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ABSTRACT

This paper examines how climate change policy can impact on competition, prices and profitability in the air transport industry. It begins with an outline of the climate change policies that have been suggested, and it gives particular attention to the inclusion of air transport in an emissions trading scheme (ETS).This is likely to prove an important policy direction, with the EU, Australia and New Zealand all planning to include air transport in their ETSs. The scope for airlines to reduce their emissions intensity in the short run and long run is examined- it is concluded that the scope in the short run is quite limited. After this, the application of the emissions trading schemes of the EU, Australia and New Zealand to air transport is discussed, and the possible impacts on air fares are assessed. Allowance is made for the cost of permits for both direct and indirect emissions.

The impacts of climate change policies, such as carbon taxes or requirements to purchase emissions permits, on airline competition, prices and profitability are analysed next. Impacts differ according to market structure- whether airline city pair markets are competitive, monopolistic or oligopolistic. They also depend on the time scale- airlines are unlikely to be able to pass on the full cost of their permits to their passengers in the short run, though in the long run, it is likely that airlines will exit from some city pairs, and this will enable to remaining airlines to raise their fares and restore their profitability. This may not occur in markets constrained by airport slots or capacity limits imposed in air services agreements on international routes, though the airlines' problems are not likely to be as severe as has been suggested.

If permits are provided free of charge to airlines, fares should still rise in the long run, assuming that airlines are profit maximisers and factor in the opportunity cost of the permits they obtain free. However even if airlines do this, there can be cases where fares do not rise by as much as they would if permits have to be purchased, because the operation of the ETS may discourage exit from markets. If airlines do not act as profit maximisers, air fare increases will be limited, and airlines will have the scope to cross subsidise less profitable routes. The limited evidence on airlines' use of free inputs (such as airport slots) is examined to obtain insights into whether airlines do indeed maximise their profits- this evidence is inconclusive. Finally the application of an ETS to international air transport is considered – this can give rise to issues of competitive non-neutrality, even when permits are sold.

1. INTRODUCTION

Several countries are introducing climate change mitigation policies, and many of these are intending to apply them to air transport. While there are several ad hoc policies which countries are implementing which are loosely justified in terms of climate change benefits, there are some comprehensive policies, such as carbon taxes and emissions trading schemes (ETSs) which are specifically designed to reduce greenhouse gas (GHG) emissions.

This paper explores how these systematic policies will impact on air transport costs, competition, fares and profits. Taxes, or the requirement to purchase emissions permits, will add to airlines' costs, and they will seek to pass these costs on to their passengers. The extent to which they will be able to do this, in the short run and long run, and whether the ability to do so depends on market structures are examined. One issue which arises is whether higher costs will induce some airlines to exit from route markets, and whether this will assist remaining airlines to maintain their profitability.

The impacts on competition and air fares are more uncertain if airlines are provided with free permits. One issue is whether there are any situations in which the impacts of free permits are the same as when permits have to be paid for, if airlines are profit maximisers. Another issue is whether the method of allocation of free permits could affect competition and fares, by encouraging airlines to stay in marginal markets or by altering their cost structures, even when airlines are profit maximisers. In such situations, some of the value of the free permits may be passed on to passengers. There is also a possibility that airlines will not maximise profits, and will not recognise the full value of the free permits they obtain when making decisions – will airlines keep fares low and try to gain market share, and will they use profits on one route to cross subsidise other routes? These issues are relevant to the question of whether introduction of climate change policies will impact on competitive neutrality on international markets.

The paper begins with a review of climate change mitigation policies which have been suggested for air transport, and pays particular attention to the workings of ETSs. It also examines the ability of airlines to reduce their emissions in the short and long run. There is a brief review of ETSs proposed for air transport, and an assessment of their possible impact on fares. Next the paper analyses how carbon taxes or permits which have to be paid for will impact on competition in unconstrained and capacity constrained markets. After this, the impacts of free permits on competition and fares are considered. How these policies might impact on competition in international markets, not necessarily directly included in the policies, is briefly considered. Finally, some conclusions based on the analysis are drawn.

2. CLIMATE CHANGE MITIGATION POLICIES AND AVIATION: AN OUTLINE

There is quite a wide range of policies which might be imposed on air transport operators, airlines and airports, to induce reductions in GHG emissions. Some of these are very general policies, such as carbon taxes, while others are specific. Some are intended to work though reducing air travel, while others are intended to work more directly, though reducing the use of fuel and thereby reducing emissions. Two aspects of these policies which are of relevance are:

- How closely or directly are the policies related to fuel use or emissions? and
- Will the policy promote leakage, by encouraging those affected to switch their behaviour and substitute to goods and services which create emissions elsewhere?

In general, it is likely that policies directly related to emissions or fuel use will be more cost effective in reducing emissions, since the closer a control is to the externality, the better it will work. There will be incentives to reduce fuel use or emissions per passenger as well as to reduce passenger numbers. Many of the policies noted here also face some risk of a leakage effect- they may reduce emissions from the traffic which is directly targeted, but emissions from substitutes will increase. Thus a tax on aviation could lead to an increase in emissions from ground transport. The likely leakage effect needs to be taken into account when assessing the effectiveness of a policy.

While many policies have been suggested, some are likely to be much more relevant than others. Thus some countries are moving to include air transport in their emissions trading schemes, and doing so will amount to a major policy shift with significant impacts. Attention here will be focussed on these core policies. Other policy options are worth noting, though they are given less attention.

2.1. Policy Options Specific Aviation Levies

Several countries are now imposing taxes on aviation which are ostensibly intended to reduce GHG emissions. The UK has the Air Passenger Duty (APD) (IATA, 2006b), and other countries such as the Netherlands have similar taxes. Others have called for specific taxes on aviation to reduce emissions (Macintosh and Downie, 2007). These are taxes levied on passengers when they take flights- they may depend on the length of the flight and be higher for higher class travel. These would only reduce emissions through their effect on air travel demand, and they would give rise to some leakage effects.

Travel Restrictions

There have been suggestions for limiting the number and duration flights that residents of specific countries might be permitted to take. While such measures could be effective in reducing emissions, they are draconian and would be very difficult to implement.

Mandatory Emissions Standards

Countries have considered setting emissions standards for aircraft which use their airports. These could work in a way similar to noise standards- noisy aircraft are prohibited from some airports. While such approaches may work for localised externalities such as noise, they will not work well for global externalities, since there is a strong likelihood of leakage. High emissions will shift to other airports and still generate emissions.

Tax Incentives

Tax incentives can be used to induce airlines to reduce their emissions. Thus corporate tax treatment of depreciation can be change to make it more attractive to airlines to have newer fleets. Since newer aircraft are less emissions intensive, this would have the effect of reducing emissions.

Air Traffic Control Reforms

Considerable emissions are generated through ATC delays and less direct flight paths (Hodgkinson, Coram and Garner, 2007). Both institutional (Single European Sky) and technological improvements have the scope to reduce these. These options should not lead to carbon leakage, since they may well be accompanied by cost reductions, encouraging greater utilisation of the air space subject to the reforms.

Airport Reforms

Many airports, especially in the US, are subject to considerable delays, on the ground and in the air, and thus emissions are higher than need be. Delays and emissions can be reduced by more efficient use of airport capacity, through the introduction or improvement of slot management schemes (see Forsyth and Niemeier, 2008), or through pricing. Again there should be no leakage, since reductions in the costs of using airports which institute reforms will encourage less use of non reformed airports.

Airport Emissions Charges

It is feasible for airports to impose emissions charges in the same way that they do for noise. Some airports, such as Zurich, impose charges related to emissions to lessen locally damaging emissions. Since airport use is not likely to be closely related to the total emissions from flights, which may be of long or short duration, this is not likely to be an effective means of controlling a global externality such as GHG emissions. There is also a strong likelihood of leakage.

Controls on Airport Development

Limits to airport expansion are frequently used as a means of lessening externalities associated with their use, such as noise. Restrictions on airport development (e.g. in London) are now being advocated as a means of limiting GHG emissions. Granted that airport use is only weakly related to emissions, and that the leakage effect is likely to be substantial (passengers will travel by car to more distant airports), this would not be a cost effective means of reducing aviation emissions.

Aviation Fuel Taxes

Aviation often does not pay much by way of fuel taxes, even on domestic services – this contrasts with high fuel taxes often levied on land transport modes such as private motor vehicles. Aviation fuel taxes would be closely related to emissions, and thus could be cost effective. They would work in a manner similar to a carbon tax, which is the more general policy instrument. There is an issue of leakage if substitute modes are not subjected to similar taxation.

Carbon Taxes

Carbon taxes are comprehensive taxes on the generation of CO_2 emissions levied across all or several industries. While many countries prefer to go down the ETS route, some countries, such as the US, could introduce carbon taxes instead. In the case of aviation, a carbon tax would most likely be implemented through a tax on fuel, related to its CO_2 content. The comprehensive nature of carbon taxes implies that substitute modes, such as land transport, will be similarly treated, and there is no risk of leakage to them. There remains some risk of leakage to other jurisdictions which do not impose comprehensive emissions policies- tourists are encouraged to visit countries which do not impose carbon policies rather than those which do.

Emissions Trading Schemes

Emissions trading schemes (ETSs) are shaping up to be the core policy instrument preferred by many countries to achieve reductions in GHG emissions (for discussion of this, see Frontier Economics, 2006; IATA, 2006a; Sentance, 2007; Thompson, 2007; Hodgkinson, Coram and Garner, 2007). The European Union, Australia, New Zealand and several US states are implementing ETSs, and all air transport is to be included in the EU scheme, while domestic air transport is to be included in the Australian and the New Zealand schemes.

ETSs normally have a cap and trade structure. An overall limit is set on emissions- this limit may be one which is agreed with international partners. While targets for particular years will be set, it will also be necessary to set trajectories from the start of the scheme to the years for which specific targets must be met. With the overall limit being set for a particular year, permits to emit up to this limit can be issued. Firms which emit are required to have a permit to emit. Permits can be traded, and a market price for them will be established. Market prices will depend on how tight the cap is, and on how easy it is for firms to achieve emissions reductions – over time, the cost of achieving a given target will fall as new technical options become available. Granted that the costs of achieving reductions in the earlier years will be higher than in later years, governments may set easier targets for the earlier years. In some schemes there may be scope to save or borrow permits from year to year.

Granted the broad structure of the ETS, there are number of issues which will need to be settled when applying one to aviation.

2.2. Air Transport in an ETS

An Air Transport Specific ETS?

A country might impose an ETS on its air transport industry- this could operate alongside a general ETS for the rest of the economy, or it could be imposed only on air transport. Such a scheme would have the effect, if implemented effectively, of achieving a specific target level of total emissions from air transport. This property is seen by some as desirable.

However an air transport specific ETS would be an inefficient means of achieving a country's targets. An ETS will work most efficiently if there is a single price for carbon for all industries, since this would encourage the greatest reduction being achieved in the industries which face the least cost in reducing emissions. If the objective is to achieve a country's overall target at least cost, specific industry targets are counterproductive. It is possible that, under an ETS, the reductions in emissions (compared to a business as usual case) in some industries such as aviation may be quite small, because they do not have much scope to reduce. If the ETS is working overall, there is no problem if aviation does not achieve much reduction in emissions.

It might be objected that aviation emissions are more damaging than other emissions (see discussion below). If this is the case, it can be handled most efficiently through adjustment factors for aviation in the ETS (e.g. requiring airlines to have more permits per unit of fuel purchased) or by supplementary schemes, such as emissions trading for other gases. Such approaches address the issues directly rather than indirectly.

Substitute Industries

If efficiency in transport choices is to be achieved, it is desirable that substitute industries for air transport, including land transport, be also included in the ETS. If this is not the case, including air transport in the ETS will encourage switching from air to land transport, at some cost in terms of overall efficiency, and lessening the impact on GHG emissions reductions.

This will be the case if each mode is efficiently priced other than for its GHG emissions. In practice, some modes (e.g. motor vehicles) may be more heavily taxed than air transport, and this tax need not be optimally set. Other modes, such as rail, may be subsidised. Imposing an ETS on an economy which already faces many tax distortions is something which needs special consideration.

Direct or Indirect Permits

An ETS may operate with all firms which produce emissions being required to have permits. Alternatively, it may operate with only a small number of firms being required to have permits directly, but with other firms which purchase inputs, the use of which generates emissions, paying indirectly for permits through the upstream suppliers being required to have permits. Thus the suppliers of aviation fuel might be required to have permits for their sales, but airlines might not be required to have permits. The indirect system simplifies administration, though it does rule out some options or makes them more complex- for example, if airlines do not use permits directly it is difficult to allocate them free permits.

Free or Sold Permits

ETS permits can be sold or issued free. Relatively few issues arise if the permits are sold, for example, by auction. If permits are given away free, to whom are they to be provided? Incumbents will receive permits, but new entrants may not qualify. The criteria for allocation between airlines pose an issue, since the allocation process can impact on competition and market outcomes (See Morrell, 2006; CE Delft, 2007a; CE Delft, 2007b).

Permits for Foreign Firms

Some jurisdictions, such as the EU, are planning to extend their ETSs to include international air services operated by foreign airlines. This poses the question of whether these airlines will qualify for permits on the same basis as home country airlines – if not, there is a problem of lack of competitive neutrality. Even if foreign airlines are granted free permits, there remains an issue of who bears the costs of reducing emissions, since foreign passengers will still be paying higher air fares as a result of the implementation of the policy.

Carbon leakages

The carbon leakage problem is a well recognised one for ETSs. Higher air fares to a country which is including air transport in its ETS will encourage visitors to go to other countries which are not imposing such policies. Airlines in the home country will have an incentive to replace their fleets with newer, lower emissions aircraft, selling their older aircraft to other countries – their reduction in emissions is partly achieved by shifting emissions offshore.

The Role of Supplementary Measures

While a country may adopt a core major policy to address GHG emissions, there is often a call for supplementary policies. The intention is often to increase the effect, for example to increase the reduction in GHG emissions achieved. Thus a carbon tax might be imposed, but in addition, airlines might be given tax incentives to renew their fleets – this would result in reductions in emissions beyond those achieved by the carbon tax. It is recognised that the response of aviation to carbon taxes or an ETS would not be large, and there have been calls for additional measures, such as aviation specific taxes, or accelerated depreciation allowances. However, if general policies such as carbon taxes are set at the right level, there should be no need to increase GHG emissions reduction from aviation – it is efficient that some industries reduce emissions less than others.

There is a further consideration which is relevant in the case of an ETS applied to air transport. In some respects, the ways an ETS works are very different from the ways carbon taxes work. Since the overall amount of GHG emissions is set by the policy, supplementary measures will have no effect on overall emissions. Thus, for example, if air transport is subjected to an additional tax, it will contract, and produce fewer emissions. However, this will free up permits, which airlines will sell to other industries, which will use them. Overall emissions will remain unchanged. Even if it is considered that the reduction in aviation emissions is too small, supplementary measures, such as air transport taxes, will not help by achieving further emissions reductions.

In the situation where air transport is subject to an ETS, and this ETS is working effectively, there is little to be achieved by imposing further supplementary measures. It does make sense to correct distortions which are in place- for example, if corporate tax arrangements are discouraging efficient investments in new fleets or to reform air traffic control arrangements. However, other measures such as restrictions on airport development or additional air transport taxes impose an efficiency cost while doing nothing to reduce GHG emissions. Once the EU ETS is applied to aviation, the UK Air Passenger Duty will be both costly and ineffective. If additional measures are to be taken, they need to be justified in terms of other benefits, not in terms of reductions in GHG emissions.

2.3. Aviation Emissions- the Complexities

Aviation emissions pose a number of complexities which need to be recognised when policies are being set. In addition, the science of aviation emissions and the damage they cause is not settled.

Aviation produces CO_2, but there is evidence to suggest that the damage done by aviation emissions is greater than that done by equivalent terrestrial emissions. Like some other processes, aviation also produces a number of other emissions, including sulphur dioxide and nitrous oxides, which contribute to global warming and thus climate change costs. The condensation trails of aircraft also affect cloud formation and can have an impact on global warming. The impacts of these emissions are not straightforward, and will depend on where they occur. While various multiples have been suggested, it may not be accurate to state that the damage and cost of a tonne of CO_2 emissions is some simple multiple of the damage and cost of a tonne of terrestrial emissions sometimes the impact might be larger, sometimes smaller.

In addition to this, there can be tradeoffs between different types of emissions. Aircraft engines can be designed to reduce their CO_2 emissions, but at the expense of increasing their nitrous oxide emissions. While CO_2 emissions can be monitored moderately accurately though fuel use, other emissions may be less easy to monitor, and the damage created by the emissions of all kinds will be more difficult to monitor. Even where there no uncertainty about effects, it would be difficult to design policies which accurately internalised the externalities.

Most current proposals involve a simple charge for CO_2 emissions, either through a tax or requirement for a permit. Moving from a zero to a positive price is probably welfare improving. If it becomes clear that CO_2 emissions from aviation are more damaging than terrestrial emissions, it would be efficient to adjust the charge upwards, by levying a higher carbon tax on aviation, or by requiring more permits to be purchased for a tonne of CO_2 from aviation. If only this is done, problems could develop in the longer term if engine manufacturers lower CO_2 emissions by increasing other emissions. If so charges for these emissions may be needed, if feasible.

3. EMISSIONS REDUCTIONS OPTIONS

Airlines, and their suppliers such as aircraft manufacturers, have a range of options available to them to reduce GHG emissions. Most of the more effective options are likely to only be available in the longer term as a result of technological change. Short term options are mostly likely to be of limited effectiveness.

3.1. Reductions Options

Voluntary Offsets

An airline can offset the emissions it creates by investing in schemes which reduce emissions, such as forestation schemes. There has been some questioning about how genuine some of these schemes are and whether they really reduce emissions. An airline can choose to offset all its emissions, and offer its passengers no choice. Such an airline will have higher costs than comparable airlines which do not offer offsets, and it will have to charge higher fares, thus risking its competitiveness. Some small airlines have chosen this path. The more common option is for airlines to offer their passengers the option of offsetting their emissions, at a price. Normally only a small proportion of passengers are willing to pay extra for a carbon offset, but there are some airlines, such as the budget carrier Jetstar in Australia which claim an over 10% take up rate.

Flightpath and Network Optimisation

With higher fuel prices, airlines have been reviewing their flightpaths and networks. A network which is optimal with a low fuel price may not be so with a high fuel price. Airlines may be able to save fuel by altering flight paths (when permitted to do so by air traffic control authorities). Airlines have more direct control over their networks, and they have options to save fuel, perhaps by offering more direct flights which lessen the distance travelled by passengers, and perhaps by consolidating loads. These changes have the effect of reducing emissions. Airlines are likely to respond in the same way if GHG emissions mitigation policies are imposed- policies which increase the price of fuel will have the same effect as any other cause of higher fuel prices.

Fleet renewal

Individual airlines have the scope to renew their fleets and rely more in less emissions intensive aircraft. Newer aircraft have lower emissions per passenger kilometre than older aircraft. If there is a downturn in traffic, they will retire or mothball the high fuel and emissions intensive aircraft first. While an individual airline can respond quickly, and reduce the emissions from its fleet by buying newer aircraft, this is not an option for the whole industry. Fleet renewal will depend on how quickly manufacturers can supply new more fuel efficient aircraft, and whether the airlines are willing to pay a large cost to turn over their aircraft more quickly. This suggests that fleet renewal will be associated with a considerable leakage problem. Airlines in countries with tough emissions policies, which impose high emissions charges, will seek to replace their fleets faster, but they will release high emissions aircraft which will be economical for the countries with weak or no emissions reductions policies to use. The gradual renewal of fleets over time will result emissions reductions of around 1% per annum per passenger kilometre, but emissions reductions policies are unlikely to speed up this process by much. It is likely that emissions reductions policies will have a positive, though quite small, impact on global emissions through fleet renewal.

Airport Operational Savings

There is some scope for aircraft to use less fuel on the ground at airports, for example, by greater use of tugs. The scope for this is greatest at airports which experience long on ground delays.

Alternative Fuels

There will be some scope for aviation emissions reductions in the medium term from the use of alternative fuels, such as biofuels. Airlines are currently experimenting with these. There does not seem much likelihood of a revolution in fuels in the medium term. There are questions about the availability and cost of alternative fuels.

Engine Developments

In the long term, in two or more decade's time, there may be significant changes in engine design, which will enable significantly lower emissions per passenger kilometre, thorough achieving improvements in fuel efficiency. Over the very long term, there is the possibility of new methods of propulsion, such as hydrogen fuel cells, which produce no GHG emissions.

3.2. Responses to Policy

Unlike other industries, such as electricity, air transport is not likely to be able to respond quickly to GHG emissions reductions policies. Emissions can be reduced by reducing air travel, or by reducing the emissions intensity of that travel. With technology being relatively locked in, there is only limited scope to reduce the emissions intensity of air travel in the short term. There is a gradual reduction in emissions intensity, and there are few options present which can accelerate this process by very much. It is unlikely that there will be technological options available for significant reductions in emissions intensity except in the very long term.

Emissions reductions policies will increase airline costs, and in the long run, subject to the qualifications below, these will mostly be passed on to passengers as higher fares. This will have an effect on demand, as air travel is moderately price elastic. In some markets, where there are good substitutes for air travel, long run demand elasticities are distinctly higher than short run elasticities, and in these markets, demand reductions will be greater. Emissions reductions policies will be being imposed on an industry with a strong and consistent growth rate, and their effects, even if carbon prices are high, will be to lower the growth rate of air travel and emission from this travel, rather than reduce it.

4. CLIMATE CHANGE POLICIES AND THEIR IMPACTS

As noted above, the most comprehensive climate change policies that countries are adopting are ETSs. While there are several ad hoc policies directed towards reducing GHG emission from air transport, and there are some taxes which appear to be revenue raising measures justified in terms of reducing GHG emissions, most countries or jurisdictions which are making a substantial effort to reduce emissions are employing an ETS. Some countries could take the carbon tax route, which should have similar quantitative impacts on air transport even though it will work rather differently.
Three jurisdictions are planning to apply an ETS to aviation in the near future. The situation is summarised in Table 1

Table 1. Applying Emissions Trading to Aviation

Jurisdiction	Aviation Sector	Time of Introduction	Comments	Allocation of Permits
EU	Intra EU	2012	Partial ETS: Motor vehicle transport excluded	Free, limited
EU	Beyond EU	2012	Partial ETS: Motor vehicle transport excluded	Free, Limited
Australia	Domestic	2010	Comprehensive ETS	Auctioned to Fuel Suppliers
Australia	International	Excluded	Comprehensive ETS	N A
New Zealand	Domestic	2009	Comprehensive ETS	Auctioned to Fuel Suppliers-possible free allocation
New Zealand	International	Excluded	Comprehensive ETS	N A

Source: Compiled from Commission of the European Communities (2008), Australia Department of Climate Change (2008), New Zealand, Ministry for the Environment (2007).

As Table 1 shows, the EU, Australia and New Zealand have advanced plans to apply their ETSs to air transport. Within the EU, international flights are to be included, but the intention is to also apply the ETS to flights beyond the EU, using both EU and non EU airlines. At this stage, Australia and New Zealand intend to exclude international aviation for the time being, though it could be included later. While at least some of the permits in the EU will be supplied free of charge to airlines, there will be no free permits in Australia and New Zealand, at least initially (though New Zealand has indicated that this could change). In both Australia and New Zealand, airlines will not be direct participants in the ETS- rather they will be covered by permits being required at the upstream level, though the sale of fuel. In Australia and New Zealand there is an intention to introduce a comprehensive ETS which covers most of the economy – in Australia's case, it will cover all industries except for agriculture and forestry, as well as international shipping and aviation. The EU ETS is less comprehensive, and does not cover motor vehicle use at this stage. There is also no coverage of emissions from imported goods and services in these ETSs.

With an ETS in place, airlines will be affected both directly and indirectly. Airlines directly create GHG emissions when they use fuel. When permits are required, they will face higher fuel prices. By far the most attention that has been paid to aviations HG emissions has concentrated on direct emissions. However, indirect emissions, which come about through the production of goods and services which are used as inputs, are also significant, though smaller than the direct emissions. Some estimates of the indirect emissions associated with Australian airlines international services, are presented in Table 2.

Table 2. Indirect GHG Emissions: Australian Airlines' International Services

Source	Emissions (Mt)	% of Direct Emissions
From Home Production	0.848	18.0
From Imports	0.438	9.3
Total Indirect	1.286	27.4
Direct Emissions	4.700	100.0

Source: Calculations based on data in Forsyth et al, (2008).

These estimates were derived using data on the pattern of air transport industry purchases, along with the input output structure of the Australian economy, as embedded in a computable general equilibrium model (Adams, Horridge and Wittwer, 2003). This model also relates CO_2 equivalent emissions from each industry to its output, enabling an estimate of the CO_2 emissions indirectly associated with air transport to be made. It indicates that indirect production of inputs in the home country generates about 18% of direct emissions, and that emissions from imported inputs account for about 9% of direct inputs. These results are for Australia, a country which relies heavily on coal, and which is a relatively carbon intensive economy. On the other hand, Australian stage lengths are long, and goods and services inputs per passenger kilometre (and thus indirect GHG emissions) would be relatively low.

Indirect emissions are of importance, but have different impacts from direct emissions. Airlines based in a country with a comprehensive ETS will be paying for indirect emissions as well as direct emissions- this will be true for international well as domestic flights.

The possible impacts of an ETS on fares are illustrated in Table 3. Five cases are considered; three short to medium haul types of flights (averages for three airlines) and two medium to long haul flights as operated by Qantas. Estimates of the GHG emissions for a passenger flight are presented- these depend on the nature of the flight and the equipment used. In the case of the London – Sydney flight, older, less fuel efficient aircraft are used. A price of €20 per tonne of CO_2 equivalent is assumed, and full pass through of permit costs is assumed. To allow for total emissions from home sources (subject to the ETS- imports are assumed not to be subject to a country's ETS), direct emissions are multiplied by 1.2. The impacts on European flights would be less than this because the European ETS is not comprehensive.

Table 3. CO2 Emissions and Impacts on Fares: Various Flights

Airline	Ryanair	Lufthansa Passage	Condor	Qantas Hong Kong Sydney	Qantas London-Sydney
Aircraft	New 737/A320	New 737/A320	New 737/A320	747 400	A330
Average Ticket Price €	44	136	90	341	644
CO_2 per pax	0.088	0.107	0.163	0.470	1.600
Cost of Permits €	1.76	2.14	3.25	9.40	32.00
% of Ticket Price	4.0	1.6	3.6	2.8	5.0
Cost of permits for Direct and Indirect Emissions €	2.11	2.57	3.90	11.28	38.4
% of Ticket Price	4.8	1.9	4.3	3.4	6.0

Source: Calculations based on data in Scheelhaase and Grimme, (2007) and Forsyth et al (2007).

This Table gives a rough order of magnitude of the impact that an ETS might have on air fares in the earlier years, before airlines have been able to reduce emissions per passenger kilometre significantly. The percentage change in fares ranges from 1.6 to 5, when only direct emissions are considered, and from 1.9 to 6 when direct and indirect emissions are included. Short haul and long haul flights are affected to about the same extent. If permit prices were higher, impacts would be proportionately higher. As can be seen, the cost imposition on airlines is significant, though smaller than that as a result of the rise in fuel prices over recent years.

5. IMPACTS OF POLICIES ON AIRLINE COMPETITION, FARES AND PROFITS

Suppose that airlines are faced with a carbon tax or an ETS in which they are required to purchase permits, either directly or indirectly through their purchases from upstream suppliers. The case of free permits is considered later. The tax or permit requirement might be levied on fuel or on emissions, though most likely, fuel will be used as a proxy for emissions. It will result in a cost increase to the airline, initially for a flight. This will mean that the cost per passenger or unit of freight will increase. The impact on competition and on prices will depend on several factors:

1. Whether the short run or the long run is being considered;
2. The market structure of the market in question, and
3. Whether there are constraints on operation, such as slots at airports or on capacity permitted on routes (mainly through international regulation through air services agreements).

Three possibilities for market structures are competition, monopoly and oligopoly. It is probably best to analyse market structure at the route level, while recognising that some routes are imperfect substitutes for each other. At the route level, there may be competition, monopoly or oligopoly.

Some busy routes could be considered competitive, since there are moderately large numbers of airlines serving the route. Some North Atlantic routes or groups of routes, such as that between South East England and North East USA, could be regarded as competitive. There are several airlines which operate between the London and New York airports, along with others which serve nearby cities. Some routes between major hubs in Europe and in Asia may also be competitive. Airlines in these markets can be regarded as price takers, and have little scope to employ oligopolistic strategies.

At the other end of the scale, routes could be monopolistic. There are many routes around the world which have only one airline serving- these are typically thin low density routes. While monopolistic, meaning that the airline has some discretion over pricing, these routes will often be marginal, not highly profitable, and airlines may face competition from surface transport.

Perhaps the most common market structure is oligopoly- there are many routes with around two to four airlines. These airlines possess some market power, and recognise their interdependence. In most, though not all cases, there will be free entry and exit. This tendency to oligopoly might be explained by fixed costs of operating a route, or by the requirements of operating an adequate frequency in order to appeal to the passengers and make one's presence evident. Hence, even though there may be many potential entrants, a market may remain dominated by a few airlines.

5.1. Market Power and Profitability- the Airline Paradox

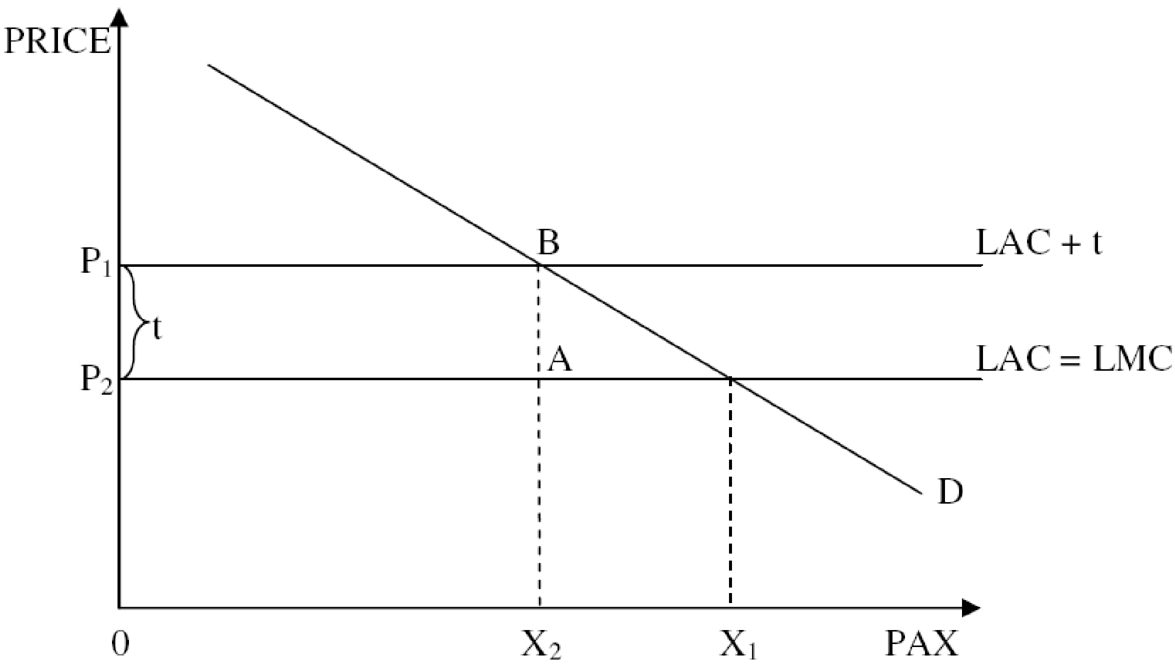
As suggested, some airline markets can be regarded as competitive, but most markets are best regarded as either oligopolistic or monopolistic. In short, airlines possess market power. If this is the case, one would expect them to be making profits over the longer term. In fact, the airline industry is hardly very profitable, struggling to earn the cost of its capital taking one year with another. Profitability is more typical of that which would be achieved in strongly competitive markets, rather than oligopolistic and monopoly markets. In addition, the industry has had to face several shocks on the cost side. These have led to short run reductions in profitability, but in the longer term profitability has been restored. Again, this result is more characteristic of competitive markets rather than oligopolistic or monopolistic markets. The paradox is explained below. The monopoly power on most routes is weak, and routes are not necessarily highly profitable. On oligopoly routes, there is free entry and exit, and these results in profits being eliminated by entry and maintained by exit.

5.2. Impacts in non constrained markets

Competition

In the short run, in a competitive market, a tax increase will impose a loss on firms in the market. As long as the price exceeds average variable cost, all airlines will stay in the market, offering the same amount of capacity. Prices will remain the same, and airlines will incur losses. While airlines may be able to reduce capacity on the market fairly quickly (and exit quickly if they choose to do so), it is likely that the values of their fleets will decline, if a large number of routes are affected by the imposition of the tax. While capacity on a route can be reduced quickly, that of all the affected airlines will not be. Profitability evaluated at the new lower opportunity cost of the aircraft can be restored quickly, but the profitability of the airlines which operate the route will not be restored to such a level as can return the cost of capital until the excess capacity in the industry is eliminated. In a growing industry such as air transport, this will happen when growth catches up with actual capacity again.

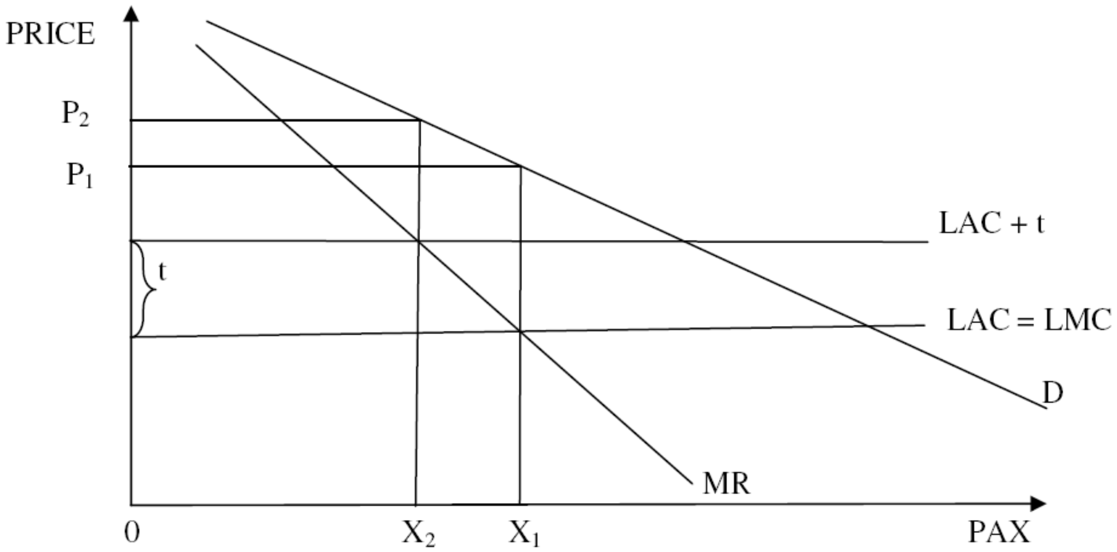
The long run case is illustrated in Fig 1. The long run average and marginal cost curves are assumed to be straight and horizontal (no scale economies). The initial equilibrium is one of price P_1 and output X_1 The imposition of a carbon tax (or permit price) of t raises the cost airline to LAC+t, and the new price P_2, will cover this. Output falls to X_2. There is full pass through of the carbon tax to the passengers, and the reduction in output will depend on the elasticity of demand for flights. Airlines neither gain nor lose from the implementation of the carbon tax in the long run. The impact on the number of firms will depend on the cost structure of the airlines. The higher costs and prices in the market are likely to be accompanied by fewer firms of about the same scale.



Monopoly

Not all airline routes are competitive- at the extreme, some may be monopolies. The case of monopoly is shown in Fig 2. With monopoly, there is little difference between the short and long run cases. Suppose that a carbon tax of t is levied. This raises the marginal cost of the monopoly by t. It does however, not raise the price to the passengers by this amount- the rise in price is from P_1 to P_2, less than the amount of the carbon tax. The exact amount that prices rise will depend on the elasticity of demand and on the form of the marginal cost function. With the smaller price increase, the impact on output will be smaller than under competition. The monopoly is unable to pass on the full carbon tax. The airline will face an unambiguous reduction in profit. This could lead to the route becoming unprofitable in the short and long run. If prices are less than average variable cost, the airline will exit the route in the short run, and if they are less than average cost, the airline will exit in the long run. As noted in the discussion of competition, the opportunity cost of aircraft will fall if the cost increase is faced across the industry, and airlines may continue to serve the market even though they are earning insufficient revenue to cover the cost of the capital they have invested. When demand grows enough to eliminate the excess capacity in the industry, the airline may drop more marginal routes (redeploying capacity to more profitable routes).

Figure 2



Oligopolistic Airline Markets

The distinction between short and long run is important in the oligopoly case, because the number of firms in the market is fixed in the short run, but variable in the long run. In oligopoly, firms may employ different strategies, such as Bertrand or Cournot strategies, and these will affect outcomes.

If the airlines on a route indulge in Bertrand competition, they will compete prices down. When faced by a cost increase, they will initially be unable to increase prices, and they will face losses. (Again, they will exit if prices fall below average variable cost). In the long run they will only continue to serve the market if they are covering their costs. If this is not feasible, firms will exit, allowing prices to rise. The long run outcome of the imposition of the carbon tax or permit requirement will be that the costs will be passed on to passengers, and the profitability of the airlines will be maintained, though there could be fewer firms competing in the market.

In the Cournot case, prices can be set above marginal and average costs. If there are very few firms, prices will be below, though close to monopoly prices, while if there are several firms, prices will be closer to competitive levels. In the short run, with a fixed number of firms, a cost increase will lead firms to increase prices, though the per unit price increase will be smaller than the per unit cost increase. The burden of the carbon tax or permit price will be shared by the airlines and their passengers.

However this is not the end of the story, since the numbers of airlines serving the market can change. If there is free entry, then airlines will enter up to the point that the marginal firm covers its costs (see Suzumura and Kiyono, 1987). More firms and more competition mean lower prices, and they also mean higher overall costs, since each firm faces a fixed cost of participating in the market. While the market is oligopolistic and the firms technically possess market power, free entry keeps prices and profits down, though profits are not necessarily reduced to zero. If prices and profits are low, the imposition of a tax or permit price raises costs, and this can render the airlines unprofitable in the long run. If so, an airline will drop out. This leads to a saving in costs, as airlines gain from greater scale, and also to less competition and higher prices, and profitability is restored.

This process involves an indivisibility, granted the small number of firms. In some cases the number of firms remains the same in these cases, the airlines were moderately profitable, and they remain profitable in spite of the cost increase. Prices increase, but not to the extent of the cost increase- airlines and passengers share the tax. In other cases, where profitability before the tax imposition is low, a firm will exit, enabling the remaining firms to increase prices and profitability. The result will be less competition, higher profits than before, and passengers paying more than the tax increase.

Overall, in airline markets, there will be examples of each of these cases. As costs increase, some more profitable markets will become less profitable, but the number of firms will not change; in other markets, firms will drop out, and markets will become less competitive, enabling higher prices and profitability. Overall, airlines will be able to pass on cost increases, such as those due to a carbon tax or permit price, to their passengers, and thus they can maintain their (low) profitability.

Summary

The effects of imposing a GHG emissions reduction policy on airlines, such as a carbon tax or requiring the purchase of permits, will depend on whether a short or long run perspective is taken.

In the short run, there is not likely to be much reduction in competition on markets, as measured by the numbers of airlines serving them. Prices will not be able to rise to the extent of the cost increase, and thus airline profitability will be reduced. This will be true regardless of the market structure- it will be so for competitive, monopolistic and oligopolistic markets. In this case the short run will last as long as overall aircraft capacity exceeds its desired level.

In the long run, there will be some exits from markets. In oligopolistic markets, these will be significant, and they will enable airlines to restore their profitability overall, though the patterns of profitability of different markets will alter. There will be some exits from competitive markets, though these will not be sufficient to affect the intensity of competition. Some marginal monopoly routes will be dropped. Profitability of airlines will be restored, helped by exits from some markets. The cost increases occasioned by the policy will ultimately be passed on to passengers.

This picture is consistent with the long run experience of the airline industry. The industry is not very profitable and it does not have much scope to absorb cost increases. It has had to face sudden cost increases, such as those resulting from fuel price shocks. In the short term it has been unable to pass all of the higher costs on to its passengers for several years, and it has experienced periods of unprofitability. Airlines have had to rationalise their services. Ultimately, with demand growth, profitability has been restored.

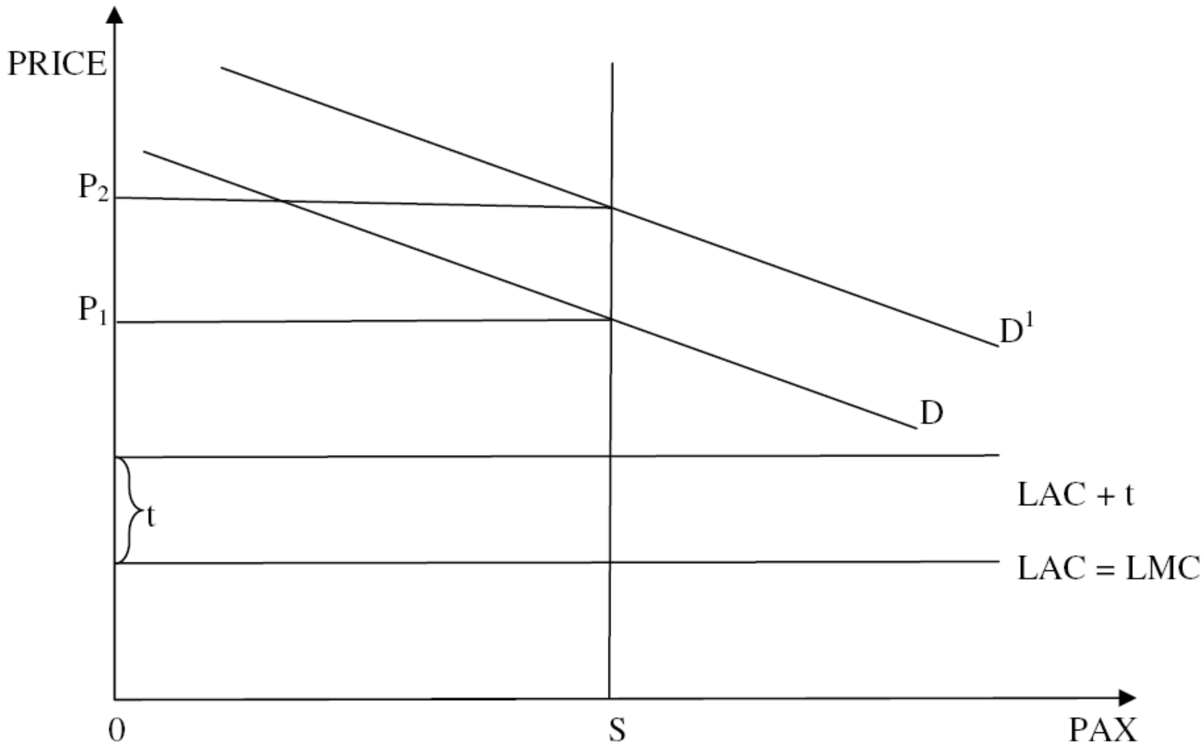
Thus the airlines will have a short run problem resulting from imposition of carbon taxes or selling of permits, and they will face an adjustment problem. The short run problem could be quite significant. In the long run, profitability will be maintained. The view that these policies will lead to chronic loss of profits, suggested by consultant reports, is not supported (e.g. Ernst and Young/York Aviation, 2007). At least in the long run, the view that airlines will be able to pass cost increases on to their passengers, as suggested by the EC, (European Commission, 2006) is supported.

5.3. Impacts in slot or capacity constrained markets

Homogeneous airlines and taxes

Many airline routes, especially in Europe and some parts of Asia, use airports which are slot constrained. Most of the major airports in Europe are slot constrained at least for part of the day. To schedule a flight into such an airport, the airline must have a slot. This may have been allocated to it earlier, or it may be able to gain a slot through trading with other airlines. Granted that there is excess demand for the airports, these slots are valuable. For present purposes, it is necessary to note that there is an overall limit on the number of flights into and out of slot constrained airports.

Figure 3



This situation is illustrated in Fig 3. The demand by flights to use the airport is shown as D, and the available capacity is shown as S. Slots ration demand to S, and the market clearing price is P_1. Given that LMC lies below P_1, there is excess demand, and slots command a premium.

If a carbon tax is levied at the rate t, the average and marginal costs to the airlines rise to LAC+t. The price to the passengers, P_1, cannot change, since it is set by the balance of demand to slot capacity. In this situation, the airline is unable to pass on any of the carbon tax, and there is no reduction in output. Airline profits fall by the amount of the carbon tax levied on them. The value of a slot falls by the amount of the carbon tax (OXERA, 2003).

This suggests that for a substantial proportion of air traffic, that which uses slot constrained airports, carbon taxes will have no effect on emissions through reducing airline demand. Taxes levied on emissions will have some effect on emissions through inducing airlines to use less GGE intensive aircraft, though this is not likely to be a large effect except in the very long run.

However, this is not the whole story- there is a situation in which airlines may be able to pass on some of the costs of a carbon tax. Suppose that some airlines, such as British Airways, operate short haul flights from a slot constrained airport such as London Heathrow, while others such as easyJet operate competing short haul flights from non constrained airports such as Luton and London Stansted. If carbon taxes are imposed on all airlines, the fares which easyJet charges will rise, though in the first instance, BA fares will not. However, since the fare premium for using London Heathrow has fallen, and since BA flights and easyJet flights are imperfect substitutes, the demand for BA flights will increase, as will the demand for use of London Heathrow airport. This is shown in Fig 3- the demand curve shifts upwards somewhat, to D'. Fares on short haul flights using the airport will rise to P_2. The value of a slot at London Heathrow will be higher, though it will be lower than the value before the imposition of the carbon tax. In this situation, the airline loses less as a result of the imposition of the carbon tax than in the case where the demand curve does not shift.

A similar situation can occur when airports are competing for hub traffic. Suppose some of these airports are slot constrained (London Heathrow, Frankfurt) while others are not as subject to slot limits (Amsterdam, Paris Charles de Gaulle) or not significantly subject to limits (Munich). If air fares in flights through the non constrained airports rise, then demand for the constrained hubs will increase, enabling fare increases for airlines using these hubs.

In each of these cases, passengers have a choice as to which airport they use. The slot premium does not come about as a result of an absolute lack of capacity relative to demand. Rather, it is a result of limited capacity at a preferred airport. Passengers are prepared to pay a premium to use Heathrow rather than Stansted. When costs increase at both of these airports by the same amount, there is no reason to expect the premium which passengers are willing to pay to use the preferred airport to fall. In such a situation, the airlines would be able to increase fares at the slot controlled airport by the same amount as for flights from the unconstrained airport. In practice, imperfect substitutability may mean that the price increase will be less at the slot constrained airport. In addition, in cases where there are no effective competitors for slot constrained airports, airlines will not be able to pass on any of the cost increase- as discussed above.

Another context in which airlines will not be able to pass on cost increases caused by carbon taxes or sold permits arises on international routes. Some routes are still subject to capacity controls, and governments have regulated capacity such that it is insufficient to cater for demand at competitive fare levels, and market fares are sufficient to enable airlines to earn economic profits. Since fares are market determined, airlines will not be able to increase fares when costs increase- thus they will be forced to absorb them. This is not likely to be a long run problem for the airlines, since capacity is a policy variable chosen by governments. As demand grows, fares will increase, and governments are unlikely to increase capacity on the route if their airlines are not achieving (the government's) desired level of profitability.

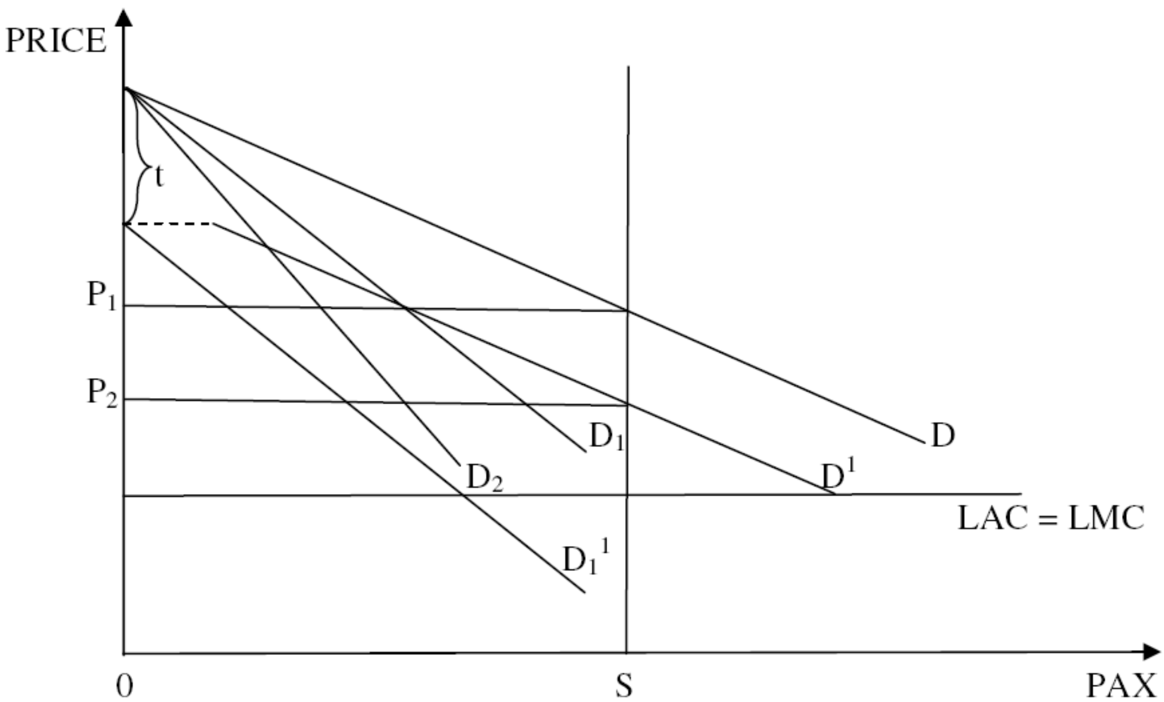
Capacity restrictions, due to slot limits at airports or air services agreements on international routes, result in fares being market determined, though competition between airports can result in fare increases at one airport leading to fare increases at the slot constrained airport. In both cases, airlines will be unable to raise fares enough to cover the tax or permit costs imposed on them (at least in the short run with international routes) - thus they will experience a reduction in profits.

Differential taxes on slot constrained routes

It is quite likely that different users of slot constrained airports will be paying different carbon taxes. For example, long haul flights are likely to have to pay higher carbon taxes per flight than short haul flights. This will affect the outcome in terms of prices and slot values.

This is illustrated in Fig 4. Suppose that there are two types of flights, with demand curves D_1 and D_2. Airline markets are competitive. The aggregate demand for the use of the airport is shown as D and the price is set at P_1. A carbon tax t is levied only on flights of type 1, and this can be shown as a downward shift in the demand curve to D_1^1. The new overall demand curve is shown as D^1. The shift downwards is less than t, and the new market clearing price is P_2. The value of a slot falls, but by less than the carbon tax. The price of type 1 flights will rise, and the price of type 2 flights will fall. More type 2 flights will use the airport, and fewer type 1 flights. Because slot values and prices have fallen, passengers of Type 2 airlines will gain, but the airlines will lose, even though they have not been subjected to the tax. By contrast, passengers on the type 1 flights will lose, and airlines will limit their losses by being able to pass on some of the carbon tax. Another way of looking at this is the fall in the slot value is smaller than the carbon tax imposed.

Figure 4



This case may be a realistic one in Europe. Long haul flights are likely to be subjected to higher carbon taxes than short haul, intra European flights. The legacy carriers, such as British Airways and Lufthansa tend to have slots at, and use extensively, the tightly slot constrained airports such as London Heathrow and Frankfurt. Their low cost carrier (LCC) competitors tend to use less constrained airports. When carbon taxes are levied on the LCCs, they will pass them on to their passengers in full. When carbon taxes are levied on the long and short haul flights using the slot constrained airports, slot prices will fall by more than the amount of the taxes levied on the short haul flights. The premium for using preferred airports will fall. Thus the costs faced by short haul flights operated by legacy carriers will fall, and in a competitive market, these cost savings will be passed on. While the airlines themselves will be worse off as a result of a fall in slot values, legacy airlines' prices will fall, while the prices of their LCC competitors will rise.

6. IMPACTS OF FREE PERMITS ON COMPETITION, FARES AND PROFITS

6.1. Profit maximising airlines

If airlines are granted free permits in an ETS, the impacts on competition prices and profits could be much the same as before, if airlines operate as profit maximisers. Since permits will be valuable and can be bought and sold, the airlines could be expected to factor the market price of permits into their decisions. The critical requirement is that the processes of allocation of the free permits not have any effect on the airlines' cost structures or behaviour. If permits were allocated permanently on the basis of past output, and there is nothing that the airlines can do to affect their future entitlements, this would be so.

In the long run, air fares will rise, and airline profits will rise to the extent that they gain free permits in the cases of competitive and oligopolistic markets. The situation will be different in the case of monopolistic markets, since in these, the airlines will be unable to raise fares by as much as the value of the permits. Even if an airline on a monopoly route is granted all the permits it needs free of charge, it will be worse off than in the pre permit days. When it recognises the market value of the permit, it will make a price/quantity choice which it had rejected before- it must therefore be gaining lower profits than before. The difference between competitive and oligopolistic markets on the one hand, and monopolistic markets on the other, is that in the former, the imposition of the permit requirement enables airlines to increase their fares- something which they normally cannot do under competition. By contrast, the monopoly is able to choose its fares whether or not it requires permits.

This result depends upon the airlines being unable to affect their allocation of future permits. This might not be the case. One possibility is that permits are conditional on actually participating in the specific route market. Permits might be allocated on a year by year basis, to airlines active in the market. If permits are allocated on a permanent basis, then an airline which is considering exiting a market will be able to take advantage of its free permits when it exits by selling them, or using them in other markets. However, if permits are allocated on a year by year basis, an airline might earn a profit if it stays in the market, with permit rents exceeding operational losses. If it exits, it would lose the rents from the free permits- thus it will stay in the market, even though an identical airline which had to pay for its permits would exit. This lock in effect is actually being planned to be used in some jurisdictions to prevent export industries moving offshore when an ETS comes into operation (Australia Department of Climate Change, 2008).

The lock in effect would dissuade marginal firms in oligopoly markets from exiting. As a result, competition will be stronger, and prices will be lower, than if the airlines had to pay for their permits. Airlines would be, in effect, forced to share some of the rents from the permits with their passengers. This effect could also be present in the competitive case in the long run. Free permits can result in lower air fares even when all airlines are profit maximisers.

A situation in which eligibility for free permits is conditional on operating in a specific airline route market is a possibility, especially where an airline operates on only one of a few markets to a foreign country with an ETS. However, most allocation systems will make eligibility dependent on total output of airlines, not their presence in a specific market (though withdrawing from a market could reduce the airline's total output and subsequent entitlement to free permits). In this scenario, there is a lock in effect which encourages an airline to stay in the industry.

If the airlines' entitlement to future free permits depends on their actual outputs, this will alter their effective cost functions. Suppose that the airlines' marginal costs are LAC and in Fig 1, and marginal costs including the opportunity cost of permits is LMC+ t. If by producing more output the airlines qualify for more free permits, the value of these permits needs to be deducted marginal cost to obtain an effective marginal cost. Thus the effect marginal cost will lie between LMC and LMC+t, in Fig 1. In competitive markets, the airlines will charge fares less than LMC+t, and some of the benefits of the free permits will be shared by the airlines' passengers. In the case of oligopoly markets, lower marginal and average costs of the airlines in the market will make remaining in the market more attractive for the marginal firm. There is less likelihood of an airline exiting, and competition will be more intense, leading to lower fares and profits.

Incumbents versus Entrants

One possible scenario is that incumbents, either in the industry or on a route, obtain free permits whereas entrants do not. If airlines are profit maximisers and not capital constrained, this should pose no problems for competition between incumbents and entrants- entrants will be less profitable than incumbents, but all will fact the same input prices. The free permits will be like a lump sum subsidy to the incumbents. However, again, the way in which permits are allocated can influence competitive outcomes. Suppose that permits are only allocated if the airline stays in the market. This can induce the incumbent to remain longer in the market than would otherwise be profitable for it to do so. If an entrant appears, the incumbent may be unable to make a profit, and it should exit- the lump sum subsidy will induce it to stay. Competition will be stronger and fares lower than if permits were not free.

Excessive competition can also come about if the entrants are granted free permits, on condition that they actually serve a market. In this situation, an entrant might be induced to enter even it would otherwise not be able to make a profit, since it can gain access to a subsidy by doing so. Subsidies can encourage excessive entry into oligopolistic markets.

If free permits are allocated for a number of years, and airline will not need to be competing in a market to gain free permits- thus an airline would be willing to exit a market and sell its permits. The lock in effect or the entry encouragement effect will be lessened if permits for multiple years can be sold.

These results will come about even if all airlines are maximising their profits. In addition, if incumbents are granted free permits while entrants are not, they will have the ability to cross subsidise marginally unprofitable routes. Entrants will know this, and will be less willing to enter markets even when they would be viable competitors.

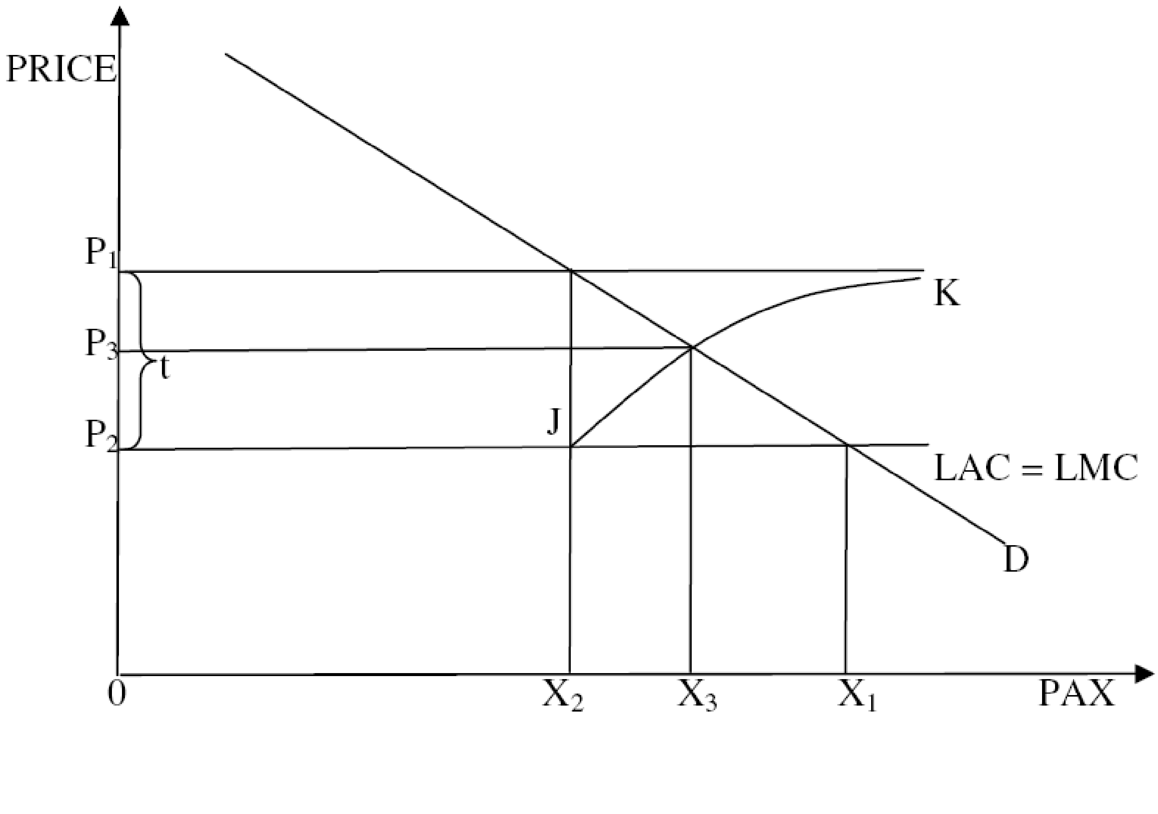
6.2. Non profit maximising airlines: average cost pricing

The analysis so far has assumed that firms maximise profits. It is possible that airlines will not act in a profit maximising manner. They may not value the permits, and factor in their opportunity cost, when making decisions about routes to fly and in pricing. Airlines might seek to cover their costs, and not seek to profit from their free permits. Thus they might keep prices down on routes which are incorporated in the ETS. Alternatively, they might price to market on routes covered by the ETS, earn profits on these, and use the profits to cross subsidise other routes.

One possibility is that airlines will simply seek to recover the average cost of their flights from passengers on a route covered by the ETS. This cost will be made up of operating costs plus the cost of any permits they need to buy- airlines may not obtain all of the permits they need free of charge. The implications of this approach are considered in Scheelhaase and Grimme (2007). The case of competitive airlines using non slot constrained airports is considered here.

The case is illustrated in Fig 5. Suppose that a scheme of carbon permits is introduced, and that the value of the permits is P_2-P_1. Consider a representative airline in a competitive industry. Suppose that this airline is granted OX_2 permits. The profit maximising price would be P_2, and this would induce an output of X_2. The airline would be profitable. Alternatively, it could choose to set prices at average cost. If it goes beyond an output of X_2, it will experience increasing average costs, since it would need to purchase more permits as output increases. The average cost will begin to rise at J and will asymptote to the price P_2. By setting prices equal to P_3, and allowing an output of X_3 the airline will just achieve cost recovery.

Figure 5



Thus the impact on prices will be smaller than under profit maximisation, and the reduction in output will be smaller. In fact, output will be inefficiently large, since the social marginal cost can be regarded as P_2 (if the level of carbon credits has been set optimally), and the actual price is less than this. If the benefits from carbon permits are passed on to the passengers, they will be relatively inefficient as a GHG emissions mitigation strategy. Carbon taxes or sold permits would be preferable on this ground, since they would be automatically passed on to passengers.

The extent to which airlines behave as profit maximisers or implement average cost pricing (thereby being sales maximisers) is an important empirical issue for determining the likely impact of including airlines in an emissions trading scheme. The difference between fares under profit and sales maximisation will be very substantial. Quite high carbon prices can be consistent with very low changes in average costs (Morrell, 2006; Scheelhaase and Grimme, 2007). Thus the impacts on GGEs will also differ markedly.

6.3. Airline Behaviour with Free permits

Airlines are used to dealing in resources which they obtain at less than market prices. Airport slots are an obvious example- airlines have obtained most of these free through grandfathering. In addition, many airlines are currently paying much less than market price for their fuel, as a result of hedging contracts. These do not represent a free or subsidised resource in the long run, and hedging has to be paid for. Nevertheless, many airlines are now paying much less than market price for their fuel. Airlines' behaviour with respect to these resources may give clues as to their likely treatment of free emissions permits.

If airlines are maximising profits one would expect that their decisions and pricing would reflect the market prices of the resources. Consider airport slots first. Airlines, such as British Airways, BMI and Lufthansa, with many slots at the very slot constrained airports, such as London Heathrow and Frankfurt, could be expected to be earning very high profits. While slots at Frankfurt are not extensively or freely traded, slots at Heathrow are very valuable, with recent sales at £25m per daily slot pair.

What happens to the slot rents that airlines enjoy is never adequately explained. Given slot values at Heathrow, one would expect higher profits for airlines such as BMI than are achieved. BMI has 11% of the slots at Heathrow, yet its profits in 2007 at £15.5m, were less than the value of a single slot pair. Even its record profit, of £29.7m in 2006, is only slightly above the value of a slot pair. It is possible that airlines are not fully factoring in the opportunity cost of slots they possess when determining whether to operate flights into Heathrow and that many Heathrow flights are not covering the cost of their slots. Alternatively, it could be that profits being earned on Heathrow routes are being used to cross subsidise routes elsewhere.

Airlines responses to fuel prices also should provide a test of their behaviour. Fuel price hedging gives some airlines a short term advantage. Some airlines have very valuable hedging contracts, enabling them to purchase, currently, much of their fuel needs at well below market prices. On the one hand, airlines are likely to have difficulties in passing on the full amount of fuel price increases to their passengers in the short run, for the reasons discussed in the context of cost increases due to climate change policies. Thus, airlines without hedging could well be unprofitable- many are. On the other hand, airlines with low hedged prices should be able to earn profits if they are able to increase their fares by more than warranted by the actual price they are paying for fuel (though this will be lower than the fares warranted by the market price of fuel). Some airlines which have been strongly hedged, such as Qantas, have been earning record profits in spite of the current downturn.

It is not possible to determine if airlines are all turning the values of their hedges fully into profits. Some airlines with good hedging may be choosing to use their advantage to increase market share- though whether this is a profitable strategy remains to be seen. It is not possible, without more detailed analysis, to determine whether airlines with good hedging are making the maximum profit out of their position (it is also possible that the well hedged airlines are also the more profit oriented).

Analysis of the pricing and profitability of airlines, with allowance for hedging, in the context of recent fuel price rises should provide useful information on both the ability of airlines to pass on costs in the short run, and on how profitably they make use of windfalls such as those which have come about from hedging.

6.4. Summary: Free Permits and Airline Pricing

If permits are free to airlines, there is some chance that their full value will not be passed on to passengers. Airlines may be profit maximisers, but the allocation of permits may create incentives for more airlines than is efficient to remain in markets, thereby lowering fares. In addition airlines may not be profit maximisers, and pass on some of the value of their free permits to passengers, keeping prices lower in pursuit of market share. If this happens, prices will be less than marginal social costs, including the externality costs of the emissions. While the ETS will face airlines with the marginal cost of their emissions, and give them an incentive to reduce emissions, it will not face passengers with the marginal costs of their travel. The ETS will be less effective and efficient than it would be if permits were not free.

7. COMPETITION AND INTERNATIONAL MARKETS

Carbon taxes or ETSs are most likely to be applied to domestic markets or intra jurisdictional markets (e.g. to international flights within the EU), though they may be applied to all markets to and from a country or jurisdiction. How the policy is implemented might have implications for competition in air transport in international markets. There are several possibilities.

7.1. Taxes or Sold Permits with International Markets Excluded

Countries such as Australia and New Zealand are planning to impose an ETS with purchased permits on domestic, but not international aviation. This is likely to their airlines earning lower profits in domestic markets in the short run, though they should recover their profitability in the long run. If the airlines are profit maximisers and not capital constrained, this should not have any implication for competition on international markets. If the airlines were not making profits on some routes, international or domestic, before, then the profits squeeze might lead them to cut back on unprofitable routes. This could lead to slightly less completion on both domestic and international routes. There is not likely to be any major effect in the long run however.

7.2. Free permits with International Markets Excluded

Free permits will enhance the profitability of home country airlines, the more so in the longer term as fares rise. If airlines are profit maximisers which face no capital constraints; this should have no impact on international markets. Airlines will have the scope to cross subsidise domestic and international routes, if they choose to do so (at the expense of their overall profitability). If initially capital constrained, they will be less so. Thus, if they wish to continue to operate on marginally unprofitable routes, or make a gamble on new routes, they will be able to do so. Thus competition in international routes could be more intense, and this would put some pressure on fares and profitability of airlines from other countries flying on the home country's international routes.

7.3. Taxes or Sold Permits on All Markets

A country could impose taxes on all flights, by home and foreign airlines, to and from its gateways as well as on its domestic markets. This policy would transfer income from foreign passengers and airlines to the home country, and it is not likely to meet with a country's air service partners. International agreements may limit its ability to do this- for present purposes suppose that it is possible. If a country does this, there should be no implications for competition on international markets, since all airlines would be treated equally. Depending on how the policy works, there could be problems for neutrality between flights which take different routings. If the permits required are based on the kilometres flown on the first stage from the home country, indirect routings will be advantaged relative to direct routings. Thus a flight from Singapore to Paris via Dubai will pay less than a direct flight from Singapore to Paris.

7.4. Free Permits for All Markets

A country may be able to secure the agreement of its partners if it provides free permits to home and foreign airlines operating on international routes. Foreign airlines would gain, though foreign passengers would lose. Again, since foreign and home airlines are being treated equally, there should not be any problems of competitive neutrality. Some flights would be affected more than others. Airlines would gain more from longer direct flights for which they gain more free permits, while passengers would prefer indirect routings for which fares would not rise as much – this could have implications for competition in these markets. Free permits would pose many practical problems for allocation- for example, if an airline changes its routing to or from a destination, will this affect its allocation of permits?

7.5. Competitive Neutrality and Indirect Emissions

Whether or not international air transport is included in an ETS, there will be an impact on competition between home and foreign airlines as a result of the ways in which indirect emissions are treated. Suppose that a country imposes a comprehensive ETS. An airline based in that country will then have to pay higher prices for its inputs, since the emissions it creates indirectly will require permits. Even if permits are free, its input prices will rise. Its foreign competitors will only be marginally affected, since they will not purchase many of their inputs in the country imposing the ETS. Thus the home country airlines will be at a competitive disadvantage, though the size of this disadvantage is not likely to be large (around 0.5% to 1.0% with a €20 per tonne permit price, as indicated above).

An ETS will make all of a country's exports less competitive on international markets, and thus it will lead to some reduction of its exchange rate. This will counteract the negative effect noted above, though how strong this effect will be is unclear. However, if countries seek to shield their export industries from the effects of their ETSs, as Australia is seeking to do (Australia Department of Climate Change, 2008), the exchange rate offset will be weak.

8. CONCLUSIONS

Countries are moving to implement climate change mitigation policies which include air transport. Most of these, especially carbon taxes and ETSs, will have the effect of raising costs to airlines, though the effects of ETSs with free allocation of permits will have ambiguous effects on costs.

With carbon taxes or requirements to purchase permits, airline costs will rise and the airlines will seek to preserve their profitability by passing the higher costs on to their passengers. The extent to which they are able to do this will depend on how they affect competition. In the short run, in all market structures, it is likely that competition (and firm numbers) will not be much affected, and fares will not rise enough to cover increases in costs- thus the airlines' profitability will be reduced. In the long run, in competitive and oligopoly markets, there is the possibility of some airline exits from route markets, and this lessening of competition will enable remaining airlines to raise fares and restore profitability. In short, full or nearly full pass through of the cost increase will be possible. This will not be the case in markets affected by airport slot constraints or capacity constraints under air services agreements, though even in these markets the airlines are likely to have more scope to increase fares than has been recognised.

The possibility of free permits poses interesting questions for airline competition. The rules for the allocation of the permits will have implications for the competitive process. If the airlines are profit maximisers, and the allocation process is neutral and does not affect airline behaviour, free permits will work like permits which have to be purchased, and fares will rise and airlines will enjoy profits as a result of them. However, depending on the allocation rules, free permits may create incentives for airlines to remain in markets, to enter markets, and may alter airlines' costs structures. If this is the case, competition is likely to be more intense than if permits are purchased, and fares will be lower, and some of the value of the free permits will be passed on to passengers, even though the airlines are maximising their profits. In addition, prices and profits are likely to be lower if airlines do not factor in the full opportunity cost of permits into their decisions, and choose to use the profits they gain to cross subsidise unprofitable routes. If free allocation of permits has these effects, airline prices will be less than marginal social costs and the ETS will be less efficient than it would be if permits were not free.

The introduction of a carbon tax or ETS, whether permits are free or not, could have implications for competition on international markets. These markets might be affected even if they are excluded from the policy directly. These policies could affect the competitive balance between international airlines, though the effects are not likely to be large.

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