AIRLINE EMISSIONS OF CARBON DIOXIDE IN THE EUROPEAN TRADING SYSTEM

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Abstract

A simulation model of international tourist flows is used to estimate the impact of including carbon dioxide emissions from aviation fuels in the European Trading System. The effect on global carbon dioxide emissions from international aviation is minimal: -0.01% at current permit prices, and –0.13% for the aggressive climate policy advocated by the Stern Review. In the latter case, total CO2 emissions from fossil fuels would fall by 0.004%, and total greenhouse gas emissions by 0.002%. Tourist numbers in Europe would fall by up to 0.6%, and would increase in the rest of the world. If the permits are grandparented, the airlines would receive a subsidy of €3 bln at current prices, and €40 bln for the Stern policy. If permits are auctioned, the effect on the airline industry would be minimal. Including aviation in the market for emission permits has almost no effect on the environment and may have a negative effect on the economy.

Key words

International tourism, tradable permit, carbon dioxide, aviation

1. Introduction

Carbon dioxide emissions from international aviation are small but growing much faster than other greenhouse gas emissions. To date, aviation emissions have been excluded from climate policy, *inter alia* because it is an international industry regulated by consensus. Recently, however, the European Commission has announced that aviation emissions will be part of the European Trading System (ETS) for carbon dioxide. Specifically, permits will be needed for all emissions from flights from and to an airport in the European Union.[1] This note investigates the implications for emissions, for travel patterns, and for the financial position of airlines.

This note builds on Tol (forthcoming). That paper was written when taxing aviation emissions was a remote prospect, and the policy scenarios there differ from the current policy proposals – particularly, the previous paper considers a global tax, while the current paper studies a European permit trade. Similarly, Michaelis (1997), Olsthoorn (2001) and Wit *et al.* (2002) analyse different policies than what is currently being proposed.

The paper only considers *international* aviation *demand* by *tourists*. Domestic air travel is excluded, as is travel for business purposes. There is a global database of reasonable quality

[1] http://ec.europa.eu/environment/climat/aviation_en.htm

on international tourist travel – but there is nothing of the sort for domestic tourist travel or for business travel. So, a choice has to be made between comprehensiveness in a geographic sense, and comprehensiveness in a travel sense. The current paper opts for the former, which of course does not make the latter less relevant. Note that business travellers are less likely to respond to price changes than are tourists.

The paper only considers shifts in demand induced by an increase in the price of air travel. Of course, carbon pricing would also induce changes in flight behaviour, aircraft technology, and perhaps fuel choice – each of which would reduce carbon dioxide emissions (Bates *et al.*, 2000; Wit *et al.*, 2002, 2005; Wulff and Hourmouziadis, 1997). This would dampen the price signal to the traveller, so that this model overestimates the economic impacts but underestimates the effect on emissions. The results suggest that this is not a major problem. Note that aircraft and fuel are fixed in the short-term. Airport authorities and air control determine the most crucial aspects of flight behaviour – taxiing, take-off, and landing – although the airlines pay for the emissions; little change is expected, therefore.

2. The model

Simulations are done with the Hamburg Tourism Model (HTM), version 1.3. Previous work focussed on climate change (Hamilton *et al.*, 2005a,b; Bigano *et al.*, 2005). The current version is designed to analyse climate policy (Tol, forthcoming).

HTM predicts the numbers of domestic and international tourists from 207 countries, and traces the international tourists to their destinations. Tourism demand is primarily driven by per capita income. Destination choice is driven by income, climate, coast, and travel time and cost. Carbon pricing would increase the travel cost, but leave other factors unaffected. See Tol (forthcoming) for details.

Data were primarily taken from WTO (2003) and EuroMonitor (2002). Behavioural relationships were estimated for 1995 (the most recent year with reasonably complete data coverage), and used to interpolate the missing observations. Observations on travel time and travel cost are very limited. Here, travel time and cost are assumed to be linear in the distance between airports, using data for Heathrow, Europe's busiest airport. The airfare elasticity of destination choice equals $-1.50 + 0.14\ln y$, where y is the average per capita income in the country of origin. For UK travellers, the elasticity equals –0.45, which compares well to the estimates of Oum *et al.* (1990), Crouch (1995), Witt and Witt (1995) and Wohlgemuth (1997).

The model was used to "predict" tourist numbers for 1980, 1985, and 1990, and shown to have a predictive power of well above 70%.

Carbon dioxide emissions equal 6.5 kg C per passenger for take-off and landing, and 0.02 kg per passenger-kilometre (Pearce and Pearce, 2000). No holidays at less than 500 km distance (one way) are assumed to be by air, and all holidays beyond 5000 km are assumed to be by air; in between the fraction increases linearly with distance. For island nations, the respective distance are 0 and 500 km. Total modelled emissions in 2000 are 140 million metric tonnes of carbon, which is 2.1% of total emissions from fossil fuels. This is from tourism only. Total international aviation is responsible for some 3% of global emissions.[2] There are no published numbers on the share of tourism in total international travel.

[2] See http://themes.eea.europa.eu/Environmental_issues/climate/indicators.

3. Scenarios and Results

3.1. Scenarios

The model was calibrated for 1995. From 1995 to 2004, populations and economies grow as observed. Between 2005 and 2020, growth rates gradually converge to the SRES A1 scenario (Nakicenovic and Swart, 2001). The price of oil is kept constant at the price in September 2006. Results are presented for 2010 only, and in deviations from the baseline, so that the baseline details are largely irrelevant.

Eight different prices of carbon permits are considered, all in euro per tonne of carbon: 0, 5, 10, 18, 25, 50, 100, and 240 €/tC; 0 €/tC is the base case; 5 €/tC (25 €/tC) corresponds to the median in Tol’s (2005) meta-analysis of the marginal damage cost of carbon for a 3% (1%) pure rate of time preference; 240 €/tC is the value recommended by Stern *et al.* (2006); 18 €/tC was the price of carbon permits in the ETS at January 5, 2007; 10, 50 and 100 €/tC are round numbers in between.

Following the proposal by the European Commission, permits are assumed to be needed for all emissions from flights to and from any airport in the European Union. Norway has announced it will join, while Iceland and Switzerland are assumed to follow suit. People residing in the European Union account for 19% of all tourism aviation emissions. However, emissions on flights to and from the EU account for 58% of global emissions. The difference is because Europe is a popular holiday destination for people from all over the world, and tourists from outside the EU fly longer distances. Note that airlines have questioned the jurisdiction of the European Commission.

3.2. Emissions

Figure 1 shows the effect of carbon dioxide emissions trading. The change in global CO2 emissions is approximately linear in the permit price. This is no surprise if one considers the scale of change in emissions: Global emissions from international tourism aviation fall by less than 0.14% if the permit price is 240 €/tC. If the price of permits is as it was in early January of 2007, emissions fall by 0.01%. For emissions by EU residents, the respective numbers are 0.28% and 0.02%.

3.3. Tourist numbers

The change in international arrivals in the European Union is larger than the change in emissions, as non-EU tourists choose the fly to other destinations. Still numbers are small, less than a 0.6% drop. The reduction in tourist numbers is not evenly spread in Europe. Peripheral island nations such as Cyprus, Malta, and Ireland see the largest reductions (-1.16%, -1.04% and –0.90%, for 240 €/tC). Slovakia (-0.43%) is affected least – generally, central countries that can also be reached by car or train face below-average impacts. Countries outside the EU would attract more tourists – the number of European tourists would fall only slightly as these tourists pay for their carbon emissions wherever they go, but tourists from China, Japan and the USA would be diverted from Europe to other countries. Nepal and South Korea gain more than 1% for a 240 €/tC permit price.

3.4. Airlines

HTM does not explicitly include airline behaviour, but the observed behaviour of power utilities in the current ETS may be a good analogue for what will happen in the air travel market. As demand is price inelastic, the costs of carbon permits are by and large passed on to electricity consumers. This is because the effect on the price of electricity is too small to have much effect on competition. In air travel, the price effect is even smaller, while airlines' emissions are more homogenous so that the competition effect is smaller too. It is therefore safe to assume that the price of permits will be passed on to the travellers.

Currently, permits are grand-parented in the ETS, that is, companies receive their permits for free; and the amount of permits is proportional to the emissions in a base year. To date, allocated permits are in fact almost equal to the expected emissions in the target year – the basic reason why the permit price is so low.

Under these assumptions, Figure 2 shows the value of the grandparented permits to the airline industry as a function of the permit price. At the permit price of early January 2007, the airline industry would be given assets with a total value of €3.0 billion per year. At the permit price advocated by Stern *et al.* (2006), the subsidy would amount to €39.6 billion. In comparison, the US industry received a hand-out of €1.9 billion in response to the 9/11 terrorist attack on the World Trade Center.[3]

An annual subsidy of this size to incumbents would increase the barriers to entry for new airlines. Grandparenting similarly rewards slow-growing airlines at the expense of fast-growing ones. Low-cost carriers face a proportionally higher price increase than other carriers. These three effects imply a reduction in competition in the air travel market. As taxiing, take-off and landing are more energy-intensive than cruising, tradable permits hit companies that specialise in short-haul flights relatively harder than companies that specialise in long-haul flights.

If carbon permits were auctioned rather than grandparented, the airline industry would not receive the wind-fall discussed above. Instead, the money would flow to the government. If the government spends that money wisely or cuts taxes, then this corresponds to a redistribution of a relatively small amount of money from air travellers to the general public.

3.5. Airports

European airports would see a reduction in number of travellers. As discussed above, the changes in the number of tourists to and from Europe are very small. However, the number of transiting passengers may fall more substantially. Under the proposed rules, emission permits are needed for the entire trip New York-Frankfurt-Johannesburg, but none for the longer trip New York-Dubai-Johannesburg. Similarly, a trip London-Dubai-Sydney would require less carbon permits than a trip London-Singapore-Sydney, but emit more CO_2. Over the longer term, hubs may develop just beyond the European Union -- as Switzerland has not entered into the ETS, Zurich International Airport may be that hub.

4. Discussion and conclusion

In sum, including aviation emissions in the European Trading System for carbon dioxide appears to be neither effective nor efficient. Of course, the first best solution for an emission reduction policy is to have a permit market that covers *all* emissions, including those from aviation. However, the current market is partial, and including aviation should not be the first priority for extending market coverage. The effect on emissions is minimal, even if the permit

[3] The Economist, September 15, 2005.

price reaches heights that are inconceivable today. If this were the only drawback, one may dismiss the inclusion of aviation emissions in the ETS as largely irrelevant, but a step in the right direction. However, in the current regime of grandparenting permits, this policy is in fact tantamount to a substantial subsidy to the airline industry – at the expense of travellers and without perceptible gains for the environment. European politicians would create the impression of leadership on climate policy while in fact contributing almost nothing to emission reduction.

The results presented here are uncertain and require substantial caveats. A sensitivity analysis on the many assumptions is not given. However, Tol (forthcoming) shows that the sensitivity of the results is less than an order of magnitude – even if the impact of carbon pricing on emissions were ten times larger, it would still be very small. The lack of technological and behavioural responses in the model seems to be the most significant omissions – but the stock of aircraft turns over only very slowly, while taxiing, take-off and landing behaviour is in fact not affected by the proposed carbon pricing. Therefore, including aviation emissions in the ETS will, at best, have no effect on emissions and, at worst, have no effect on emissions but give a handsome subsidy to the airlines.

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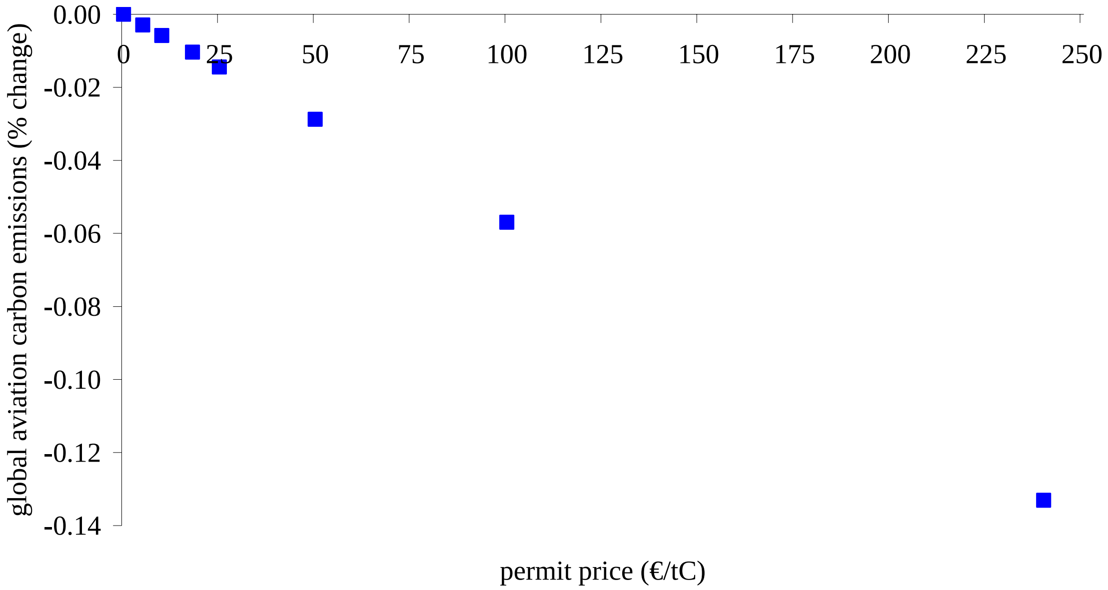

Figure 1. Emissions as a function of permit price.

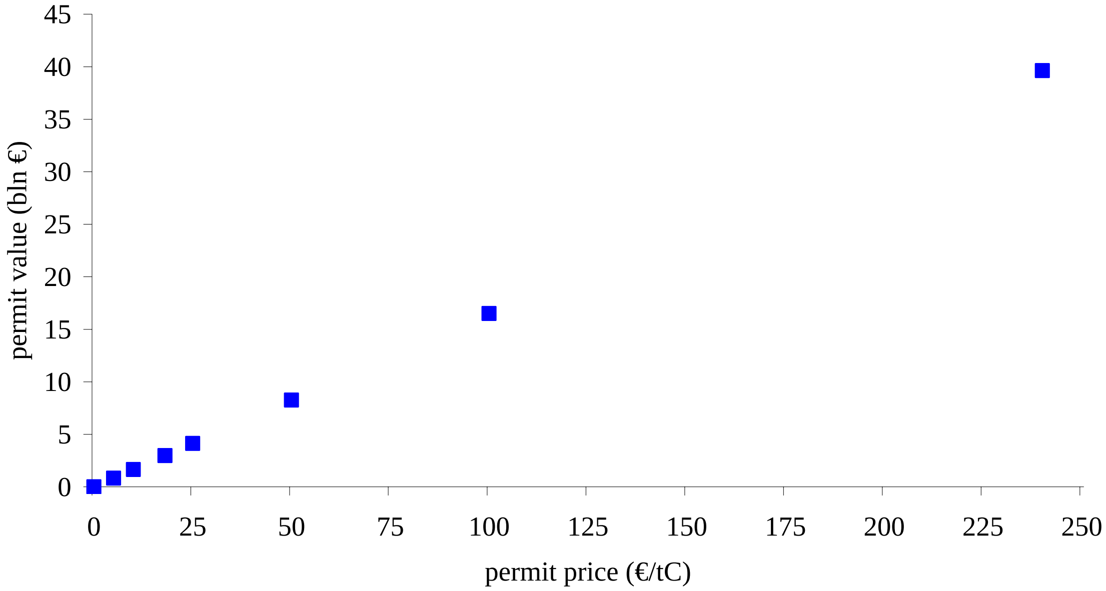

Figure 2. Subsidy to the airline industry as a function of permit price.