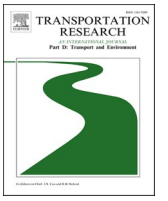
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Does cutting airport slots reduce climate impact? The case of Amsterdam airport

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ABSTRACT

This study evaluates the effectiveness of airport slot reductions as a strategy for mitigating greenhouse gas (GHG) emissions, focusing on Amsterdam Schiphol Airport. Following the Dutch Government's decision to reduce slots from 500,000 to 440,000, we analyse various risk scenarios using the D'Hondt method for proportional slot allocation and the Fuel Estimation in Air Transportation (FEAT) model to estimate fuel consumption. Strategies include proportional slot cuts, prioritising short-haul flights, and shifting to rail alternatives. Results show that short-term emissions reductions are modest and do not scale with slot reductions unless long-haul flights are significantly curtailed. Moreover, aircraft up-gauging could lead to increased emissions if airline behaviour is not addressed. Our findings challenge the effectiveness of slot reductions as a climate strategy, highlighting the importance of targeting long-haul flights and adopting comprehensive policies to achieve substantial emissions reductions. The study offers critical insights for sustainable aviation policy development.

1. Introduction

The contribution of aviation to anthropogenic climate change has been estimated to 1.65 % in greenhouse gas (GHG) emission terms (IPCC, 2022) or 3.5 % in terms of effective radiative forcing (Lee et al., 2021). Despite this, the rate of emissions from air transport has consistently outpaced the overall global emissions growth, largely due to the strong correlation between air traffic expansion and the socioeconomic development of nations (IPCC, 2022, Lamb et al., 2021). As a result, over the past decade, air travel has been increasingly pointed out as an excessively harmful activity regarding climate impact. The climate policy challenge of aviation can be summed up as follows. Firstly, in technological terms, aviation is the least fuel-efficient transportation mode, and, in contrast to other modes, non-CO_2 effects dominate its climate impact (Lee et al., 2021). Secondly, the industry has no reliable short- or medium-term solutions to increase fuel efficiency significantly or reduce GHG emissions, at least at a cost that is compatible with airlines' low-profit margins (Gössling and Humpe, 2024; Huwe et al., 2024) or with the consumer and societal expectations, as higher costs would be passed through to the consumer (Fichert et al., 2020b). Also, gains in fuel efficiency are offset by traffic growth (Budd and Suau-Sanchez, 2016; Peeters et al., 2016; Baer, 2020; Gössling and Lyle, 2021; Dobruszkes and Ibrahim, 2022). Thirdly, from the

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demand side, only a minority of the world's population flies, and an even smaller share flies frequently, as the propensity to fly sharply increases with income (Gössling and Humpe, 2020; Büchs and Mattioli, 2021; Büchs and Mattioli, 2022; Hopkinson and Cairns, 2021; Zheng & Rutherford, 2022), being disproportionate at the top-end if we consider celebrities and private jet usage (Gössling, 2019; Sobieralski and Mumbower, 2022; Gössling et al., 2024).

In this context, many experts and some policymakers argue that the only efficient policy available in the short term would be curbing demand for air travel or, in other words, demand management strategies. However, such an option is often considered taboo when discussed at all (Gössling and Cohen, 2014; Köves and Bajmócy, 2022). There are also concerns that flight- and carbon-intensive social and economic practices are becoming locked-in (Mattioli, 2016, 2020). Hence, most existing policies are restricted to funding research on technological solutions, trust in emission trading schemes, and some limited attempts to discourage air travel.

An example of the latter is how, in France, following a Citizens' Assembly petition, a legislative ban on short-haul domestic flights was implemented on 23 May 2023 (Euronews, 2023). This regulation prohibits flights for which there is a train alternative of less than two-and-a-half hours and which are not connected to long-haul flights. Consequently, this decree impacts a limited number of routes, such as those from Paris Orly to Bordeaux, Nantes, or Lyon, resulting in a modest effect on reducing greenhouse gas emissions. Recent studies have shown that the fuel or GHG savings from short-haul flight bans are limited (Baumeister, 2019; Dalkic et al., 2017; Robertson, 2013; Wang et al., 2019; Avogadro et al., 2021; Reiter et al., 2022). Indeed, as noted by Dobruszkes et al. (2024), 82 % of fuel consumption occurs in flight sectors longer than 1,000 km, where high-speed trains cannot easily replace air travel. Therefore, while substituting short-haul flights with high-speed trains may convey a strong societal message, it may also divert policy efforts from achieving more significant emission reductions.

Further airport capacity is added every year. On the one hand, many new airports have been built over the past decades, especially in Asia (e.g., Beijing Daxing International Airport) and the Middle East (e.g., Istanbul Airport). In the EU-27, twelve new airports for civil aviation have been opened since 1995 (Rudolph et al., 2023). On the other hand, many existing airports have benefited from on-site expansion to accommodate more traffic (Rodrigue et al., 2017). In the EU-27, ten new runways have been inaugurated since 1995 (Rudolph et al., 2023). Recent examples include Hong Kong Airport (third runway opened in 2022 and ongoing terminal expansion), New York JFK Airport (where several terminals are being expanded or rebuilt), Frankfurt (fourth runway in 2011, new terminal being built) and Dublin (second runway opened in 2022), among many others. Further projects to be confirmed include Vienna (third runway) and Prague (third runway), among many others.[1] In the UK, for example, there is an extensive list of planned expansions,[2] but at the same time, the UK Climate Change Committee (CCC), in their Sixth Carbon Budget, required under the Climate Change Act, argued there should be no net increase in the UK's airport capacity. In the 2023 progress report to Parliament, the CCC stated that "there has been continued airport expansion in recent years, counter to our assessment that there should be no net airport expansion across the UK" (CCC, 2024).

Along similar lines, a growing number of scholars and NGOs are calling for a moratorium on airport expansion (Element Energy, 2022; Gössling and Lyle, 2021; Greenpeace, 2023; Kuhnhenn et al., 2023; Stay Stay Grounded, 2019; Transport & Environment, 2023). Recent research conducted in six European countries (including the Netherlands) finds that the public broadly supports stopping the expansion of airports but is divided on whether this would effectively reduce aviation GHG emissions (Hodgson, 2024). It has also been suggested that concerns about the climate are one of the factors behind European policymakers' reluctance to expand airports since the COVID-19 pandemic (Cagney, 2024).

Against this background, the Dutch Government caused a major stir when it announced, on June 24, 2022, a decrease in the number of available slots at Amsterdam Schiphol Airport from 500,000 in 2022 to 440,000 from November 2023 onwards. Note, however, that at that moment, the airport was operating under that threshold, but 500,000 slots were the historically agreed operational limit for the airport. The original main motivation for this policy decision was, in fact, related to noise pollution, not GHG emissions (Government of the Netherlands, 2022). The Government's proposal arose from a situation of legal uncertainty. Under the EU Habitat Directive, Schiphol, like other companies in The Netherlands, requires an ecological permit to safeguard nature from various externalities, including nitrogen deposition. However, the process of securing this permit has proven to be highly complex. Without an ecological permit in place, the airport traffic decree, which underpins the enforcement system for regulating maximum noise nuisance, cannot be established. This lack of a legal foundation left the Government with no choice but to revert to the most recent noise regulation, the Airport Traffic Decree of 2008, to restore legal certainty. Having said that, the Government also viewed the slot reduction as an opportunity to balance air transport activity with citizens' quality of life while reducing GHG emissions—a symbolic and concrete step towards greener aviation policies. The Governmental Letter announcing the slot decrease (Ministerie van Infrastructuur en Waterstaat, 2022) emphasised that fewer aircraft movements would result in reduced noise pollution as well as lower emissions of CO2, nitrogen, (ultra)fine particles, and other harmful substances. Greenpeace echoed this perspective, highlighting the multidimensional benefits of the measure. Their aviation expert remarked, "Schiphol is finally shrinking; this is a historic breakthrough. (…) Fewer flights are desperately needed for our nature, health, and the climate. (…). This is a boost for Schiphol to finally come up with a plan that takes the Paris Climate Agreement into account" (Karst, 2022).

Assertions around the impact of a slot limit on emissions are challenging (see Niemeier and Forsyth, 2024), as emissions depend not only on the volume of flights but mainly on the aircraft type and distance flown (Dobruszkes et al., 2024). Hence, in this paper, we first contribute by analysing potential trajectories of slot reduction in saving emissions, considering different risk assessment scenarios for

[1] See, for instance, https://www.airport-technology.com/airport-construction-projects/ for an inventory of projects.

[2] See, https://www.carbonbrief.org/guest-post-planned-growth-of-uk-airports-not-consistent-with-net-zero-climate-goal/ for a UK specific list of expansion projects.

the case of Amsterdam Schiphol Airport. This should allow us to define not only the impact of a slot reduction on GHG, but also, more importantly, the accompanying policies required for each of the different trajectories to achieve the GHG reduction goals. Second, we contribute to the discussion on the challenges of implementing demand management strategies in the aviation sector.

The remainder of this paper is structured as follows. Section 2 reviews the existing literature on the relations between slots, distance and aircraft type, as well as introduces the Amsterdam Airport case. Section 3 presents the data, methods and risk assessment scenarios. Section 4 presents and discusses the results, and Section 5 concludes the paper.

2. Literature review

2.1. The relationship between airport slots, distance and aircraft type

Airport slots are allocated and managed following the Worldwide Airport Slot Guidelines (WASG), a non-binding global standard. In Europe, slot allocation is regulated by Regulation 793/2004, based primarily on WASG. The process divides the year into summer and winter seasons. Airlines declare their slot preferences in advance, and an independent coordinator allocates slots within the airport's capacity based on transparent and non-discriminatory principles. Historical rights, commonly known as 'grandfather rights' are recognised: if an airline has used a series of slots (≥5) for at least 80 % of the previous equivalent season, it retains them for the next season. Unused slots revert to the coordinator's pool for reassignment. Up to 50 % of this pool is reserved for new entrants, with the remainder for incumbents. The coordinator may use additional criteria, such as Public Service Obligations routes or year-round services, to allocate slots.

The slot regulation was designed to manage limited capacity at congested airports, especially Level 3 airports requiring year-round slot coordination.[3] In Europe, 70 % of seat capacity and flights are at Level 3 airports, compared to 40 % globally (van Houten and Burghouwt, 2022). The congestion at European airports has caused some limitations of the Slot Regulations in the form of inefficient use of slots or reduced competition. Inefficiencies include slot hoarding —holding slots to prevent competitor entry— and slot babysitting, where poor slot use aims to transfer slots to another airline (EC, 2011).

Another common effect of the Slot Regulation in congested airports is the phenomenon known as "up-gauging," where airlines shift their operations from smaller to larger aircraft and from short-haul to long-haul services. This shift is driven by the high opportunity costs associated with operating in capacity-constrained airports as slot rents increase (Forsyth et al., 2023). Since airport slots are scarce and highly valuable, airlines aim to maximise the revenue generated per slot. Larger aircraft and long-haul routes typically offer higher revenue potential compared to smaller aircraft or shorter routes, as they can carry more passengers and often yield higher ticket prices. However, this strategic adjustment by airlines often comes at the expense of the diversity of destinations served. As airlines prioritise routes that generate the most profit, they may reduce or eliminate short-haul flights in favour of fewer, but longer-haul services. Consequently, the overall number of destinations accessible from the airport diminishes. Additionally, the shift to longer routes with larger aircraft increases the average distance flown per flight departing from the airport (Gudmundsson et al., 2014; SEO and Cranfield University, 2017).

This dynamic has implications not only for the airport's connectivity but also for its environmental impact, as these longer-haul flights tend to generate higher GHG emissions due to greater fuel consumption per flight segment. Several authors emphasise that distance and aircraft type are crucial factors influencing aviation emissions (e.g., Burzlaff, 2017; Seymour et al., 2020; Dobruszkes et al., 2022; Dobruszkes et al., 2024). Despite their frequency and low fuel efficiency, short-haul flights contribute less to total emissions due to lower fuel consumption per flight. In contrast, long-haul flights, although fewer in number, have significantly higher total emissions because they burn more fuel. Aircraft type also impacts emissions, as different models have varying fuel efficiencies, depending on weight at take-off and on when the aircraft was designed. The authors reveal a strong correlation between seat-kilometres and fuel burnt, indicating that longer distances and less efficient aircraft lead to higher emissions.

2.2. The case study of Amsterdam Airport and greenhouse gas emissions

Amsterdam Schiphol Airport has traditionally engaged in active communication with local stakeholders to keep noise under control. This has historically been an important success strategy of the airport, as citizens have been particularly vocal about the importance of quality of life and low stress levels (Suau-Sanchez et al., 2011; Burghouwt and Dobruszkes, 2014). In that regard, since 2008, the airport operation has been limited to 500,000 movements as part of the agreement with the local stakeholders in the Alders Table and, since 2003, the 'Schiphol Act' regulated the airport planning around the airport and the air traffic in the area of safety and noise contours (de Jong, et al., 2008). The current Vision 2030, developed and published by Schiphol Group[4] before the COVID-19 pandemic, constitutes a commitment to the 500,000 movements limit and improving the quality of the living environment locally and globally. The discussions after the COVID-19 pandemic to further limit the airport slot capacity (see Fig. 1 for the movement

[3] Slot guidelines categorise airports according to their level of demand/supply imbalance. Different airport coordination principles and procedures apply at different levels. In Level 1 airports, airport capacity is generally adequate to meet demand and no airport coordination is required. In Level 2 airports, there is some potential congestion during periods of the day, week or season, and schedule adjustments are mutually agreed with the airlines. Finally, in Level 3 airports, airport demand significantly exceeds the airport capability and it is necessary for all airlines and operators to have a slot allocated by an independent slot coordinator to arrive and depart at the airport.

[4] Available at: https://www.schiphol.nl/en/schiphol-group/strategic-qualities/.

evolution and limits) represent a step forward in the historical trajectory of operating Schiphol under socially and environmentally agreed limits.

Fig. 1 shows the airport's annual utilisation and how it has exceeded the 500,000 limit over several years. Note, however, that the 500,000 annual aircraft movement limit at Schiphol does not apply to general aviation. However, the distribution of movements is not evenly distributed throughout the year (Fig. 2), and the number of passengers that go through the airport depends not only on the slots held but also on the aircraft size used by airlines, which has increased over the years (Fig. 3). The slot capacity is dominated by KLM, with approximately half of the scheduled commercial passenger traffic (50.4 % in 2022), followed by Easyjet (8.5 %) and Transavia (7.3 %).

While the proposal to reduce slots at Amsterdam Schiphol Airport was motivated by noise, the airport has conducted some preliminary assessments of the need to reduce GHG emissions. In 2023, Schiphol Airport commissioned three roadmap studies to investigate what is required to bring its CO_2 emissions in line with the Paris Agreement.[5] The studies are straightforward and conclude that, in order to reduce its CO_2 emissions by 32 % to 66 % from 2019, the airport needs to implement significant demand management measures by 2030, focusing on lowering the number of long-distance flights, which are major contributors to CO_2 emissions. Schiphol identifies some other complementary strategies to achieve these targets, including renewing the fleet, improving operational efficiencies, and significantly increasing the use of sustainable aviation fuel (SAF). However, previous literature (see, for example, Fichert et al., 2020a and Fichert et al., 2020b) shows that is a challenging endeavour. Hence, this paper contributes to the ongoing discussion by modelling the impact of slot reductions at Amsterdam Schiphol Airport and the potential CO_2 emission reductions, considering different airline reactions and scenarios, as well as the challenges of implementing flight reductions and complementary strategies.

3. Methodology: data, methods and scenarios

3.1. Aviation data and fuel burn model

Our method required data on airline schedules, which came from the OAG Schedules Analyser dataset and covered the year 2019, which was the year of peak airport activity as airport traffic continued recovering after COVID-19. The OAG dataset includes information on the airlines' supply of flights, including variables like aircraft model, aircraft seat capacity, number of movements, and great circle distance flown between the origin and destination.[6]

In this paper, following previous studies (e.g., Dobruszkes et al., 2022; Dobruszkes et al., 2024), fuel burnt is considered as a proxy for GHG emissions and climate change impact.[7] In general, the longer the flight and the heavier the aircraft, the higher the fuel burnt. The literature agrees that this relationship is roughly linear with some slight variations due e.g., to differences in aircraft weight. Burzlaff (2017) concluded that some variations are near the aircraft's range limit. Similarly, Park and O'Kelly (2014) detect range limit variations for wide-body aircraft. Filippone et al. (2021) and Filippone and Parkes (2021) consider that variations depend on atmospheric conditions, flight altitude, payload and other factors. Finally, Seymour et al. (2020) consider that the relationship follows a slightly quadratic function, and Turgut et al. (2019) note higher dispersion for longer distances.

Simplified models of fuel of fuel burnt and/or of GHG emissions are based on aircraft type and distance flown. Dobruszkes et al. (2022) thoroughly reviewed the available models to calculate fuel burn and compared different distance-fuel burnt curves. These are the EMEP/EEA Air pollutant emission inventory (Baumeister and Leung, 2021), the Eurocontrol Small Emitter Tool (SET) (Boussauw and Decroly, 2021), the ICAO Carbon Emissions Calculator (Sobieralski and Mumbower, 2022), and the Fuel Estimation in Air Transportation (FEAT) of Seymour et al. (2020) (Sobieralski and Mumbower, 2022; Dobruszkes et al., 2022). The difference between the models is the shape of the fuel function against distance, which can be linear, upward quadratic or downward quadratic. Following Dobruszkes et al. (2022), we use the Fuel Estimation in Air Transportation (FEAT) model of Seymour et al. (2020). Although all models deliver similar results, FAET has some advantages: it takes into account the non-linear effect of the distance flown due to the extra fuel required (and therefore the extra weight at take-off) for longer flights, resulting in upward quadratic specifications; it is transparent, as the methodology is explained in detail; it is easy to use, as all equations are published; it has a large scope, as 175 airliners are covered (one equation per aircraft type). Fig. 4 shows selected FAET functions for aircraft commonly used at Amsterdam Airport. We acknowledge, however, that this model slightly overestimates fuel consumption for flights shorter than 200 km that use narrow-body aircraft (e.g., A320, B737). Still, this does not invalidate our analysis, as the proportion of this type of flight is small.

[5] Amsterdam Schipol Airport studies Delft (2024), NLR (2024) and SEO (2023) on the reduction of $C0_2$ emissions are available at https://www.schiphol.nl/en/you-and-schiphol/news/accelerated-co2-reduction-necessary/.

[6] It is important to highlight three points here. First, our analysis does not include passenger demand data or full itinerary details (e.g., MIDT data). As a result, our study does not capture passenger flow dynamics, including transfer traffic patterns or airline-specific demand variations. While this represents a limitation, the strategic nature of our analysis focuses on overall slot allocation impacts and their implications in terms of fuel burnt and CO_2 emissions, rather than passenger-level behaviour. Second, it should be noted that fuel consumption is directly related to aircraft operations rather than individual passengers. Third, airline networks (supply) are strategically designed to respond competitively to passenger demand; thus, the supply data already inherently reflect certain elements of passenger flow dynamics.

[7] CO_2 is strictly proportional to fuel burnt but not perfectly related to climate change impact because the non-CO_2 effects (including other emissions like NO_x and water vapour, as well as and contrails formation) are not always linear but are place, altitude and time dependent (Lee et al., 2021, Filippone and Parkes, 2021). Hence, in this research we consider only fuel burnt due to the complexity of calculating the non-CO_2 term (Dahlmann et al., 2023).

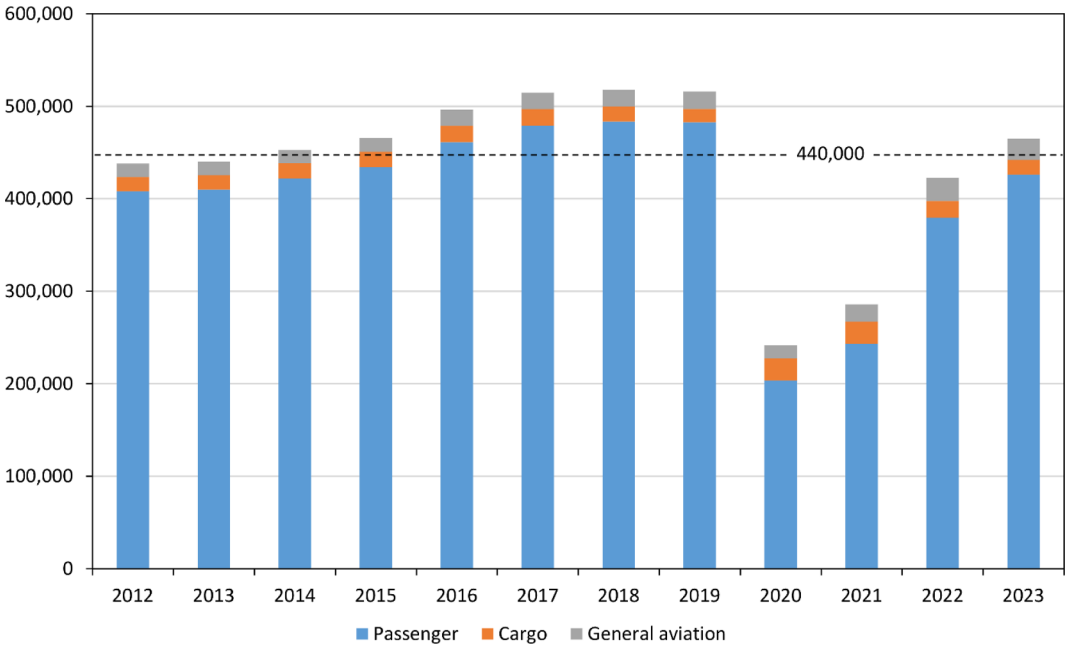


Fig. 1. Number of aircraft movements at Amsterdam Schiphol Airport.
Source: Royal Schiphol Group.

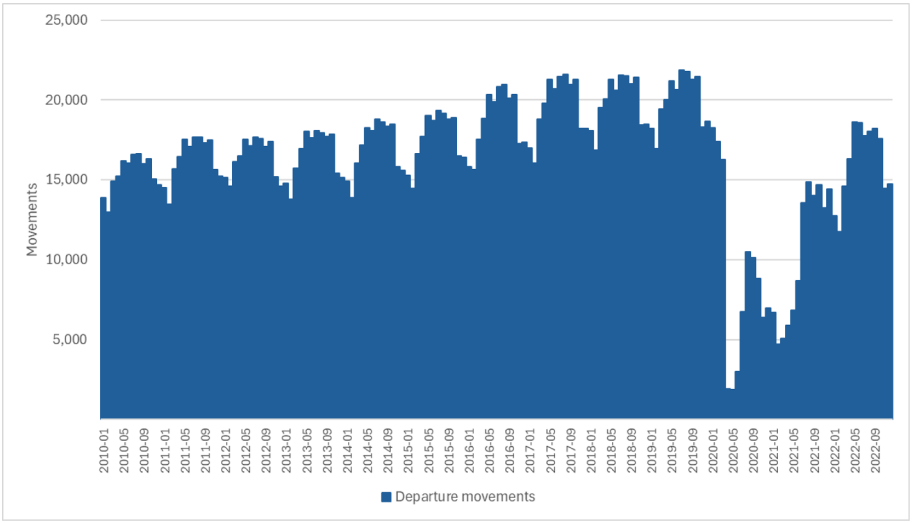


Fig. 2. Monthly distribution of departure movements at Amsterdam Schiphol Airport, 2010–2022.
Source: OAG.

3.2. Allocation of slot reduction criteria and risk scenario building

We apply the proportionality principle established by the Worldwide Airport Slot Board (WASB) during the COVID-19 pandemic to determine slot reductions. This principle dictates that all airlines should experience reductions in equal proportion (WASB, 2020). However, assigning a uniform percentage reduction to each airline's flight frequency can lead to rounding complications. For example, airlines operating a few flights may face excessive reductions if rounded up or insufficient cuts if rounded down. This issue arises because slot allocations, expressed as whole numbers, cannot accommodate fractional reductions in a strictly proportional manner across airlines.

To address this, we draw a parallel between this issue and the allocation of parliamentary seats following elections. We employ the D'Hondt (or greatest divisor) method to distribute the slot reductions fairly and proportionally across the airlines. As Gallagher (1991) noted, this method ensures a whole-number allocation of slots that approximates proportionality as closely as possible. Regarding the

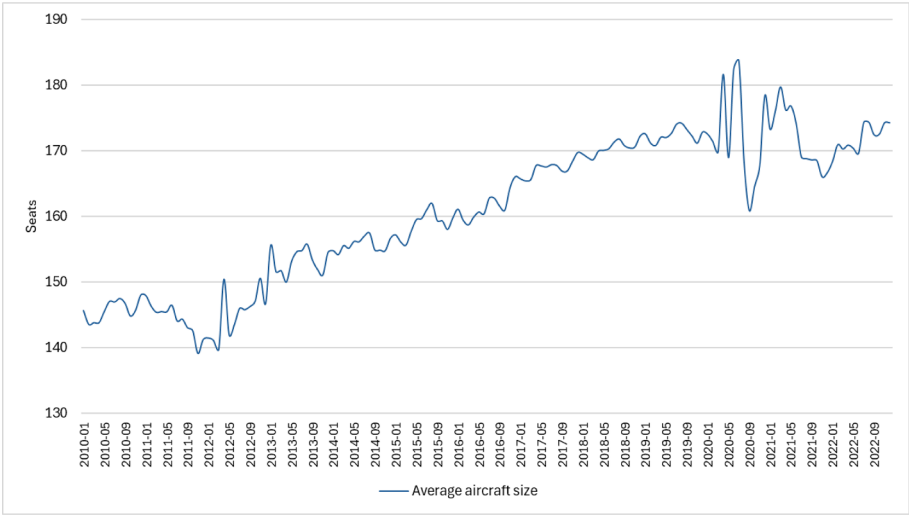


Fig. 3. Monthly average aircraft size, commercial scheduled services, at Amsterdam Schiphol Airport, 2010–2022. Source: OAG.

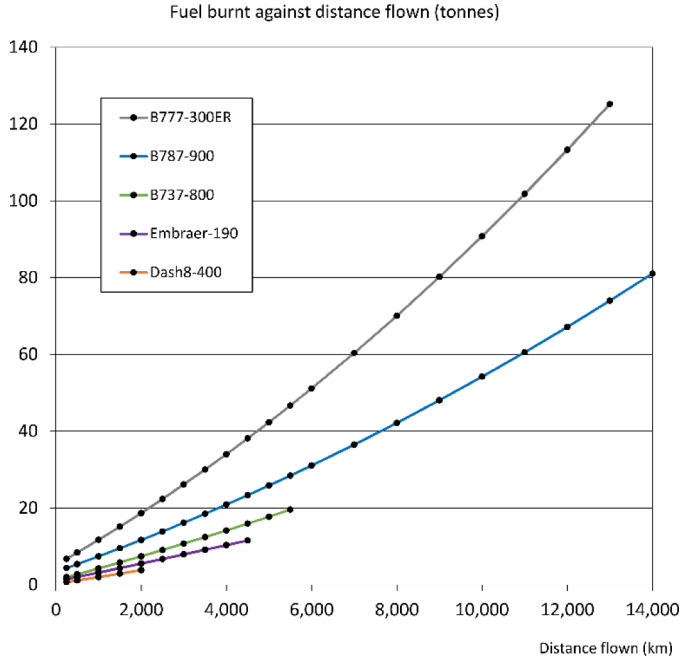


Fig. 4. Selected Seymour et al.'s (2020) FAET functions for fuel burnt against distance flown.

reference variable for slot distribution (analogous to 'votes'), the most logical choice appears to be the frequency of each airline's operations during the affected time period over the relevant year, as this is the proportionality to be maintained. However, using flight frequencies can lead to 'ties', particularly among smaller airlines that operate an identical number of flights over a season. To alleviate this issue, we propose using the total seats offered during the year as the reference variable. Any remaining ties among smaller carriers will be resolved randomly, though this is unlikely to significantly impact the overall outcome at the airport level.

In addition to passenger flights, Amsterdam Airport accommodates cargo operations, which will be treated separately, representing approximately 4.3 % of air traffic movements. Cargo flights will absorb their share of the proportional reduction accordingly.

While the D'Hondt method has been applied to distribute slot reductions fairly across airlines, it is important to contextualise this approach within existing slot allocation regulations. Current slot regulations primarily manage congestion and growth rather than reductions. As mentioned above, during the COVID-19 pandemic, a temporary waiver was introduced to relax the 80 % utilisation rule, allowing airlines to retain their slots despite operational downturns. However, this was an emergency measure rather than a structured

slot reduction method. In contrast, our study introduces a methodological framework for reducing slots under normal operating conditions in a manner that ensures fairness across all airlines.

Additionally, we considered the impact of public service obligations (PSOs). In our dataset (2019), the only PSO-protected route at Schiphol was Strasbourg–Amsterdam, which was under a French tender until April 2019. As this route lost its PSO status for most of 2019 and remained unprotected in our 2024 baseline scenario, we treated it as a non-PSO route. We acknowledge that the route regained PSO status in 2025, but this falls outside our analysis scope.

Furthermore, while slot allocation regulations prioritise new entrants in slot applications, this provision does not apply in capacity reduction scenarios. Similarly, the role of grandfather rights in our methodology is nuanced. Since we do not have slot utilisation data, we assumed full slot usage, an assumption consistent with capacity-constrained premium airports. For short-term airline services lacking guaranteed future rights (i.e. routes with a slot series below five), we adopted an equitable approach, ensuring that such routes and smaller carriers were not disproportionately disadvantaged. These services remain in our scenarios unless removed due to specific scenario requirements. Given that short-term routes account for only 0.18 % of total available seat-km and 0.17 % of total fuel burn, their presence or absence does not materially affect our results. Consequently, exploring alternative slot prioritisation schemes would not significantly alter the findings at the strategic level of analysis conducted in this research.

Once a reduction vector of 'flights to cut' is established for each airline, we assume the decision of which specific flights to remove will be left to the airlines themselves, influenced by various policy scenarios and strategy incentives. With the existing information, it is impossible to design exact scenarios to what could happen. Therefore, we use a risk scenario-building approach, crafting a narrative based on the literature and the available information regarding some of the stakeholders' intentions, describing the circumstances and consequences if it were to happen. The narrative is subsequently condensed into a single sentence or a limited number of sentences, referred to as a risk statement, which conveys the key components of the scenario. These scenarios are explained below and summarised in Table 1.

Scenario S1 Baseline: This scenario is our baseline and comprises all scheduled flights for 2019 (as extracted from OAG Schedules), with no slot reduction, but a minor update of the aircraft types that were retired after COVID-19. For example, KLM's Boeing 747s were changed to two different aircraft used in 2024. When different aircraft types are used in a route that used to be operated by a B747, we have considered only the aircraft type with more dominance in the route. For the 380s, we have kept the Emirate's, as they continued operating them but changed China Southern's to the new aircraft type.

S2A Gov: This scenario is based on the initial Government proposal to reduce the airport capacity by 12 % to 440,000 slots. The reduction is applied proportionally to all airlines following the D'Hondt method, and then we assume that airlines will withdraw the shortest flights in their network, as they have lower yields, but the number of flights to withdraw will be determined by the proportionality principle guided by the D'Hondt method.

S2B Dist: This scenario is based on the initial Government proposal to reduce the airport capacity by 12 % to 440,000 slots. The reduction is applied directly to the shortest-distance flights, disregarding the airline proportionality principle. This scenario considers that in a congested scenario, airlines might choose to remove the shortest flights because of lower yields, and policymakers may want to focus on less fuel-efficient routes, disregarding the absolute GHG emissions.

S2C Rail: This scenario is based on the initial Government proposal to reduce the airport capacity by 12 % to 440,000 slots. The reduction is applied directly to the shortest-distance flights in the routes with a railway alternative by ascending rail travel time, disregarding the airline proportionality principle. This scenario considers that in a congested scenario, airlines might choose to remove the shortest flights because of stronger competition with high-speed rail, and policymakers may focus the effort on corridors where passengers have a valid rail alternative.

S3 Equal distance: This scenario is based on the initial Government proposal to reduce the airport capacity by 12 % to 440,000 slots. The reduction is applied proportionally to all airlines following the D'Hondt method, and all flight distances are equally affected.

S4 Short distance: This scenario is based on the initial Government proposal to reduce the airport capacity by 12 % to 440,000 slots. The reduction is applied proportionally to all airlines following the D'Hondt method and withdrawing the shortest-distance

Table 1
Risk assessment scenarios.

	S1 Baseline	S2A Gov	S2B Dist	S2C Rail	S3 Equal distance	S4 Short distance	S5 Long distance
Movements demand	493,728	493,728	493,728	493,728	493,728	493,728	493,728
Mov. Limits	500,000	440,000	440,000	440,000	440,000	440,000	440,000
Slot reduction	None	60,000	60,000	60,000	60,000	60,000	60,000
Commercial passenger flight reduction	None	52,188	52,188	52,188	52,188	52,188	52,188
Reduction strategy	None	Slot pro rata, then the shortest distances flown	Shortest distances flown	Shortest rail travel times	Slot pro rata, all distances equally affected	Slot pro rata, then the shortest distances flown + 10,000 extra long flights turned into short-haul	Slot pro rata, then the shortest distances flown + 10,000 extra short flights turned into long-haul

flights. From the remaining flights, the longest 10,000 flights (in practice: flights longer than 8,800 km) are turned into short-haul flights. To do so, the original frequencies (i.e. frequencies in 2019) of the 10,000 shortest flights (in practice: flights up to 333 km) have been restored.

S5 Long distance: This scenario is based on the initial Government proposal to reduce the airport capacity by 12 % to 440,000 slots. The reduction is applied proportionally to all airlines following the D'Hondt method and withdrawing the shortest-distance flights. From the remaining flights, the shortest 10,000 flights (in practice: flights up to 367 km) are turned into long-haul flights to simulate the up-gauging aircraft process resulting from increases in opportunity costs and slot rents of airlines (Forsyth et al., 2023). To do so, the frequency of all flights longer than 4,000 km has been evenly multiplied by the same factor to be increased from 34,136 (after the initial drop based on the D'Hondt method) to 44,136 flights.

This scenario-based approach provides a framework for evaluating the impact of different slot reduction strategies. Unlike a sensitivity analysis, which isolates the effect of changing a single variable while holding others constant, our scenarios are designed to reflect realistic policy choices and airline responses, allowing for a broader assessment of interdependent factors. For instance, S3 Equal Distance ensures a proportional reduction across all airlines and distances, while S2A Gov builds upon this by incorporating a distance-based reduction. S2B Dist removes proportionality, focusing solely on distance, whereas S5 Long Distance explicitly considers the effect of aircraft up-gauging, a key industry response to slot constraints. The way the scenarios have been designed allow us to observe the effects of independent variables, eliminating the need for an additional sensitivity analysis. Furthermore, as we do not have access to demand data (e.g., MIDT), it is not possible to calculate load factors, and given the strategic level of analysis, variations in load factors would have only a marginal impact on the overall findings, as flights would take place in any case disregard of small variations in load factors. Thus, the scenario approach employed in this study offers a comprehensive and policy-relevant perspective without requiring additional single-variable sensitivity testing.

4. Results and discussion

4.1. Overall results

Table 2 presents the results of our analysis for the multiple scenarios, and a graphical representation of the fuel burnt curve is presented in Fig. 5. The most obvious result is that only the S4 Short-distance scenario (in which some long-haul flights are substituted by short-haul flights) provides large fuel burnt reductions (−31.5 %). In all remaining scenarios, the fuel burnt reduction percentage is lower than the 12 % capacity reduction or is absent altogether. In other words, the short-term gains in terms of GHG emission reductions are below the capacity reduction effort, unless they are complemented by a targeted effort to reduce the activity of long-haul flights. So, whilst GHG emissions are reduced in the short-term in most scenarios, the impact of the measure is limited if no action is taken on the long-haul market. In addition, the scenario with more long-haul flights than today (S5) involves a significant increase in fuel burnt (+13.5 %) despite the 12 % slot cut. This suggests that the slot reduction might even backfire (in the short term), if the decision of which flights to operate is left entirely to the airlines.

For most scenarios, reductions in fuel burnt are modest, between 1.7 % and 10,9 %. The S3 Equal Distance scenario achieves a 10.9 % reduction of fuel burnt as the reduction is applied to all flight distances equally, which means that some longer flights are affected. This contrasts with the S2B Distance and S2C Rail scenarios, which focus the reduction effort on the shortest distance flights and thus achieve the lowest fuel savings. The largest impact (−31.5 % fuel burnt) is achieved with the S4 Short distance scenario, which effectively takes out of the market flights of more than 8,800 km. As Fig. 6 shows, this scenario has the smallest proportion of long-haul flights of more than 4,000 km. Hence, distance is confirmed to be crucial in emissions and fuel burnt reductions (Dobruszkes and Ibrahim, 2022; Dobruszkes et al., 2024; Reiter et al., 2022).

The idea of the "tyranny of distance" (Dobruszkes and Ibrahim, 2022; Dobruszkes et al., 2024) in climate change is further supported when comparing the S4 Short distance scenario with the results of the S5 Long distance scenario that, rather than a reduction in emissions, presents an increase of emissions. This results from the aircraft up-gauging process, i.e., a process of progressively changing the aircraft to a larger size to accommodate more demand and consequently flying longer distances. There is evidence to suggest that up-gauging takes place in congested markets. Fig. 7 shows the up-gauging process at London-Heathrow Airport, which has been at full capacity since 2008, and its impact on the average distance of flights. This suggests that an up-gauging scenario is conceivable in a congested Amsterdam Schiphol Airport, making the S5 Long-distance a plausible scenario. Hence, capacity constraints will not necessarily reduce the fuel burnt in the medium term if airline strategic reactions are not considered.[8] This suggests the need to target policy measures primarily at long-haul flights, as illustrated in the S4 Short distance scenario (Dobruszkes et al., 2024).

4.2. Specific results by geographic market and airline

To better understand the ramifications of these scenarios on the connectivity of the Netherlands and, consequently, on the broader economy, Tables A.1 and A.2 in the Appendix present the percentage change in flight frequencies by destination country and airline.

From a geographical perspective, the different scenarios yield varying consequences, though very few cases result in the complete loss of connectivity to a country. In Scenario S2A Gov, Belgium and Luxembourg lose all flights due to their proximity to Amsterdam,

[8] Note, however, that in the (very) long term, any limit to airport capacity will eventually result in a reduction in fuel burnt as compared to the counterfactual scenario where capacity and air travel activity keeps increasing indefinitely.

Table 2
Results for the different risk scenarios.

	S1 Baseline	S2A Gov	S2B Dist	S2C Rail	S3 Equal distance	S4 Short-distance	S5 Long-distance
Slot reduction	None	60,000	60,000	60,000	60,000	60,000	60,000
Reduction strategy	None	Slot pro rata, then shortest distances flown	Shortest distances flown	Shortest rail travel times	Slot pro rata, all distances equally affected	Slot pro rata, then the shortest distances flown + 10,000 extra long flights turned into short-haul	Slot pro rata, then shortest distances flown + 10,000 extra short flights turned into long-haul
Fuel burnt departing comm. pass. flights (ktonnes)	2,695	2,552	2,649	2,645	2,401	1,804	3,062
Change in emissions from baseline	REF	–5.3 %	–1.7 %	–1.8 %	–10.9 %	–31.5 %	+13.6 %

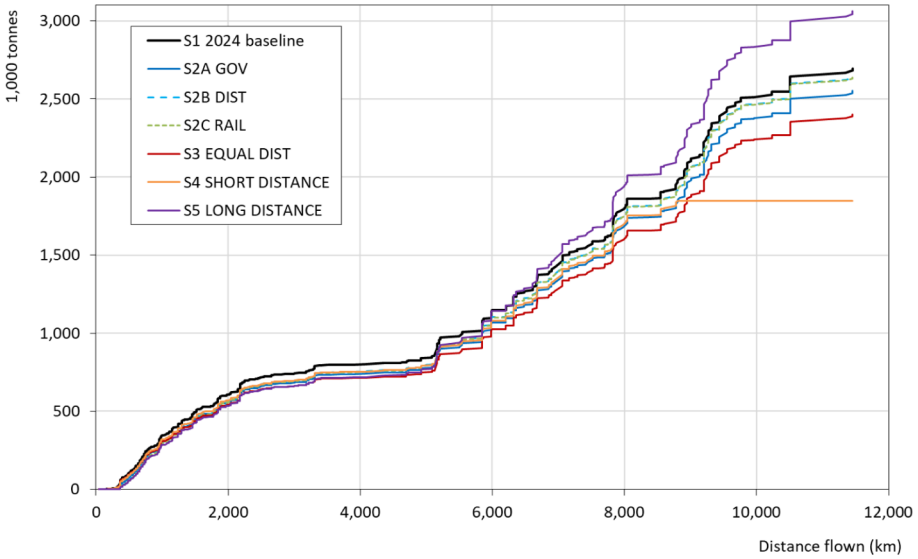


Fig. 5. Cumulative fuel burnt against distance flown, scheduled passenger flights from Amsterdam Airport.
Source: own analysis.

while the rest of the capacity reduction is proportionally distributed across European, medium-haul, and long-haul destinations. Notably, airline size, network specialisation, and market size play an important role in shaping these effects. For instance, Spain, a major market served by locally based airlines with a diverse portfolio of destinations (KLM and Transavia), experiences only a 2 % reduction in frequencies. In contrast, the United Kingdom sees a larger reduction (−18 %), as a significant share of the Amsterdam–UK market is served by non-local airlines (British Airways, easyJet, Flybe), which operate fewer destinations from Amsterdam and thus have less flexibility in selecting routes for reduction.

The S2B Dist and S2C Rail scenarios—both of which deliver lower fuel burn savings—result in more limited geographical impacts. The S2B Dist scenario eliminates connectivity to Belgium, Luxembourg, and other Dutch airports while reducing frequencies to the UK (−37 %) and Germany (−25 %). The S2C Rail scenario, being more selective, affects countries with viable rail alternatives. While Luxembourg retains connectivity, Germany experiences a 33 % reduction, and the UK sees a milder impact (−26 %). In contrast, Scenario S3 Equal Distance, which applies the D'Hondt method without additional criteria, ensures the most balanced reduction across geographical markets (Table A.1) and airlines (Table A.2). This highlights the fairness of the D'Hondt method, while also demonstrating the need for additional policy criteria to guide decision-making.

Scenario S4 Short Distance has the greatest impact on fuel burn savings but also results in significant connectivity losses, particularly in long-haul markets, where lower-density routes are most affected. This is a direct consequence of forcing a shift from long-haul to short-haul flights. Conversely, Scenario S5 Long Distance, which simulates an up-gauging process, results in the highest increase in fuel burn. This occurs due to the reduction in short-haul flights to European and North African destinations, with flights to Belgium, Luxembourg, and domestic Dutch airports disappearing, while long-haul frequencies increase across all regions. It is worth noting that

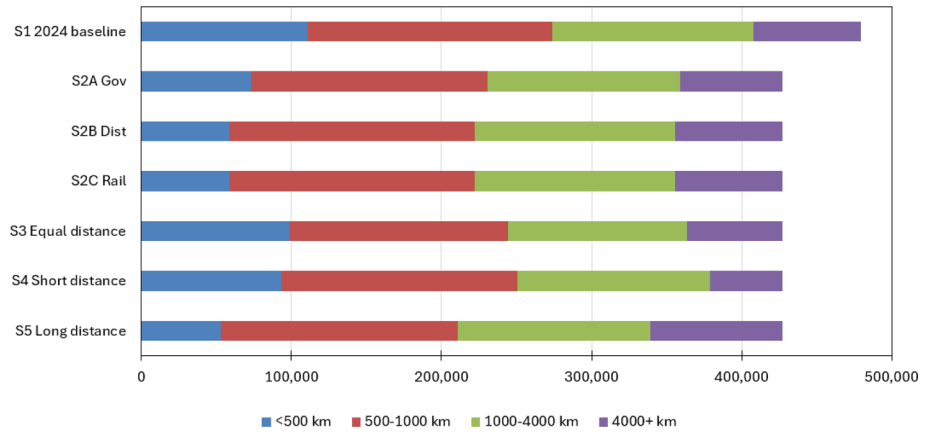


Fig. 6. Movements per distance category and scenario.
Source: own analysis.

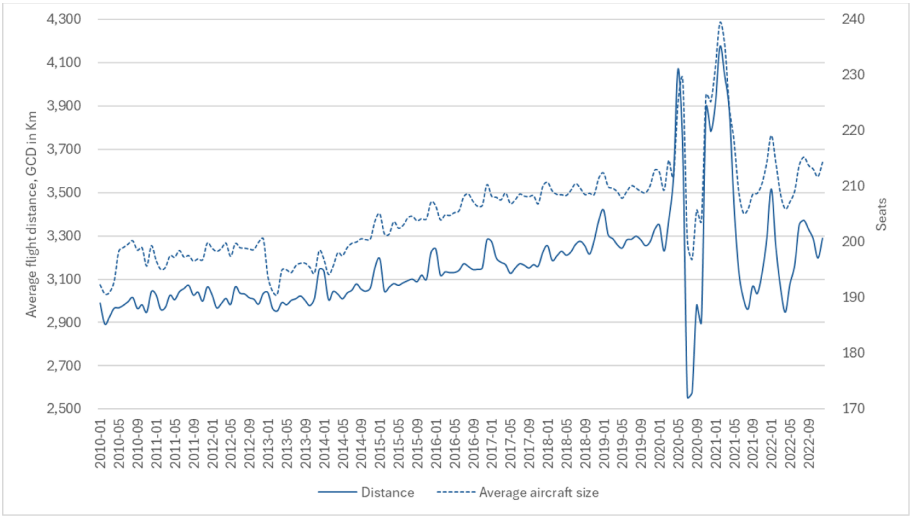


Fig. 7. Average flight distance and average aircraft size at London Heathrow Airport, 2010–2022.
Source: OAG.

while African and Latin American markets show the highest percentage increases in frequencies, this is largely due to their initially low flight volumes, meaning small absolute increases result in large relative percentage changes.

As noted earlier regarding Scenario S3 Equal Distance, applying the D'Hondt method ensures that slot reductions remain proportional among airlines. However, the impact on specific airlines (Table A.2) is highly dependent on the reduction policy applied and the diversity of an airline's route portfolio. For example, British Airways, which operates relatively high-frequency services to only three destinations from Amsterdam, is disproportionately affected in multiple scenarios. Similarly, KLM, as the airline with the largest frequency share at the airport, experiences significant variations in different scenarios but never faces the risk of disappearance.

Interestingly, in Scenario S5 Long Distance, KLM is unable to fully capitalise on the up-gauging process, as it is forced to reduce part of its short-haul feeder flights. In contrast, foreign airlines that are not based at Amsterdam Airport can increase their long-haul frequencies, but are not affected by the reduction of short-haul flights. While this might seem counterintuitive—given KLM's dominant market position—the initial reduction in short-haul connectivity disrupts KLM's feeder network, limiting its ability to up-gauge in other markets. Meanwhile, foreign airlines take advantage of premium hub opportunities, expanding into slots previously occupied by airlines that had focused solely on short-haul operations. This trend is evident in the negative impacts observed for British Airways, KLM Cityhopper, easyJet, and Jet2.com (see Table A.2).

4.3. The need for additional policies

One of the well-documented limitations of the EU Emissions Trading Scheme (ETS) is its potential to create a waterbed effect, which is not fully neutralised by the Market Stability Reserve (MSR) (Rosendahl, 2019; Perino, 2018). This means that carbon savings from

slot reductions at Amsterdam Airport could translate into lower allowance prices, thereby undermining actual emissions reductions (Fichert et al., 2020a; Fichert et al., 2020b). However, it is important to consider the broader context of the EU ETS in aviation.

Currently, the EU ETS applies to a limited proportion of flights, leaving a significant share of European aviation emissions unpriced. Recent estimates indicate that 80.4 % of KLM's emissions and 93.4 % of Air France's emissions were not covered by the EU ETS in 2023 (Transport & Environment, 2024). Given that the majority of airline emissions for flights taking off in the European Economic Area (EEA) fall outside the EU ETS framework, the waterbed effect is less significant than often assumed. Furthermore, our findings suggest that slot reductions alone do not lead to substantial emissions savings and, in up-gauging scenarios (S5 Long distance), emissions may even increase due to airlines adapting their networks in response to capacity constraints. This underscores the need for complementary policies to ensure that slot reductions meaningfully contribute to emissions reductions while mitigating potential waterbed effects.

A comprehensive policy toolbox is essential to enhance the effectiveness of slot reductions in terms of climate change mitigation. One of the most direct approaches would be the cancellation of an equivalent number of allowances from the EU ETS when airport slots are reduced, following a Cancellation Mechanism (CM). This would effectively reduce the total emissions permitted under the system, though one-time cancellations have limitations in terms of both price and long-term emissions impact (Bocklet et al., 2019). Additionally, to prevent potential carbon price reductions resulting from slot constraints, the introduction of a carbon price floor could provide stability. The UK's Carbon Price Support Mechanism in the power sector has already demonstrated positive results in maintaining price signals for emissions reductions (Leroutier, 2021).

Beyond these market-based adjustments, our results indicate that policy measures should focus primarily on long-haul flights, where emissions are disproportionately concentrated. Two key policy options could be pursued. First, expanding the EU ETS to include all departing flights, including extra-EEA routes, would significantly increase the system's effectiveness and ensure that demand reductions at Amsterdam lead to emissions reductions on a broader scale, rather than merely shifting emissions to long-haul routes outside the system. Second, a distance-based tax on long-haul flights could be introduced, further aligning incentives with climate objectives by discouraging emissions-intensive travel. In fact, the Air Passenger Duty (APD) in the UK ranges depending on the flight distance and class of travel (Table 3). However, the effectiveness of APD as a demand management measure depends on airport capacity constraints. At slot-constrained airports, where demand exceeds available slots, APD does not necessarily reduce flight numbers but rather affects the economic rent of slots. If the APD is lower than the slot rent, airlines are likely to absorb the cost, leading to unchanged airfares and no reduction in demand or emissions. Only in cases where the APD exceeds the slot rent would airfares rise, potentially reducing demand and associated emissions (Fichert et al., 2020b). In the same vein, some argue that an Air Miles Levy, taking the distance flown into account, rather than a more often heard Frequent Flyer Levy, a progressive tax on frequent flyers, could have a higher impact in GHG emissions than the UK ADP. A recent study by Ricardo (2021) for the European Commission on air transport sector taxation explores the potential adjustments to the existing tax framework for commercial aviation to tackle the insufficient internalisation of climate-related external costs. The study evaluates various fuel and ticket tax rate models, such as a uniform rate for all passengers, a tax that increases with flight distance, and one that decreases with distance (the latter two with different cutting points). A fuel tax differs from APD in that it directly affects airline operating costs, creating a supply-side effect that may lead airlines to reduce marginal short-haul routes and focus on high-yield long-haul services. However, this dynamic is mitigated when long-haul operations depend on short-haul feeder traffic, as is the case for KLM at Amsterdam Schiphol. In such cases, airlines may retain key feeder routes despite higher fuel costs, ensuring connectivity for long-haul passengers while optimising schedules and aircraft selection. Unlike fuel taxes, ticket taxes tend to have, at most, an indirect connection to fuel use (e.g., via distance-based increments), offering no direct incentives for improved fuel efficiency—meaning passengers on flights with different fuel efficiencies would still incur the same ticket tax. Ticket taxes thus function as a demand management measure, primarily raising ticket prices. This characteristic presents a minor disadvantage for ticket taxes compared to fuel taxes. However, a key advantage of ticket taxes lies in their more straightforward application (legally) over a broader range of flights (within or beyond the EEA, or both), enhancing the potential demand impact of the tax while reducing the need to renegotiate certain international air transport agreements. A ticket tax increase with distance can deliver a 4.5 % reduction in demand for extra-EEA flights, and combining fuel and ticked price taxes can reduce demand by 8.9 % (Ricardo, 2021).

Additionally, it could be argued that demand-side measures redistributing air passengers outside the aviation system could also potentially make slot reductions more emission effective. However, in line with recent research (Dobruszkes et al., 2024), our results for the S2C Rail scenario challenge the relevance of shift-to-rail policies. Indeed, Reiter et al. (2022) highlighted that a blanket approach to short-haul bans with distance thresholds does not appear effective, as it achieves emission reductions of only 2.7 % in the affected corridors. Instead, they argue for a more route-specific approach for corridors with higher reductions.

Our findings also highlight the problems related to GHG leakage (i.e., emission shifting to other airports or countries). Indeed, capacity limitations in Amsterdam may result in some passengers looking for alternative air connectivity in other nearby airports. But also, connecting passengers affected by the capacity limitation at Schiphol could choose alternative global hubs. The evident implication is that airport-specific actions might be intrinsically flawed, and a more comprehensive approach is necessary. This is consistent with the demands of experts and NGOs to introduce a moratorium on airport expansion at the European (Greenpeace, 2023) or global level (Kuhnhenn et al., 2021; Stay Grounded, 2019).

Hence, our findings, together with the literature, confirm that the unequal distribution of emissions depending on the flight distance means that aviation emission reduction policies should be proportional to the distance to offer a more considerable emissions reduction when targeting long-haul travel than when focusing on shorter flights (Wadud et al., 2024). However, the unequal distribution of emissions depends not only on the flight distance, but also on passengers, particularly frequent fliers, which are highly concentrated. Only 1 % of the world population is responsible for 50 % of commercial aviation emissions (Gössling and Humpe, 2020). Therefore, recent research points to the need for higher air travel taxes (Büchs and Mattioli, 2022), as the accumulated emissions of

Table 3
Air Passenger Duty rates from 1 April 2024.

Distance in miles from London)	Reduced rate (lowest class of travel)	Standard rate (1) (other than the lowest class of travel)	Higher rate (2)
Domestic band	£7	£14	£78
Band A (0 to 2,000 miles)	£13	£26	£78
Band B (2,001 to 5,500 miles)	£88	£194	£581
Band C (over 5,500 miles)	£92	£202	£607

(1) If any class of travel provides a seat pitch in excess of 1.016 m (40 in.) the standard rate is the minimum rate that applies.
(2) The higher rate applies to flights aboard aircraft of 20 tonnes and above with fewer than 19 seats.
Source: UK HM Revenue & Customs.

millionaires in 2050 will equal 72 % of the remaining carbon budget (Gössling and Humpe, 2023), continued growth in emissions at the top makes a low-carbon transition less likely.

Overall, we argue that demand management measures, such as the slot reductions proposed for Amsterdam Airport, are unlikely to substantially reduce emissions on their own. To be effective, such measures need to be implemented at a larger scale rather than at a single airport level (Niemeier and Forsyth, 2024) and must be complemented by broader regulatory mechanisms, such as carbon pricing, taxation, and expanded emissions trading schemes. However, as discussed above, these regulatory mechanisms also have their own limitations in delivering meaningful emissions reductions, often due to incomplete coverage or unintended market effects. Our findings reinforce the limitations of slot reductions as a standalone climate policy, as most scenarios show only marginal emission savings, and in cases where airlines respond by up-gauging (S5 Long distance), emissions may even increase due to a shift towards larger aircraft and longer flight distances. This confirms that slot constraints alone do not guarantee emission reductions and may, in some cases, reallocate rather than eliminate emissions. Given the limited scope of the EU ETS and the ineffectiveness of CORSIA in ensuring meaningful carbon pricing —and with little expectation that these schemes will undergo major structural reforms in the foreseeable future (Niemeier and Forsyth, 2024)—, and the limited progress on slot reform (Niemeier and Forsyth, 2023), additional measures such as expanding the EU ETS to long-haul flights, introducing distance-based taxation, or establishing a carbon price floor are supports to consider, even if the benefits are limited.

Beyond regulatory interventions, there is also a need to adopt a systemic socio-technical approach (Geels et al., 2017a) and a multi-level perspective (Geels et al., 2017b) to address the complex challenges of decarbonising aviation. This requires not only technological advancements and industrial regulatory changes but also a broader transformation of societal, cultural, and political frameworks, ensuring that climate policies in aviation are not only effective but also equitable. Without such comprehensive reforms, aviation decarbonisation efforts risk being unsystematic and insufficient in achieving long-term climate objectives.

5. Conclusions

In this paper, we have analysed the controversial government policy proposal to reduce slot capacity at Amsterdam Schiphol Airport. This policy intended to mitigate noise pollution first, but also was presented as favourable in terms of climate change impact. We analysed therefore different slot reduction risk scenarios to save fuel burnt (considered as a proxy for climate change impact) at the airport and discussed the results against policy trends. Our results show that this policy can be inefficient in the short term, as only one scenario, which focuses on significantly reducing the longest flights, more than matches the 12 % reduction of slots in terms of fuel burnt reduction. The fuel burnt reduction is also the weakest for the scenarios focusing on eliminating the shortest flights, including considering a shift-to-rail policy. This confirms previous research on the relevance of this type of policy (Dobruszkes et al., 2024; Reiter et al., 2022). Additionally, when we consider the long-term effects of aircraft up-gauging in the S5 scenario, a plausible scenario, we observe increasing emissions as the airport accommodates a more significant amount of larger aircraft that fly longer distances. Overall, the “tyranny of distance” is confirmed, as capacity constraints will not necessarily reduce the long-term fuel burn unless airline strategic reactions are considered and the longest flights are targeted.

Our findings also complement previous commercial research commissioned by Amsterdam Schiphol Airport (Delft, 2024; NLR, 2024; SEO, 2023). Only when retiring the longest flights, a significant fuel burnt reduction is achieved. Our results also point towards caution if that is to be done using a slot reduction strategy. Hence, such a strategy would need to be accompanied by additional measures to ensure that the long-haul flights are under control and serve the long-term ambitions of the airport. Additionally, should long-haul flights be cut at Amsterdam Schiphol Airport, they could reappear in other airports following the connecting vessel principle.

But is the Dutch case an isolated attempt or a major bifurcation in aviation policy? European institutions and part of the public have been increasingly concerned about climate change and quality of life. As a result, there has been growing contestation against airport expansion (e.g., Suau-Sanchez et al., 2011; Sack, 2014; Griggs and Howarth, 2016; Hilbrandt, 2016). Indeed, since 2020, expansion plans have been shelved in Paris-Charles de Gaulle, London-Heathrow,[9] and Brussels Airports. Some argue that climate concerns are behind a recent “airport capacity crunch” in Europe and that stopping airport expansion is “Europe’s unspoken plan to decarbonise aviation” (Cagney, 2024). As airport expansion has become more complex, Member States and the European Commission are focused

[9] London-Heathrow’s expansion has been reactivated in 2025 by the Labour Government. Still, the Mayor of London has opposed and judicial reviews are expected (BBC, 2025).

on better using existing capacity through EU reform on runway slots, ground handling and charges. Large airports have also focused more on asset upgrades than expansions, but we have seen more policies focusing on demand management. For example, the difficulties at Dublin Airport in approving their airport expansion led the Irish Aviation Authority to limit 2024–2025 winter capacity to 14.4 million seats and the 2025 summer season to 25.2 million seats, which is 1 million less than the 2024 summer season (IAA, 2024).

This paper also has limitations. While our D'Hondt method contributes methodologically to the literature, in a real-world context, our methodology needs to be applied carefully. If all airlines lose a similar proportion of their slots, this should, in theory, preserve the existing levels of competition at the airport. However, airline competition occurs at the route level and on each origin and destination market. This means that to fully follow the WASB guidelines and ensure non-intended competition effects, the correlation between route-level competition and overall market competition should be stable before and after the slot reduction. In that regard, the analysis of this paper could be expanded to cover in more detail the competition implications of the different scenarios, and the various noise and air quality implications of the scenarios, notably the S5 in which there is a growth in the use of wide-body aircraft.

CRediT authorship contribution statement

Pere Suau-Sanchez: Writing – review & editing, Writing – original draft, Visualization, Project administration, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Frédéric Dobruszkes:** Writing – review & editing, Visualization, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Giulio Mattioli:** Writing – review & editing, Validation, Conceptualization.

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Appendix

Table A1
Percentual change in frequency and fuel burnt per destination country and scenario. Ordered by variation of frequency in the S5 Long distance scenario.

	S2A Gov		S2B Dist		S2C Rail		S3 Equal Dist		S4 Short Dist		S5 Long Dist	
Country/Region	**Δ Freq**	**Δ Fuel**	**Δ Freq**	**Δ Fuel**	**Δ Freq**	**Δ Fuel**	**Δ Freq**	**Δ Fuel**	**Δ Freq**	**Δ Fuel**	**Δ Freq**	**Δ Fuel**
Sierra Leone	0 %	0 %	0 %	0 %	0 %	0 %	−11 %	−11 %	0 %	0 %	33 %	33 %
Senegal	0 %	0 %	0 %	0 %	0 %	0 %	−9%	−9%	0 %	0 %	30 %	30 %
Angola	0 %	0 %	0 %	0 %	0 %	0 %	−11 %	−11 %	0 %	0 %	30 %	30 %
Ghana	0 %	0 %	0 %	0 %	0 %	0 %	−11 %	−11 %	0 %	0 %	30 %	30 %
Costa Rica	0 %	0 %	0 %	0 %	0 %	0 %	−10 %	−10 %	−100 %	−100 %	29 %	29 %
Dominican Rep.	0 %	0 %	0 %	0 %	0 %	0 %	−10 %	−10 %	0 %	0 %	29 %	29 %
Tanzania	0 %	0 %	0 %	0 %	0 %	0 %	−11 %	−11 %	0 %	0 %	29 %	30 %
Colombia	0 %	0 %	0 %	0 %	0 %	0 %	−11 %	−11 %	−100 %	−100 %	29 %	29 %
Curaçao	0 %	0 %	0 %	0 %	0 %	0 %	−11 %	−11 %	0 %	0 %	29 %	29 %
Aruba	0 %	0 %	0 %	0 %	0 %	0 %	−11 %	−11 %	0 %	0 %	29 %	29 %
Argentina	0 %	0 %	0 %	0 %	0 %	0 %	−11 %	−11 %	−100 %	−100 %	29 %	29 %
Ecuador	0 %	0 %	0 %	0 %	0 %	0 %	−11 %	−11 %	−100 %	−100 %	29 %	29 %
Malaysia	0 %	0 %	0 %	0 %	0 %	0 %	−11 %	−11 %	−100 %	−100 %	29 %	29 %
Nigeria	0 %	0 %	0 %	0 %	0 %	0 %	−11 %	−11 %	0 %	0 %	29 %	29 %
Panama	0 %	0 %	0 %	0 %	0 %	0 %	−11 %	−11 %	−81 %	−82 %	29 %	29 %
Peru	0 %	0 %	0 %	0 %	0 %	0 %	−11 %	−11 %	−100 %	−100 %	29 %	29 %

(*continued on next page*)

Table A1 (*continued*)

	S2A Gov		S2B Dist		S2C Rail		S3 Equal Dist		S4 Short Dist		S5 Long Dist	
Country/Region	**Δ Freq**	**Δ Fuel**	**Δ Freq**	**Δ Fuel**	**Δ Freq**	**Δ Fuel**	**Δ Freq**	**Δ Fuel**	**Δ Freq**	**Δ Fuel**	**Δ Freq**	**Δ Fuel**
Rwanda	0 %	0 %	0 %	0 %	0 %	0 %	−11 %	−11 %	0 %	0 %	29 %	29 %
South Africa	0 %	0 %	0 %	0 %	0 %	0 %	−11 %	−11 %	−100 %	−100 %	29 %	29 %
Cape Verde	0 %	0 %	0 %	0 %	0 %	0 %	−11 %	−11 %	0 %	0 %	29 %	29 %
Bonaire	0 %	0 %	0 %	0 %	0 %	0 %	−11 %	−11 %	0 %	0 %	29 %	29 %
Saudi Arabia	0 %	0 %	0 %	0 %	0 %	0 %	−11 %	−11 %	0 %	0 %	29 %	29 %
Japan	0 %	0 %	0 %	0 %	0 %	0 %	−11 %	−11 %	−100 %	−100 %	29 %	29 %
Brazil	0 %	0 %	0 %	0 %	0 %	0 %	−11 %	−11 %	−79 %	−84 %	29 %	29 %
Kuwait	0 %	0 %	0 %	0 %	0 %	0 %	−11 %	−11 %	0 %	0 %	29 %	29 %
Cuba	0 %	0 %	0 %	0 %	0 %	0 %	−11 %	−11 %	0 %	0 %	29 %	29 %
Sint Maarten	0 %	0 %	0 %	0 %	0 %	0 %	−11 %	−11 %	0 %	0 %	29 %	29 %
Sri Lanka	0 %	0 %	0 %	0 %	0 %	0 %	−12 %	−12 %	0 %	0 %	28 %	28 %
Canada	−3%	−3%	0 %	0 %	0 %	0 %	−11 %	−11 %	−3%	−3%	26 %	26 %
Thailand	−3%	−3%	0 %	0 %	0 %	0 %	−11 %	−11 %	−100 %	−100 %	25 %	25 %
India	−4%	−5%	0 %	0 %	0 %	0 %	−11 %	−11 %	−4%	−5%	24 %	23 %
Taiwan	−4%	−4%	0 %	0 %	0 %	0 %	−11 %	−11 %	−100 %	−100 %	24 %	24 %
Korea, Rep. of	−4%	−4%	0 %	0 %	0 %	0 %	−11 %	−11 %	−4%	−4%	24 %	24 %
Gambia	−4%	−4%	0 %	0 %	0 %	0 %	−11 %	−11 %	−4%	−4%	24 %	24 %
Suriname	−4%	−4%	0 %	0 %	0 %	0 %	−11 %	−11 %	−4%	−4%	23 %	24 %
China	−5%	−5%	0 %	0 %	0 %	0 %	−11 %	−11 %	−65 %	−70 %	23 %	23 %
Hong Kong	−5%	−5%	0 %	0 %	0 %	0 %	−11 %	−11 %	−100 %	−100 %	22 %	22 %
Kenya	−6%	−5%	0 %	0 %	0 %	0 %	−11 %	−11 %	−6%	−5%	22 %	22 %
Mexico	−5%	−5%	0 %	0 %	0 %	0 %	−11 %	−11 %	−100 %	−100 %	22 %	23 %
Singapore	−5%	−5%	0 %	0 %	0 %	0 %	−11 %	−11 %	−100 %	−100 %	22 %	23 %
Mauritius	−6%	−7%	0 %	0 %	0 %	0 %	−11 %	−11 %	−100 %	−100 %	21 %	20 %
United Arab Emirates	−7%	−8%	0 %	0 %	0 %	0 %	−11 %	−11 %	−7%	−8%	20 %	19 %
United States	−7%	−7%	0 %	0 %	0 %	0 %	−11 %	−11 %	−12 %	−14 %	20 %	20 %
Iran	−11 %	−11 %	0 %	0 %	0 %	0 %	−11 %	−11 %	−11 %	−11 %	15 %	15 %
Indonesia	−11 %	−11 %	0 %	0 %	0 %	0 %	−11 %	−11 %	−100 %	−100 %	15 %	15 %
Qatar	−11 %	−11 %	0 %	0 %	0 %	0 %	−11 %	−11 %	−11 %	−11 %	15 %	15 %
Albania	0 %	0 %	0 %	0 %	0 %	0 %	−10 %	−10 %	0 %	0 %	0 %	0 %
Cyprus	0 %	0 %	0 %	0 %	0 %	0 %	−11 %	−11 %	0 %	0 %	0 %	0 %
Hungary	0 %	0 %	0 %	0 %	0 %	0 %	−11 %	−11 %	0 %	0 %	0 %	0 %
Lebanon	0 %	0 %	0 %	0 %	0 %	0 %	−11 %	−11 %	0 %	0 %	0 %	0 %

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Table A1 (*continued*)

	S2A Gov		S2B Dist		S2C Rail		S3 Equal Dist		S4 Short Dist		S5 Long Dist	
Country/Region	Δ **Freq**	Δ **Fuel**	Δ **Freq**	Δ **Fuel**	Δ **Freq**	Δ **Fuel**	Δ **Freq**	Δ **Fuel**	Δ **Freq**	Δ **Fuel**	Δ **Freq**	Δ **Fuel**
Sweden	−1%	−1%	0 %	0 %	0 %	0 %	−11 %	−11 %	−1%	−1%	−1%	−1%
Switzerland	−2%	−2%	0 %	0 %	0 %	0 %	−11 %	−11 %	−2%	−2%	−2%	−2%
Norway	−2%	−3%	0 %	0 %	0 %	0 %	−11 %	−11 %	−2%	−3%	−2%	−3%
Spain	−2%	−2%	0 %	0 %	0 %	0 %	−11 %	−11 %	−2%	−2%	−2%	−2%
Denmark	−3%	−3%	0 %	0 %	0 %	0 %	−11 %	−11 %	−3%	−3%	−3%	−3%
Czech Rep.	−3%	−3%	0 %	0 %	0 %	0 %	−11 %	−11 %	−3%	−3%	−3%	−3%
Portugal	−3%	−3%	0 %	0 %	0 %	0 %	−11 %	−11 %	−3%	−3%	−3%	−3%
Italy	−3%	−3%	0 %	0 %	0 %	0 %	−11 %	−11 %	−3%	−3%	−3%	−3%
Greece	−3%	−3%	0 %	0 %	0 %	0 %	−11 %	−11 %	−3%	−3%	−3%	−3%
Finland	−4%	−4%	0 %	0 %	0 %	0 %	−11 %	−11 %	−4%	−4%	−4%	−4%
Israel	−4%	−4%	0 %	0 %	0 %	0 %	−11 %	−11 %	−4%	−4%	−4%	−4%
Romania	−5%	−5%	0 %	0 %	0 %	0 %	−11 %	−11 %	−5%	−5%	−5%	−5%
Poland	−5%	−5%	0 %	0 %	0 %	0 %	−11 %	−11 %	−5%	−5%	−5%	−5%
Russian Federation	−5%	−6%	0 %	0 %	0 %	0 %	−11 %	−11 %	−5%	−6%	−5%	−6%
Ukraine	−5%	−6%	0 %	0 %	0 %	0 %	−11 %	−11 %	−5%	−6%	−5%	−6%
Croatia	−6%	−6%	0 %	0 %	0 %	0 %	−11 %	−11 %	−6%	−6%	−6%	−6%
Morocco	−6%	−6%	0 %	0 %	0 %	0 %	−11 %	−11 %	−6%	−6%	−6%	−6%
Serbia	−7%	−7%	0 %	0 %	0 %	0 %	−11 %	−11 %	−7%	−7%	−7%	−7%
Ireland	−7%	−8%	0 %	0 %	0 %	0 %	−11 %	−11 %	−7%	−8%	−7%	−8%
Bulgaria	−8%	−7%	0 %	0 %	0 %	0 %	−11 %	−11 %	−8%	−7%	−8%	−7%
France	−8%	−7%	0 %	0 %	−32 %	−27 %	−11 %	−11 %	−8%	−7%	−8%	−7%
Egypt	−9%	−9%	0 %	0 %	0 %	0 %	−11 %	−11 %	−9%	−9%	−9%	−9%
Jordan	−9%	−9%	0 %	0 %	0 %	0 %	−11 %	−11 %	−9%	−9%	−9%	−9%
Turkey	−9%	−9%	0 %	0 %	0 %	0 %	−11 %	−11 %	−9%	−9%	−9%	−9%
Iceland	−10 %	−10 %	0 %	0 %	0 %	0 %	−11 %	−11 %	−10 %	−10 %	−10 %	−10 %
Belarus	−11 %	−11 %	0 %	0 %	0 %	0 %	−11 %	−11 %	−11 %	−11 %	−11 %	−11 %
Latvia	−11 %	−11 %	0 %	0 %	0 %	0 %	−11 %	−11 %	−11 %	−11 %	−11 %	−11 %
Estonia	−11 %	−11 %	0 %	0 %	0 %	0 %	−11 %	−11 %	−11 %	−11 %	−11 %	−11 %
Malta	−11 %	−11 %	0 %	0 %	0 %	0 %	−11 %	−11 %	−11 %	−11 %	−11 %	−11 %
Lithuania	−11 %	−11 %	0 %	0 %	0 %	0 %	−11 %	−11 %	−11 %	−11 %	−11 %	−11 %
Georgia	−11 %	−11 %	0 %	0 %	0 %	0 %	−11 %	−11 %	−11 %	−11 %	−11 %	−11 %
Kazakhstan	−11 %	−11 %	0 %	0 %	0 %	0 %	−11 %	−11 %	−11 %	−11 %	−11 %	−11 %
Austria	−15 %	−14 %	0 %	0 %	0 %	0 %	−11 %	−11 %	−15 %	−14 %	−15 %	−14 %

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Table A1 (*continued*)

	S2A Gov		S2B Dist		S2C Rail		S3 Equal Dist		S4 Short Dist		S5 Long Dist	
Country/Region	**Δ Freq**	**Δ Fuel**	**Δ Freq**	**Δ Fuel**	**Δ Freq**	**Δ Fuel**	**Δ Freq**	**Δ Fuel**	**Δ Freq**	**Δ Fuel**	**Δ Freq**	**Δ Fuel**
Germany	−31 %	–22 %	−25 %	−16 %	–33 %	−25 %	−11 %	−11 %	−18 %	−14 %	−31 %	–22 %
Tunisia	−36 %	−44 %	0 %	0 %	0 %	0 %	−11 %	−11 %	−36 %	−44 %	−36 %	−44 %
United Kingdom	−18 %	−15 %	−37 %	−35 %	−26 %	−24 %	−11 %	−11 %	−9%	−9%	−39 %	−37 %
Slovenia	−51 %	−58 %	0 %	0 %	0 %	0 %	−11 %	−11 %	−51 %	−58 %	−51 %	−58 %
Macedonia	−68 %	−66 %	0 %	0 %	0 %	0 %	−11 %	−11 %	−68 %	−66 %	−68 %	−66 %
Belgium	−100 %	−100 %	−100 %	−100 %	−100 %	−100 %	−11 %	−11 %	0 %	0 %	−100 %	−100 %
Luxembourg	−100 %	−100 %	−100 %	−100 %	0 %	0 %	−11 %	−11 %	0 %	0 %	−100 %	−100 %
Netherlands	−14 %	−15 %	−100 %	−100 %	−100 %	−100 %	−12 %	−12 %	0 %	0 %	−100 %	−100 %

Source: Own calculations based on OAG

Table A2
Percentual change in frequency and fuel burnt per airline and scenario. Ordered by market share in S1 Baseline scenario.

	S1 Baseline	S2A Gov		S2B Dist		S2C Rail		S3 Equal Dist		S4 Short Dist		S5 Long Dist	
Airline	**Market Share**	**Δ Freq**	**Δ Fuel**	**Δ Freq**	**Δ Fuel**	**Δ Freq**	**Δ Fuel**	**Δ Freq**	**Δ Fuel**	**Δ Freq**	**Δ Fuel**	**Δ Freq**	**Δ Fuel**
KLM	52.8 %	−11 %	−1%	−10 %	−1%	−9%	−1%	−11 %	−11 %	−11 %	−40 %	−7%	21 %
Easyjet	8.2 %	−11 %	−7%	−34 %	–23 %	−29 %	−20 %	−11 %	−11 %	−1%	−1%	−34 %	–23 %
Transavia	6.4 %	−11 %	−6%	0 %	0 %	−2%	−1%	−11 %	−11 %	−11 %	−6%	−11 %	−5%
Delta Air Lines	2.6 %	−11 %	−11 %	0 %	0 %	0 %	0 %	−11 %	−11 %	−13 %	−14 %	15 %	15 %
Flybe	2.5 %	−11 %	−9%	−7%	−5%	−7%	−5%	−11 %	−11 %	−4%	−4%	−11 %	−9%
British Airways	2.4 %	−11 %	−11 %	−100 %	−100 %	−48 %	−41 %	−11 %	−11 %	−11 %	−11 %	−100 %	−100 %
Air France	1.9 %	−11 %	−8%	0 %	0 %	−48 %	−53 %	−11 %	−11 %	−11 %	−8%	−11 %	−8%
Lufthansa	1.7 %	−11 %	−11 %	0 %	0 %	−52 %	−46 %	−11 %	−11 %	−11 %	−11 %	−11 %	−11 %
Vueling Airlines	1.7 %	−11 %	−5%	−10 %	−4%	−10 %	−4%	−11 %	−11 %	−11 %	−5%	−11 %	−5%
TUI fly Netherlands	1.2 %	−11 %	−3%	0 %	0 %	0 %	0 %	−11 %	−11 %	−11 %	−3%	1 %	17 %
SAS	1.2 %	−11 %	−11 %	0 %	0 %	0 %	0 %	−11 %	−11 %	−11 %	−11 %	−11 %	−11 %
Aer Lingus	0.8 %	−11 %	−11 %	0 %	0 %	0 %	0 %	−11 %	−11 %	−11 %	−11 %	−11 %	−11 %
Turkish Airlines	0.8 %	−11 %	−11 %	0 %	0 %	0 %	0 %	−11 %	−11 %	−11 %	−11 %	−11 %	−11 %
Alitalia	0.8 %	−11 %	−11 %	0 %	0 %	0 %	0 %	−11 %	−11 %	−11 %	−11 %	−11 %	−11 %
Ryanair	0.7 %	−11 %	−11 %	0 %	0 %	0 %	0 %	−11 %	−11 %	−11 %	−11 %	−11 %	−11 %
United Airlines	0.7 %	−11 %	−11 %	0 %	0 %	0 %	0 %	−11 %	−11 %	−11 %	−11 %	15 %	15 %
Austrian Airlines	0.6 %	−11 %	−11 %	0 %	0 %	0 %	0 %	−11 %	−11 %	−11 %	−11 %	−11 %	−11 %
SWISS	0.6 %	−11 %	−11 %	0 %	0 %	0 %	0 %	−11 %	−11 %	−11 %	−11 %	−11 %	−11 %
TAP Air Portugal	0.6 %	−11 %	−11 %	0 %	0 %	0 %	0 %	−11 %	−11 %	−11 %	−11 %	−11 %	−11 %
Air Baltic	0.6 %	−11 %	−11 %	0 %	0 %	0 %	0 %	−11 %	−11 %	−11 %	−11 %	−11 %	−11 %

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Table A2 (*continued*)

	S1 Baseline	S2A Gov		S2B Dist		S2C Rail		S3 Equal Dist		S4 Short Dist		S5 Long Dist	
Airline	**Market Share**	**Δ Freq**	**Δ Fuel**	**Δ Freq**	**Δ Fuel**	**Δ Freq**	**Δ Fuel**	**Δ Freq**	**Δ Fuel**	**Δ Freq**	**Δ Fuel**	**Δ Freq**	**Δ Fuel**
LEVEL	0.6 %	−11 %	−5%	–23 %	−11 %	–23 %	−11 %	−11 %	−11 %	−11 %	−5%	–23 %	−11 %
Pegasus Airlines	0.5 %	−11 %	−11 %	0 %	0 %	0 %	0 %	−11 %	−11 %	−11 %	−11 %	−11 %	−11 %
LOT	0.5 %	−11 %	−11 %	0 %	0 %	0 %	0 %	−11 %	−11 %	−11 %	−11 %	−11 %	−11 %
Corendon	0.5 %	−11 %	−11 %	−1%	0 %	−1%	0 %	−11 %	−11 %	−11 %	−11 %	−10 %	−9%
Norwegian A.S	0.5 %	−11 %	−3%	0 %	0 %	0 %	0 %	−11 %	−11 %	−11 %	−3%	−1%	19 %
Aeroflot	0.5 %	−11 %	−11 %	0 %	0 %	0 %	0 %	−11 %	−11 %	−11 %	−11 %	−11 %	−11 %
Eurowings	0.4 %	−11 %	−10 %	0 %	0 %	0 %	0 %	−11 %	−11 %	−11 %	−10 %	−11 %	−10 %
Emirates	0.4 %	−11 %	−11 %	0 %	0 %	0 %	0 %	−11 %	−11 %	−11 %	−11 %	15 %	15 %
Air Europa	0.3 %	−11 %	−11 %	0 %	0 %	0 %	0 %	−11 %	−11 %	−11 %	−11 %	−11 %	−11 %
Finnair	0.3 %	−11 %	−11 %	0 %	0 %	0 %	0 %	−11 %	−11 %	−11 %	−11 %	−11 %	−11 %
Iberia	0.3 %	−11 %	−11 %	0 %	0 %	0 %	0 %	−11 %	−11 %	−11 %	−11 %	−11 %	−11 %
China Southern	0.3 %	−11 %	−11 %	0 %	0 %	0 %	0 %	−11 %	−11 %	−56 %	−59 %	15 %	15 %
Czech Airlines	0.3 %	−11 %	−11 %	0 %	0 %	0 %	0 %	−11 %	−11 %	−11 %	−11 %	−11 %	−11 %
Tarom	0.3 %	−11 %	−11 %	0 %	0 %	0 %	0 %	−11 %	−11 %	−11 %	−11 %	−11 %	−11 %
Air Arabia Maroc	0.2 %	−11 %	−11 %	0 %	0 %	0 %	0 %	−11 %	−11 %	−11 %	−11 %	−11 %	−11 %
El Al Israel Airlines	0.2 %	−11 %	−11 %	0 %	0 %	0 %	0 %	−11 %	−11 %	−11 %	−11 %	−11 %	−11 %
Icelandair	0.2 %	−11 %	−11 %	0 %	0 %	0 %	0 %	−11 %	−11 %	−11 %	−11 %	−11 %	−11 %
Royal Air Maroc	0.2 %	−11 %	−11 %	0 %	0 %	0 %	0 %	−11 %	−11 %	−11 %	−11 %	−11 %	−11 %
American Airlines	0.2 %	−11 %	−11 %	0 %	0 %	0 %	0 %	−11 %	−11 %	−11 %	−11 %	15 %	15 %
Air Serbia	0.2 %	−11 %	−11 %	0 %	0 %	0 %	0 %	−11 %	−11 %	−11 %	−11 %	−11 %	−11 %
Jet Airways	0.2 %	−11 %	−11 %	0 %	0 %	0 %	0 %	−11 %	−11 %	−11 %	−11 %	15 %	15 %
SunExpress	0.2 %	−11 %	−11 %	0 %	0 %	0 %	0 %	−11 %	−11 %	−11 %	−11 %	−11 %	−11 %
Croatia Airlines	0.2 %	−11 %	−11 %	0 %	0 %	0 %	0 %	−11 %	−11 %	−11 %	−11 %	−11 %	−11 %
Kenya Airways	0.2 %	−11 %	−11 %	0 %	0 %	0 %	0 %	−11 %	−11 %	−11 %	−11 %	15 %	15 %
Corendon Airlines	0.2 %	−11 %	−11 %	0 %	0 %	0 %	0 %	−11 %	−11 %	−11 %	−11 %	−11 %	−11 %
Etihad Airways	0.2 %	−11 %	−11 %	0 %	0 %	0 %	0 %	−11 %	−11 %	−11 %	−11 %	15 %	15 %
Aegean Airlines	0.2 %	−11 %	−11 %	0 %	0 %	0 %	0 %	−11 %	−11 %	−11 %	−11 %	−11 %	−11 %
Aeromexico	0.2 %	−11 %	−11 %	0 %	0 %	0 %	0 %	−11 %	−11 %	−100 %	−100 %	15 %	15 %
Cathay Pacific	0.2 %	−11 %	−11 %	0 %	0 %	0 %	0 %	−11 %	−11 %	−100 %	−100 %	15 %	15 %
Egyptair	0.2 %	−11 %	−11 %	0 %	0 %	0 %	0 %	−11 %	−11 %	−11 %	−11 %	−11 %	−11 %
Qatar Airways	0.2 %	−11 %	−11 %	0 %	0 %	0 %	0 %	−11 %	−11 %	−11 %	−11 %	15 %	15 %
Singapore Airlines	0.2 %	−11 %	−11 %	0 %	0 %	0 %	0 %	−11 %	−11 %	−100 %	−100 %	15 %	15 %
Ukraine International	0.2 %	−11 %	−11 %	0 %	0 %	0 %	0 %	−11 %	−11 %	−11 %	−11 %	−11 %	−11 %

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Table A2 (*continued*)

	S1 Baseline	S2A Gov		S2B Dist		S2C Rail		S3 Equal Dist		S4 Short Dist		S5 Long Dist	
Airline	**Market Share**	**Δ Freq**	**Δ Fuel**	**Δ Freq**	**Δ Fuel**	**Δ Freq**	**Δ Fuel**	**Δ Freq**	**Δ Fuel**	**Δ Freq**	**Δ Fuel**	**Δ Freq**	**Δ Fuel**
AtlasGlobal	0.2 %	−11 %	−11 %	0 %	0 %	0 %	0 %	−11 %	−11 %	−11 %	−11 %	−11 %	−11 %
Bulgaria Air	0.2 %	−11 %	−11 %	0 %	0 %	0 %	0 %	−11 %	−11 %	−11 %	−11 %	−11 %	−11 %
Jet2.com	0.1 %	−11 %	−11 %	0 %	0 %	0 %	0 %	−11 %	−11 %	−11 %	−11 %	−11 %	−11 %
Belavia	0.1 %	−11 %	−11 %	0 %	0 %	0 %	0 %	−11 %	−11 %	−11 %	−11 %	−11 %	−11 %
Norwegian	0.1 %	−11 %	−11 %	0 %	0 %	0 %	0 %	−11 %	−11 %	−11 %	−11 %	−11 %	−11 %
Air Malta	0.1 %	−11 %	−11 %	0 %	0 %	0 %	0 %	−11 %	−11 %	−11 %	−11 %	−11 %	−11 %
Garuda Indonesia	0.1 %	−11 %	−11 %	0 %	0 %	0 %	0 %	−11 %	−11 %	−100 %	−100 %	15 %	15 %
Air Canada	0.1 %	−11 %	−11 %	0 %	0 %	0 %	0 %	−11 %	−11 %	−11 %	−11 %	15 %	15 %
Korean Air	0.1 %	−11 %	−11 %	0 %	0 %	0 %	0 %	−11 %	−11 %	−11 %	−11 %	16 %	16 %
Adria Airways	0.1 %	−11 %	−11 %	0 %	0 %	0 %	0 %	−11 %	−11 %	−11 %	−11 %	−11 %	−11 %
Transavia. France	0.1 %	−11 %	−11 %	0 %	0 %	−100 %	−100 %	−11 %	−11 %	−11 %	−11 %	−11 %	−11 %
Air Astana	0.1 %	−11 %	−11 %	0 %	0 %	0 %	0 %	−11 %	−11 %	−11 %	−11 %	−11 %	−11 %
China Airlines	0.1 %	−11 %	−11 %	0 %	0 %	0 %	0 %	−11 %	−11 %	−100 %	−100 %	15 %	15 %
China Eastern	0.1 %	−11 %	−11 %	0 %	0 %	0 %	0 %	−11 %	−11 %	−100 %	−100 %	15 %	15 %
Royal Jordanian	0.1 %	−11 %	−11 %	0 %	0 %	0 %	0 %	−11 %	−11 %	−11 %	−11 %	−11 %	−11 %
Surinam Airways	0.1 %	−11 %	−11 %	0 %	0 %	0 %	0 %	−11 %	−11 %	−11 %	−11 %	15 %	15 %
EVA Airways	0.1 %	−10 %	−10 %	0 %	0 %	0 %	0 %	−10 %	−10 %	−100 %	−100 %	16 %	16 %
Air Transat	0.1 %	−11 %	−11 %	0 %	0 %	0 %	0 %	−11 %	−11 %	−11 %	−11 %	15 %	15 %
Xiamen Airlines	0.1 %	−11 %	−11 %	0 %	0 %	0 %	0 %	−11 %	−11 %	−100 %	−100 %	15 %	15 %
Iran Air	0.0 %	−11 %	−11 %	0 %	0 %	0 %	0 %	−11 %	−11 %	−11 %	−11 %	15 %	15 %
Onur Air Tasimacilik	0.0 %	−10 %	−9%	0 %	0 %	0 %	0 %	−10 %	−10 %	−10 %	−9%	−10 %	−9%
Georgian Airways	0.0 %	−11 %	−11 %	0 %	0 %	0 %	0 %	−11 %	−11 %	−11 %	−11 %	−11 %	−11 %
Arkia – Israeli Airlines	0.0 %	−11 %	−11 %	0 %	0 %	0 %	0 %	−11 %	−11 %	−11 %	−11 %	−11 %	−11 %
WOW Air	0.0 %	−11 %	−11 %	0 %	0 %	0 %	0 %	−11 %	−11 %	−11 %	−11 %	−11 %	−11 %
Tunisair	0.0 %	−11 %	−11 %	0 %	0 %	0 %	0 %	−11 %	−11 %	−11 %	−11 %	−11 %	−11 %
Air Mauritius	0.0 %	−10 %	−10 %	0 %	0 %	0 %	0 %	−10 %	−10 %	−100 %	−100 %	16 %	16 %
KLM Cityhopper	0.0 %	−12 %	−12 %	−100 %	−100 %	−100 %	−100 %	−12 %	−12 %	0 %	0 %	−100 %	−100 %
Air Antwerp	0.0 %	−12 %	−12 %	0 %	0 %	0 %	0 %	−12 %	−12 %	−12 %	−12 %	−12 %	−12 %
Ural Airlines	0.0 %	−11 %	−11 %	0 %	0 %	0 %	0 %	−11 %	−11 %	−11 %	−11 %	−11 %	−11 %
Corendon Europe	0.0 %	−12 %	−4%	−6%	−1%	−6%	−1%	−12 %	−13 %	−6%	−3%	−12 %	−4%
Flynas	0.0 %	−14 %	−14 %	0 %	0 %	0 %	0 %	−14 %	−14 %	−14 %	−14 %	14 %	14 %
TUI fly Belgium	0.0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %

Source: Own calculations based on OAG

Data availability

Data will be made available on request.

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