced, more has been invested in production capacity than necessary (see also Burtraw et al., 2005).

Which costs are to be considered fixed thus depends upon the time scale. In the short-term (2008-2012), OXERA estimates the share of fixed costs to be 30%. IATA Economics (2007: 10) estimates the share at 50%, while Price Waterhouse Coopers (2005: 38) estimates the share even at 60%.

Of all airline costs, only the station, infrastructure and the equipment costs are fixed on a substantial timescale, i.e. in the order of 25 years. In 2005, these costs made up some 23% of total costs faced by European airlines (AEA, 2006: 8; see for similar numbers: PWC, 2005: 38; Doganis, 2002: 87-92). All other costs, including flight deck crew, cabin attendants and maintenance costs are variable within a few years, i.e. less than the period between the scheduled introduction of the EU ETS and its announcement by the European Commission.

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[18] See e.g. Brons *et al.*, 2002; Gillen *et al.*, 2003.

Although these percentages may be right on a time scale of two to three years, we do not believe there are substantial fixed costs that may induce losses when incorporating the sector in the EU ETS. The reason is that aviation is a strongly growing sector. The impact on demand from emission trading is limit to a few percent compared to a business as usual growth roughly doubling air transport by 2020. Therefore, it is difficult to see how this marginal slowing down in growth might result in production capacity being unused due to the introduction of the ETS. Moreover, because there is some time between introduction of aviation in the EU ETS and its announcements, airlines are able to adjust their invest plans (to that extent that a lowering of demand requires this). The longer the time period between announcing the scheme and actual introduction, the more time airlines have to adjust their investment levels, the lower the fixed costs for the time span are, and the lower any losses will be.

Given the strong growth expected, and the lead period between announcement of the scheme and actual introduction, we expect that there will be few other profit losses than those estimated by the AERO model. Nonetheless, if deemed necessary, account may be taken of the potential fixed costs by increasing the level of auctioning over time. As the share of fixed costs diminishes over time, clarity on future levels of auctioning may enable airlines to take full account of the demand effect induced by emissions trading in their investment decisions.

5.4 Impact on ticket prices

We have estimated the potential impact the different scenarios for allocation may have on ticket prices. This has been done in line with previous analysis by CE Delft on the impact of emissions trading on ticket prices, so to ensure comparability (e.g. CE Delft et al., 2005 and the analysis underlying the Impact Assessment of the European Commission). The main assumptions are listed below. Additional assumptions and a description of the methodology can be found in Annex B.

The impact on ticket prices has been estimated for three exemplary flights:
- Short-haul flight: Amsterdam – Paris Charles de Gaulle, 480 km (259 nm).
- Medium-haul flight: Munich – Palma de Mallorca, 1,402 km (757 nm).
- Long-haul flight: London Gatwick – Newark, 6,404 km (3,458 nm).

For these flights, we have assumed the detailed specifications as listed in Table 10. Data on fuel use have been taken from the EMEP/CORINAIR database[19].

Table 10 Data assumptions for impact calculations

	Aircraft type	Seats / Occupancy rate	Trip fuel (kg)	CO_2 emissions trip (kg)
Short haul	Airbus A320	150 / 70%	2,539	8,024
Medium haul	Boeing 737-400	150 / 70%	4,998	15,793
Long haul	Boeing 777	340 / 70%	49,694	157,033

[19] EMEP/CORINAIR Emission inventory guidebook – 3rd edition, September 2004 Update.

The results under the various options depend directly on the extent to which expenditures and opportunity costs are passed through. Given the assumptions under the different variants as described in chapter 3, we estimate the levels of pass through of all expenditures and opportunity costs as presented in Table 11.

Table 11 Estimated levels of pass through under different variant

Variant	Estimated level of pass through
EC proposal	47.3%
100% auctioning	100%
Sub variant 1	100%
Sub variant 2	83.7%
Sub variant 3	75%
Sub variant 4	50%

In Table 12 the estimated impacts on ticket prices in the different variants are presented. Ticket price increases depend linearly on the assumed level of pass through. If all costs are passed through, the expected increase is twice the size of the variant in which only 50% is passed through. The ticket price increase also depends linearly on the allowance price. Price increases vary from € 1,10 on a short haul round trip for an allowance prices of € 15, to up to € 60 for a long haul flight with an allowance price of € 45. Note that these results are very sensitive to the load factor. If the load factor increases over 70%, the price increase per ticket decreases proportionally.

Table 12 Impact on ticket prices in 2020 (in Euro per round trip)

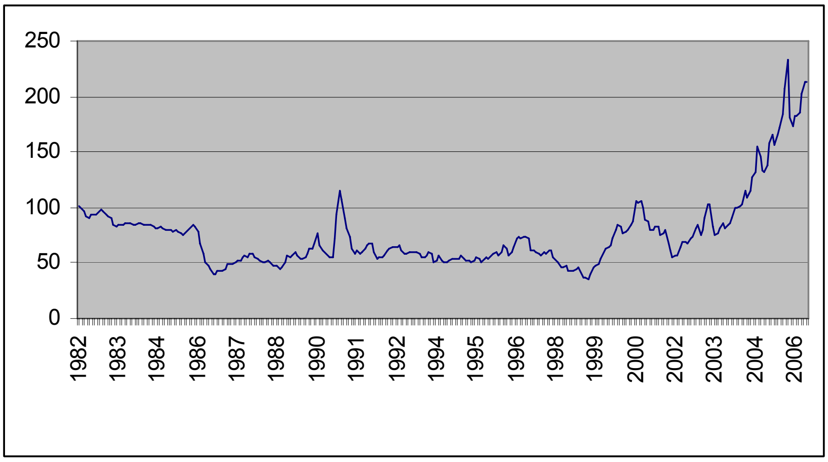
	Short haul	Medium haul	Long haul
EC proposal	1.1 – 3.3	2.1 – 6.4	9.4 – 28.1
100% auctioning	2.3 – 6.9	4.5 – 13.5	19.8 – 59.4
Sub variant 1	2.3 – 6.9	4.5 – 13.5	19.8 – 59.4
Sub variant 2	1.9 – 5.8	3.8 – 11.3	16.6 – 49.7
Sub variant 3	1.7 – 3.4	3.4 – 10.2	14.8 – 44.5
Sub variant 4	1.1 – 3.4	2.3 – 6.8	9.9 – 29.7

Note: Figures indicated the expected increase in ticket prices for round trips in 2020, based on the assumptions discussed in the text and the Annex. The first figure is the increase in ticket price for an allowance price of € 15 per tonne CO_2, the second for an allowance price of € 45.

Note that in estimating these, we have assumed that the aviation sector does not make emission reductions itself, but instead covers the increase in emissions by purchasing allowances from other sectors. In reality, however, there exists some potential for the aviation sector to reduce its emissions at a cost lower than that of purchasing allowances. For example, some operators may be able to save money by implementing measures to improve fuel efficiency. They would do this if the costs per unit of emissions saved is below the allowance price. Therefore, in this respect, all of these figures are potentially slight over-estimates.

In Figure 4, the development in the price of aircraft fuel is presented. The recent increase in oil prices has clearly impacted the aviation industry as well.

Figure 4 Refiner price of kerosene – Jet Fuel for resale (dollar cents per gallon)



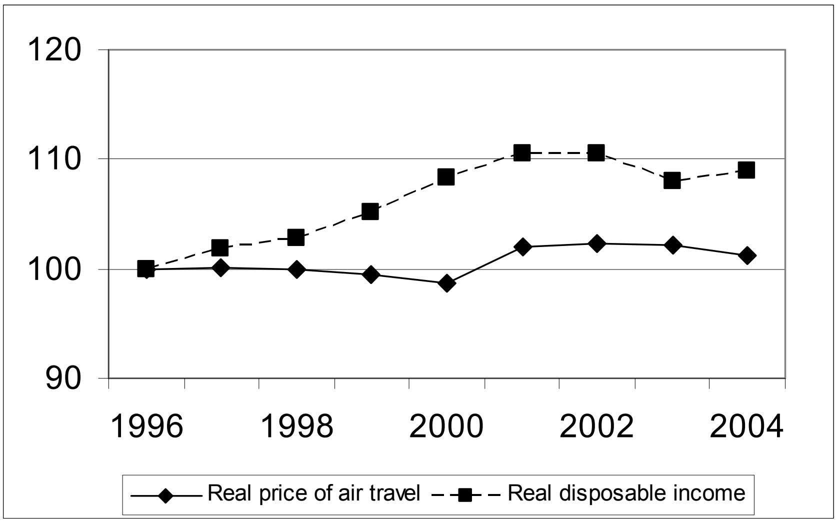
Source: Energy Information Administration, monthly energy review.

Increases in fuel prices have a similar impact on the sector as the introduction of emissions trading. With emissions equal to 9.47 kg CO_2 per gallon of jet fuel and an average fuel price for 2007 of $ 2.02 or € 1.49 per gallon (source: IATA), emissions trading with an allowance price of € 30 per ton CO_2 would have the same impact as an increase in fuel price of about 20%.

5.5 General development of ticket prices and disposable income

It should be noted that the ticket price impacts as estimated in section 5.4 are on top of the general business as usual development of ticket prices. Over the last 10 years, the real price of air travel has remained relatively stable, according to Eurostat data. Meanwhile, the real disposable income has increased by about 10%, making air travel more accessible. The growth in disposable income is one often put forward as one of the main drivers for the growth in air travel.

Figure 5 Real price index of air travel and disposable income in EU 25 (1996 = 100)



Source: CE Delft, based on Eurostat 2005, 2006 and 2007.

6 Discussion

The first objective of this study was to assess the interaction between allocation method and the likelihood that costs of allowances are passed through. In addition, we have analysed how the allocation method may affect emission reductions within the aviation sector. Finally, the third objective was to assess the impact of high levels of auctioning on the profitability of the aviation sector.

Before discussing the results of our analysis in detail, please remember that the use of allowances implies opportunity costs, whether the allowances have been bought or obtained free of charge. In the first case, the opportunity costs are reflected in actual expenditures on allowances either from the purchase of allowances at an auction or at the EU ETS market. Not passing through real expenditures will negatively affect the operating margins. This does not hold if the opportunity costs of freely allocated allowances are not passed through. In fact, if the opportunity costs of freely allocated allowances are passed through, this may actually increase the operating margin.

In general, in competitive markets where price setting is based on marginal cost levels, opportunity costs will be passed through fully in air fares, whether they are related to actual expenditures or not. Empirical results for the power sector indicate that pass through of opportunity costs is real. There are however two situations in which these opportunity costs might not accompanied by a (full) corresponding increase in air fares. First, from a theoretical perspective, it may be argued that expenditures on allowances will not be passed through fully in case of congested airports. The empirical data available however point in the direction that also at congested airports additional expenditures are passed through fully.

Second, in addition to opportunity costs there may also be what we call ‘opportunity benefits’. In its proposal for aviation the European Commission put forward so-called repeated or updated benchmarking. The allowances allocated for the next trading period depend on the performance during the current trading period. There are thus opportunity benefits of producing RTKs in addition to the opportunity costs. These cancel out largely and it is therefore not expected that these allowances will be reflected in the ticket prices. Note that this is not in line with the results reported in previous CE Delft studies. These did not consider in detail the impacts of updated benchmarking. Under one off benchmarking, in contrast, there are no opportunity benefits and it may be expected that opportunity costs are fully passed through.

The second objective of the study was to analyse the impact of different allocation options on emission reduction within the sector. In general, under emissions trading aircraft operators will take all measures that cost less than handing in allowances. These measures may be technical (e.g. purchasing a more efficient aircraft), operational (e.g. increasing the load factor), or may

incorporate volume measures. Volume measures are said to occur when the cost pass through in tickets results in lower demand.
In case of updated benchmarking, the incentive for volume measures is reduced substantially. The reason is that under updated benchmarking freely allocated allowances are not reflected in ticket prices. The expenditure on allowances on the EU ETS market will still be passed through and have its effect on air fares. This means that the total reduction within the sector will be lower than under auctioning or one off benchmarking. In any case, the expected reductions within the sector are in the order of 2 to 10% of the allowances purchased on the EU ETS market.

Table 13 summarizes the likely impacts under different allocation methods. If it is decided that (part of) the allowances should be allocated free of charge, there will either be windfall profits and a demand effect, or no windfall profits and no demand effect. Only in case of auctioning windfall profits can be avoided while still inducing a demand effect.

Table 13 summarizes the likely impacts under different allocation methods.

Table 13 Qualitative comparison of impacts of different allocation methodologies

	Pass through in ticket prices	Windfall profits	Demand effect	Industry measures
Auctioning	++	- -	++	++
Grandfathering	+	+	+	++
Repeated benchmarking	-	-	-	++
One off benchmarking	+	+	+	++

Note: ++: very likely; +: likely; -: unlikely; - -: very unlikely.

Third, based on these results we have studied the impacts of different allocation methods on the profitability of airlines. We find that the operating margin of airlines is not affected much, provided that opportunity costs associated with expenditures are passed through and opportunity costs from updated benchmarking are cancelled out by the opportunity benefits this allocation method induces.
If, for some reason and contrary to the outcome of our analysis, airlines do not pass through the expenditures on allowances, they will incur a loss and the operating margin will decrease. They would have expenditures that would not be met by revenues.
Similarly, if airlines would receive allowances free of charge without future updating, as would be the case under one off benchmarking, airlines could increase air fares while not having expenditures. Consequently, their operating margin would increase and there would be windfall profits.

It should be noted that the model applied is a static model, calculating equilibrium situations. It thus assumes that the aviation industry has fully adapted to the new policy and investments levels have been adjusted accordingly. In the short run there may be fixed costs associated to the investments, and environmental policy that reduces demands may cause excess capacity. This would mean a loss to airlines.

Given the strong growth of the aviation sector and the lead time between the announcement of emissions trading and actual implementation, we expect the potential of overinvestment to be small. However, there may be some years between ordering an aircraft and its delivery, possibly exceeding the lead time of emission trading. In that case, raising the percentage of auctioned allowances over time may further enable airlines to take full account of the influence of emissions trading on their investment decisions.

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Allocation of allowances for aviation in the EU ETS

The impact on the profitability of the aviation sector under high levels of auctioning

Final report Annexes

Report

Delft, June, 2007

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A Assumptions on business as usual emission developments

A.1 Assumptions

The aviation related Business as Usual (BaU) CO_2 emissions have been assessed for the years 2012 and 2020. The amount of CO_2 emissions for the year 2005, computed by EUROCONTOL, is used as a basis for this assessment. The expected BaU growth of CO_2 emissions over the period 2005 to 2020 is based on the FESG2002 scenario. This FESG2002 scenario forecasts passenger km for the global aviation industry (including a forecast for routes to, from and within the EU).

The FESG2002 scenario is supplemented with assumptions regarding the BaU developments of aircraft technology (especially assumptions regarding fuel efficiency improvement are relevant). Furthermore for the period 2013-2019 an ATM efficiency improvement of 1% per year is assumed.

We have computed and presented CO_2 emissions separately for 4 route groups:

a Emissions related to the national routes within the 30 European countries considered (referred to as 'Intra EU - domestic').
b Emissions related to the routes between the 30 European countries considered (referred to as 'Intra EU - international').
c Emissions related to all routes departing from any of the 30 European countries considered (referred to as 'EU to non-EU').
d Emissions related to all routes arriving at any of the 30 European countries considered (referred to as 'non-EU to EU').

Table 14 provides an overview of the BaU CO_2 emissions for these route groups. The summation of the emissions related to these 4 route groups reflects the emissions for the geographical scope option considered (All departing and arriving flights from 30 European countries). The numbers for 2005, as computed by EUROCONTROL, exclude the CO_2 emissions related to aircraft with an MTOW < 20 ton. Also in the emission quantities computed for the future years, the emissions of these small aircraft are not included.

Table 14 shows that the expected BaU growth in aviation CO_2 emissions over the period 2005 – 2020 is 80% to 85% (some variation across route groups). This is an average yearly growth in CO_2 emissions of about 4%. The yearly growth in the period 2012-2020 is somewhat lower, which follows from the assumed ATM efficiency improvement.

Table 14 BaU CO_2 emissions in 2005, 2012 and 2020 based on FESG2002 scenario

BaU scenario CO_2 emissions 2005-2020 (in Kton)			
Route group / geographical scope option	Year		
	2005	2012	2020
Route groups			
A. Intra EU - domestic	14,591	20,348	26,555
B. Intra EU - international	40,035	56,247	72,268
C. EU to non-EU	82,040	115,811	151,969
D. Non-EU to EU	81,025	114,685	150,223
Geographical scope option			
EU - All arriving and departing (A+B+C+D)	217,690	307,091	401,016
BaU scenario CO_2 emissions (indexed to 2005 = 100)			
Route group / geographical scope option	Year		
	2005	2012	2020
Route groups			
A. Intra EU - domestic	100	139	182
B. Intra EU - international	100	140	181
C. EU to non-EU	100	141	185
D. Non-EU to EU	100	142	185
Geographical scope option			
EU - All arriving and departing (A+B+C+D)	100	141	184

BaU scenario CO_2 emissions (growth per year in periods between scenario years considered)		
Route group / geographical scope option	Periods	
	2005 - 2012	2012 - 2020
Route groups		
A. Intra EU - domestic	4.9%	3.4%
B. Intra EU - international	5.0%	3.2%
C. EU to non-EU	5.0%	3.5%
D. Non-EU to EU	5.1%	3.4%
Geographical scope option		
EU - All arriving and departing (A+B+C+D)	5.0%	3.4%

B Assumptions and methodology for analysis of ticket price impacts

B.1 Assumptions

To provide an indication of the impact on ticket prices and freight rates, we estimated the potential cost increases per passenger ticket, for three exemplary flights. The exemplary flights are the following:
- Short-haul flight: Amsterdam – Paris Charles de Gaulle, 480 km (259 nm).
- Medium-haul flight: Munich – Palma de Mallorca, 1,402 km (757 nm).
- Long-haul flight: London Gatwick – Newark, 6,404 km (3,458 nm).

This assessment is based on the following assumptions and specifications:
1. Results relate to the year 2020.
2. The policy variants and assumptions on pass through are defined as in chapter 3.
3. In the BaU scenario, the CO_2 emissions are based on an implementation of the FESG 2002 scenario for RTKs using the AERO model, see annex A.
4. It is assumed that the aviation sector is a net buyer of allowances, which would be the case if it has high marginal abatement costs for CO_2 emission reduction, as is generally assumed.
5. The effects have been calculated assuming two alternative market prices for allowances, set at € 15 and € 45 per tonne of CO_2. We furthermore assume that:
   a. The average price of initially auctioned allowances equals the price on the market for allowances. This seems a plausible assumption given the relatively high marginal abatement costs in the aviation sector compared with other sectors and expected scarcity due to air transport growth expectations.
   b. The policy-induced cost increases to airlines are passed through to consumers by increasing fares on those routes subject to the EU ETS. We assume no cross-subsidising over and above the current level of cross-subsidisation with routes not subject to the scheme.
   c. We assume that the costs of reduction measures taken within the sector equal the allowance price on the EU ETS market.

B.2 Methodology

We illustrate the calculation methodology for a short-haul flight with an allowance price of € 15. The total CO_2 emissions are estimated at 8,024 tonnes for a one way trip (see Table 10). Allowances for these emissions will have to be surrendered at the end of the commitment period. If allowances are auctioned or purchased, the price equals € 15 per tonne. Under 100% auctioning, the cost increase per return flight thus equals 2 (return flight) times 8,024 times € 15 = € 241.

The cost increase per ticket can be calculated by dividing the cost increase at flight level by the average number of occupied seats, which in this case is assumed to be 105 (70% of 150). This gives € 241 / 105 = € 2.3.

C AERO modelling results

C.1 Presentation of effects

In this Annex the full results of the modelling work with AERO are presented. In total 12 AERO runs have been made. The effects computed by AERO are presented in various tables. Hereby the variants are grouped together as follows:
- Main variants assuming two allowance prices (€ 15 and € 45 – effects in 2012).
- Main variants assuming two allowance prices (€ 15 and € 45 – effects in 2020).
- Sub variants assuming one allowance price of (€ 45 – effects in 2020).

For each group of variants 3 tables with computational results are presented, as follows:

Main variants assuming two allowance prices (€ 15 and € 45 – effects in 2012)
- Table 15. Effects for intra EU and intercontinental routes of main variants in 2012.
- Table 16. Effects EU and non-EU carriers of main variants in 2012.
- Table 17. Coverage of CO_2 emissions in 2012 for main variants.

Main variants assuming two allowance prices (€ 15 and € 45 – effects in 2020)
- Table 18. Effects for intra EU and intercontinental routes of main variants in 2020.
- Table 19. Effects EU and non-EU carriers of main variants in 2020.
- Table 20. Coverage of CO_2 emissions in 2020 for main variants.

Sub variants assuming one allowance price (€ 45 – effects in 2020)
- Table 21. Effects for intra EU and intercontinental routes of sub variants in 2020.
- Table 22. Effects EU and non-EU carriers of sub variants in 2020.
- Table 23. Coverage of CO_2 emissions in 2020 for sub variants.

Tables 15, 18 and 21 present a number of effects for two route groups which are assumed to be subject to emission trading:
- Intra EU routes. This route group includes both national routes (within EU States) and international routes between EU States.
- Intercontinental routes. This route group includes all routes between EU States and non-EU States.

Effects are presented in terms of % effects relative to the Business as Usual (BaU) situation. The BaU situation reflects the projection of the aviation industry for 2012 (Table 15) or 2020 (Tables 18 and 21) without emission trading. The absolute quantities for the BaU situation for the various indicators are also included in the tables. The tables include the effects on demand (passenger km, cargo ton km and RTK[20]) and supply (flights and aircraft km), fuel use and CO_2 emissions and fuel efficiency in terms of fuel use per RTK.

Tables 16, 19 and 22 present effects from a carrier perspective. A distinction is made between effects for:
- EU carriers.
- Non-EU carriers.

EU carriers refer to carriers which have their home base in one of the 30 European countries which are assumed to participate in the emission trading scheme. Non-EU carriers refer to all other carriers in the world. Clearly EU carriers are affected more significantly by an European Emission Trading Scheme as almost all their operations will be subject to emission trading, whereas for non-EU carriers only part of their operations (i.e. only their operations to, from and within the EU) will be subject to emission trading. Also in Tables 16, 19 and 22 effects are presented in terms of % effects relative to the Business as Usual (BaU) situation. The tables include effects on demand and supply (RTK and aircraft km) and financial effects (total operating costs, total operating revenues and total operating result). The total operating costs reflect all costs for airlines including direct operating costs (cost directly related to flight operations) and overhead costs for airlines (ticketing, ground personnel etc.). Total operating revenues reflect the incomes for airlines. Revenues are computed by multiplying the number of passengers (or tonnes of cargo transported) by the ticket prices (or cargo rates). The operating result is the profit margin and is simply the total operating revenues minus the total operating costs. The effect on the total operating result is expressed differently compared to the other effects. For both the BaU situation and for the various policy variants, the total operating result is expressed as a percentage of total operating revenues. Finally the tables also present information on the costs per RTK and the revenues per RTK.

Tables 17, 20 and 23 present the covering of the projected BaU CO_2 emissions in 2012 (Table 17) or 2020 (Tables 20 and 23). A split is made between:
1 Emissions covered by benchmarked allowances.
2 Emissions covered by auctioned allowances.
3 Reduction of CO_2 within the aviation sector. Compared to BaU, the aviation sector will emit less CO_2 because of supply side measures leading to improved fuel efficiency and because of a demand reduction. The latter follows from the assumption that costs for allowances are assumed to be (fully or partly) passed through by airlines to consumers.
4 Allowances bought from other sectors. These allowances cover the emissions above the 2005 CO_2 emission level.

[20] RTKs (Revenue Tonne Kms) reflect the total payload of the aviation industry. It is a summation of passenger km and cargo ton km. Passenger km are translated into ton km assuming an average weight of a passenger (including luggage) of 100 kg.

C.2 Results

Table 15 Effects for intra EU and intercontinental routes of main variants in 2012

Effect	Unit	BaU 2012	Policy variants and assumed allowance prices (% effect relative to BaU)			
			Main variant A Comm. proposal Allow. price €15	Main variant B 100% auctioning Allow. price €15	Main variant A Comm. proposal Allow. price €45	Main variant B 100% auctioning Allow. price €45
Intra EU routes						
Air transport and aircraft operations						
Pax demand	10^9 pax-km pa	539.7	-0.3%	-1.0%	-0.9%	-2.9%
Cargo demand	10^9 ton-km pa	4.3	-0.4%	-1.2%	-1.1%	-3.5%
RTK	10^9 RTK pa	58.3	-0.3%	-1.0%	-0.9%	-3.0%
Flights	10^6 flights pa	10.0	-0.3%	-0.9%	-0.9%	-2.6%
Aircraft Km	10^9 ac-km pa	6.7	-0.3%	-0.9%	-0.9%	-2.6%
Aviation fuel consumption and emissions						
Fuel use	10^9 kg pa	24.3	-0.4%	-1.1%	-1.1%	-3.1%
CO_2 emissions	10^9 kg pa	76.6	-0.4%	-1.1%	-1.1%	-3.1%
Fuel efficiency						
Fuel/RTK	kg / ton-km	0.39	-0.1%	-0.1%	-0.2%	-0.2%
Intercontinental routes: EU to non-EU and non-EU to EU						
Air transport and aircraft operations						
Pax demand	10^9 pax-km pa	1,607.6	-0.5%	-1.7%	-1.5%	-4.7%
Cargo demand	10^9 ton-km pa	96.8	-0.5%	-1.5%	-1.3%	-4.1%
RTK	10^9 RTK pa	257.6	-0.5%	-1.6%	-1.5%	-4.5%
Flights	10^6 flights pa	2.7	-0.5%	-1.3%	-1.2%	-3.6%
Aircraft Km	10^9 ac-km pa	9.7	-0.6%	-1.8%	-1.6%	-4.9%
Aviation fuel consumption and emissions						
Fuel use	10^9 kg pa	73.0	-1.2%	-2.2%	-3.2%	-6.2%
CO_2 emissions	10^9 kg pa	230.5	-1.2%	-2.2%	-3.2%	-6.2%
Fuel efficiency						
Fuel/RTK	kg / ton-km	0.25	-0.7%	-0.7%	-1.7%	-1.7%

Table 16 Effects EU and non-EU carriers of main variants in 2012

Effect	Unit	BaU 2012	Policy variants and assumed allowance prices (% effect relative to BaU)			
			Main variant A Comm. proposal Allow. price €15	Main variant B 100% auctioning Allow. price €15	Main variant A Comm. proposal Allow. price €45	Main variant B 100% auctioning Allow. price €45
EU carriers						
Air transport and aircraft operations						
RTK	10^9 RTK pa	208.3	-0.4%	-1.3%	-1.2%	-3.8%
Aircraft Km	10^9 ac-km pa	12.3	-0.4%	-1.2%	-1.1%	-3.3%
Financial effects						
Operating costs	10^9 €	184.1	0.0%	0.2%	0.1%	0.6%
Operating revenues	10^9 €	188.6	0.0%	0.2%	0.1%	0.5%
Oper. costs / RTK	€	0.88	0.5%	1.5%	1.4%	4.6%
Oper. rev. / RTK	€	0.91	0.5%	1.5%	1.4%	4.4%
Operating result*	% of rev.	2.4%	2.4%	2.4%	2.4%	2.3%
Non-EU carriers						
Air transport and aircraft operations						
RTK	10^9 RTK pa	637.9	-0.1%	-0.3%	-0.3%	-1.0%
Aircraft Km	10^9 ac-km pa	39.0	-0.1%	-0.3%	-0.2%	-0.7%
Financial effects						
Operating costs	10^9 €	452.2	0.0%	0.1%	0.1%	0.2%
Operating revenues	10^9 €	463.9	0.0%	0.1%	0.1%	0.2%
Oper. costs / RTK	€	0.71	0.1%	0.4%	0.4%	1.2%
Oper. rev. / RTK	€	0.73	0.1%	0.4%	0.4%	1.2%
Operating result*	% of rev.	2.5%	2.5%	2.5%	2.5%	2.5%

* The total operating result is expressed as a percentage of revenues for both the BaU situation and for the variants considered.

Table 17 Coverage of CO_2 emissions in 2012 for main variants

Effect	Unit	Policy variants and assumed allowance prices			
		Main variant A Comm. proposal Allow. price €15	Main variant B 100% auctioning Allow. price €15	Main variant A Comm. proposal Allow. price €45	Main variant B 100% auctioning Allow. price €45
Aviation CO_2 emissions on all routes departing from / arriving at EU airports in BaU scenario					
CO_2 emiss. 2005 (EUROCONTROL)	megaton	217.7	217.7	217.7	217.7
CO_2 emiss. 2012 (BaU projection)	megaton	307.1	307.1	307.1	307.1
Covering of projected BaU CO_2 emissions in 2012					
Allowances benchmarked	10^6 allow.	211.2	0.0	211.2	0.0
Allowances auctioned	10^6 allow.	6.5	217.7	6.5	217.7
Reduction CO_2 within aviation sector	megaton	3.0	6.0	8.1	16.5
Allowances bought from other sectors	10^6 allow.	86.4	83.4	81.3	72.9
Total	megaton	307.1	307.1	307.1	307.1
Financial implications					
Costs to buy allow. from other sectors	million €	1,296.3	1,251.5	3,657.2	3,279.5
Auction revenues	million €	98.0	3,265.5	293.9	9,796.5

Table 18 Effects for intra EU and intercontinental routes of main variants in 2020

Effect	Unit	BaU 2020	Policy variants and assumed allowance prices (% effect relative to BaU)			
			Main variant A Comm. proposal	Main variant B 100% auctioning	Main variant A Comm. proposal	Main variant B 100% auctioning
			Allow. price €15	Allow. price €15	Allow. price €45	Allow. price €45
Intra EU routes						
Air transport and aircraft operations						
Pax demand	10^9 pax-km pa	803.1	-0.4%	-0.9%	-1.2%	-2.5%
Cargo demand	10^9 ton-km pa	6.5	-0.5%	-1.1%	-1.4%	-3.1%
RTK	10^9 RTK pa	86.8	-0.4%	-0.9%	-1.2%	-2.6%
Flights	10^6 flights pa	14.3	-0.4%	-0.9%	-1.1%	-2.4%
Aircraft Km	10^9 ac-km pa	9.1	-0.4%	-0.9%	-1.2%	-2.5%
Aviation fuel consumption and emissions						
Fuel use	10^9 kg pa	31.3	-0.5%	-1.0%	-1.3%	-2.7%
CO_2 emissions	10^9 kg pa	98.8	-0.5%	-1.0%	-1.3%	-2.7%
Fuel efficiency						
Fuel/RTK	kg / ton-km	0.34	-0.1%	-0.1%	-0.1%	-0.1%
Intercontinental routes: EU to non-EU and non-EU to EU						
Air transport and aircraft operations						
Pax demand	10^9 pax-km pa	2,351.5	-0.7%	-1.5%	-2.0%	-4.1%
Cargo demand	10^9 ton-km pa	169.7	-0.6%	-1.3%	-1.7%	-3.7%
RTK	10^9 RTK pa	404.9	-0.6%	-1.4%	-1.9%	-3.9%
Flights	10^6 flights pa	4.0	-0.6%	-1.2%	-1.6%	-3.3%
Aircraft Km	10^9 ac-km pa	13.4	-0.8%	-1.6%	-2.2%	-4.4%
Aviation fuel consumption and emissions						
Fuel use	10^9 kg pa	95.7	-1.0%	-1.8%	-3.0%	-5.0%
CO_2 emissions	10^9 kg pa	302.2	-1.0%	-1.8%	-3.0%	-5.0%
Fuel efficiency						
Fuel/RTK	kg / ton-km	0.21	-0.4%	-0.4%	-1.1%	-1.1%

Table 19 Effects EU and non-EU carriers of main variants in 2020

Effect	Unit	BaU 2020	Policy variants and assumed allowance prices (% effect relative to BaU)			
			Main variant A Comm. proposal	Main variant B 100% auctioning	Main variant A Comm. proposal	Main variant B 100% auctioning
			Allow. price €15	Allow. price €15	Allow. price €45	Allow. price €45
EU carriers						
Air transport and aircraft operations						
RTK	10^9 RTK pa	322.1	-0.5%	-1.2%	-1.6%	-3.3%
Aircraft Km	10^9 ac-km pa	16.9	-0.5%	-1.1%	-1.5%	-3.1%
Financial effects						
Operating costs	10^9 €	275.4	0.1%	0.2%	0.3%	0.6%
Operating revenues	10^9 €	284.2	0.1%	0.1%	0.2%	0.5%
Oper. costs / RTK	€	0.86	0.6%	1.4%	1.9%	4.1%
Oper. rev. / RTK	€	0.88	0.6%	1.3%	1.8%	3.9%
Operating result*	% of rev.	3.1%	3.1%	3.0%	3.0%	2.9%
Non-EU carriers						
Air transport and aircraft operations						
RTK	10^9 RTK pa	992.7	-0.1%	-0.3%	-0.4%	-0.9%
Aircraft Km	10^9 ac-km pa	52.3	-0.1%	-0.2%	-0.3%	-0.7%
Financial effects						
Operating costs	10^9 €	685.8	0.0%	0.1%	0.1%	0.2%
Operating revenues	10^9 €	708.1	0.0%	0.1%	0.1%	0.2%
Oper. costs / RTK	€	0.69	0.2%	0.4%	0.5%	1.1%
Oper. rev. / RTK	€	0.71	0.2%	0.4%	0.5%	1.0%
Operating result*	% of rev.	3.1%	3.1%	3.1%	3.1%	3.1%

* The total operating result is expressed as a percentage of revenues for both the BaU situation and for the variants considered.

Table 20 Coverage of CO_2 emissions in 2020 main variants

Effect	Unit	Policy variants and assumed allowance prices			
		Main variant A Comm. proposal	Main variant B 100% auctioning	Main variant A Comm. proposal	Main variant B 100% auctioning
		Allow. price €15	Allow. price €15	Allow. price €45	Allow. price €45
Aviation CO_2 emissions on all routes departing from / arriving at EU airports in BaU scenario					
CO_2 emiss. 2005 (EUROCONTROL)	megaton	217.7	217.7	217.7	217.7
CO_2 emiss. 2020 (BaU projection)	megaton	401.0	401.0	401.0	401.0
Covering of projected BaU CO_2 emissions in 2020					
Allowances benchmarked	10^6 allow.	211.2	0.0	211.2	0.0
Allowances auctioned	10^6 allow.	6.5	217.7	6.5	217.7
Reduction CO_2 within aviation sector	megaton	3.5	6.4	10.2	17.7
Allowances bought from other sectors	10^6 allow.	179.8	177.0	173.1	165.6
Total	megaton	401.0	401.0	401.0	401.0
Financial implications					
Costs to buy allow. from other sectors	million €	2,696.6	2,654.3	7,788.9	7,453.7
Auction revenues	million €	98.0	3,265.5	293.9	9,796.5

Table 21 Effects for intra EU and intercontinental routes of sub variants in 2020

Effect	Unit	BaU 2020	Sub variants and assumed allowance prices (% effect relative to BaU)			
			Sub variant 1: 100% pass on grandfathered allowances	Sub variant 2: Increased auctioning over time	Sub variant 3: No pass on at congested airports	Sub variant 4: 50% pass on of all expenditures at all airports
			Allow. price €45	Allow. price €45	Allow. price €45	Allow. price €45
Intra EU routes						
Air transport and aircraft operations						
Pax demand	10^9 pax-km pa	803.1	-2.5%	-2.2%	-1.9%	-1.3%
Cargo demand	10^9 ton-km pa	6.5	-3.1%	-2.6%	-2.3%	-1.6%
RTK	10^9 RTK pa	86.8	-2.6%	-2.2%	-1.9%	-1.3%
Flights	10^6 flights pa	14.3	-2.4%	-2.1%	-1.9%	-1.4%
Aircraft Km	10^9 ac-km pa	9.1	-2.5%	-2.2%	-2.0%	-1.5%
Aviation fuel consumption and emissions						
Fuel use	10^9 kg pa	31.3	-2.7%	-2.3%	-2.1%	-1.4%
CO_2 emissions	10^9 kg pa	98.8	-2.7%	-2.3%	-2.1%	-1.4%
Fuel efficiency						
Fuel/RTK	kg / ton-km	0.34	-0.1%	-0.1%	-0.1%	-0.1%
Intercontinental routes: EU to non-EU and non-EU to EU						
Air transport and aircraft operations						
Pax demand	10^9 pax-km pa	2,351.5	-4.1%	-3.5%	-3.2%	-2.1%
Cargo demand	10^9 ton-km pa	169.7	-3.7%	-3.1%	-2.8%	-1.9%
RTK	10^9 RTK pa	404.9	-3.9%	-3.4%	-3.0%	-2.0%
Flights	10^6 flights pa	4.0	-3.3%	-2.8%	-2.7%	-2.0%
Aircraft Km	10^9 ac-km pa	13.4	-4.4%	-3.8%	-3.6%	-2.7%
Aviation fuel consumption and emissions						
Fuel use	10^9 kg pa	95.7	-5.0%	-4.5%	-4.1%	-3.1%
CO_2 emissions	10^9 kg pa	302.2	-5.0%	-4.5%	-4.1%	-3.1%
Fuel efficiency						
Fuel/RTK	kg / ton-km	0.21	-1.1%	-1.1%	-1.1%	-1.1%

Table 22 Effects EU and non-EU carriers of sub variants in 2020

Effect	Unit	BaU 2020	Sub variants and assumed allowance prices (% effect relative to BaU)			
			Sub variant 1: 100% pass on grandfathered allowances	Sub variant 2: Increased auctioning over time	Sub variant 3: No pass on at congested airports	Sub variant 4: 50% pass on of all expenditures at all airports
			Allow. price €45	Allow. price €45	Allow. price €45	Allow. price €45
EU carriers						
Air transport and aircraft operations						
RTK	10^9 RTK pa	322.1	-3.3%	-2.8%	-2.5%	-1.7%
Aircraft Km	10^9 ac-km pa	16.9	-3.1%	-2.6%	-2.5%	-1.9%
Financial effects						
Operating costs**	10^9 €	275.4	-2.0%	0.5%	1.3%	2.0%
Operating revenues	10^9 €	284.2	0.5%	0.4%	0.3%	0.2%
Oper. costs / RTK	€	0.86	1.4%	3.4%	3.9%	3.8%
Oper. rev. / RTK	€	0.88	3.9%	3.3%	2.9%	1.9%
Operating result*	% of rev.	3.1%	5.4%	2.9%	2.1%	1.3%
Non-EU carriers						
Air transport and aircraft operations						
RTK	10^9 RTK pa	992.7	-0.9%	-0.7%	-0.7%	-0.4%
Aircraft Km	10^9 ac-km pa	52.3	-0.7%	-0.6%	-0.5%	-0.4%
Financial effects						
Operating costs**	10^9 €	685.8	-0.4%	0.2%	0.4%	0.6%
Operating revenues	10^9 €	708.1	0.2%	0.1%	0.1%	0.1%
Oper. costs / RTK	€	0.69	0.5%	0.9%	1.0%	1.0%
Oper. rev. / RTK	€	0.71	1.0%	0.9%	0.8%	0.5%
Operating result*	% of rev.	3.1%	3.7%	3.1%	2.9%	2.7%

* The total operating result is expressed as a percentage of revenues for both the BaU situation and for the variants considered.
** For sub variant 1 the operating costs exclude the opportunity costs for grandfathered allowances.

Table 23 Coverage of CO_2 emissions in 2020 for sub variants

Effect	Unit	Sub variants and assumed allowance prices			
		Sub variant 1: 100% pass on grandfathered allowances	Sub variant 2: Increased auctioning over time	Sub variant 3: No pass on at congested airports	Sub variant 4: 50% pass on of all expenditures at all airports
		Allow. price €45	Allow. price €45	Allow. price €45	Allow. price €45
Aviation CO_2 emissions on all routes departing from / arriving at EU airports in BaU scenario					
CO_2 emiss. 2005 (EUROCONTROL)	megaton	217.7	217.7	217.7	217.7
CO_2 emiss. 2020 (BaU projection)	megaton	401.0	401.0	401.0	401.0
Covering of projected BaU CO_2 emissions in 2020					
Allowances benchmarked	10^6 allow.	217.7	65.3	0.0	0.0
Allowances auctioned	10^6 allow.	0.0	152.4	217.7	217.7
Reduction CO_2 within aviation sector	megaton	17.7	15.7	14.3	10.8
Allowances bought from other sectors	10^6 allow.	165.6	167.6	169.0	172.5
Total	megaton	401.0	401.0	401.0	401.0
Financial implications					
Costs to buy allow. from other sectors	million €	7,453.7	7,543.4	7,604.2	7,764.3
Auction revenues	million €	0.0	6,857.6	9,796.5	9,796.5
Windfall profits	million €	9,796.5	0.0	0.0	0.0

C.3 Discussion of modelling results

C.3.1 Main variants A and B

For the main variants A and B it is assumed that the policy-induced cost increases for airlines are passed through to consumers by increasing the fares on the routes which are subject to emission trading. These policy-induced cost increases relate to the costs for acquiring auctioned allowances and for buying allowances from other sectors. In the case of main variant A it is assumed that 3% of the allowances is auctioned (compared to 100% for main variant B). Because the further assumption for main variant A is that the opportunity costs for the freely allocated allowances are not passed through to consumers (see Table 1), the size of the cost increase passed through to consumers is less compared with main variant B. Hence, assuming the same allowance price, the effect on demand for main variant A is less compared with main variant B (for example from Table 15 compare effect on RTK on Intra EU routes of -0.3% for main variant A to effect of -1.0% for main variant B – allowance price € 15).

In order to be able to cover the projected growth of CO_2 emissions over the period 2005 – 2020, the aircraft operators have to either acquire additional allowances from other economic sectors or introduce emission reduction measures within the aviation industry. The costs of acquiring the additional allowances are passed through to consumer. This generates a demand effect, resulting in lower supply and associated emissions. The projected growth of CO_2 emissions over the period 2005 – 2020 will partly be covered by a reduction within the aviation sector and partly by buying allowances from other economic sectors. The reduction within the aviation sector is both related to a demand and a supply side effect. The supply side effect reflects that the costs for acquiring allowances will provide an incentive to airlines to shift more strongly to newer, more fuel-efficient (and associated lower emissions), technology aircraft than they would have in case of no emission trading. It is noted that AERO does not take into account a so-called manufacturer’s response which implies that the fuel efficiency of new aircraft would be improved as a result of the introduction of an emission trading scheme.

Table 15 shows that for the main variants A and B (allowance price € 45) the estimated reduction of CO_2 emission within the aviation industry in 2012 is respectively 1.1% and 3.1% on Intra EU routes and 3.2% and 6.2% on the EU related intercontinental routes. In absolute terms this is equal to a reduction of CO_2 emissions in 2012 within the aviation industry by 8.1 and 16.2 megaton for respectively main variant A and B (see Table 17). The number of allowances to be bought from other economic sectors, in order to cover emission above the 2005 emission baseline, is estimated to 81.3 and 72.9 million for main variants A and B million in the year 2012. For both main variant A and B, the vast majority of the emission growth from 2005 onwards will thus be covered by buying allowances on the open market.

For main variant A, the assumed price of € 45 per allowance and the number of 87.8 million allowances to be bought (either auctioned allowances or allowances bought on the open market) imply a cost increase for airlines of about € 4 billion (see Table 17). These costs are included in the operating costs presented in Table 16. For EU airlines, Table 16 indicates that the operating costs per RTK for main variant A (allowance price € 45) increases by 1.4%. This equals an increase in costs of roughly € 2.5 billion. So, roughly two-thirds of the total cost increase of 4 billion will be borne by EU carriers (and thus one third by non-EU carriers). However, the total operating costs are roughly unchanged (+0.1% for main variant A – allowance price € 45). This is because of the fall in demand and the associated decrease in supply, and hence a decrease in the number of required operations and associated costs.

If one compares the effects of main variants A and B, the main difference is that main variant B brings about a larger effect on demand and a larger reduction of emissions within the aviation sector. This directly follows from the fact that the policy-induced cost increases in the case of variant B are significantly higher because of the larger number of auctioned allowances for which the costs are passed through. However, the effect on the operating result in the case of variant B is not significantly different compared with main variant A. This follows from the assumption that all cost increases are passed through to consumers.

Over time, there is an increasing number of allowances required to cover the expected growth of CO_2 emissions associated with higher air transport volumes, whereas the number of allowances allocated to the sector remains constant. For main variant A (allowance price € 45) in the year 2020, 173.1 million allowances are estimated to be bought by the aviation industry on the open market (see table 20). This is more then twice as much as the allowances bought on the open market in 2012 for the same case (81.3 million – see Table 17). Main variant B shows a comparable increase over time of the allowances to be bought on the open market. The cost increase for the airline industry in 2020 in the case of variant A (allowance price € 45) will be about € 8 billion (see Table 20). As indicated above, in 2012 this is about € 4 billion.

C.3.2 Sub variants

In sub variant 1 all allowances are allocated using one off benchmarking, whereby it is assumed the opportunity costs and the costs for buying allowances from other economic sectors are passed through to consumers. This implies that the policy-induced cost increase for sub variant 1 is the same as for main variant B (where all allowances were auctioned). Hence the effects on demand for sub variant 1 are the same as for main variant B (see Table 21 for effects for sub variant 1 and Table 18 for effects main variant B with allowance price € 45). However, the effects on the profit margins are quite different. For sub variant 1, the opportunity costs which are assumed to be passed through by airlines do not reflect real costs for airlines. Because of the windfall profits in the case of sub variant 1, which equal about € 10 billion (see Table 23), the profit margin of airlines increases. Table 22 shows that for EU carriers the profit margin

(operating result expressed as a percentage of operating revenues) goes up from 3.1% in the BaU case to 5.4% in the case of sub variant 1. Also for non-EU carriers the profit margin slightly goes up (from 3.1% in the BaU situation to 3.7%).
The amount of windfall profits is directly related to the assumed allowance price. Because the CO_2 emissions in 2005 are 217.7 megaton, for every Euro increase of the allowance price, the yearly windfall profit for the airline industry goes up by € 217.7 million. This thus for the situation where the all allowances allocated to the aviation sector would be benchmarked and the opportunity costs of these allowances would be fully passed through.

In the case of sub variant 2, 70% of the allowances are auctioned, and the opportunity costs of the remaining allowances are not passed through. Logically, the effects for sub variant 2 are in between the effects for main variant A (3% auctioning) and main variant B (100% auctioning).
For sub variants 3 and 4 it is assumed that part of the policy-induced cost increase cannot be passed through by airlines to consumers. In sub variant 3 the assumption is that 100% of the allowances are auctioned, but that the costs for acquiring auctioned allowances and the costs for buying allowances on the open market are not passed through at congested airports (further assuming that 25% of the airports is congested). In sub variant 4 also 100% of the allowances allocated to the sector are auctioned, and only 50% of the costs for acquiring auctioned allowances and the costs for buying allowances on the open market are assumed to be passed through (at all airports). Because in both sub variants not all costs are passed through to consumers, the demand effects are more limited compared to sub variant 1 and main variant B where it is assumed that all costs are passed through. The effects on the operating result for sub variants 3 and 4 are rather significant. Because airlines are faced with real costs increases (i.e. costs made for acquiring allowances), but only part of these costs can be passed through to consumers, the operating result decreases significantly. For EU carriers the total operating result (expressed as a percentage of operating revenues) in the case of sub variant 3 goes from 3.1% in the BaU situation to 2.1%. For sub variant 4 the operating result of the EU carriers even goes down to 1.3% of operating revenues. The effect on the operating result for non-EU carries is less significant, because only a limited proportion of their operations will be subject to emission trading.

D Response to Ernst & Young and York Aviation (2007)

D.1 Introduction

Just after the draft final version of this report had been completed, Ernst & Young and York Aviation published a report titled 'Analysis of the EC proposal to include aviation activities in the Emission Trading Scheme'. This report had been commissioned by six European airline associations (AEA, EBAA, ECA, ELFAA, ERA and IACA). It will be referred to as Ernst & Young 2007.

Ernst & Young (2007) is a critical review of the Impact Assessment published by the European Commission (SEC(2006)1684). Ernst & Young considers some of the same issues that are studied in this report. However, in some cases, Ernst & Young arrives at different conclusions than CE Delft. The remainder of this appendix is devoted to clarifying the differences on cost pass through (D.2) and windfall profits (D.3)[21].

The conclusion of this appendix is that Ernst & Young's assumption that cost increases will not be passed through fully is incorrect from a theoretical point of view and improbable given the available empirical evidence. As a result, Ernst & Young's conclusion that airlines profits will be severely negatively affected is disputable.

D.2 Cost pass through

Ernst & Young (2007) states that 'it is highly unlikely that aircraft operators could simply pass on their ETS costs to consumers' (1). According to Ernst & Young, a full pass through of costs is only conceivable 'in a situation of perfect competition' (5). Aviation, they argue, is not in such a situation. Instead, it operates mostly in monopolistic or oligopolistic markets, where prices are higher than marginal costs and monopoly or oligopoly rents are extracted. In the case of oligopolies, this is called a Cournot competition. In that situation, only a fraction of the cost increase is passed through to the consumer. Furthermore, Ernst & Young singles out the competition from and to congested airports. In these market, it argues, costs will not be passed through at all.

This study argues otherwise. It builds on the assumption that aviation markets are competitive, even when they are oligopolistic, and even on routes to and from congested airports. Because markets are closer to perfect competition than to Cournot oligopolies, costs will be passed through.

This study finds support for the assumption that aviation markets are competitive in theoretical considerations and empirical evidence and thus will pass through cost increases. Both will be discussed in subsequent subsections.

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[21] Ernst & Young (2007) criticises the EC Impact Assessment on other issues as well. These will not be discussed here as they are not directly related to the analysis presented in this study.

D.2.1 Type of competition

It is undeniable that many routes are oligopolistic in the sense that there is only a limited number of competitors. And Ernst & Young (2007) rightly assumes that in many cases, routes can be regarded as markets. The issue then comes down to the question whether prices in oligopolistic markets are necessarily higher than marginal costs. In many cases they are, and this is known as Cournot competition. However, it should be noted that not all oligopolies are Cournot oligopolies. There are also Bertrand oligopolies, in which prices do reflect marginal costs (and thus would pass through cost increases fully). So it is incorrect to assume, as Ernst & Young does, that the observation that many aviation markets are oligopolistic necessarily implies that prices are higher than marginal costs.

Cournot oligopolies are characterised by oligopoly rents, i.e. by higher than normal profit margins. If the profit margins were not higher than normal, an oligopolist could not absorb some of the cost rises and would have the choice to either pass them through or exit the market. This study assumes a profit margin in the aviation sector of 2.5%. Ernst and Young assumes a profit margin of 4% for network carriers (2007, p. 16). Neither of these profit margins indicate substantial oligopoly rents and thus justify the assumption of Cournot competition as the basic model for the aviation sector.

D.2.2 The demand curve

Ernst & Young (2007) uses the following formula for demonstrating that in Cournot competition, costs will not be passed through fully:

$$\frac{dp}{dc} = \frac{N}{(N+1)}$$

With *dp* the change in price, *dc* the change in costs, and *N* the number of firms in the market.

The report fails to recognise, however, that this formula is only valid for a linear demand curve. If demand is isoelastic, meaning that there is a constant price elasticity of demand, a different formula has to be used. Since Ernst & Young seems to assume constant price elasticities (p. 6), they should have used the following formula for estimating cost pass through, even in Cournot competition:

$$\frac{dp}{dc} = \frac{N\varepsilon}{(N\varepsilon+1)}$$

With *dp* the change in price, *dc* the change in costs, *N* the number of firms in the market and ε the price elasticity of demand.

If demand is elastic (i.e. ε < -1), as Ernst & Young assumes for leisure passengers, passengers of low cost airlines and cargo, the formula results in a pass through rate of over 100%. If N=3 and $\varepsilon = -1.5$, for example, the price change would be 129% of the cost change.

Please note that this appendix does *not* argue that more than 100% of the cost changes are passed through to the consumer. This subsection just shows that the market assumptions taken by Ernst & Young are not internally consistent, and that they are not entirely consistent with its conclusions.

D.2.3 Empirical data

Doubt about a low cost pass through is also raised by empirical data. First, Price, Waterhouse and Coopers (2005) found by empirical analysis that increases in kerosene prices were almost fully passed through in the past, also by low-cost airlines. Therefore, there is no reason to assume additional costs of emission allowances cannot or will not be passed through as well. Second, it should be realized that if aviation would have to buy *all* allowances at auction against 30 Euro per ton CO_2, this would have the same impact as a further increase in fuel price of about 20%. This 20% should be compared against the *quadrupling* of kerosene prices over the last five years. Aviation could not have survived if it were unable to substantially pass through this quadrupling of kerosene prices. Only if some airlines would not have to carry the full burden of ETS in the market (if they were able to compensate the higher costs by subsidies or by higher profits elsewhere, for example), could it be assumed that the costs would not be passed through fully.

D.2.4 Cost pass through at congested airports

Although Ernst &Young (2007) gives a thorough discussion of expectations regarding the share of congested airports in the future, their analysis of cost pass through at congested airports is less detailed. It follows OXERA (2003) in its assumption of a *zero* cost pass through. The pass through rate at congested airports is a controversial matter, however. PWC (2005) and the Competition Commission (2002), for example, argue on the basis of empirical data and the low profitability of the sector that it is very unlikely if additional costs are not passed through at congested airports.

Moreover, the following three assumptions by Ernst & Young are difficult to hold simultaneously in a realistic scenario. First, it is assumed that at congested airports ticket prices are (well) above the airlines' marginal costs given the restricted airport capacity (p. 14). Second, it is assumed that 50% of passengers will be handled at heavily congested airports in 2025, while the percentage of revenue from such airports is assumed even higher (p.15). Third, it is assumed that the average profit margin of network airlines is a constant 4%, which can hardly be considered as high (p. 16). The only way to reconcile these assumptions would be that airlines incur heavy losses on routes between uncongested airports. But why would they maintain these routes if they lose so much money on them? Not to feed their operations on congested airports, since in that case at least one leg of the route would be in a congested airport.

D.2.5 Conclusion

In sum, this appendix argues that the mere fact that there are oligopolies on many routes does not imply that there cannot be a full pass through of costs. Moreover, empirical data on airline profits is inconsistent with the assumption that airlines are in Cournot competition with each other and are therefore able to extract oligopoly rents and are not able to pass through cost increases borne by all the actors in the market. Finally, empirical evidence on the pass through of fuel prices is at odds with the conclusion that ETS associated costs could not be passed through.

D.3 Windfall profits

This study agrees with Ernst & Young (2007) that there are no windfall profits in the aviation sector, but for other reasons. According to Ernst & Young windfall profits do not occur in liberalized sectors with a high price elasticity of demand. This is incorrect, however. Windfall profits simply occur if a firm obtains an asset for free of which the opportunity costs can be passed through. This holds even more in liberalized than regulated markets. However, in the case of updated benchmarking, the opportunity costs of allowances in possession are cancelled by the opportunity benefits of allowances to be earned for the next period. Therefore, ticket prices do not rise due to free allowances and no windfall profits occur.