The impact of the European Union Emissions Trading Scheme on US aviation

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ABSTRACT

We estimate the economic impacts on US airlines that may arise from the inclusion of aviation in the European Union Emissions Trading Scheme from 2012 to 2020. We find that the Scheme would only have a small impact on US airlines and emissions, and that aviation operations would continue to grow. If carriers pass on all additional costs, including the opportunity costs associated with free allowances, to consumers, profits for US carriers will increase. Windfall gains from free allowances may be substantial because, under current allocation rules, airlines would only have to purchase about a third of the required allowances. However, an increase in the proportion of allowances auctioned would reduce windfall gains and profits for US airlines may decline.

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1. Introduction

In 2005, the European Union (EU) implemented an emissions trading scheme (ETS) for certain industries and installations to partially fulfill its obligations under the Kyoto framework to reduce greenhouse gas emissions (European Union, 2003). The EU-ETS is in its second phase (2008–2012) and a third phase will operate from 2013 to 2020. The EU will develop post-2020 climate policies according to future international policy developments and progress in the understanding of the science of global climate change.

The EU-ETS sets progressively lower caps on annual greenhouse gas emissions and 2020 limits are set at 79% of 2005 emissions covering all EU states plus Iceland, Liechtenstein and Norway. It covers carbon dioxide (CO_2) emissions and nitrous oxide emissions from installations in the energy sector such as power stations, combustion plants and oil refineries, and emissions from most other industrial installations.

In 2008, the European Commission adopted directive 2008/101/EC, to include aviation in the EU-ETS from the beginning of 2012. All flights to or from airports in ETS countries, irrespective of carrier nationality, will have to acquire allowances to cover CO_2 emissions. While the International Civil Aviation Organization (ICAO) and International Air Transport Association (IATA) generally support market-based policies to abate aviation emissions, the inclusion of aviation in the EU-ETS has been challenged. Some foreign governments and airlines argue that the EU-ETS in its current form is both unjustly harmful to airlines and contravenes international treaties, such as the Chicago Convention. In this connection, the US government has requested an exemption from the EU-ETS for US carriers. Additionally, some US airlines and their trade body, Airlines for America (A4A), have filed a case in the European Court of Justice. Other countries, such as China, are also calling for exemptions (Flottau et al., 2011). Under current EU legislation, an exemption may be granted for airlines from countries that implement measures "equivalent" to those in the EU to reduce GHG emissions.

In extending the EU-ETS to aviation, the European Commission will allocate aviation allowances for 97% of average annual emissions from 2004 to 2006 in 2012, and 95% of the same historical average from 2013 to 2020. However, aviation emissions may exceed the quantity of aviation emissions allowances if aviation buys allowances from other sectors covered by the EU-ETS and/or purchases emissions credits from certain clean energy projects. Under current regulations, 85% of aviation emissions allowances will be granted for free (grandfathered) each year based on each carrier's market share in 2010, and 15% of allowances will be auctioned. However, EU legislation allows policy makers to revise the number of allowances grandfathered from 2015 onwards.

2. Modeling framework

Following Winchester et al. (2011), we assess the impact of the EU-ETS on aviation by linking an economy-wide computable general equilibrium (CGE) model with a partial equilibrium model

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that focuses on the aviation industry. We use a CGE model to determine the impact of the EU-ETS on fuel prices and GDP, and simulate the impact of changes in these variables in a partial equilibrium model of the aviation industry.

Our chosen CGE model is the Emissions Prediction and Policy Analysis (EPPA) model. The EPPA model is a recursive dynamic model of the global economy that links GHG emissions to economic activity (Paltsev et al., 2005).

We model the aviation industry using the Aviation Portfolio Management Tool for Economics (APMT-E). APMT-E is one of a series of models that is being developed by the FAA and the Partnership for Air Transportation Noise and Emissions Reduction Center of Excellence. The APMT tool suite is designed to assess the effects of aviation on the environment, and APMT-E focuses on airline responses to policy changes. The model has been used in support of International Civil Aviation Organization/Group on International Aviation and Climate Change (2009) and International Civil Aviation Organization/Committee on Aviation Environmental Protection (2010) and is outlined by MVA Consultancy (2009). In the model, airlines can respond to CO_2 costs by raising prices (and flying less) and, when purchasing new aircraft, selecting more fuel efficient alternatives. The model is calibrated using 2006 data.

APMT-E identifies 23 route groups (e.g., North Atlantic, Domestic US, North America-South America and Europe-Africa). As we wish to determine the impact of the policy on US airlines, our analysis focuses on the North Atlantic. Based on Kincaid and Tretheway (2007), in the model, the price elasticity of demand on the North Atlantic for passenger travel is assumed to be -0.72 and -0.99 for freight.

Existing functionality in APMT-E does not allow us to consider at least two second-order effects of the EU-ETS on US airlines. First, we do not consider the impact of the policy on US carriers on routes outside the North Atlantic, such as decreased US domestic flights due to reduced connecting passengers from North Atlantic flights. Second, we do not consider asymmetric effects of the EU-ETS on competitiveness. For example, cost increases for US airlines transporting passengers to non-EU destinations via the EU relative to airlines that bypass the EU. This argument has been widely voiced by the EU aviation industry, but Albers et al. (2009) conclude that competitive distortions due to the EU-ETS will be small.

To evaluate the impact of the EU-ETS on US airlines, we focus on the North Atlantic route by carrier nationality. APMT-E identifies airline nationality for passenger travel, but not for freight. We extend the model using market share data from the International Air Transport Association (2010) and the US Department of Transportation (2011a) to estimate freight transported by US carriers on the North Atlantic. We do not consider belly-hold freight.

Grandfathered permits will be allocated according to 2010 revenue tonne kilometers (RTKs) shares of EU-ETS traffic. In modeling we augment this to adjust for freight by nationality; the 2010 market share of US carriers is 9% a figure validated by the Marketing Information Data Transfer (MIDT) database. The market share of US airlines in European traffic in this database is 10.2%, but the MIDT calculation is based on cargo data for US operations on all Atlantic operations. They thus include US cargo to several non-European regions, including Africa, the Middle East and India and also traffic to, within and from all European countries. To be consistent with APMT-E baseline assumptions, our allocation of free allowances to US airlines is based on a 9% market share, although 11% is also considered in a sensitivity analysis. We limit our analysis to the third phase of the EU-ETS ending in 2020 and do not consider climate policies in other regions.

To investigate the impact of the EU-ETS on US aviation, we compare three scenarios with a reference case ("business as usual", BaU). Our reference scenario is based on International Civil Aviation Organization/Group on International Aviation and Climate Change (US-ICAO/GIACC) (2009). As we are examining the incremental impact of including aviation in the EU-ETS, the impact of the EU-ETS on other sectors is modeled in our reference scenario. Specifically, using predictions from an EPPA simulation of the EU-ETS that excludes aviation, we update US-ICAO/GIACC fuel prices and demand forecasts. Following Lee et al. (2001), we assume an annual increase in the fuel efficiency for new aircraft of 1.4%, rather than 1% in the US-ICAO/GIACC forecast.

In our scenarios, we calculate an effective fuel price, which is equal to the reference fuel price plus the cost of CO_2 emissions from fuel combustion. The price of CO_2 emissions allowances hovered around €15 per tonne of CO_2 (tCO_2) for most of 2010 (European Energy Exchange, 2011). There is also evidence that firms are banking allowances for use in later years (Grubb et al., 2009). Consequently, we assume a carbon price of €15/tCO_2 in 2010 and increase this by 4% each year; approximately equal to the current yield on 10-year German bonds, a low-risk investment, plus a 1% risk premium. EU legislation prevents airlines from selling allowances to other sectors, but there are no restrictions on airlines purchasing allowances from other sectors. Under these regulations, the price of aviation allowances could differ from that for other sectors. However, empirical evidence (Winchester et al., 2011) and our simulations indicate that CO_2 abatement costs are higher for aviation than other sectors, so it is likely that aviation will purchase allowances from elsewhere. Therefore, we assume that there is a single price of CO_2 allowances for all EU-ETS covered sectors.[1]

Airlines' cost pass-through behavior is an important determinant of the impact of the EU-ETS on aviation. Consistent with profit maximizing behavior in competitive markets, most studies assume that airlines will pass on the full cost of CO_2 allowances, including opportunity costs associated with 'free' allowances. However, airfares may rise by less than the cost of CO_2 allowances for at least three reasons. First, there may be opportunity benefits from using free allowances. Opportunity benefits arise when current traffic is used to determine future allowance allocations. The presence of opportunity benefits creates an incentive for airlines to reduce fares (and expand demand) relative to a case without opportunity benefits. If there are opportunity benefits, airfares will increase by less than the cost of allowances or may decrease.

The allocation of free allowances for aviation in the EU-ETS is currently based on a one-off benchmark using market share data for 2010, measured in RTKs. This benchmark will likely be used until 2020. If the EU follows current regulation, future allocations will be based on market shares in the year ending 24 months before the start of the next trading period (2020). As operations from 2012 to 2017 and 2019 to 2020 would not influence the share of free allowances allocated after 2020, opportunity benefits are unlikely to be present in these years. Opportunity benefits may exist in non-benchmark years, if current market shares depend on past operations, but incentives to inflate market shares in non-benchmark years are likely to be second order. Overall, we expect opportunity costs to be passed on to consumers during all years except 2018.

In 2018, opportunity benefits may exist, but would depend on the proportion of allowances grandfathered for future years. Although there are no historical observations for aviation, the

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[1] Values in APMT-E are expressed in US dollars using a purchasing power parity (PPP) exchange rate of $1.24 per € (Organization for Economic Cooperation and Development, 2011).

European Commission has decreased the share of allowances grandfathered to other sectors over time. For example, nearly all allowances were grandfathered in the first trading period and in the third trading period around 50% of allowances will be grandfathered. This indicates that the number of allowances which are granted for free to airlines may be reduced, once the introductory trading period for aviation ends in 2020. It therefore appears that opportunity benefits in 2018 will be small.

Market distortions due to imperfect competition are a second reason why airlines might not fully pass on additional costs. Full cost pass-through will occur in competitive markets, in which prices reflect marginal production costs and no abnormal profit margins are present; i.e. the absence of significant profits leaves no room for firms to absorb costs without going bankrupt. If a firm has market power it can charge a price that exceeds marginal production costs and earn higher profits than in a competitive market. The existence of profits leaves room for firms to raise prices by less than the increase in costs without going bankrupt. Under most theories of imperfect competition, an airline will absorb a proportion of cost increases.[2]

The number of suppliers is sometimes used to infer market power. Airline schedule data for June 2011 shows that 91% of all routes (defined as airport-pairs) on the North Atlantic are served by one or two carriers. At face value, this suggests that airlines have market power on most North Atlantic routes. However, a small number of carriers on a particular route may not be a good indicator of market power as (a) some airport-pairs serve overlapping catchment areas (e.g., EWR-LHR and JFK-LHR), (b) direct routes may compete with routes involving a connecting flight (e.g., FRA-SFO and FRA-BOS-SFO), (c) connecting passengers for whom the transatlantic flight is only part of their journey might select other itineraries (e.g., SFO-AMS-BUD instead of SFO-FRA-BUD) and (d) the threat of entrants (except in congested airports such as FRA, JFK, LHR and ORD) may prevent airlines from offering fares significantly greater than costs.[3]

To assess market power on the North Atlantic, we examine profit margins. According to data from the Bureau of Transportation Statistics (US Department of Transportation, 2011b), the annual average profit margin for Atlantic divisions of US airlines was 3.4% of operating revenue between 2000 and 2010, and 3.8% between 2006 and 2010. These profit margins are lower than the average profit margin for publicly listed US companies, which was 5.3% between 2000 and 2010 and 4.8% between 2006 and 2010 (Damadoran, 2011). Therefore, we conclude that the North Atlantic market for air services is, on average, competitive. This conclusion is consistent with the antitrust immunity analyses conducted by the US Department of Transportation. In its tentative decision to grant antitrust immunity for a joint venture between oneworld airlines on some North Atlantic operations, the US Department of Transportation stated that, "no single airline [on the North Atlantic] has a dominant share of nonstop passengers, indicating a general competitive market" (US Department of Transportation, 2010).

A third reason why there may be less than full cost pass-through is the existence of sunk/unrecoverable costs. Influential factors in determining whether airlines are operating in a short-run or a long-run situation with respect to the EU-ETS include

Table 1
Cumulative US carrier outcomes on the North Atlantic (2012–2020).

	BaU	Full	Expense	Absorb
RTKs (CAGR, %)	3.35	3.11	3.25	3.35
CO$_2$ emissions (CAGR, %)	1.72	1.49	1.63	1.72
CO$_2$ emissions (tonnes, million)	210.10	206.74	208.93	210.10
Allowances purchased (million)	–	71.13	73.31	74.48
Share of allowances purchased (%)	–	34.40	35.09	35.45
NPV of purchased allowances ($ billion)	–	1.37	1.41	1.43
Operating costs, NPV ($ billion)	143.02	141.76	143.50	144.45
Operating revenue, NPV ($ billion)	147.37	148.62	147.81	147.37
Operating revenue per RTK, NPV ($/RTK)	0.87	0.89	0.88	0.87
Profit margin (%)	2.95	4.62	2.92	1.98
Net US to EU transfer, NPV ($ billion)	–	–1.24	1.41	1.43

announcement of the policy several years prior to implementation and rapid expansion of the aviation industry.[4] Announcement of the EU-ETS several years in advance provided scope for airlines to adjust planning decisions and partially avoid unwanted costs. Including aviation in the EU-ETS was first discussed in an extensive consultation process in 2004 and 2005, and legislation was proposed in 2006 and finalized in 2009. This process may have given airlines time to adjust operations in anticipation of the policy. Related to this theme, high growth in demand for aviation services provides opportunities for airlines to respond to the policy by scaling back expansion plans, rather than reducing operations relative to current levels.

To account for uncertainty regarding cost pass-through behavior, we consider three scenarios. In our first scenario, Full, we assume that airlines pass on all costs associated with CO$_2$ allowances, including opportunity costs for free allowances. When firms pass on all costs (including opportunity costs) and allowances are grandfathered, firms receive windfall gains (Williams-Derry and de Place, 2008). Full cost pass-through of EU-ETS costs has been observed in some electricity generation markets and in oil refining (Alexeeva-Talebi, 2011).[5] In our second scenario, which we label Expense, airlines pass on expenses from purchasing allowances but not opportunity costs for free allowances. In our third scenario, Absorb, airlines do not pass on any costs associated with CO$_2$ allowances.

3. Results

We start from an emissions price of €15/tCO2 in 2010 and increase it by 4% a year. Using a PPP exchange rate, the CO$_2$ price, in 2010 dollars, is $20/tCO$_2$ in 2012 and rises to $27.45/tCO$_2$ by 2020. The price of a gallon of jet fuel in BaU is $2.29 in 2012 and $2.77 in 2020. Our BaU fuel prices are an extrapolation of 2006 (the base year for APMT-E) fuel prices based on long-run forecasts and accounting for the impact of the EU-ETS applied to other sectors. As such, our BaU prices do not necessarily reflect current fuel prices, which can be influenced by business cycles and speculation. When aviation is included in the EU-ETS, the effective price of jet fuel,

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[2] While several studies investigate market structure and cost pass-through for other industries, few have focused on airlines. One exception is Forsyth (2008), which concludes that full cost pass-through is a likely outcome, if airlines do not have substantial market power.

[3] The widespread price discrimination found in the airline industry, is sometimes cited as evidence of market power. However, price discrimination can take place in competitive markets and the airline industry is one example of the presence of competitive price discrimination (Baumol and Swanson, 2003).

[4] Related to sunk costs, adjustment costs may result in climate policy influencing industry profits. Goulder et al. (2010) conclude that grandfathering fewer than 15% of emission allowances prevents profit losses in coal mining and coal-fired electricity generation, which experience large output decreases.

[5] It is also possible that, depending on the relative bargaining strengths of airlines and airports, airlines will pass on some cost increases associated with the EU-ETS to airports. The outcome for US airlines when some cost increases are passed on to airports and some to consumers will be similar to when all costs are passed on to consumers.

including CO_2 costs, when flying to or from the EU in 2020 is $3.05 per gallon, 10% higher than in BaU.

Table 1 presents cumulative modeling results for US carriers on the North Atlantic for 2012 to 2020. We evaluate cumulative traffic changes by calculating the compound annual growth rate (CAGR) for air traffic, measured in RTKs. In the Full scenario, demand decreases relative to BaU but traffic continues to grow. Between 2011 and 2020, traffic increases by 31.8% in the Full scenario, compared to 34.5% in BaU. Airfare increases are smaller when airlines only pass on the costs of purchased allowances rather than all costs, so the annual growth rate for traffic in the Expense scenario exceeds that in the Full scenario. There are no traffic changes in the Absorb scenario relative to BaU, as airfares are the same in the two scenarios.

Traffic growth drives increases in CO_2 emissions, but emissions increases are smaller than traffic increases as the fleet becomes more efficient over time. The lowest annual growth in emissions occurs when airlines pass on all costs associated with CO_2 allowances. Table 1 also reports cumulative CO_2 emissions between 2012 and 2020. Comparing emissions for our policy scenarios to reference emissions indicates that 3.35 million tonnes of CO_2 are abated in the Full scenario and 1.17 million tonnes in the Expense scenario. These numbers represent small proportional decreases in emissions relative to BaU − 1.6% in the Full scenario and 0.6% in the Expense scenario. Annual CO_2 emissions from US airlines on the North Atlantic increase from 21.9 million tonnes in 2012 to 25.2 million tonnes in 2020 in the BaU, and to 24.7 million tonnes in the Full scenario.

Although emissions abated by aviation differ across scenarios, abatement aggregated across all sectors is constant due to the economy-wide emissions cap. That is, the increase in aviation emissions is facilitated by purchasing allowances from sectors with lower abatement costs. In this connection, our EPPA simulations indicate that EU electricity emissions will be 57% below 2012 emissions in 2020. Between 2012 and 2020, in the Full scenario, US airlines purchase allowances for about one-third of allowances required by US airlines. Allowance purchases are largest in the Absorb scenario, as traffic is largest in this scenario.

Present values (in 2010 dollars) of financial indicators for US operations on the North Atlantic between 2012 and 2020 are presented in the second half of Table 1. Our present value calculations use a discount rate of 4%, which is similar to the discount rate recommended by the US Office of Management and Budget (2003). As airfares in the Absorb scenario equal reference airfares, operating costs rise by the cost of allowances in this scenario. In the Expense scenario, the increase in airfares reduces traffic and operating costs net of CO_2 costs. However, the cost of purchasing CO_2 allowances results in a rise in costs relative to BaU. Costs decrease in the Full scenario, as decreases in cost due to reduced traffic exceed the cost of purchasing allowances.

Operating revenues are a function of traffic and air fares. As demand is inelastic, the revenue impact of reduced traffic is more than offset by an increase in airfares in the Full scenario, so operating revenues increase. Operating revenue also increases in the Expense scenario. Airfares and traffic in the Absorb scenario are unchanged relative to BaU, so there is no change in operating revenues. Decreased traffic and increased revenue result in revenue per RTK increasing in both the Full and Expense scenarios.

The impact of the policy on profit margins is of key interest to airlines. We calculate average profit margins for 2012 to 2020 by dividing net income by operating revenues, both in present value.[6] Airlines pass on the cost of purchasing allowances in the Expense

scenario, so the profit margin in this scenario is very similar to the profit margin in BaU. However, profits decrease relative to BaU because the profit margin is earned on a lower volume. In the Absorb scenario, as airlines incur additional costs that are not passed on, the average profit margin decreases. In the Full scenario, there is a large increase in the profit margin because, in addition to the cost of purchasing allowances, airlines pass on opportunity costs associated with grandfathered allowances. Windfall gains from grandfathering are worth $2.6 billion in the Full scenario.

Windfall gains from free allowances represent a transfer from the EU to the US. However, allowances purchased by US airlines from the European Commission and from EU firms represent a transfer from the US to the EU. In the Full scenario, the present value of free allowances exceeds the value of purchases resulting in a net transfer from the EU to the US. In the Expense and Absorb scenarios, there are no windfall gains, which result in net transfers from the US to the EU. Consistent with the scope of our economic analysis we do not address the distribution of environmental damages associated with the US aviation operations on the North Atlantic, although we anticipate impacts in both the EU and US (in addition to other impacts globally).

To summarize our analysis so far, for all cost pass-through assumptions, traffic and CO_2 emissions continue to increase over time when aviation is included in the EU-ETS. When some CO_2 costs are passed on to consumers, there are small decreases in emissions relative to BaU. Unlike CO_2 emissions, the impact of the EU-ETS on airline profitability varies widely for alternative cost pass-through assumptions. If there is full cost pass-through, US airlines will experience a windfall gain of $2.6 billion between 2012 and 2020 from the granting of free allowances. On the other hand, if airlines are only able to pass on the costs of allowances purchased or are unable to pass on any costs, US airline profits will decrease.

Our analysis has focused on the operations of US airlines on the North Atlantic, which accounts for about 12% of operations for US airlines measured in RTKs. To gauge the overall impact of the EU-ETS on US aviation, we report selected metrics for US operations in Table 2. The results indicate that the EU-ETS will have a very small impact on aggregate traffic and CO_2 emissions. In the Full scenario, which generates the largest decrease in emissions, US airline CO_2 emissions fall by only 0.16% relative to BaU. Similarly, for all scenarios, there are small changes in operating revenues, operating costs and profit margins relative to BaU. These results indicate that the EU-ETS will have a relatively small impact on the overall operations of US airlines.

4. Sensitivity analysis

As with other studies, we find that the EU-ETS will have a relatively small impact on aviation emissions because of the high marginal abatement costs in aviation relative to other sectors (Winchester et al., 2011). The finding that the EU-ETS may increase profits for US airlines is more controversial. Influential drivers for this, which we consider in sensitivity analyses, include future demand for air services on the North Atlantic, and the number of allowances grandfathered. We also examine the sensitivity of our

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[6] As our modeling framework does not consider price discrimination practiced by airlines, estimated changes in operational profits represent lower bounds.

Table 2
Cumulative US carrier outcomes on all routes, 2012–2020.

	BaU	Full	Expense	Absorb
RTKs CAGR (%)	3.65	3.62	3.63	3.65
CO_2 emissions (tonne, million)	2139	2136	2138	2139
Operating costs, NPV ($ billion)	1589	1588	1590	1591
Operating revenue, NPV ($ billion)	1637	1639	1638	1637
Profit margin (%)	2.92	3.07	2.92	2.83

results to the market share of US airlines in European operations. The EU-ETS has little impact on profits in the Expense scenario, so our analysis focuses on the Full and Absorb scenarios.

Our BaU demand forecasts are derived from US-ICAO/GIACC estimates. Faster or slower underlying demand growth will influence the quantity of allowances required by aviation and ultimately airline profitability. Demand for air services on the North Atlantic grew by 3.4% per year in the core scenarios. In separate sensitivity analyses, we consider demand growth rates of 2.4% and 5.5% in both BaU and our policy scenarios.

Table 3 shows proportional changes in average profits margins between 2012 and 2020 relative to BaU for the core demand growth scenario and for low and high demand growth alternatives. In latter, airlines need to purchase more allowances than in the base case and fewer in low-growth scenarios. Consequently, profit margins in high-growth cases exceed those in our core scenarios and the opposite is true in low-growth cases, but changes in profit margins are small.

Regarding allowance allocations, we followed current legislation in our core scenarios and assumed that allowances for 85% of 2010 emissions will be grandfathered each year from 2012 to 2020. However, EU regulations provide scope for changes to allocation rules from 2015 onwards and the European Commission has reduced the number of allowances grandfathered to other sectors following introductory periods. Consequently, we consider cases, beginning in 2015, where 50% of aviation benchmark allowances are grandfathered, and where aviation receives no free allowances.

Changes in average profit margins for alternative allowance allocation assumptions and our base case, which assumes that 85% of allowances are grandfathered each year, are seen in Table 3. Airlines have to purchase more allowances when fewer are grandfathered, which reduces profit margins in all scenarios, with the largest decrease in the Absorb scenario, but the average profit margin is still positive. However, 2012/2020 average profit margins mask important annual variations. In the Absorb scenario, profit margins decrease to 1.03% by 2020 when 50% of allowances are grandfathered, and are negative in 2020 when all allowances are auctioned. Profits are always positive in the Full scenario as grandfathering fewer allowances only erodes windfall gains.

Decreasing the proportion of allowances grandfathered also has a large impact on net transfers from the US to the EU. When all post-2015 allowances are auctioned, net US to EU transfers between 2012 and 2020 are $2.21 billion in the Full scenario (compared to −1.24 billion when 85% of allowances are grandfathered). The corresponding value in the Absorb scenario is $3.15 billion (compared to $1.43 billon when 85% of allowances are auctioned).

As mentioned above, the share of allowances grandfathered will be based on 2010 market shares in traffic to, from and within EU-ETS countries. Official market share data had not been released by the European Commission at the time of writing. The 2010 market share of US airlines in EU-ETS operations derived from APMT-E was 9%, and an estimate from an external data source was 10.2%. To investigate the impact of a higher market share for US airlines on our results, we consider a market share of 11% in a sensitivity analysis.

Increasing the market share of US carriers increases emissions from US airlines in the reference and policy scenarios, but has no impact on profit margins in our policy scenarios relative to the reference case. This is because the number of free allowances increases with market share-driven increases in emissions. On the other hand, increasing the market share of US airlines has a large impact on international transfers. In the Full scenario, driven by a larger number of allowances grandfathered to US airlines, the 2012–2020 present value of transfers from the EU to the US is $1.48 billion when the US market share is 11%, 21% higher than when the market share is 9%. In the Absorb scenario, US airlines have to purchase more allowances when they have a higher market share, so transfers from the US to the EU are $1.71 billion, 20% larger than in our core scenario.

5. Conclusions

We forecast the potential impact of the EU-ETS on US airlines from 2012 to 2020. Reflecting current market behavior, we modeled an emissions price of €15/tCO$_2$ in 2010 that increased by 4% per year. We considered three cost pass-through assumptions. In our modeling framework, CO$_2$ emissions from US airlines between 2011 and 2020 increased by 35% in the reference scenario and 32% under the EU-ETS when there is full cost pass-through. The small reduction in aviation emissions reflects high abatement costs in aviation relative to abatement costs in other industries. When there is full cost pass-through, airlines received windfall gains of $2.6 billion from the grandfathering of allowances.

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Table 3
Changes in 2012 to 2020 average profit margins relative to BaU, %.

	(a) Annual demand growth			(b) Proportion of 2015–2020 allowances grandfathered		
	2.4%	3.4%	5.5%	95%	50%	0%
Full	59.0	56.6	52.0	56.6	41.0	17.3
Absorb	−30.8	−32.9	−37.4	−32.9	−48.5	−72.5

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