UP IN THE AIR

AVIATION FIT FOR 55 – EU ETS SCOPE EXPANSION

NOTE

seo • amsterdam economics

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Executive Summary: Aviation Fit For 55 update[1]

The proposal of the European Parliament to expand the scope of EU ETS to all flights leaving the EEA intensifies the impacts of the Aviation Fit for 55 policies. While flights within the EEA are not affected by this proposal, there is an additional increase in ticket prices and a further shift of passengers to competing non-EEA hub airports in close proximity. The proposed EU ETS update lowers aviation CO_2 emissions but intensifies competitive distortion and carbon leakage.

The **costs** of air travel increase due to the EU ETS scope expansion. For direct and indirect flights leaving the EEA to a non-EEA destination, ticket prices increase on average by € 85 per passenger in 2030 and € 129 in 2035 compared to the reference scenario without any Fit for 55 measures. For the route example Frankfurt-Tokyo, ticket prices increase on average by € 127 per passenger in 2030 and € 197 in 2035. This cost increase is higher than in the setting without the EU ETS scope expansion (see SEO & NLR, 2022). We reconfirm that EEA hubs located closer to the EEA borders (e.g. Helsinki, Madrid, Cyprus) are still more affected by the price increase than centrally located EEA airports and non-EEA airports far away. This is because flights with longer distances departing from an EEA airport imply higher costs due to EU ETS. In 2035, the price increase due to the EU ETS scope expansion would be 10% larger than in 2030.

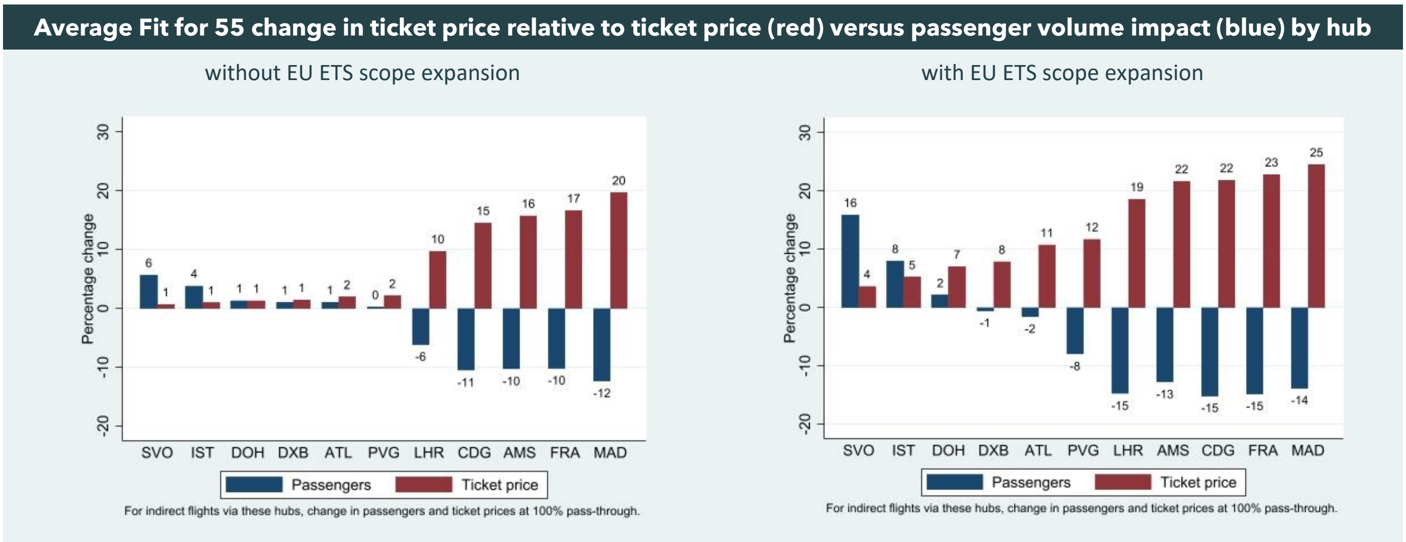
The **demand** for air travel decreases due to higher ticket prices. For direct flights to a non-EEA country and indirect flights through an EEA hub, passenger volumes, which are 141 million passengers in the baseline scenario without any Fit for 55 measures, decrease by 7.8 percent in 2030. This is equivalent to a total annual reduction of 10.9 million passengers. In 2035 this decrease is 11.2 percent, which is a reduction of 18.7 million passengers. We observe that hubs in border regions are both, winners and losers in relative terms, depending on the route and the side of the EEA border. For the winners, non-EEA hubs in close proximity to the EEA, the distance between the first and second flight leg is important since if the first flight is shorter compared to the second flight, there is a higher probability of gaining passengers. For routes to a non-EEA country through a non-EEA hub, passenger volumes increase by 1.6 percent, adding up to 850.000 additional passengers in 2030. In 2035, this increase is 2.1 percent, adding up to 1.3 million additional passengers.

Figure S.1 on the next page illustrates these effects on costs and demand and compares the results in the setting of the proposed EU ETS scope expansion with the results in the setting without EU ETS scope expansion for the year 2030. While flights through Istanbul gained 4% more passengers without the scope expansion, in the new situation the passenger gains double to 8%. In 2035 these gains would be even larger, with an increase of 24% for Moscow and 11% for Istanbul

The **CO_2 savings and carbon leakage** are directly related to changes in demand. Due to an increase in ticket prices, there is a shift in demand to non-EEA countries, which leads to **carbon leakage**. There is a net CO_2 reduction of 9.2 megatons in 2030 and 23.5 megatons in 2035, whilst carbon leakage leads to an increase of 2.0 megatons of CO_2 in 2030 and 2.8 megatons in 2035 in the setting of the EU ETS scope expansion.

1 This independent assessment is commissioned by Air France-KLM Group and Lufthansa Group.

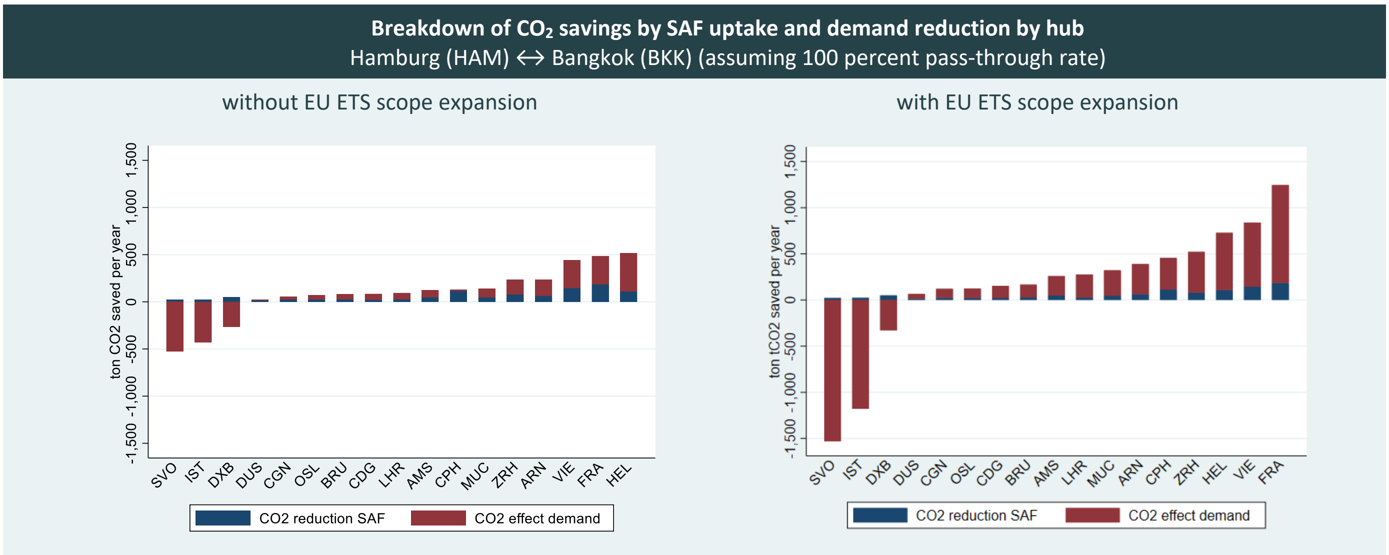
Figure S.1 Relationship between the ticket price increase and the demand impact by selected hubs - 2030



Source: SEO Amsterdam Economics (2022).

There is an inverse relationship between passengers and CO_2 savings. If passengers increases, the percentage of **CO_2 savings** decreases, and vice versa. This reversed relationship is illustrated for the route example Hamburg-Bangkok in Figure S.2 below. Furthermore, it is observable that carbon leakage increases for non-EEA hubs (e.g. Moscow, Istanbul and Dubai). We find that carbon leakage can add up to 38.4% for the route example Hamburg Bangkok by 2035. This is an increase of 3% in comparison to the setting without EU ETS scope expansion.

Figure S.2 Breakdown of CO_2 savings by SAF uptake and demand reduction by hub - 2030



Source: SEO Amsterdam Economics (2022).

We conclude that the EU ETS scope expansion intensifies the effects of the Fit for 55 Aviation policies. As a result, changes to ticket prices and passenger volumes are even larger in the setting of the proposed EU ETS expansion. Although total CO_2 savings are higher compared to the setting without EU ETS scope expansion, carbon leakages are also magnified on certain routes. The proposed EU ETS scope expansion further increases competitive distortion compared to the setting without EU ETS scope expansion since the demand for EEA hubs is further reduced. This leads to a greater loss of connectivity of EEA hubs. For the year 2035, these effects are even more pronounced.

Introduction

The European Union Emissions Trading Scheme (EU ETS) is a milestone of the EU's policy to tackle climate change and is a central tool for lowering greenhouse gas emissions. The European Parliament voted to expand the scope of the EU ETS to include all flight departures from the European Economic Area from 2024.

In July 2021, the European Parliament proposed the Fit for 55 package, which aims to reduce greenhouse gas emissions in the EU by 55 percent by 2030. Several proposals aim to support the European aviation industry to become more sustainable and reduce emissions. One component of this package is the EU Emissions Trading System (EU ETS). The European Parliament proposed expanding the EU ETS scope to all flights leaving the European Economic Area (EEA). The EU ETS scope expansion leads to additional costs for flights leaving the EEA. As the additional costs are (partly) passed on to consumers by an increase in ticket prices, this will translate to changes in volumes, network composition and competitiveness.

In this research report, SEO Amsterdam Economics (SEO) forecasts the changes in prices, demand, carbon emission and leakage for flights leaving the EEA due to the EU ETS scope expansion. We compare the results of the EU ETS scope expansion with those in a setting without this extension from the previous study '*Aviation Fit for 55*' by SEO (2021). We update the highly detailed market model NetCost to take into account the additional components included within the proposed EU ETS scope expansion. By doing this, we are able to generate the expected fares for a set of typical routes.

This research also estimates the tons of CO_2 saved due to the measures of the Fit for 55 package and compares the results with the setting without an EU ETS scope expansion. Furthermore, we analyse whether CO_2 leakage changes due to the extension of EU ETS. It is examined which EU and non-EU regions or airports are affected the most and which non-EU airports might benefit from potential leakage, e.g. due to a shift in passenger demand.

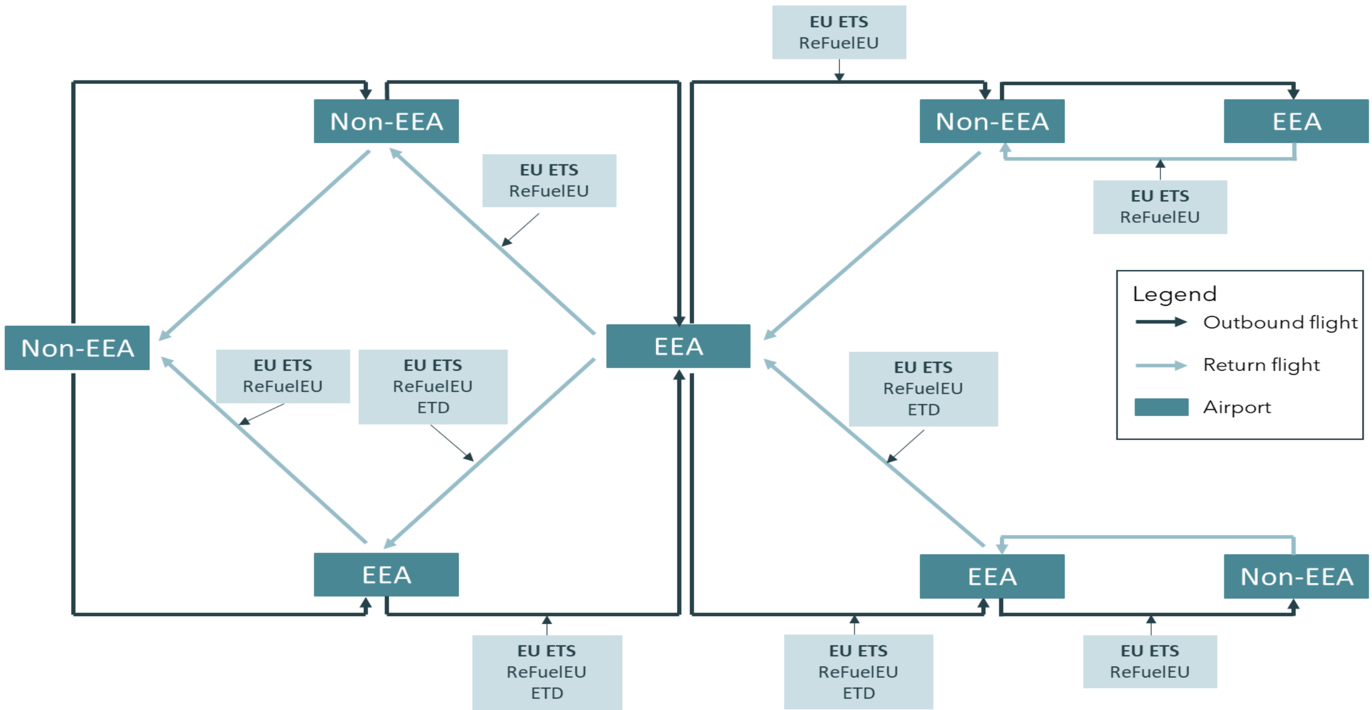
In the next section, the scope expansion of the EU ETS is set out. Afterwards, the results are presented, and lastly a conclusion is drawn. We only show 2030 results in the main text and list 2035 results in the appendix since the latter are similar to the former but somewhat more pronounced. Furthermore, there are three route examples in the appendix.

EU ETS proposed scope expansion update

The European Parliament proposed to expand EU ETS to flights leaving the EEA. Due to the EU ETS scope expansion, airlines need additional allowances to cover emissions for flights leaving the EEA. We assume that the price per EU ETS allowance increases from € 130 per ton of CO_2 in 2030 to € 175 in 2035. We take into account that due to the net zero rating of SAF, there is a cost trade-off with EU ETS. Furthermore, with regard to the UK, it is assumed that Fit for 55 regulations apply as if it were an EEA country, except for the ETD (kerosene tax). For additional information, see footnote 1.

Figure 1 gives a stylized overview of the flight options and associated applicability of the Fit for 55 package with the proposed EU ETS scope expansion. The dark blue arrows represent the outward travel, while the light blue arrows represent the return travel. In the setting of the proposed EU ETS scope expansion, there are costs due to EU ETS for all flights departing from the EEA, so for intra-EEA flights as well as flights leaving the EEA. For flights departing from non-EEA countries to the EEA or to another non-EEA country, there are no costs due to EU ETS. Since CORSIA applies to flights without EU ETS, it is omitted from this figure.

Figure 1 Overview of flight options and associated costs



Source: SEO Amsterdam Economics (2022).

The impact of EU ETS on travel entirely within the EEA is not directly affected from the scope expansion and described in detail in the precursor study, i.e. SEO & NLR (2022). We only include flights within the EEA that are followed by a connecting flight to a destination outside the EEA and flights that are inbound from a non-EEA origin.

Impact Fit for 55

The EU ETS scope expansion increases costs for flights leaving the EEA. Since these costs are passed on to passengers via ticket prices, this leads to a drop in passenger demand. Net CO_2 emissions are reduced due to the policy proposals. However, flights from or connecting through EEA hubs and flights from EEA hubs leaving the EEA become more expensive. This reduces competitiveness for EEA hubs and airlines in addition to causing further carbon leakage.

In this section, the results of the costs of the EU ETS scope expansion are presented and compared to the setting without the EU ETS scope expansion detailed in the precursor study SEO & NLR (2022). Furthermore, the associated demand implications are described as well as the resulting carbon savings and leakage.

Routes and airports with relatively higher associated costs due to Fit for 55 regulations lose demand. Since the EU ETS scope expansion induces additional costs not only for flights within the EEA but also for flights leaving the EEA, an even higher share of passengers switches to routes via non-EEA hubs that incur lower costs for the onward travel of the second leg. Compared to the setting without an EU ETS scope expansion, EU hubs closer to the EU borders are still more affected by the price increase than centrally located airports.

Cost Impact - ticket prices per country and hub airport

With the NetCost model, we estimate the average ticket price increase for direct flights and indirect flights from EEA to non-EEA countries, assuming a 100% cost pass-through rate to consumers. In Figure 2, on the left-hand side in the upper panel, ticket prices increase in a setting without EU ETS scope expansion are displayed for direct flights. On the right-hand side, price increases are shown in the proposed updated setting with an EU ETS scope expansion. The lower panel displays price increases for indirect flights.

In 2030, we find that in the proposed scope expansion, prices for direct flights increase the least for Cyprus with an average of € 11 per ticket and the most for Portugal with an average price of € 63. These findings are driven mainly by the average flight distance from these countries, which determines the additional costs due to the EU ETS scope expansion and the required amount of SAF based on the ReFuelEU proposal. Compared to the setting without a EU ETS scope expansion, ticket prices for direct flights leaving the EEA increased by additional € 9 for Cyprus and € 51 for Portugal.

For indirect flights, the lowest ticket price increase is still in Cyprus with an average of € 26 per ticket and the highest increase occurs in Spain with an average of € 90 per ticket. This is an additional price increase of € 23 for Cyprus and an additional increase of € 17 for Spain. We observe that price increases for direct flights are less strong than for indirect flights. However, for both direct and indirect flights, it is observable that the order of countries has shifted. Compared to the setting without an EU ETS scope expansion, EU hubs closer to the EU borders are more affected by the price increase than centrally located airports.

In 2035 the ticket price increase is even higher due to EU ETS and higher costs due to an increased required amount of SAF. For direct flights, the ticket price increase is lowest for Cyprus with an average of € 17 per ticket and highest for Portugal with an average of € 96 per ticket. Also, for indirect flights, the increase is lowest for Cyprus with € 41 per ticket and highest for Spain with € 133 per ticket (see Appendix B.1).

Figure 2 Expected ticket price increase per passenger per European country - direct & indirect non-EEA in the year 2030

Source: SEO Amsterdam Economics (2022).

After considering the average cost impact per country, we now show the cost impact for selected major airport hubs. In the setting without an EU ETS scope expansion, we found that the average price increase is not uniformly distributed between airports. This is because ticket price increases for flights going through non-EEA hub airports are lower than for EEA hub airports. Figure 3 depicts that in the setting of the proposed update (right figure), some non-EEA airports still have lower ticket price increases compared to EEA countries, e.g. an average increase of € 21 per ticket for Moscow and € 22 for Istanbul airport. However, for some non-EEA countries, ticket prices increase much stronger, e.g. € 57 for Hamad airport and € 67 for Dubai airport. Ticket prices increase most for Shanghai airport (€ 118), London Heathrow airport (€ 113) and Paris Charles de Gaulle (€ 110). It is important to mention that due to the comparatively larger flight distance from the EEA to Shanghai , the ticket price increase is higher compared to the other hubs, changing the order of airports in terms of price distribution. Furthermore, it is observable that the distribution of average ticket price increases per airport changed in the scope expansion.

Additional costs from the EU ETS now cause the largest share of the ticket price increase. In 2035 the expected ticket price increase is even higher due to an increase in costs due to SAF. The increase is still lowest for Moscow airport with an average ticket price of € 36 and highest for Shanghai airport with an average € 182 per ticket (see Appendix B.2).

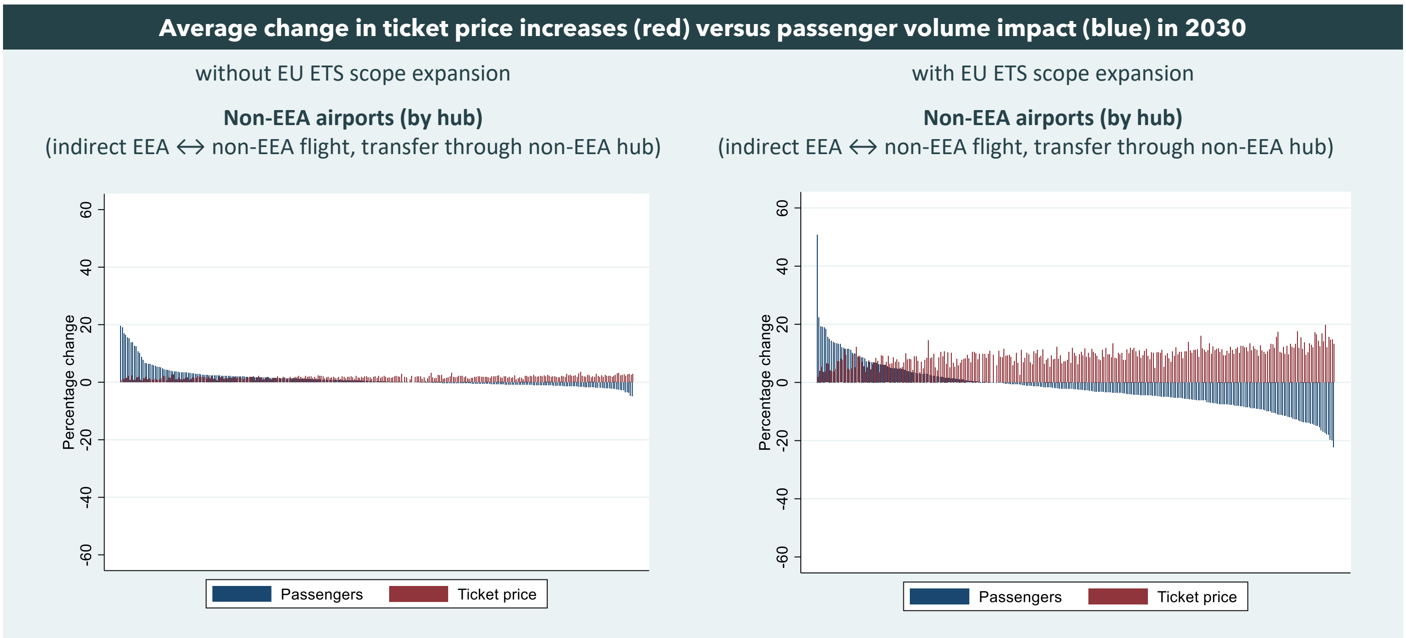
Figure 3 Ticket price increase per passenger by selected EEA and non-EEA hubs - 2030

Source: SEO Amsterdam Economics (2022).

Demand Impact – per airport and hub airport

To analyze the impact of the proposed EU ETS scope expansion on demand, we inspect the relationship between ticket price increases and demand per airport for 2030. The left-hand side of Figure 4 presents the costs and demand impacts for all non-EEA airports by origin airport in the setting without EU ETS scope expansion, and the graph on the right-hand side presents cost and demand impacts in the updated setting. For each origin airport, there are two corresponding bars, one for the average change in ticket prices and another one for the average change in passengers, sorted in decreasing order over the latter. Ticket prices increase for all airports but passenger demand increases for some airports while it decreases for others. Within the extended scope, the ticket price and demand effects are larger. Passenger volumes through some of the non-EEA hubs increase by up to 50 percent, other hubs lose up to 20 percent traffic as a result of the Fit for 55 cost increases including the EU-ETS scope expansion. Ticket prices increase on average between 5 percent and 20 percent for non-EEA hubs. We observe that hubs in border regions gain and loose passengers depending on route characteristics. For routes to gain passengers, the distance between the first and second flight leg is important since if the first flight leg is shorter than the second flight leg outside the EEA, there are relatively lower costs and more passengers to gain. In 2035 the effects on passenger are even more pronounced than in 2030 (see Appendix B.3).

Figure 4 Relationship between the ticket price increase and the demand impact – 2030



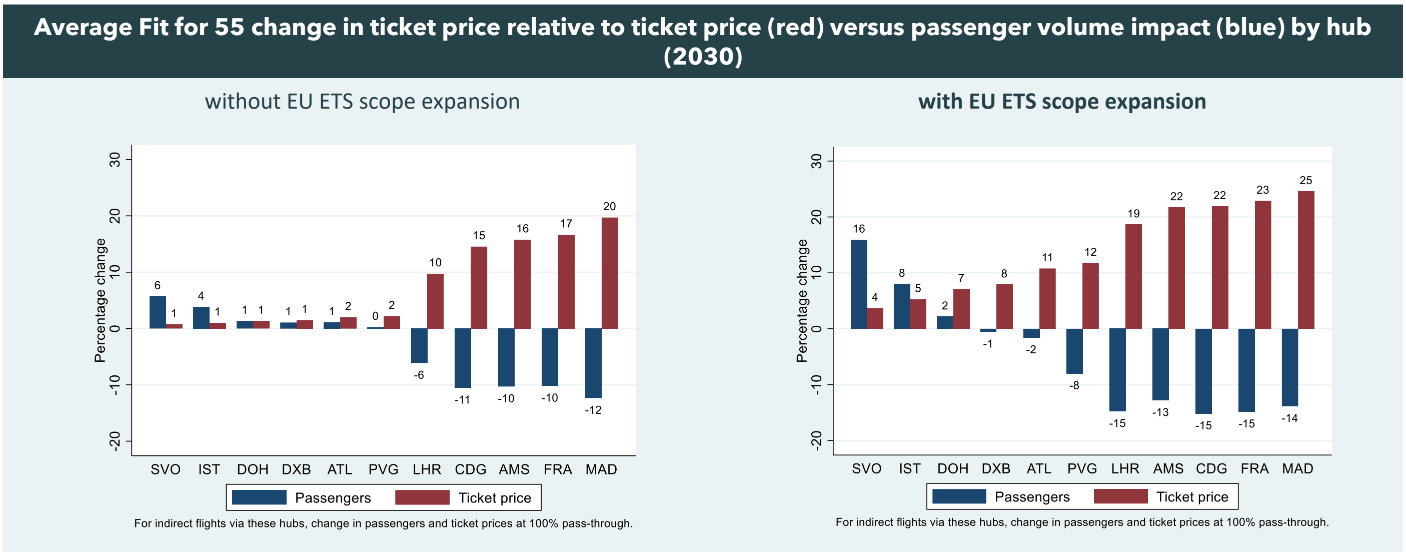
Note: Indirect return flights per route through non-EEA Airport at 100 percent pass-through, sorted by change in passengers.

Source: SEO Amsterdam Economics (2022).

In Figure 5, we zoom in on selected EEA and non-EEA hubs. The graph on the left-hand side shows the relationship between the average ticket price increase and the demand in the setting without EU ETS scope expansion. The graph on the right-hand side shows this relationship in the proposed updated setting with EU ETS scope expansion. We find that EEA airports lose even more passenger volumes after the expansion. Also some non-EEA airports lose passengers now, which gained passengers in the setting without EU ETS scope expansion, namely Dubai loses 1 percent of passenger demand and Atlanta loses 2 percent of passenger demand. Some other non-EEA airports, such as Moscow and Istanbul, gain even more in passenger demand (up to 24 percent) in the updated setting despite the increase in cost, as they gain a further competitive advantage over EEA hubs. In 2035, ticket prices are even higher, which results in stronger effects on passenger demand for the selected hubs compared to the year 2030 (see Appendix B.4).

For all passengers travelling to a non-EEA destination, EEA hubs lose 7.8 percent of their traffic in 2030, which is 10.9 million passengers in absolute terms. The traffic via non-EEA hubs increases by 1.6 percent, which is about 0.85 million passengers.

Figure 5 Relationship between the ticket price increase and the demand impact by selected hubs - 2030



Note: Changes in passengers weighted by passenger volume per route.
Source: SEO Amsterdam Economics (2022).

CO_2 impact and carbon leakage

The goal of the EU ETS scope expansion is to further reduce aviation emissions, therefore, it is important to calculate the amount of CO_2 saved by this expansion. However, due to cost increases which lead to a shift in demand, there is potential for carbon leakage. Carbon leakage with regards to EU ETS scope expansion might be caused by the diversion of passengers to (transfer) airports where they face less additional costs or airports without a sustainability mandate. We showed that cost increases are less strong for non-EEA airports which results in an increase in demand for those airports. Flying longer distances outside the EEA due to the diversion of passengers to non-EEA airports might lead to more fuel burned and therefore higher emissions.

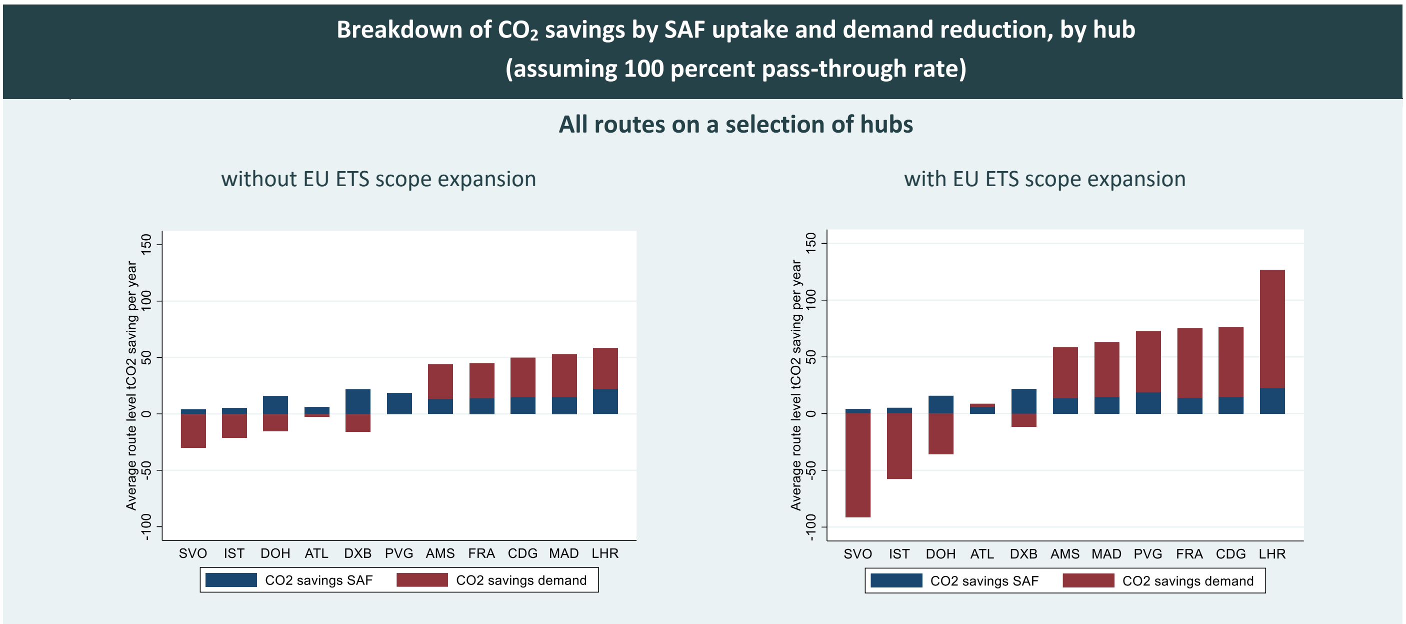
Figure 6 Relationship between passengers and CO_2 savings - 2030

Note: Indirect return flights per route through non-EEA Airport at 100% pass-through, sorted by change in passengers.

Source: SEO Amsterdam Economics (2022).

We observe that in the setting of EU ETS scope expansion there is an inverse relationship between passengers and CO_2 savings in 2030 (see Figure 6). If the percentage of passengers increases, the percentage of CO_2 savings decreases, and vice versa. This inverse relationship is even more pronounced in 2035 (see Appendix B.5).

Figure 7 Breakdown of CO_2 savings by SAF uptake and demand reduction, by hub (2030)



Source: SEO Amsterdam Economics (2022).

When looking at the breakdown of CO_2 savings by SAF uptake and demand reduction for a selection of hubs it is observable that, on the one hand, there is an increase in CO_2 savings due to a drop in demand for some route options via the non-EU hubs in the setting of EU ETS scope expansion (see Figure 7). This increase is larger compared to the setting without EU ETS scope expansion. On the other hand, we observe a reduction in CO_2 savings (carbon leakage) for some non-EU hubs compared to the setting without EU ETS scope expansion due to a rise in demand for these hubs. Especially, for Moscow and Istanbul airport we observe a noticeable increase in carbon leakage. On routes through Moscow, the amount of carbon leakage is up to 90 tons CO_2 on average per route (Istanbul 58 tons CO_2). By comparison, average route-level carbon leakage at Moscow and Istanbul is comparable in size to average CO_2 savings on major EEA hub airports such as Frankfurt (74 tons CO_2) and Amsterdam (58 tons CO_2). These effects on CO_2 savings and carbon leakage are even stronger for year 2035 (see Appendix B.6).

Since the average route-level carbon leakage is difficult to interpret, it helps to look at specific routes. For the route example Hamburg – Bangkok, we find carbon leakage of 2941 tons CO_2, while CO_2 savings are 6109 tons by 2030 (see C.3). This means that carbon leakage can add up to 48.1% for this route. By 2035, carbon leakage increases to 4682 tons CO_2 in relation to 12207 tons CO_2 saved, which is 38.4% carbon leakage. This is an increase of 3% with respect to a situation without EU ETS scope expansion in 2035. For the route example Nice-Seoul, carbon leakage amounts to 42.1% and for the route example Atlanta-Mumbai it can even add up to 80.6% by 2035 (see C.4 and C.6 respectively).

Conclusion

The findings of our analysis are summarized in Table 1 below. In the setting of the proposed EU ETS expansion, the demand for EEA hubs is further reduced compared to the setting without the EU ETS scope expansion, namely 7.8% in relative terms in year 2030 while it was only 2.7percent in the setting without EU ETS scope expansion. At the same time, the demand for non-EEA hubs is increasing by 1.6 percent in relative terms. This means a higher competitive distortion and loss of connectivity of EEA hubs in the setting of the proposed EU ETS scope expansion. We conclude that CO_2 savings are higher than the setting without EU ETS scope expansion, that is 16.7percent in relative terms. However, carbon leakage is higher on certain routes, namely about 2.0 megatons in the EU ETS scope expansion setting. It is only about 0.7 megatons in the setting without EU ETS scope expansion. For the year 2035, these effects are more pronounced.

Table 1 Overview of impacts on demand and CO_2 emissions

	EEA à non-EEA					
	2030			2035		
	EEA hubs or direct	non-EEA hubs	**Total**	EEA hubs or direct	non-EEA hubs	**Total**
Passenger demand [a)]						
Baseline traffic (x mln pax) (without FF55 measures)	141	53	194	167	63	230
Absolute change (x mln pax) (due to FF55 measures)	-10.9	0.85	-9.9	-18.7	1.3	-17.25
Relative change (%)) (with scope expansion)	-7.8%	1.6%	-5.1%	-11.2%	2.1%	-7.5%
Relative change (%) (without scope expansion)	-2.7%	1.9%	-1.4%	-6.0%	2.2%	-3.8%
CO_2 emissions [b)]						
Baseline emissions (x Mton)	62	39	101	71	46	118
Absolute change (x Mton)	-10.4	-1.0	-9.2	-21,9	-4.65	-23.5
Relative change (%) (with scope expansion)	-16.7%	-2.6%	-9.1%	-30.8%	-10.1%	-19.9%
Relative change (%) (without scope expansion)	-7.4%	-0.5%	-4.7%	-22%	-7%	-16%
Carbon leakage (x Mton) (with scope expansion)			2.0			2.8
Carbon leakage (x Mton) (without scope expansion)			0.7			1.1

Notes: [a)]: Total number of departing Origin & Destination (O&D) passengers from EEA airports.
[b)]: Total estimated CO_2 emissions of all departing O&D passengers from EEA airports. Baseline emissions are without Ff55 measures but include reduced CO_2 emissions due to technological and operational improvements, based on developments according to Destination 2050.
[c)]: Sum of all additional emissions due to a demand shift to non-EEA hubs.

Source: SEO Amsterdam Economics (2022).

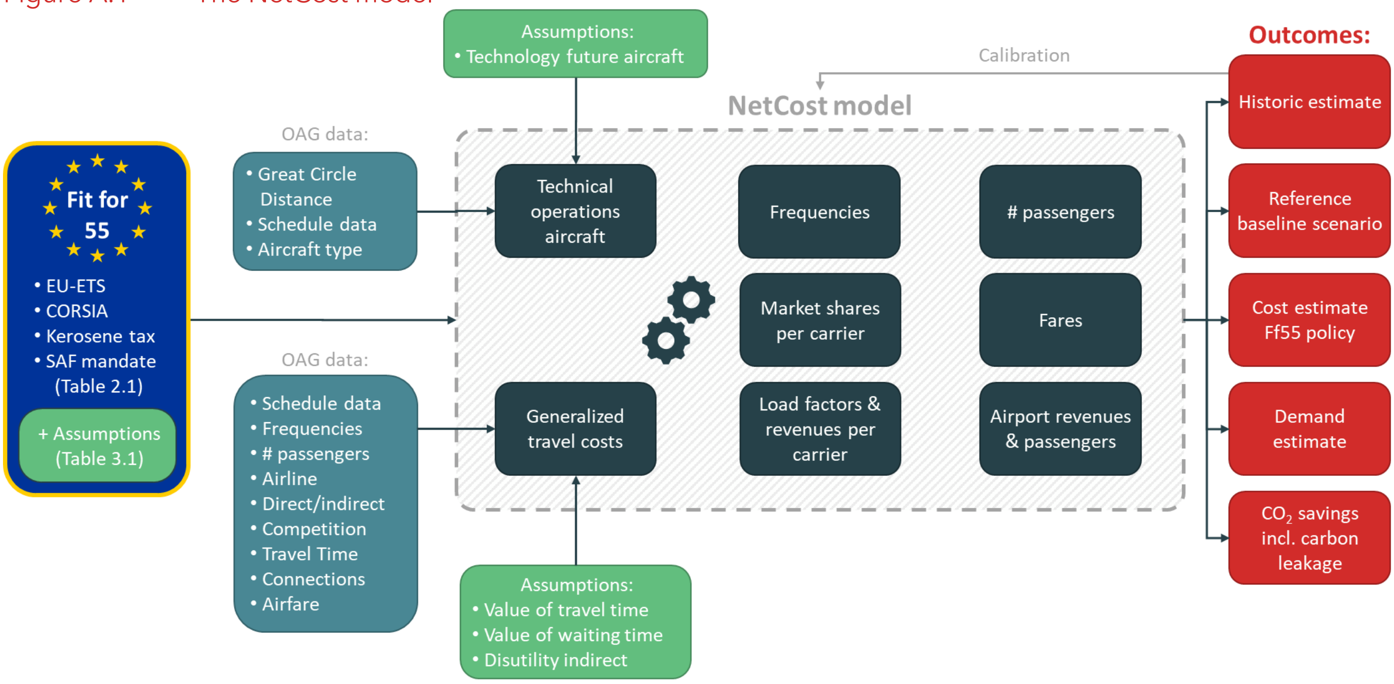
Appendix A Technical details NetCost passenger choice model

The NetCost model has been used to calculate the demand impacts of the Ff55 measures. The same model was applied for the modelling in Destination 2050, to which we refer for the underlying demand forecasts. The model uses OAG schedule data for all direct and indirect alternatives to determine generalized costs and market shares for individual markets. The NetCost model was first presented in Heemskerk and Veldhuis (2006a, 2006b) and developed by Veldhuis and Lieshout (2009). NetCost has been used to compute generalized travel costs in the baseline and the Ff55 scenarios. NetCost allows to compute the average increase or decrease in travel costs per passenger and demand impacts as a result thereof.

Passenger demand is determined using a four-step approach:

1. Construct baseline airline networks for 2030, 2035 and 2050, based on OAG schedule data and passenger growth forecasts.
2. Determine generalized travel costs and consumer utility in each scenario using the NetCost price model.
3. Using price elasticities for business and leisure, compute the change in generalized travel costs between the baseline and Ff55 scenario. This results in total passenger demand impacts.
4. Break down the consumer benefits into time savings, cost savings, connectivity and capacity components.

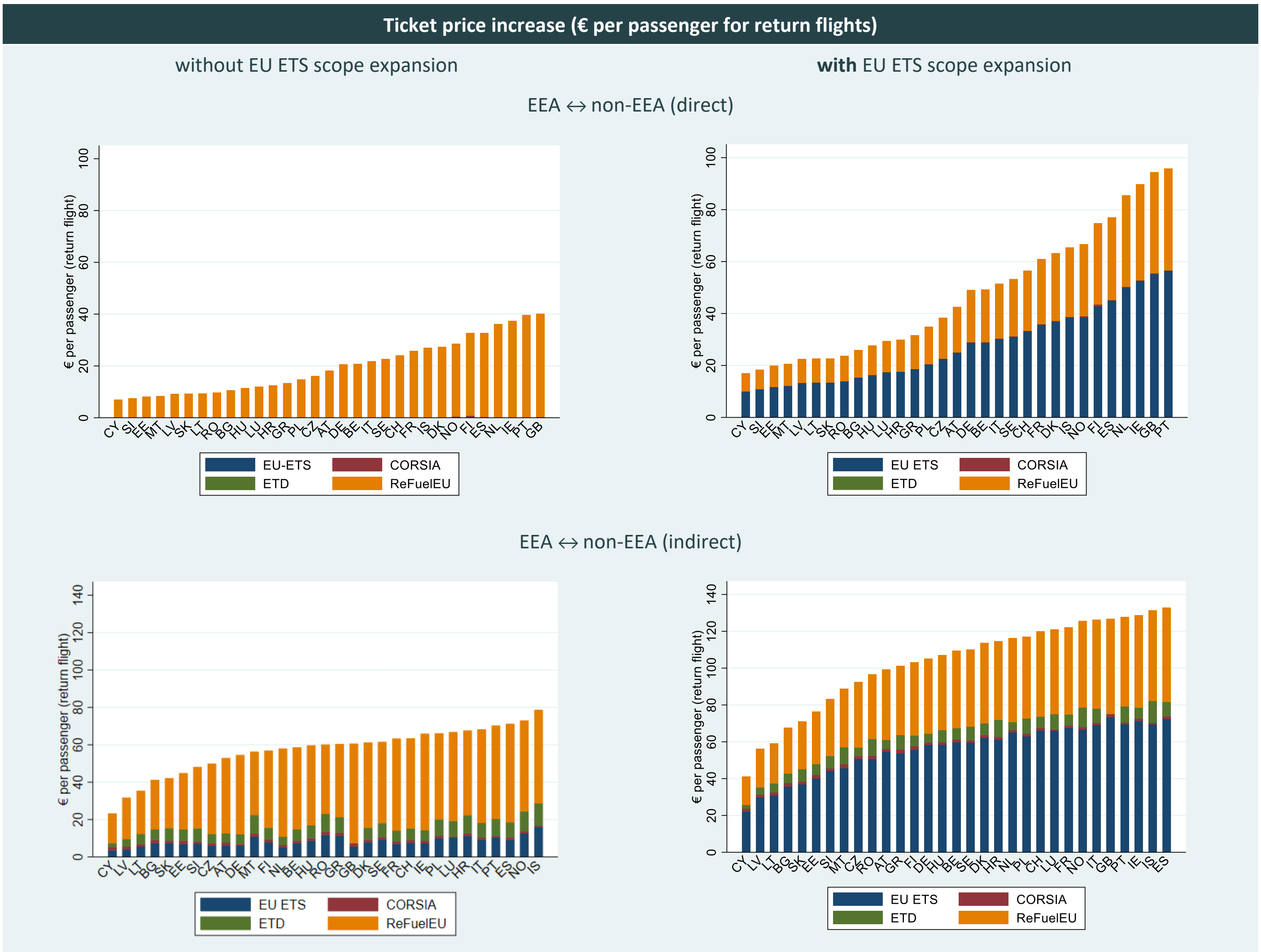
Figure A.1 The NetCost model



Source: SEO Amsterdam Economics (2022).

Appendix B Year 2035

Figure B.1. Expected ticket price increase per passenger per European country direct & indirect - non-EEA (2035)

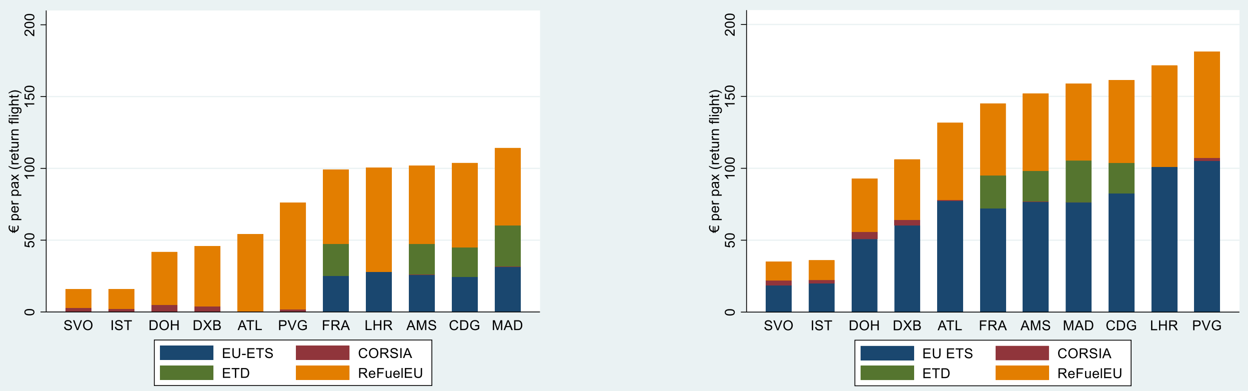


Source: SEO Amsterdam Economics (2022).

Figure B.2 Ticket price increase per passenger by selected EEA and non-EEA hubs - 2035

Ticket price increase (€ per passenger for return flights)

without EU ETS scope expansion | **with** EU ETS scope expansion



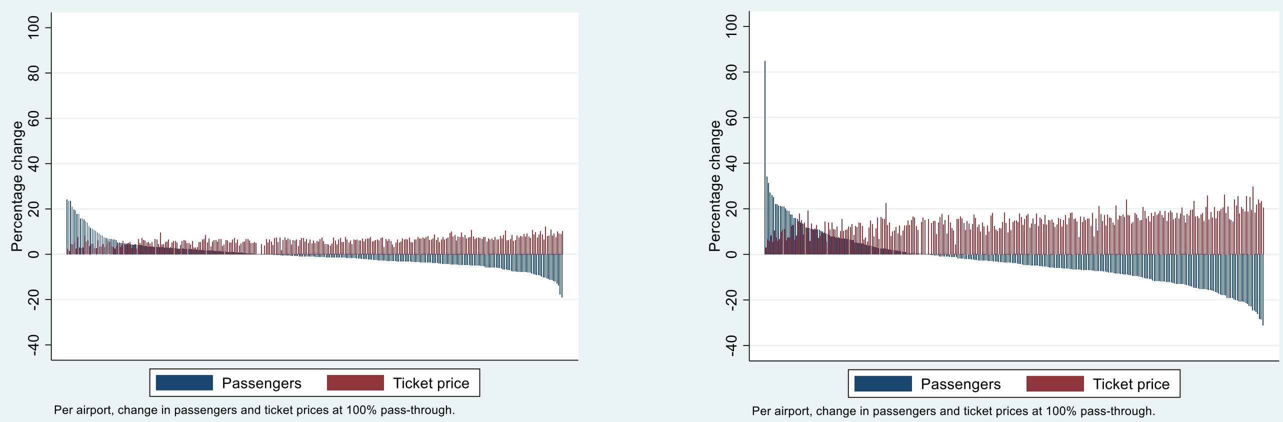
Source: SEO Amsterdam Economics (2022).

Figure B.3 Relationship between the ticket price increase and the demand impact - 2035

Average change in ticket price increases (red) versus passenger volume impact (blue) in 2035

Non-EEA airports (by hub)
(indirect EEA ↔ non-EEA flight, transfer through non-EEA hub)

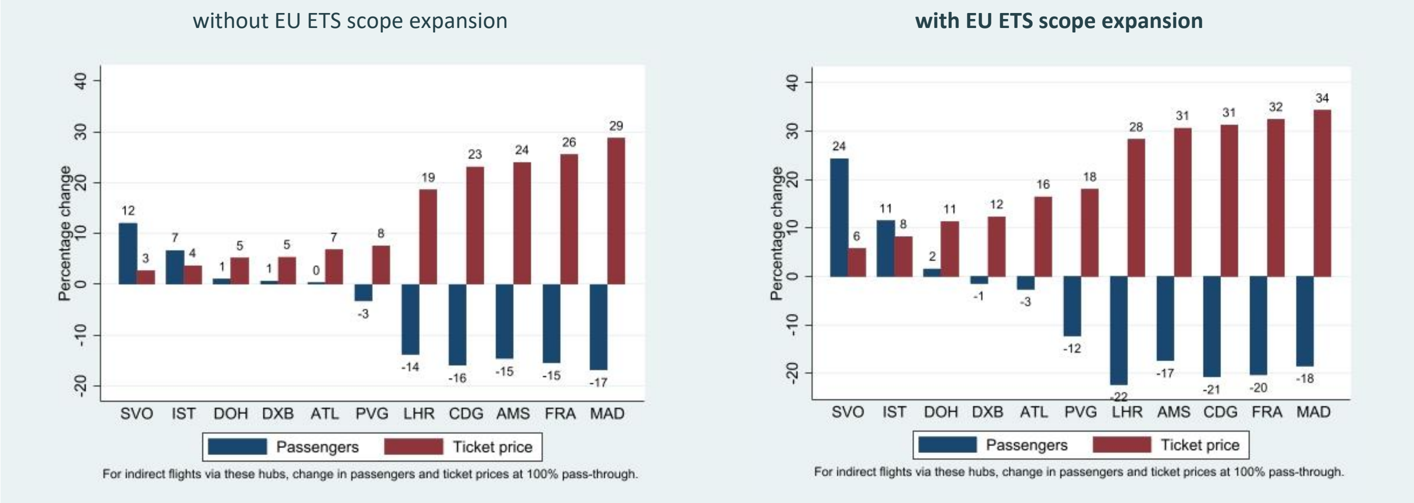
Non-EEA airports (by hub)
(indirect EEA ↔ non-EEA flight, transfer through non-EEA hub)
updated



Source: SEO Amsterdam Economics (2022).

Figure B.4 Relationship between the ticket price increase and the demand impact by selected hubs - 2035

Average Fit for 55 change in ticket price relative to ticket price (red) versus passenger volume impact (blue) by hub (2035)



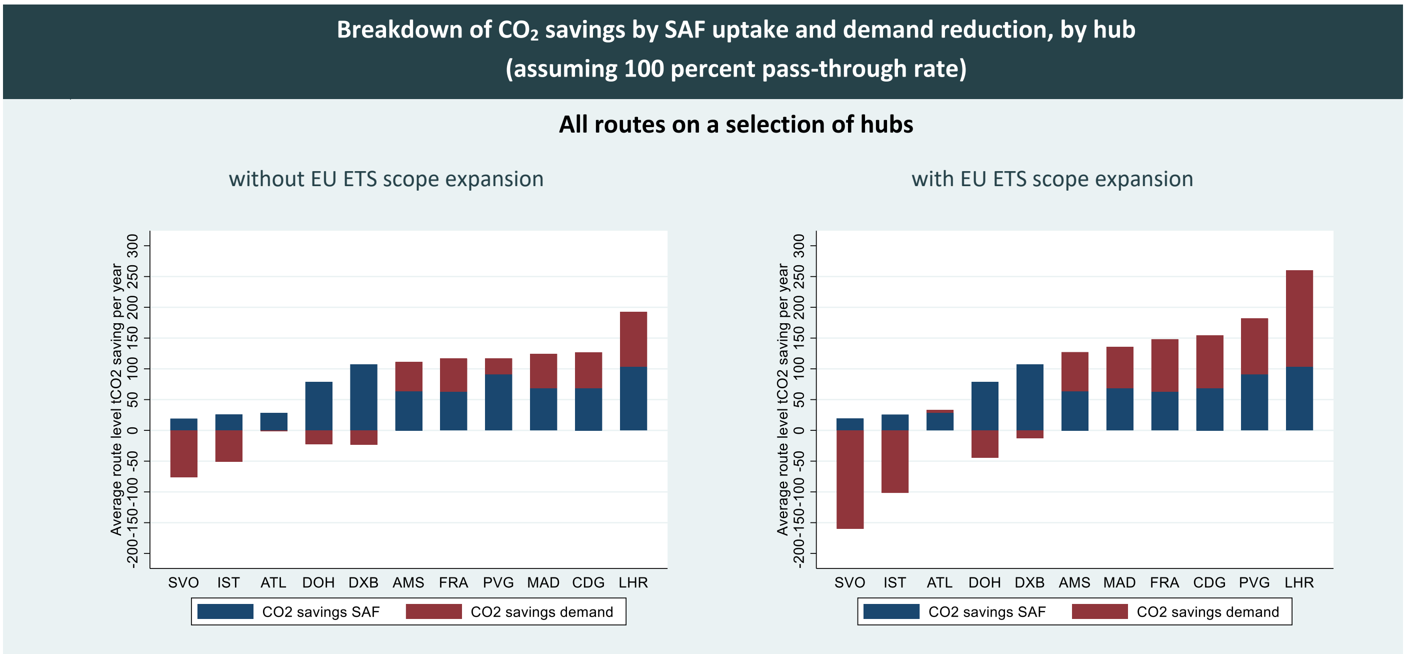
Note: Changes in passengers weighted by passenger volume per route.
Source: SEO Amsterdam Economics (2022).

Figure B.5 Relationship between the ticket price increase and the demand impact by selected hubs - 2035

Average Fit for 55 change in ticket price relative to ticket price (red) versus passenger volume impact (blue) by hub (2035)

Note: Changes in passengers weighted by passenger volume per route.
Source: SEO Amsterdam Economics (2022).

Figure B.6 Breakdown of CO_2 savings by SAF uptake and demand reduction, by hub (2035)



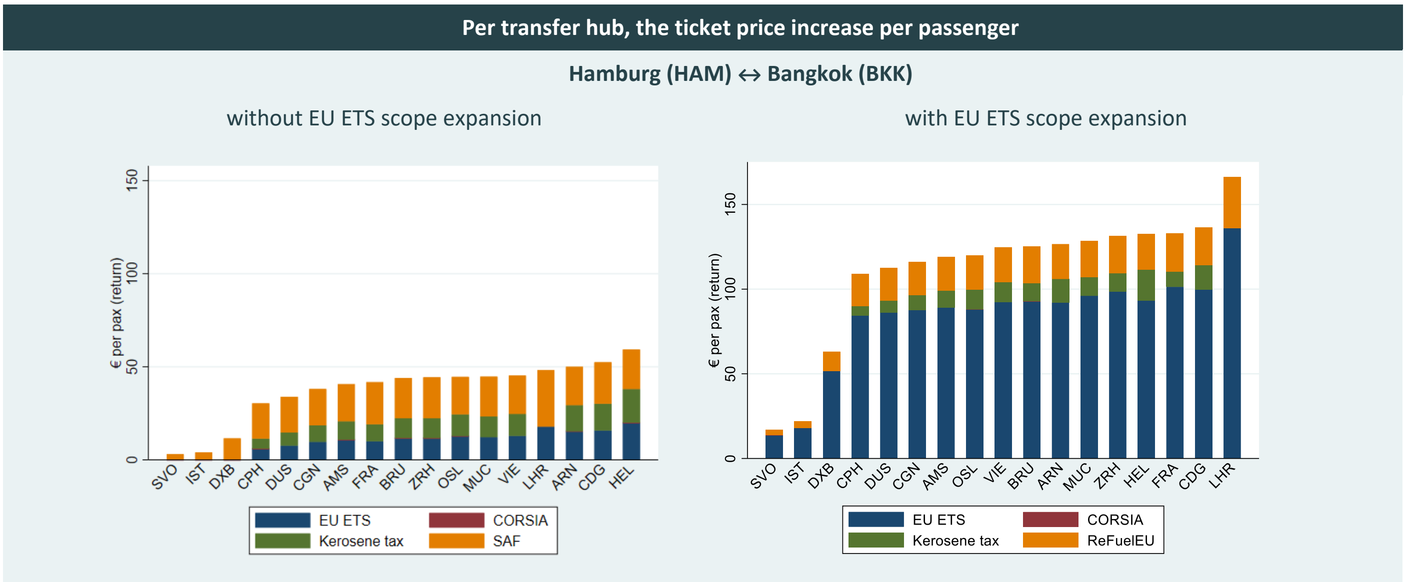
Source: SEO Amsterdam Economics (2022).

Appendix C Route level factsheets

Ticket price increase for Hamburg – Bangkok

Figure C.1 details the ticket price increase per transfer hub for all indirect flights between Hamburg and Bangkok in the setting without EU ETS scope expansion (left figure) and in the updated setting with EU ETS scope expansion (right figure). In the setting with EU ETS scope expansion, we still observe that price increases in EEA hub airports are much higher compared to non-EEA hubs like Moscow, Istanbul and Dubai. The lowest ticket price increase is for Moscow airport, and the highest ticket price increase is for London Heathrow. In 2035, for EEA airports, there is an additional increase of more than € 100 per ticket compared to the setting without EU ETS scope expansion.

Figure C.1. Ticket prices increase for the Hamburg – Bangkok route (2030)



Source: SEO Amsterdam Economics (2022).

Demand impact for Hamburg – Bangkok

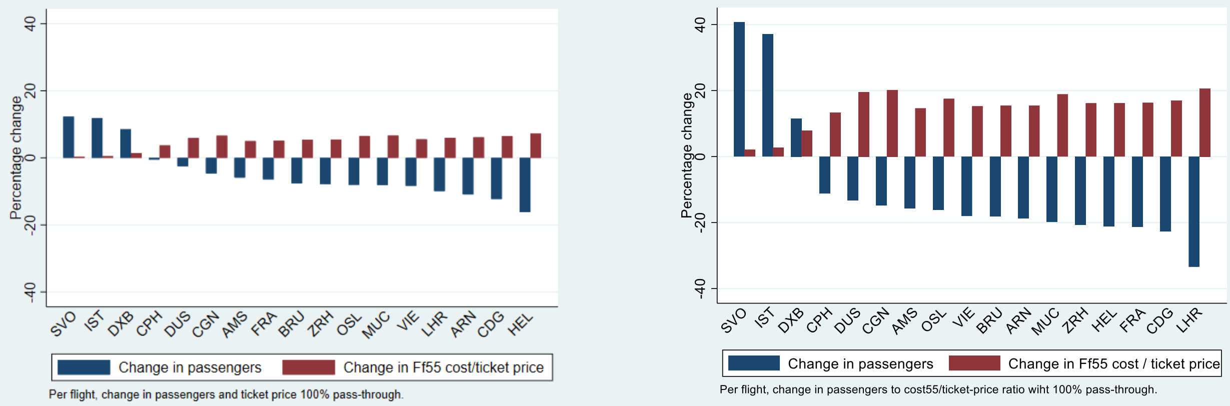
Figure C.2 details the relationship between the average ticket price increase and the demand impact for the Hamburg-Bangkok route. We find that passenger demand via EEA hubs decreases stronger in the EU ETS scope expansion setting. The decrease in passengers is least strong for the route through Copenhagen (19 percent), Düsseldorf airport (21 percent) and Cologne Bonn airport (23 percent). The decrease is highest for the route through Frankfurt airport (31 percent), Paris Charles de Gaulle airport (32 percent) and London Heathrow airport (45 percent). On routes through non-EEA hubs such as Moscow (SVO), Istanbul (IST) and Dubai (DXB), passenger numbers increase even more in the setting with EU ETS scope expansion. In Moscow, the passenger increase is highest, followed by Istanbul and Dubai. This means demand shifts become more exaggerated in the setting of EU ETS scope expansion compared to the setting without EU ETS expansion.

Figure C.2. Relative ticket price and demand impact for 2030 for different intercontinental flights with a transfer hub - 2030

Per transfer hub, the relative ticket price increase per passenger and the demand impact (2030)

Hamburg (HAM) ↔ Bangkok (BKK)

without EU ETS scope expansion | **with EU ETS scope expansion**



Source: SEO Amsterdam Economics (2022).

CO_2 impact and carbon leakage for Hamburg – Bangkok

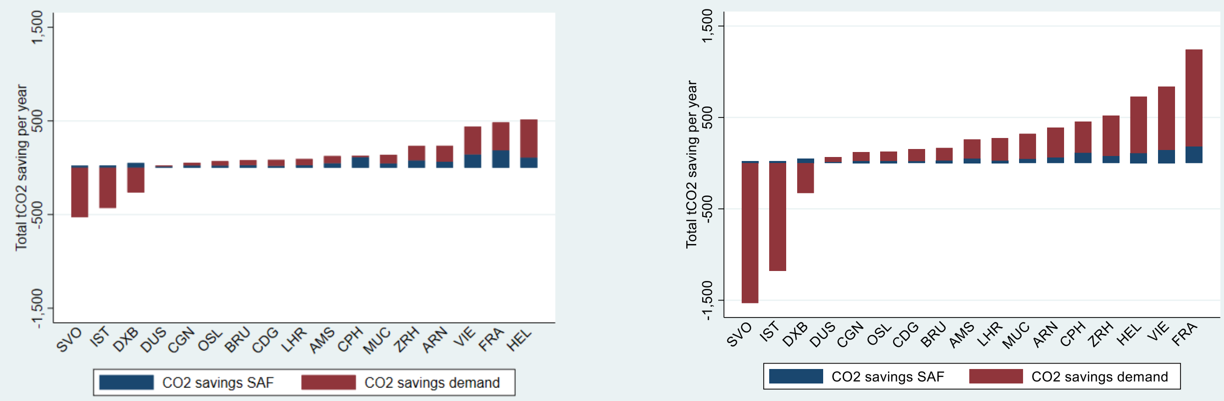
For the route example Hamburg – Bangkok, in 2030 and with the EU ETS scope expansion, we find that carbon leakage is 2941 tons CO_2, while CO_2 savings are 6109 tons (see C.3). This means that carbon leakage can add up to 48.1% for this route.

Figure C.3. Ticket cost example for the Hamburg – Bangkok route with cost and CO_2 savings in % (2030)

Breakdown of CO_2 savings by SAF uptake and demand reduction, by hub

Hamburg (HAM) ↔ Bangkok (BKK)

without EU ETS scope expansion | with EU ETS scope expansion



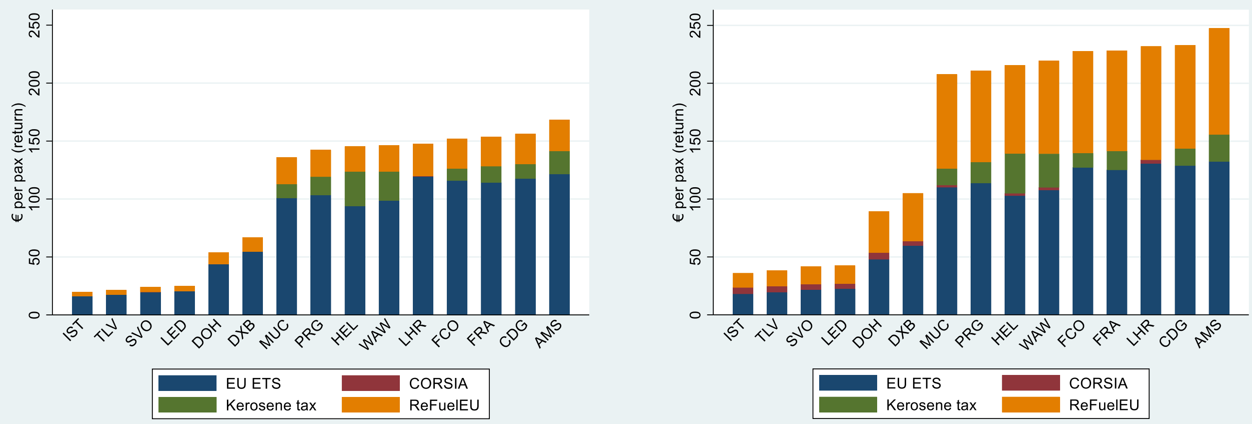
tCo2 save/leak	+624	-423	+6109	-2941

Source: SEO Amsterdam Economics (2022).

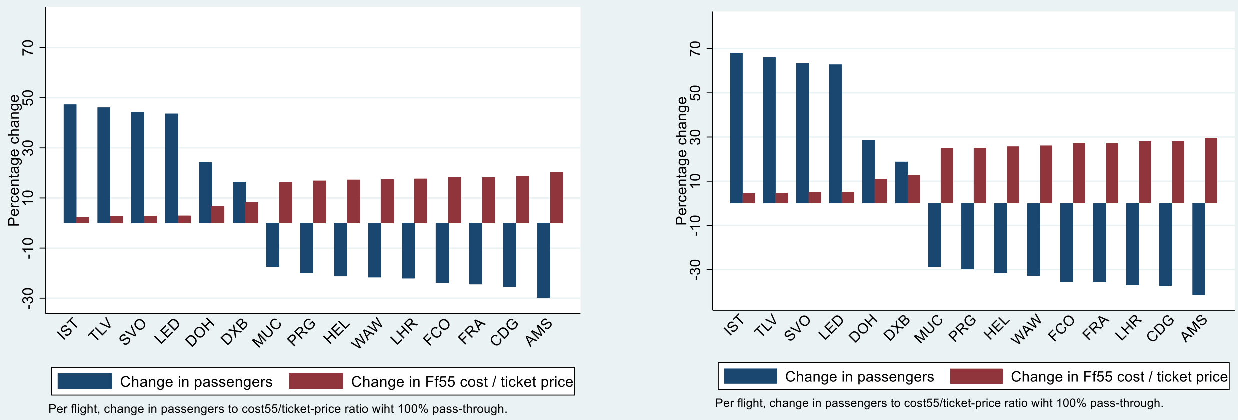
Figure C.4. Ticket prices increase for the Nice (NCE) - Seoul (ICN) route

Per transfer hub, the ticket price increase per passenger: Nice (NCE) - Seoul (ICN)

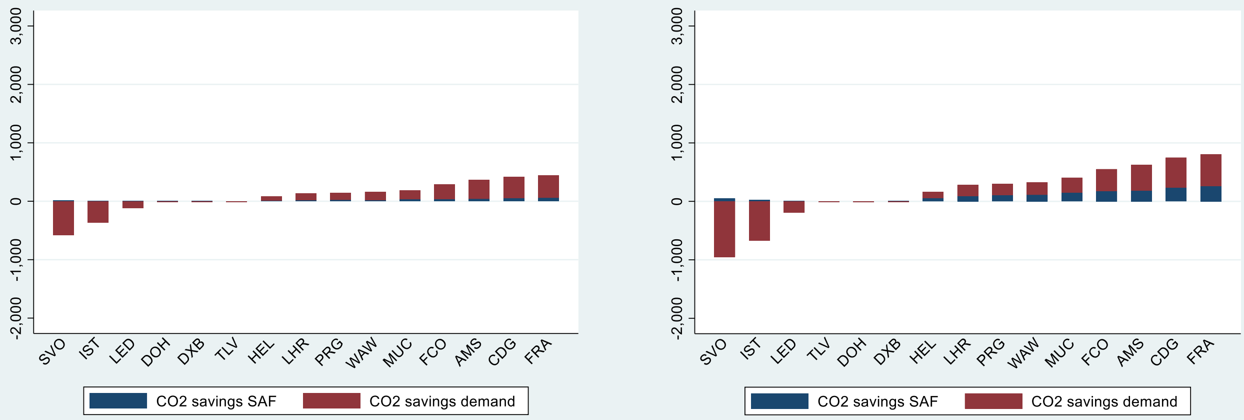
2030 /2035



Per transfer hub, the relative ticket price increase per passenger and the demand impact

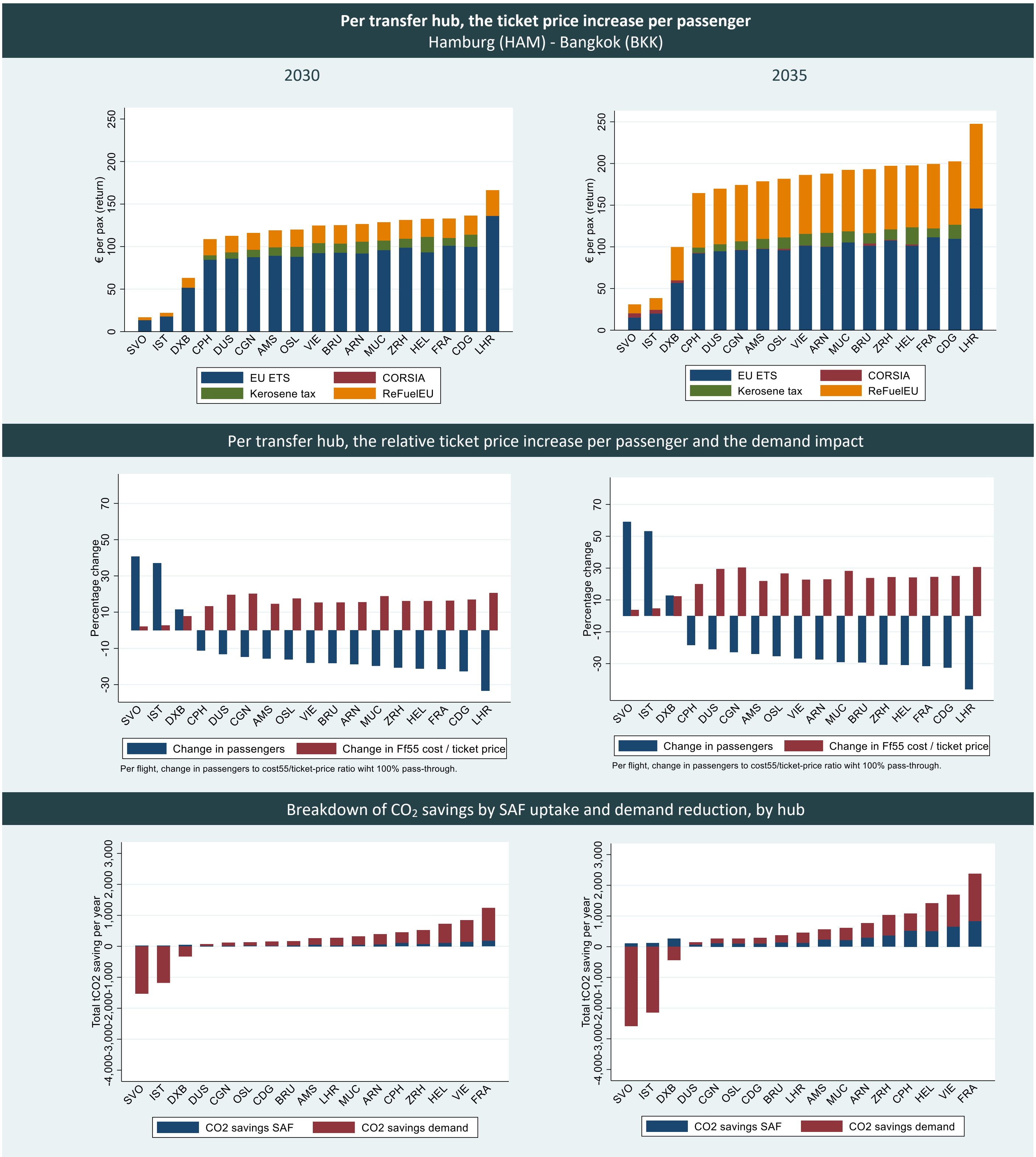


Breakdown of CO_2 savings by SAF uptake and demand reduction, by hub



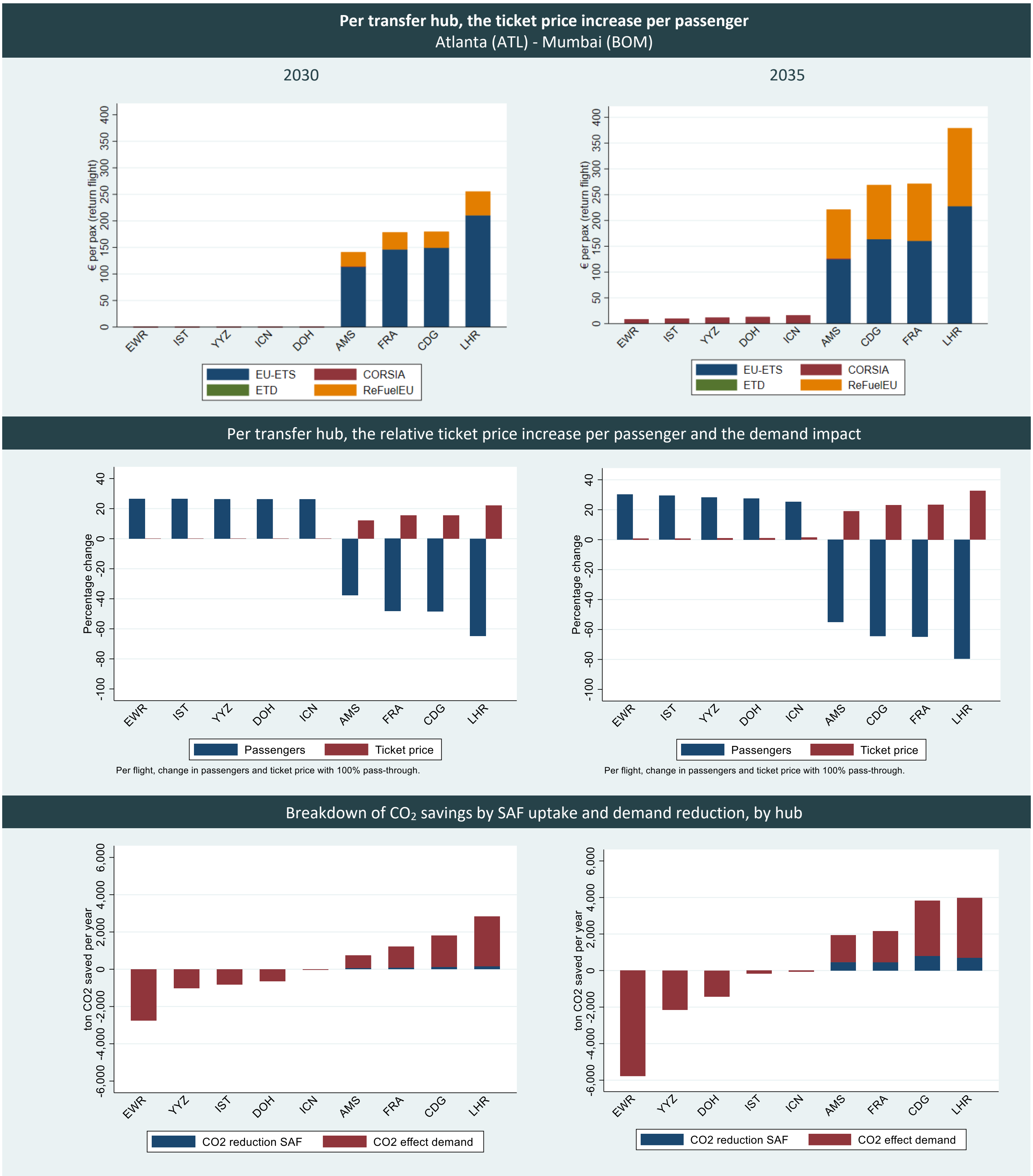
Source: SEO Amsterdam Economics (2022). Assuming 100 percent pass-through rate.

Figure C.5. Ticket prices increase for the Hamburg (HAM) - Bangkok (BKK) route



Source: SEO Amsterdam Economics (2022). Assuming 100 percent pass-through rate.

Figure C.6 Ticket prices increase for the Atlanta (ATL) - Mumbai (BOM) route



Source: SEO Amsterdam Economics (2022). Assuming 100 percent pass-through rate.