

ECONOMIC IMPACT ASSESSMENT

Modelling the Economic Impacts of Heathrow Expansion

Consultancy report prepared for Heathrow Airport Limited

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Date	25 September 2026
Authors	Lynnette Dray, Khan Doyme, Yagmur Simge Gok, Andreas W Schäfer
Prepared by	Air Transportation Systems Lab, UCL

Independent analysis by UCL Air Transportation Systems Lab

atslab.org | University College London

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Executive Summary

This study examines the potential economic impacts of expanding Heathrow Airport, focusing on how additional runway capacity affects airline behaviour, passenger demand, fares, competition between London airports, airline profitability, consumer welfare and aviation CO₂ emissions. The analysis uses the UCL ATSlab's Airline Behaviour Model (ABM), which explicitly represents competition between airlines and passenger choices and allows airlines to adjust fares, flight frequencies, aircraft deployment and networks in response to changing airport capacity, costs and market conditions. The analysis covers intra-European and Transatlantic aviation, representing around 70% of Heathrow's current operations.

Key Findings

- Heathrow expansion increases traffic across the London airport system, while also redistributing some traffic between airports. By 2050, London airport flights are around 108,000 (9%) higher and passenger movements 6.8 million (4%) higher with expansion. Passenger numbers at other London airports nevertheless continue to grow, although some grow less than without Heathrow expansion.
- Expansion substantially reduces the scarcity premium associated with Heathrow's capacity constraint. In the core 2050 scenario, the average Heathrow economy fare is around 17% lower with expansion, due to a combination of a decrease in average flight length and reduction in the scarcity premium. Fares also decline at the other London airports as a result of competitive effects.
- Passengers benefit, while airline profits are reduced. By 2050, Heathrow expansion produces an estimated £3.05 billion annual increase in consumer surplus for UK origin and destination passengers, alongside a £1.16 billion reduction in airline producer surplus across all airlines. Airline operating profit margins nevertheless remain positive and above their 2025 level in both scenarios.
- In the core scenarios, the pre-expansion impact on demand of increasing landing charges to fund expansion is small. However, larger increases in landing charges than anticipated could have a material impact on passenger and flight movements.
- Expansion strengthens Heathrow's role as a hub. Within the markets modelled, Heathrow's flow centrality—a measure of its importance as a connecting hub—is approximately 30% higher with expansion than without it.
- Expansion increases UK-attributable aviation CO₂ emissions relative to the no-expansion case. In 2050, modelled UK-departing aviation CO₂ increases from 8.25 Mt to 8.72 Mt, or approximately 0.5 Mt, under the assumption of a 70% UK and EU departing flights SAF mandate. Carbon leakage effects arise from changes in international traffic patterns and asymmetric SAF policies.
- The main findings are robust across the alternative scenarios examined, although their magnitude varies. Lower economic growth, higher airport charges, constrained aircraft availability and higher fuel prices slow the uptake of additional capacity, but do not fundamentally change the principal effects of Heathrow expansion.

The core analysis compares a future in which planned airport expansion occurs without Heathrow expansion (2R) with one in which Heathrow is also expanded (3R). Heathrow expansion is based on the airport's 2025 expansion proposal (HAL, 2025) and is assumed to increase annual airport capacity from around 480,000 to 756,000 aircraft movements. The

scenarios are modelled to 2050 and incorporate projected changes in economic growth, airport charges, fuel and carbon prices, sustainable aviation fuel (SAF) policy, aircraft technology and fleet renewal. Sensitivity analyses examine lower economic growth, higher and lower Heathrow charges, constrained aircraft availability, higher fuel prices and a reduction in Air Passenger Duty (APD).

A principal finding is that Heathrow expansion generates additional traffic across the London airport system, rather than simply redistributing existing traffic between airports. Under the core assumptions, expansion increases modelled Heathrow flights in 2050 by around 45% and passenger movements by around 34% relative to the 2R case. Some activity relocates from other London airports to Heathrow, particularly from Stansted and Luton, but this displacement is substantially smaller than the increase at Heathrow. Consequently, total modelled London airport flights are around 9% higher with Heathrow expansion, while passenger movements are around 4% higher. The smaller increase in passengers than flights partly reflects airlines' ability to use smaller aircraft once Heathrow's capacity constraint is relaxed.

Expansion also changes fares and the competitive structure of the London airport market. Capacity constraints at Heathrow generate scarcity rents: airlines can charge higher fares because the number of flights is constrained. Expansion reduces these rents and enables airlines to offer higher frequencies and additional direct itineraries. It also allows the airport to maintain shorter direct routes which would otherwise be dropped due to capacity constraints, leading to a decrease in average flight length with expansion. In the core 2050 scenario, the average Heathrow economy fare is around 17% lower with expansion. Competitive effects extend beyond Heathrow, with fares also falling at other London airports. At the same time, Heathrow's importance as a hub increases: its modelled flow centrality is approximately 30% higher in the 3R than the 2R case.

These changes produce significant but contrasting effects for passengers and airlines. Following expansion, lower fares and a wider range of itineraries generate substantial gains in consumer welfare: by 2050, consumer surplus for UK arriving and departing passengers is around £3.1 billion per year higher in the core 3R scenario than in the 2R scenario. Airline producer surplus across all airlines is lower, however, by around £1.2 billion, principally because lower fares reduce airline profit margins. Nevertheless, modelled system-wide airline operating profit margins remain positive and are higher in 2050 than in 2025 in both the 2R and 3R scenarios.

The direction of these central results is maintained under the alternative scenarios explored, although their magnitude is sensitive to future conditions. Lower UK economic growth slows the uptake of new capacity and reduces switching between airports, but Heathrow remains capacity-constrained before expansion and expansion still increases both Heathrow and London-wide demand while reducing fares. Under these assumptions, Heathrow flights increase by around 28% and passenger movements by around 23% relative to the corresponding 2R case. London-wide increases remain smaller as some traffic is redistributed between airports.

Airport charges, aircraft availability and fuel prices materially affect the rate at which additional capacity is used. Higher Heathrow charges can temporarily reduce demand below existing capacity before the third runway opens, while lower charges stimulate demand. Constraints on the availability of new aircraft slow growth and cause airlines to retain older aircraft or use aircraft that are less well matched to particular routes. Higher fuel prices also reduce demand and encourage the use of larger aircraft to reduce fuel cost per passenger, with low-cost

carriers particularly affected. Reducing APD stimulates demand, with the strongest effects at airports and airlines serving more price-sensitive passengers.

Heathrow expansion also increases UK-attributable aviation CO₂ emissions relative to the no-expansion case. Under the fuel and SAF assumptions used in the study, which include a 70% SAF mandate for UK and EU departing flights, modelled UK-departing aviation CO₂ in 2050 increases from approximately 8.25 Mt in the 2R case to 8.72 Mt in the 3R case, an increase of around 0.5 Mt. However, the geographic distribution of emissions is complex. Expansion reduces emissions attributable to some countries containing competing European hubs, while increasing emissions in the UK and North America. Carbon leakage is particularly relevant on Transatlantic routes because the scenarios assume asymmetric SAF mandates between outbound and inbound flights.

Overall, the modelling indicates that Heathrow expansion is likely to generate additional demand rather than simply redistribute a fixed volume of traffic among London airports. It reduces capacity scarcity, lowers fares, increases passenger choice and consumer welfare, and strengthens Heathrow's hub role, while reducing airline producer surplus and increasing aviation CO₂ emissions relative to a no-expansion scenario. The magnitude of these effects is uncertain and depends particularly on future economic growth, fuel prices, airport charges and aircraft availability. The analysis is limited to intra-European and Transatlantic markets; extending the model to faster-growing markets, particularly Europe–Asia, would provide a more complete assessment of future capacity pressures and the effects of Heathrow expansion.

1. Introduction

1.1 Economic Impacts of Heathrow Expansion

Heathrow Airport has for many years sought permission to construct a third runway to address chronic capacity constraints at the UK's only hub airport. The proposed northwest runway would increase annual capacity from around 480,000 to 756,000 aircraft movements, enabling Heathrow to serve up to 150 million passengers per year, expand long-haul connectivity, and accommodate future growth in passenger and freight demand.

The objective of this work is to provide a better understanding of the economic impacts of this expansion on airlines and passengers, including how competing airlines respond to capacity increases by changing their operations and the itineraries and fares they offer, and how passengers respond to these changes. The analysis is limited to the European and Transatlantic market, accounting for 70% of Heathrow's traffic in 2025, and is carried out with the UCL ATSlab's Airline Behaviour Model (ABM; Doyme et al., 2019).

1.2 Description of the Airline Behaviour Model

The Airline Behaviour Model (ABM) is an aviation systems model that simulates how airline competitive behaviour affects aviation system response to changes such as fuel price increases, capacity expansion, new policies, or new technology availability. It represents the supply side of airline networks through the profit-maximizing behaviour of competing air carriers, with segment flight frequencies, itinerary airfares, and aircraft deployment as key decision variables. Passengers in turn choose itineraries based on utility maximization. For this study, we used the transatlantic version of the ABM, which simulates intra-European, intra-North American, and Transatlantic flights, accounting for around 70% of Heathrow's operations. The scope of the

model, in terms of broad aircraft size class, is shown in Figure 1. The current representation includes 237 airports in Europe and 84 airports in North America, connected initially with 25,160 itineraries and 12,542 flight segments.

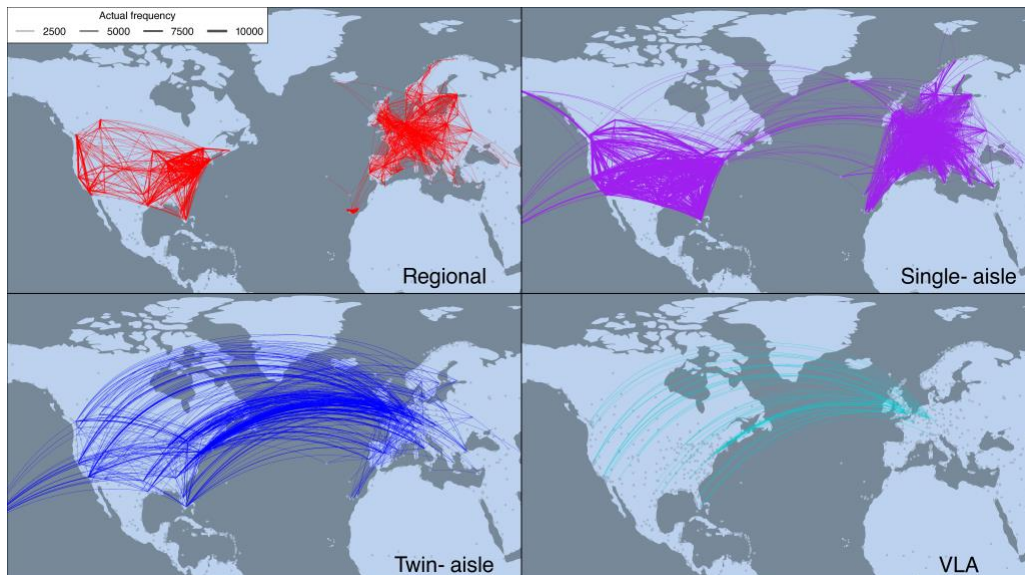


Figure 1 Transatlantic ABM – geographic scope, showing 2019 base year movements for regional, single-aisle, twin-aisle and very large aircraft

For each route group within this scope, the demand side is modelled using a city-pair gravity framework combined with utility-maximising consumer choices among transport modes, relevant travel classes, airports, and itineraries (Doyme et al., 2019), as illustrated in Figure 2. Model inputs are limited to socio-economic drivers of air travel demand and infrastructure characteristics, including aircraft performance, direct operating costs (DOC) by aircraft type, airport capacities, and airport and airspace charges—all other variables are endogenous, i.e., computed by the model. The ABM is formulated as an n-player non-cooperative game that iterates between supply and demand until a profit equilibrium is reached.

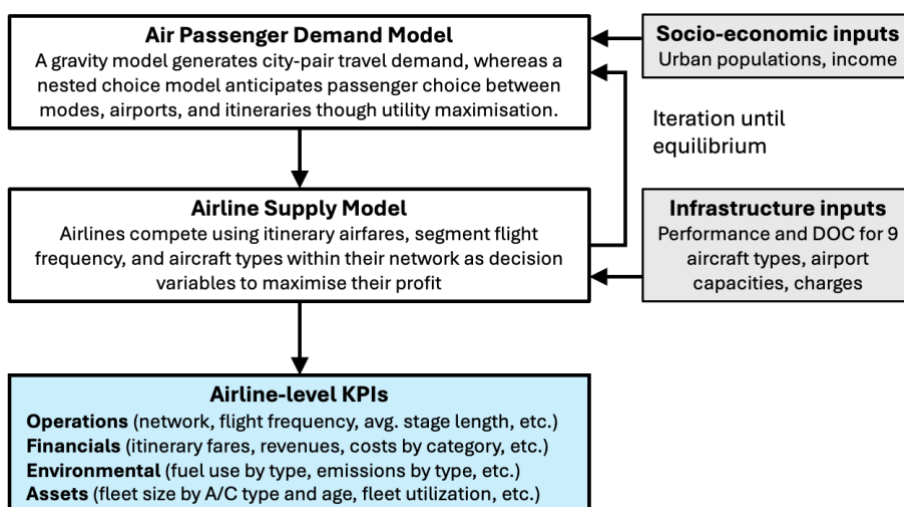


Figure 2 Structure of the Airline Behaviour Model

The objective function, where airline A maximises profits (P_A), is composed of a revenue term and two cost terms, as follows:

$$P_A = \sum_{i \in ITN_A} (fare_i + arev_i) \cdot pax_i - \sum_{j \in SEG_A} \sum_{a \in CRFT_j} opcost_{a,j} \cdot freq_{a,j} - \sum_{j \in SEG_A} \sum_{a \in CRFT_j} paxcost_{a,j} \cdot pax_{a,j}$$

The revenue term is defined as the annual number of passengers on itinerary i , pax_i , multiplied by the average airfare, $fare_i$, and ancillary charges, $arev_i$, summed over all itineraries, ITN_A , offered by airline A . The first cost term captures flight-specific operating costs (e.g. fuel burn and en-route charges). It is calculated as the operating cost of aircraft type a on segment j , $opcost_{a,j}$, multiplied by the annual flight frequency on that segment using aircraft type a , $freq_{a,j}$, summed over all segments, SEG_A , operated by airline A . The second cost term reflects passenger-related operating costs (e.g., passenger airport charges). It is given by the marginal cost per passenger on segment j using aircraft a , $paxcost_{a,j}$, multiplied by the annual number of passengers carried on that segment j using aircraft a , $pax_{a,j}$.

Itineraries may consist of a single segment (direct) or multiple segments (indirect). The set of aircraft types used in the model is exogenously specified and includes commercial aircraft categorized by size and generation. The baseline fleet representation is shown in Table 1. Two further distinctions are made in practice: aircraft that are under 10 years old have different lease conditions than older aircraft, making them more difficult to dispose of if not needed; and large narrowbody aircraft are split into standard and long-range models, to account for increasing use of long-range narrowbodies in the transatlantic market.

Table 1 Baseline fleet representation

		Reference aircraft	
		Previous generation	Current generation
Regional jet	Small (SR)	ATR-72	-
	Large (LR)	Embraer E190	Embraer E190-E2
Single aisle	Small (SSA)	Airbus A319ceo	Airbus A319neo
	Medium (MSA)	Airbus A320ceo	Airbus A320neo
	Large (LSA)	Airbus A321ceo	Airbus A321neo
Twin aisle	Small (STA)	Boeing 767-400	Boeing 787-800
	Medium (MTA)	Airbus A330-300	Airbus A330-900neo
	Large (LTA)	Boeing 777-300ER	Airbus A350-900
Very large aircraft	VLA	Airbus A380	-

The airline supply model includes constraints that represent real-world limitations and requirements within the aviation network system, such as airport capacity limits that restrict the number of take-offs and landings in a day, and resource constraints limiting the number of

aircraft available to the airlines. For the current model scope, we deal with flights to and from regions not modelled by scaling airport capacity downwards in proportion to the level of model coverage. For London airports, assumptions about slot/runway capacity are for the current baseline and 2050 with and without runway capacity expansion at Heathrow as shown in Table 2.

Table 2 Scaled runway capacity assumptions, with non-scaled values in brackets

Airport	Scaled (non-scaled) capacity assumption, flight movements/year		
	Current	2050 (2R)	2050 (3R)
Heathrow	361 (480)	361 (480)	567 (756)
Gatwick	217 (280)	307 (389)	307 (389)
Stansted	248 (274)	248 (274)	248 (274)
Luton	203 (231)	203 (231)	203 (231)
City	111 (111)	111 (111)	111 (111)
Southend	241* (241)	241* (241)	241* (241)

*Not slot controlled, so based on theoretical runway capacity. A local limit of 53,000 flights is currently applied, but in practice the airport does not reach either limit in the model runs for this project.

Passenger response to the selection of itineraries offered is modelled via a demand constraint. The demand constraint restricts the passengers, pax_i , on a given itinerary to be smaller or equal to the predicted passenger demand for itinerary i , with D_{o_i, d_i} representing the total demand of all itineraries between the origin cities o_i and destination cities d_i of itinerary i and MS_i , the market share of itinerary i :

$$pax_i \leq MS_i \cdot D_{o_i, d_i}, \quad \forall i \in ITN_A$$

Predicted passenger demand is modelled using a combination of a gravity model to predict city-pair demand and a nested logit model to represent passenger choices between the itineraries available to them (and, for short-haul travel, the choice of travel modes). The exact model specification differs between route groups, but its general form is given in Doyme et al. (2019). For intra-regional routes, passengers are grouped into a single travel class and freight is omitted. For long-haul routes, two travel classes (economy and upper) are modelled and airlines also have the option of taking on hold freight at a set freight rate, based on a simple model for estimated demand per state-pair. Data on baseline passenger movements, fares and flight schedules are derived from Sabre (2023).

In the Transatlantic ABM, twelve airlines or alliances compete. These are the three major alliances (Oneworld, Star, Skyteam); six large non-alliance low-cost carriers in North America and Europe (Southwest, Ryanair, Easyjet, Wizz, Norwegian, Westjet) and three additional carriers that are important for transatlantic competition in specific markets (Icelandair, Air Transat, Air Azores). The ABM is executed sequentially, beginning with the airline that has the largest network. Given the prior decisions of its competitors, each airline determines its optimal strategy—flight

frequency on each segment, aircraft type, and airfare—to maximize profit. The next airline then repeats the process using updated market shares and demand levels. After all airlines have made their decisions, the model checks whether any further profit-improving adjustments are possible. A “quasi-equilibrium” is reached when profits for all airlines no longer change significantly from one iteration to the next.

Because the ABM relies on annual data across diverse markets, it cannot fully capture itinerary-level heterogeneity, such as time-of-day effects or regional economic differences. A calibration procedure is therefore required before running scenarios. Calibration involves adjusting the airfare coefficient and alternative-specific constant for each itinerary, as well as the city-pair demand scale parameter in the Air Passenger Demand Model, until modelled airfares and passenger volumes for each itinerary fall within 30% of observed values for the 2019 base year (Sabre, 2023). Figure 3 presents the modelled and observed itinerary passenger numbers, segment flight frequencies, and airfares after calibration for the Western Europe region.

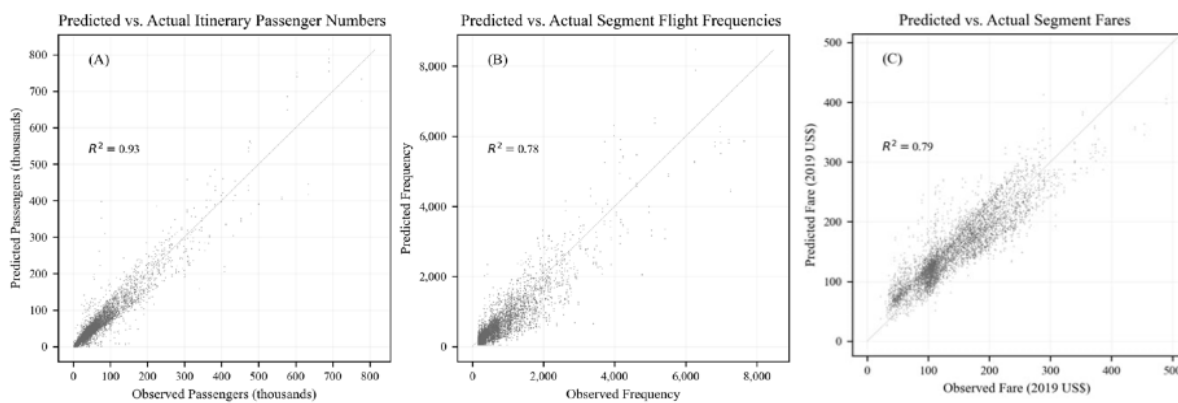


Figure 3 Exemplary model validation for itinerary passengers (A), segment flight frequency (B) and segment airfare (C) for the Western Europe region

The ABM directly computes welfare changes. Consumer surplus is calculated by first determining the maximum expected utility (logsum) of air and surface transport for each city-pair in the market. The logsum is then scaled by the inverse of the marginal utility of fares, which converts utility into monetary values. Summing across all passengers and city-pairs yields a measure of total consumer welfare. The change in consumer surplus is then computed as the difference in consumer welfare between scenarios. In contrast, airline producer surplus—here defined as the overall change in profits for each airline—is directly determined by the model.

1.3 Time horizon and time steps

For this study, we model the 2025–2050 period, using 5-year time steps to manage long model run times. Each preceding year provides the initial conditions for the subsequent period. The modelling sequence for the core runs (expansion/no expansion) is shown in Figure 4.

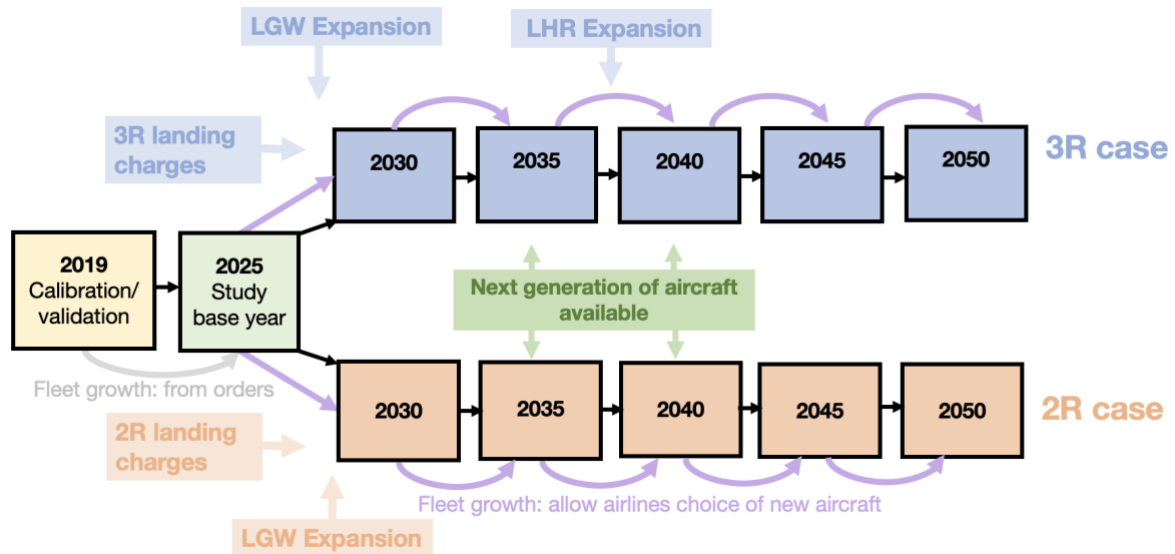


Figure 4 Core model runs over time

A key dynamic component of the ABM is airline fleet renewal. In the implemented aircraft leasing model, airlines are required to retain leased aircraft for a minimum period of 10 years under a hell-or-high-water clause. At the end of the lease term, airlines may choose to: (i) extend the lease of the existing aircraft at a reduced lease rate, (ii) enter into a new lease for a more modern aircraft with lower fuel burn but a higher lease rate, or (iii) terminate the lease without replacement. These decisions are affected by scenario parameters such as the capacity of the airports that airlines operate from, the availability of new aircraft, and the fuel prices they are subject to. For example, a scenario with higher fuel prices and more stringent capacity constraints may result in more purchases of large aircraft and fewer smaller aircraft.

Airline networks are also set dynamically. Airlines start off with the network that they operated in the base year. At each subsequent year, they are given the option of taking up new routes. To manage model runtime, we limit this to specific types of new routes for these model runs:

- New Transatlantic itineraries (including indirect itineraries using new transatlantic flight legs); and
- For the London airport system, new routes from London airports to destinations that the airline already serves from a different London airport, providing they already have some operations at the new airport.

New routes are subject to new route opening costs in their first year. These are derived from a study of airline willingness to pay to switch between airports (derived from Yang et al., 2025). If the route is economically successful (defined here as the airline's profit-optimal solution including that route at a flight frequency of 100 or more flights a year), it is retained for the following timestep, and can be operated then without route opening costs. If not, it is removed. This means that factors such as fuel prices and capacity constraints can also affect airline networks. For airports that are capacity constrained, airlines can move operations to less constrained alternatives. They can also change their network's balance between hub-and-spoke and point-to-point operations (if their fleets are suitable to do so).

1.4 Exogenous model parameters

As shown in Figure 2, the key exogenous model parameters which can be used to define and explore future scenarios consist of:

- Assumptions about when and by how much airport capacity is expanded, and by how much airport charges change to fund this;
- Socioeconomic variables (population and per person GDP), which drive demand growth;
- Fuel prices, including conventional jet fuel, sustainable aviation fuel (SAF), and power-to-liquids (PtL);
- Regional policy that affects the effective fuel price the airline pays, including carbon prices and SAF mandates;
- Techno-economic characteristics of current and future aircraft, including the availability of new aircraft; and
- Other policy variables that affect costs to passengers or airlines, including the UK's Air Passenger Duty (OBR, 2025).

Assumptions for these parameters vary between scenarios. They are discussed in the following section.

1.5 Scenarios modelled

The scenarios modelled in this project are intended to examine the change in London airport system-related traffic and economic impact with a Heathrow expansion, taking into account airline competition. Additionally, a set of variant scenarios are run to check which input assumptions the outcomes are particularly sensitive to.

We compare the following scenarios:

- Core scenarios under reasonable optimistic economic assumptions
 - **2R:** All planned airport expansions occur other than Heathrow
 - **3R:** As 2R, but Heathrow is also expanded
- Variant scenarios
 - **2R lower economic growth:** As 2R, but growth in UK GDP/capita is 0.5%/year lower
 - **3R lower economic growth:** As 3R, but growth in UK GDP/capita is 0.5%/year lower
 - **3R lower charges:** As 3R, but landing charges from 2030 are 20% below Heathrow's expected landing charges
 - **3R higher charges:** As 3R, but landing charges from 2030 are 20% above Heathrow's expected landing charges
 - **3R low fleet:** As 3R, but additional restrictions on aircraft production mean that airlines cannot access all the new aircraft they would ideally like
 - **3R high fuel costs:** As 3R, but using a higher SAF cost trajectory which increases airlines' fuel costs on SAF mandate routes
 - **3R tapered APD:** As 3R, but Air Passenger Duty is tapered down to 2/3 of its 2025 level between 2040 and 2050.

Additionally, a variant scenario in which a LCC is given access to slots at Heathrow on expansion was considered. However, preliminary model runs suggested that a more in-depth exploration of the conditions under which LCCs would use Heathrow was needed, and so this scenario was not pursued for this project. The scenario specifications for all scenario input variables are given below.

1.5.1 Expansion assumptions

All scenarios include Gatwick airport expansion, with model capacity constraints set at the values shown in Table 2. Gatwick expansion is assumed to take place in 2029 (Gatwick Airport, 2023). Heathrow expansion, where modelled, is assumed to take place in 2037.

Other London airports have expansion plans which focus more on passenger and terminal capacity rather than numbers of flight movements:

- **Stansted:** The UK government and local authorities approved a £1.1 billion expansion in late 2025, to raise annual capacity from 43 million to 51 million passengers by 2040. Plans include a 16,500 m² terminal extension, a larger immigration hall, upgraded security technology, and an improved departure lounge (Stansted Airport, 2026).
- **Luton:** The UK government approved London Luton Airport's expansion in April 2025, increasing annual capacity from 18 million to 32 million passengers by 2043. The project includes a new terminal, extra taxiways, and upgrades to support about 78,000 additional flights each year (DfT, 2026a).
- **London City:** The UK government approved London City Airport's expansion in August 2024, raising annual passenger capacity from 6.5 million to 9 million by 2031. The plan permits more early morning and weekend flights but rejects extending Saturday evening operating hours (London City Airport, 2026).

In the Airline Behaviour Model, the most limiting capacity constraint is typically on the numbers of flight movements. However, we additionally check outcomes to make sure they do not violate terminal-related passenger growth constraints. Note that we do not model the demand impact of the Universal United Kingdom Resort (planned to open nearby in 2031) on demand at Luton airport.

1.5.2 Charge profiles

The charge profiles for Heathrow's 2R and 3R expansion scenarios are provided by HAL. Charge profiles for the other airports are derived from the RDC database of airport charges (RDC, 2017). Within the Airline Behaviour Model, charges are split into per-passenger and per-movement charges, where per-movement charges are dependent on aircraft type.

Heathrow adjusts its charges depending on the mix of aircraft in use at the airport. To represent this in the model, we additionally scale charges to make sure that the following two conditions are met:

- Passenger charges make up 55% of total charges; and
- The average charge per passenger, accounting for both per-passenger and per-movement charges, matches the scenario-specific values provided by HAL.

Variant landing charge cases were also explored at +/- 20% from the core 3R case from 2030.

Gatwick airport has stated that they do not plan to increase landing charges to fund expansion (Gatwick Airport, 2023). We assume landing charges at Gatwick are kept constant in real terms over the expansion period.

1.5.3 Socioeconomic Variables

Multiple self-consistent scenarios for future population and GDP are available from government, industry, academic and NGO sources. For consistency with UK government projections, we use socioeconomic scenarios as defined by the UK DfT's Common Analytical Scenarios (CAS) and Transport Analysis Guidance (TAG) databooks (DfT, 2026b) combined with OECD projections for other countries using the OECD central BAU1 scenario (OECD, 2025). For the UK, these scenarios are defined at the whole-country level rather than accounting for likely differences in economic growth between regions. However, for the London airport system, London growth specifically is of interest. To account for likely differences between regional growth, we use projections of how regional-level growth will differ from country-level growth from the LUISA project (Lavalle et al. 2020), scaled to maintain DfT growth rate assumptions at the whole-country level.

Aviation outcomes are typically sensitive to economic growth assumptions. For this project, we consider two different sets of projections:

- The **Reasonable Optimistic Scenario**, which uses the 'High Economy' inputs for UK economic growth from the CAS databook, scaled by LUISA regional growth assumptions, and OECD central BAU1 inputs for all other countries; and
- The **Lower Economic Growth Scenario**, which uses the same inputs but takes UK core assumptions from the TAG databook instead.

Some examples of projections for the combined scenarios over the 2019-2050 period are shown in Table 3. Note that values shown are averages across the cities modelled in the ABM and so may not exactly match country-level values from DfT (2026).

Table 3 Socioeconomic scenarios

Variable	Scenario	UK	Europe	North America
Population (avg. %/year change 2019-2050)	Reasonable Optimistic	0.59	0.23	0.64
GDP/capita (avg. %/year change 2019-2050)	Reasonable Optimistic	1.52	1.30	1.40
Population (avg. %/year change 2019-2050)	Lower Economic Growth	0.59	0.23	0.64
GDP/capita (avg. %/year change 2019-2050)	Lower Economic Growth	1.02	1.30	1.40

The Reasonable Optimistic Scenario is used for the core and most variant model runs. The Lower Economic Growth Scenario is used for variant runs testing the impact of lower economic growth in the 2R and 3R cases.

1.5.4 Fuel Prices and Fuel Policy

The effective price of fuel for airlines depends on the price of fossil Jet A; the carbon price that is applied to it per route; any SAF mandates that are applied per route; and the price of SAF.

For compatibility with UK Government assumptions, we derive oil and carbon price assumptions from DESNZ scenarios. Fossil Kerosene prices are derived from DESNZ (2025a), using their

central scenario (Scenario B). ETS Carbon prices use the DESNZ (2025b) Market Traded Scenario; for simplicity, it is assumed that UK and EU ETS carbon prices align into the future. CORSIA carbon prices are derived from the TAG Databook (DfT, 2026b). The most recently available projected CORSIA prices at the time of modelling were used; it should be noted that these are relatively high compared to other projections.

SAF prices to 2050 are also uncertain, as are the levels that the UK SAF mandate will be set at. For this project, we set year-2050 SAF mandate levels at RefuelEU levels for the UK as well, following Argus (2026). Aviation system outcomes are sensitive to fuel price assumptions, which in turn are strongly affected by SAF price assumptions by 2050. To explore this uncertainty, we consider two SAF price scenarios. In the core runs, we use SAF price assumptions from the IEA Net Zero Scenario (IEA, 2021). Under these assumptions, the price of SAF remains above that of fossil kerosene plus carbon price in 2050, but the two prices are relatively close. In practice, this also means that a scenario with a lower SAF mandate would likely have similar economic outcomes. We also run a high fuel price variant scenario in which SAF prices follow trajectories modelled by Argus (2026). Under these assumptions, SAF prices stabilise at values around 50% above the effective price of fossil kerosene plus carbon. Table 4 shows these assumptions for 2050, including their implications for effective fuel price. Figure 5 shows how prices develop over time in the different regions and scenarios.

Table 4 Fuel Price and Policy Assumptions

	UK	North America	Europe	Source
Jet fuel price (£2025/tonne)	720	720	720	DESNZ (2025) Scenario B
CO2 price (£2025/tonne CO2)	2271	0 ¹	2271	DESNZ (2025) Market traded scenario
Total effective jet fuel price (£2025/tonne)	1437	720	1437	
Total effective jet fuel price (£2025/bbl)	184	97	184	
SAF price (£2025/tonne)	1,580	1,580	1,580	IEA Net Zero Scenario (IEA, 2021)
SAF price (£2025/bbl)	203	203	203	
High fuel price SAF price (£2025/tonne)	3,211	3,211	3,211	Argus (2026) Baseline scenario; provided by HAL
High fuel price SAF price (£2025/bbl)	412	412	412	
SAF mandate level (%)	70% ²	0%	70% ²	RefuelEU specifications

¹ For CORSIA-eligible flights, a post-2035 successor to CORSIA is assumed.

² Departing flights scope. As long-term UK SAF mandate levels are not yet set, the RefuelEU mandate level is assumed across Europe, including in the UK. Note that there are some indications UK mandate levels may be below this (e.g. CCC, 2025).

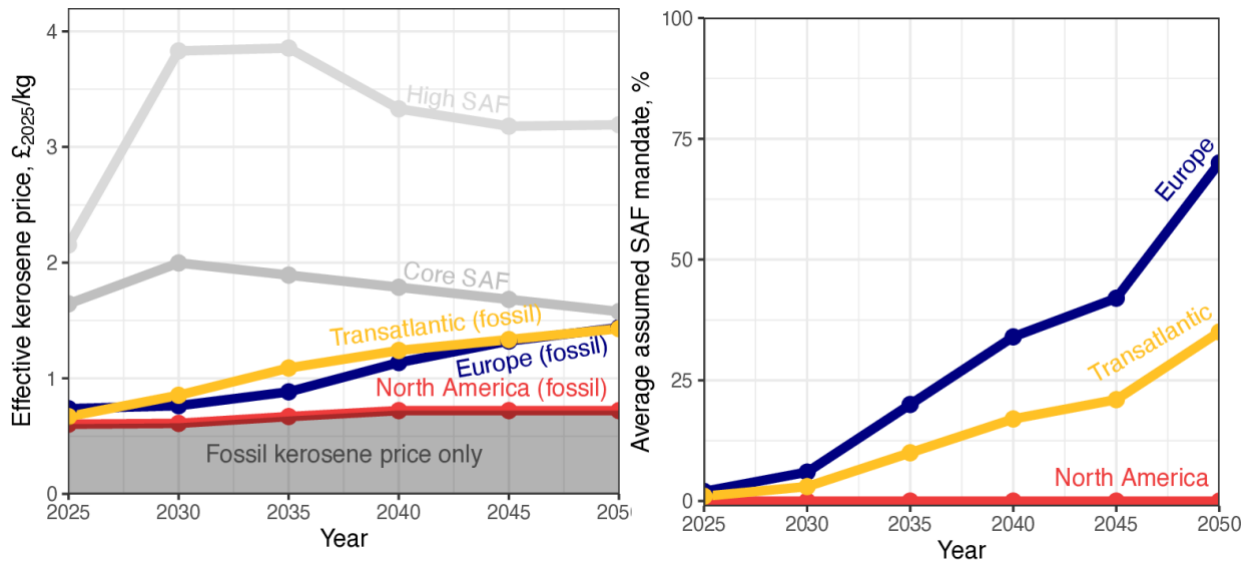


Figure 5 Fuel price and fuel policy assumptions over time

1.5.5 New Aircraft Techno-Economic Characteristics

Table 1 showed the baseline fleet representation in the ABM. For existing aircraft, the technological performance characteristics of all aircraft size classes are described in ATA and Ellondee (2018). The operating cost characteristics are derived from multiple sources.

- Fuel operating costs depend on aircraft fuel burn (derived from a metamodel to the output of the PIANO-X aircraft performance model; Lissys 2017) and the jet fuel price.
- Crew and maintenance (engine and airframe) costs are based on a statistical analysis of US Form 41 data (BTS, 2026) and adjusted for each airline using airline annual reports.
- Aircraft depreciation costs are modelled as leasing costs, which depend on the lease rate factor, aircraft capital costs (from the Airliner Price Guide; ACI, 2023), insurance costs, and annual usage. Airlines can return the leased aircraft to the leasing company after a certain number of years (depending on aircraft type) and obtain more modern and fuel-efficient aircraft at a higher lease rate factor.
- Typical navigation costs for existing flight legs by airport-pair are derived from the RDC database of enroute charges (RDC Aviation, 2017). For flight legs that do not currently exist, enroute charges are estimated based on charges on existing legs with a similar distance and origin and destination country.
- Airport charges are derived from the RDC database of airport charges (RDC aviation, 2017) and are aggregated into typical per-passenger charges and typical per-aircraft movement (by size class) charges.

The older (N-1) generation of these aircraft entered service between 1989 and 2004, while the current (N) generation entered service between 2018 and 2022, with the exception of the very small aircraft segment. The projected next-generation (N+1) aircraft are expected to enter service around 2035, so assumptions about these aircraft are needed. We use projected future aircraft characteristics derived from Schofield & Schäfer (2026), omitting more radical new technologies such as hydrogen aircraft. No replacement in the small regional and very large aircraft categories is assumed, and we assume that N+1 widebody aircraft entry into service (EIS) is offset from N+1 narrowbody aircraft EIS, as is typical for aircraft development. A summary of assumptions for the N+1 generation of aircraft is shown in Table 5.

Table 5 Assumptions about the next generation of aircraft

Size class	Current generation reference	New aircraft characteristics, relative to reference		
		EIS	Change in fuel use, %	Change in DOC (£/RPK), %*, at £0.67/kg jet fuel
Small Regional	ATR72-600	No replacement assumed		
Large Regional	E190 E2	2035	-18.0	-5.3
Small Single Aisle	A319neo	2035	-14.7	-5.7
Medium Single Aisle	A320neo	2035	-14.7	-5.7
Large Single Aisle	A321neo	2035	-14.7	-5.7
Small Twin Aisle	787-800	2040	-17.2	-5.7
Medium Twin Aisle	A330-900neo	2040	-17.2	-5.7
Large Twin Aisle	A350-1000	2040	-19.1	-10.3
Very Large Aircraft	A380-800	No replacement assumed		

In the ABM, airlines are given the choice of adding new aircraft to their fleets at each timestep. In practice, production line constraints mean that there is a limit to the number of aircraft that can be added. Typically, roughly 1,500 new narrowbody aircraft and 200 new widebody aircraft can be delivered in a year at current production capacity. We scale these numbers to the proportion of global RPK modelled by the current system and apply them as limits on the number of new aircraft available. An additional buffer is applied to account for the fact that not all airlines will choose all aircraft that are available to them, set at a level which broadly matches historical rates of new fleet entering the system.

We also run a variant case in which airlines are not able to access all the fleet that they would ideally like. This simulates a situation in which manufacturers underestimate upcoming demand, there are delays in new aircraft programmes, or groundings or geopolitical events affect which airlines can purchase aircraft from which manufacturers. As a simple way of simulating this, we remove the buffer factor discussed above, reducing the theoretical maximum aircraft availability by 50%.

1.5.6 Air Passenger Duty

HMRC charges Air Passenger Duty (APD) on all UK departing passengers, unless they are travelling on APD-exempt routes or aircraft. APD rates as of April 2025 are shown below, based on OBR (2026). Reduced rates apply to the lowest class of travel available, with seat pitch of under 40 inches. Standard rates apply to all other passengers (other than passengers on business jets, for whom higher rates apply).

Table 6 UK Air Passenger Duty: rates from 1 April 2025

Band	Reduced rate	Standard rate
Domestic	£7	£14
Band A (0-2,000 miles)	£13	£28
Band B (2,001-5,500 miles)	£90	£216
Band C (over 5,500 miles)	£94	£224

Our default assumption is that APD remains constant in real terms to 2050. In the 3R tapered APD scenario, APD is tapered down to 2/3 of its 2025 level between 2040 and 2050.

1.5.7 Summary of model runs

All model runs use the same assumptions about aircraft techno-economic characteristics, Jet A and carbon prices, and SAF mandate policy. Other assumptions differ between scenarios and are summarised in Table 7 below.

Table 7 Summary of assumptions per scenario

Scenario	Economic growth	Expansion	Heathrow charges	SAF prices	New aircraft availability	APD
2R	Reasonable optimistic	All planned except Heathrow	2R planned	IEA NZS	Baseline	Constant from 2025
3R	Reasonable optimistic	All planned except Heathrow	3R planned	IEA NZS	Baseline	Constant from 2025
2R lower economic growth	Reasonable optimistic	All planned	2R planned	IEA NZS	Baseline	Constant from 2025
3R lower economic growth	Reasonable optimistic	All planned	3R planned	IEA NZS	Baseline	Constant from 2025
3R lower charges	Reasonable optimistic	All planned	3R planned -20% (from 2030)	IEA NZS	Baseline	Constant from 2025
3R higher charges	Reasonable optimistic	All planned	3R planned +20% (from 2030)	IEA NZS	Baseline	Constant from 2025
3R low fleet	Reasonable optimistic	All planned	3R planned	IEA NZS	Reduced	Constant from 2025
3R high fuel costs	Reasonable optimistic	All planned	3R planned	Argus	Baseline	Constant from 2025
3R tapered APD	Reasonable optimistic	All planned	3R planned	IEA NZS	Baseline	Tapers 2040-50 to 2/3 of 2025 values

2 Results

2.1 Core Scenarios: 2R vs. 3R

2.1.1 Whole-system outcomes

Figure 6 shows whole-system growth in demand, in terms of revenue passenger-kilometres (RPK), for the reasonable optimistic scenario. At a system level, RPK grows by an average of 1.6% per year. Although demand is higher in the 3R case than the 2R case, at a whole-system level demand growth rates round to the same numbers. These RPK growth estimates can be compared to those from industry forecasts. The Airbus (2025) Global Market Forecast (Airbus, 2025) projects RPK growth of 1.6%/year in the intra-North American region over the next 20 years, and 2.1% per year for Europe-USA routes. These numbers are close to our estimates for these route groups. However, our estimate of the intra-European growth rate is much lower than Airbus's estimate (0.8%/year vs. 1.7% per year). This difference likely arises because of differences in assumptions around economic growth and fuel prices. In these model runs, the intra-European RPK growth rate starts off around 1.7% per year and decreases over time. Past ABM runs using lower fuel price and higher European country GDP per capita growth rates instead maintain this rate to 2050.

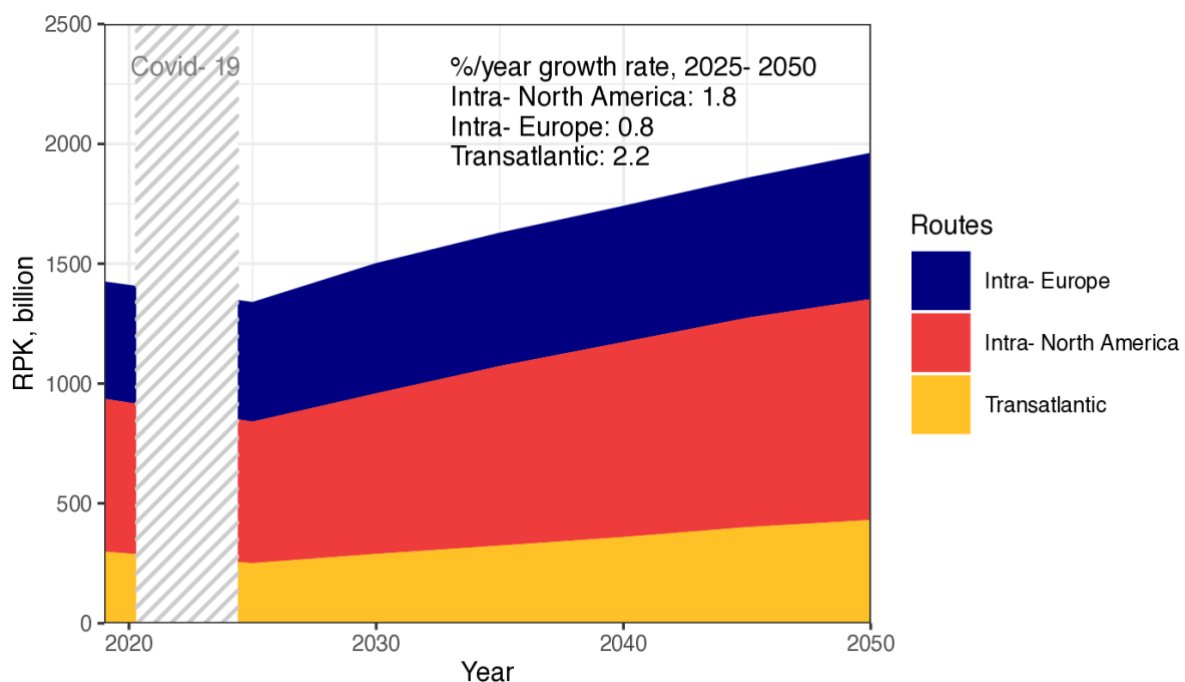


Figure 6 Whole-system RPK growth, reasonable optimistic scenario

For the assumptions used here, UK demand growth is higher than the European average and there is a difference between the 2R and 3R scenarios. The UK within-set departing flights RPK growth rate is 1.4% between 2025 and 2050 in the 2R scenario, and 1.6% in the 3R scenario.

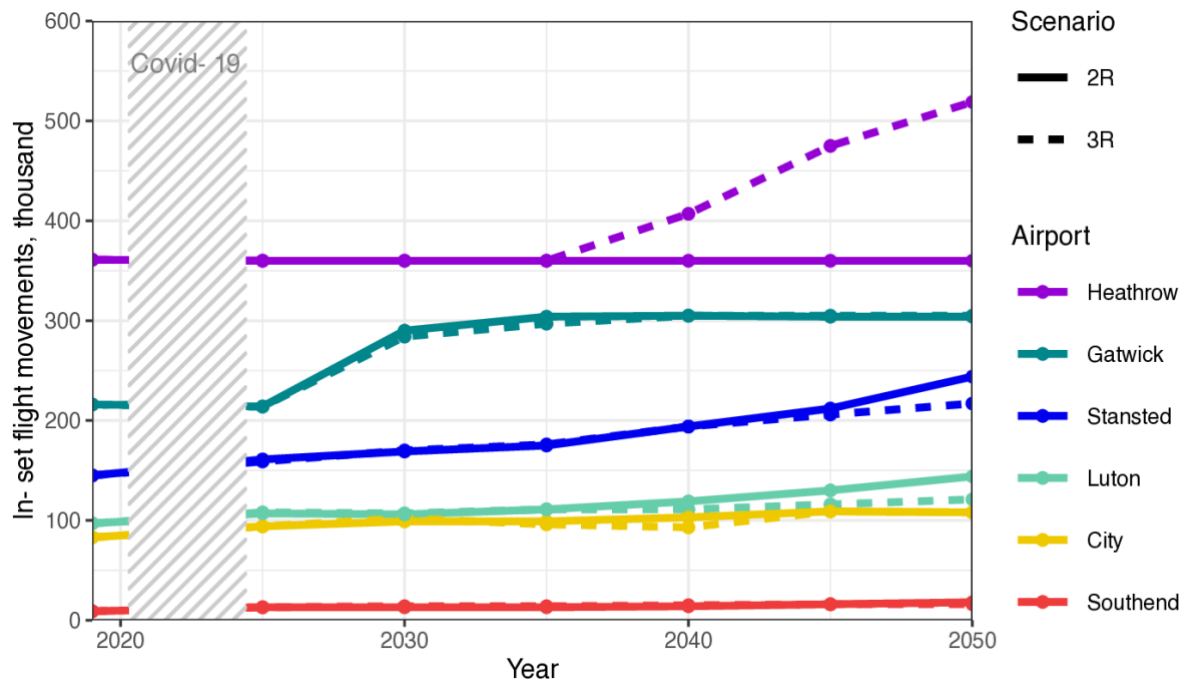


Figure 7 Within-set flight movements at London airports: 2R vs. 3R scenario

2.1.2 Outcomes at London airports

Figure 7 shows the number of within-set flight movements at London airports over time in the 2R and 3R scenarios. Under Reasonable Optimistic conditions, growth is relatively robust: new capacity at Gatwick from 2029 is rapidly taken up, and Gatwick reaches capacity again around 2035-2040. Heathrow remains at capacity until it is expanded, despite increases in landing charges to fund the expansion. After expansion, demand at Heathrow grows steadily, with most of the new capacity in use by 2050.

In the 2R scenario, where new capacity is not provided at Heathrow, there is higher growth at other London airports as airlines switch their operations between airports to find space. However, this effect is somewhat limited by capacity limits at other London airports and the extent to which the other airports can substitute for Heathrow, given their different networks and passenger facilities. London City substitutes some (mainly shorter-haul) flights from Heathrow, but reaches its own capacity limits by 2040. After the new capacity at Gatwick is taken up, additional capacity is used at Stansted and Luton in the 2R case. Figure 8 and Figure 9 show how airport use is distributed between airlines and alliances over time in the 2R and 3R scenarios.

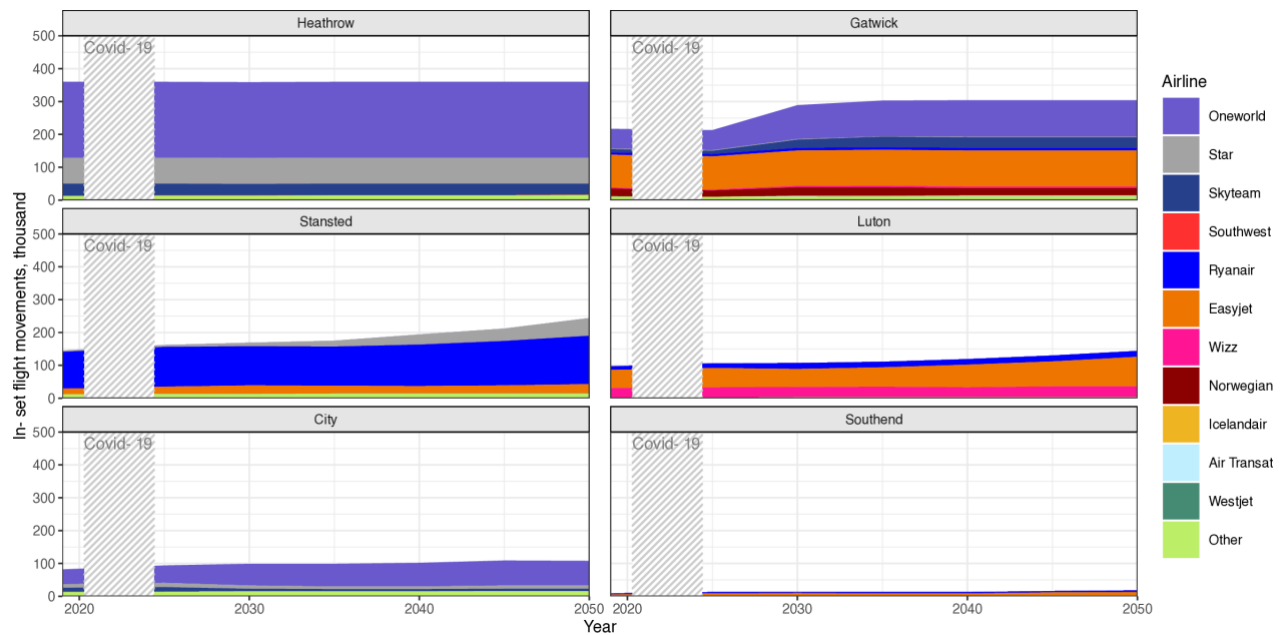


Figure 8 Flights over time at London airports by airline/alliance: 2R scenario

In both scenarios, full-service carriers experience the majority of growth. This is because all scenarios modelled assume at least a doubling of effective fuel price on European and Transatlantic routes from base year values, primarily due to carbon pricing and SAF mandate policy. Low-cost carriers, who accommodate more price-sensitive passengers and whose business model is dependent on minimizing operating costs, using fleets that are usually based around a single aircraft type, have less flexibility to adapt to persistently high fuel prices. When Heathrow is not expanded, the major alliances switch shorter-haul Heathrow operations that are less dependent on connecting passengers to alternative airports where they already have some presence. In case Heathrow is expanded, this switching is significantly reduced.

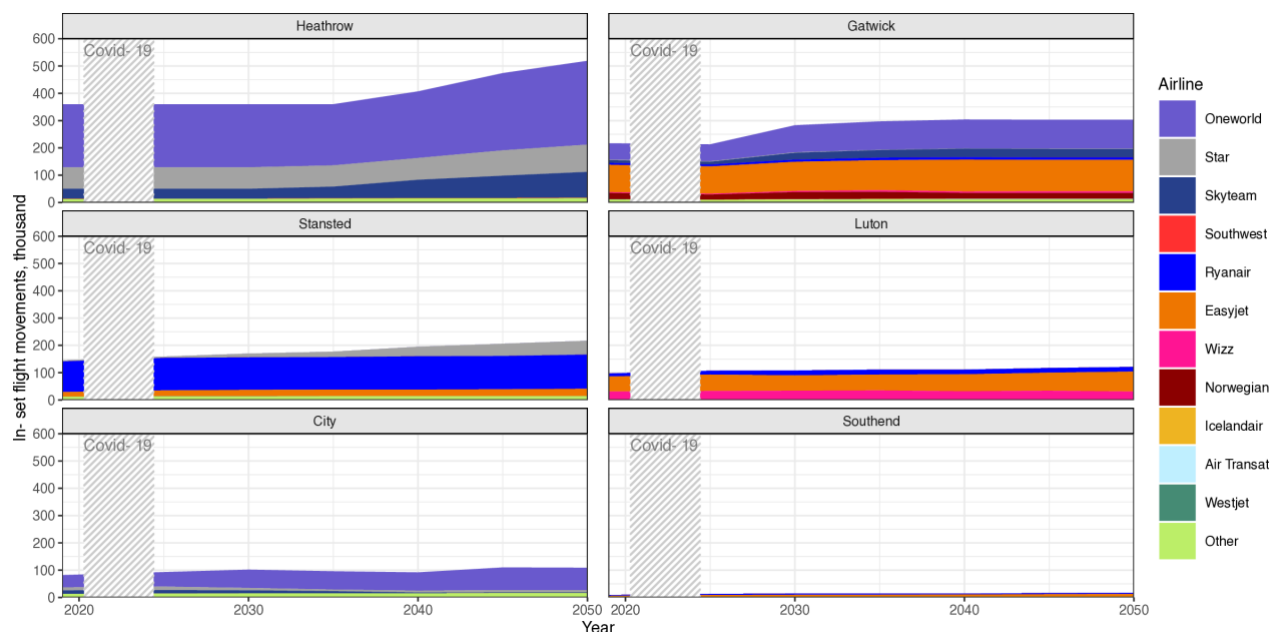


Figure 9 Flights over time at London airports by airline/alliance: 3R scenario

Table 8 Year-2050 within-set number of flights at London airports: 2R vs. 3R scenario

Metric	2050 scenarios		
	2019 baseline	2R case	3R case
Europe + Transatlantic flights at LHR, thousand	360	360	519 +159
Europe + Transatlantic flights at LGW, thousand	217	304	305 +1
Europe + Transatlantic flights at STN, thousand	149	244	217 -27
Europe + Transatlantic flights at LTN, thousand	91	144	121 -23
Europe + Transatlantic flights at LCY, thousand	71	108	108 +0
Europe + Transatlantic flights, all London airports, thousand	900	1178	1286 +108

Table 8 shows the overall number of within-set flights at London airports in 2019 by scenario in 2050; totals split by route group are reported in Annex A.1. Although reductions in flights at Stansted and Luton are significant in the 3R scenario compared to the 2R scenario, they are much smaller than the increase in flights at Heathrow. The increase in number of flights across the London region is around two thirds of the increase in flights at Heathrow alone. There are several reasons why this occurs.

- Capacity expansion allows airlines to offer itineraries that are more attractive for passengers (higher frequencies to existing destinations, direct flights to new destinations), leading to higher demand.
- Flights from capacity-constrained airports experience scarcity rents – that is, airlines can charge higher fares to equalize demand with the constrained available supply. When the capacity constraint is removed, so is the scarcity rent, leading to lower fares, which also leads to higher demand.
- Capacity limits lead to airlines using larger aircraft than they would ideally like. When these are relaxed, airlines can switch back to using smaller aircraft, leading to more flights for the same number of passengers.

Figure 10 shows the impact of expansion on the average economy class fare from different airports. These are two reasons why Heathrow fares are lower on expansion. First, in the 2R scenario Heathrow drops mainly short-haul flights over time in response to capacity constraints (see Annex A for the distribution of flights by distance in the 2R and 3R scenarios). These flights return in the 3R scenario. They have lower fares on average than longer flights, leading to a decrease in average fare. Second, capacity expansion removes scarcity rents, also leading to a decrease in average fare.

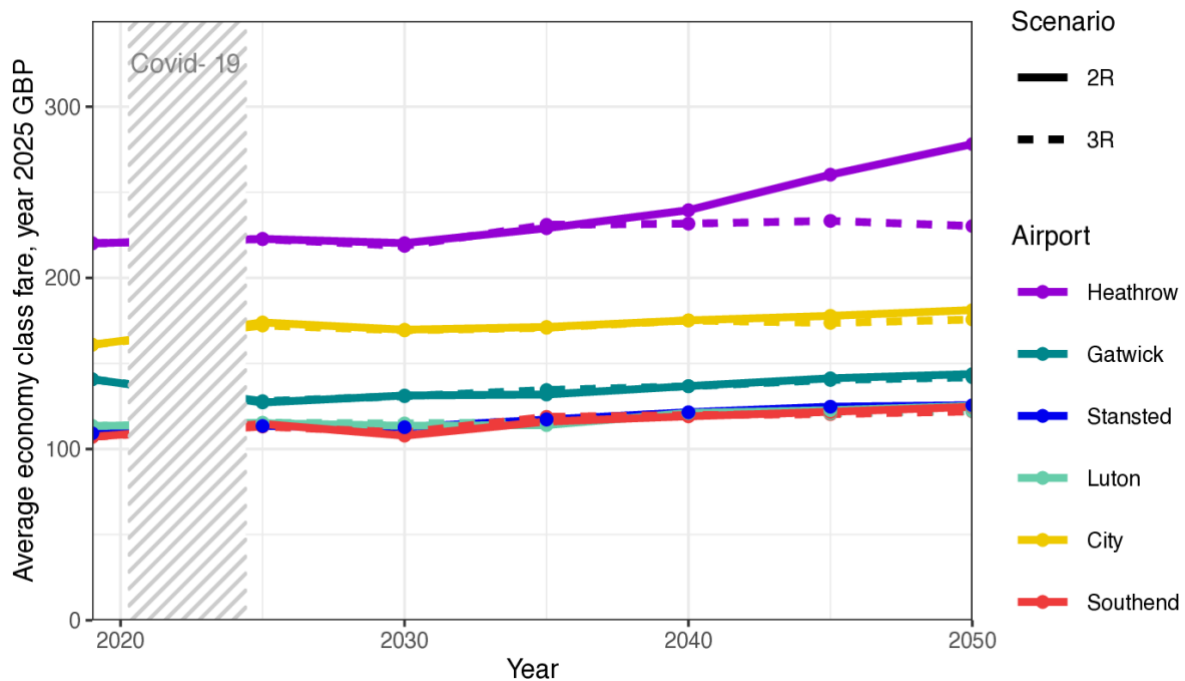


Figure 10 Average economy class fare at London airports: 2R vs. 3R scenario

In 2030, before Heathrow is expanded, there is a small increase in fares across London airports in the 3R scenario. This arises from the higher Heathrow landing charges in this scenario compared to those in the 2R scenario (see Figure 5). Profit-maximising airlines mostly do not pass these on to passengers, instead experiencing reduced profits. However, there is some passthrough on short-haul routes, leading to higher fares. In turn, competing itineraries at other airports also increase their fares.

Table 9 shows the impact of the Heathrow expansion on average economy class fare and on airline fare revenues at major London airports. Fares decrease at all London airports in response to the fall in fares at Heathrow. For the two airports that also see a demand decrease (LTN, STN), this translates into reductions in fare revenue of 10-20%. Although Gatwick's average economy class fare decreases, a slightly higher number of higher class passengers increases overall fare revenue in the 3R case.

Table 9 Change in average fare and airline fare revenues at London airports: 2R vs 3R scenario

Airport	Year-2050 3R vs. 2R, change in:	
	Average economy class fare, %	Fare revenue, %
Heathrow	-17.2	12.8
Gatwick	-1.3	3.5
Stansted	-0.4	-13.7
Luton	-2.3	-18.7
City	-3.0	-10.9

Figure 11 shows the corresponding number of passenger movements per airport over time. Table 10 shows within-set totals in 2050; totals split by route group are reported in Annex A.1. Passenger numbers follow similar trends to aircraft movements. However, there is an additional trend towards larger aircraft over time. This applies both generally, at a system level (for example, there is a system-wide switch towards larger narrowbody aircraft compared to mid-size ones) and specifically at congested airports, where using larger aircraft allows airlines to carry more passengers for the same number of flight movements.

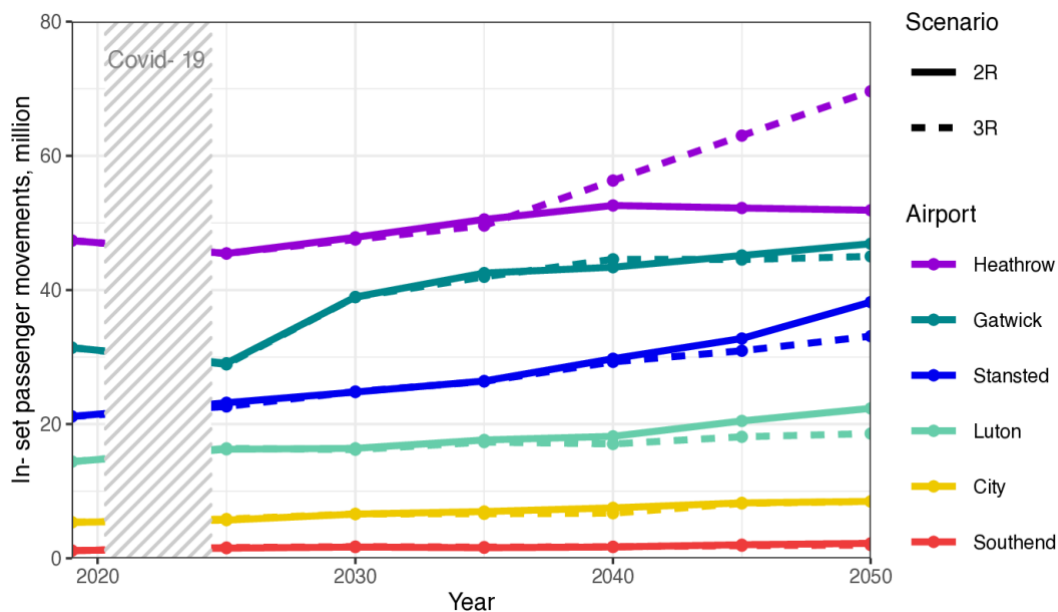


Figure 11 Within-set passenger movements at London airports: 2R vs. 3R scenario

Table 10 Year-2050 number of flights at London airports: 2R vs. 3R scenario

Metric	2019 baseline	2050 scenarios	
		2R case	3R case
Europe + Transatlantic passenger movements at LHR, million	47.6	51.9	69.6 +17.7
Europe + Transatlantic passenger movements at LGW, million	31.9	46.9	45.0 -1.9
Europe + Transatlantic passenger movements at STN, million	21.2	38.2	33.1 -5.1
Europe + Transatlantic passenger movements at LTN, million	13.7	22.3	18.6 -3.7
Europe + Transatlantic passenger movements at LCY, million	4.3	8.5	8.5 +0
Europe + Transatlantic passenger movements, all London airports, million	120	170.0	176.8 + 6.8

At a passenger movement level, there is a larger substituting effect between airports than at a flight level. This is because some of the increase in the number of flights, particularly at Heathrow, is driven by the use of smaller aircraft. For passengers, the increase in number of passengers at the London level is around one third of the increase in passengers at Heathrow.

Figure 12 shows the simulated change in year-2050 aircraft size between the 2R and 3R scenarios. The main change at Heathrow is in the number of narrowbody flights, particularly large narrowbody aircraft. However, expanding Heathrow also leads to a decrease in the average aircraft size at Gatwick. Airports outside the London system see some decreases in narrowbody flights, suggesting that airlines are choosing to use aircraft to increase frequency to London rather than in other parts of their networks.

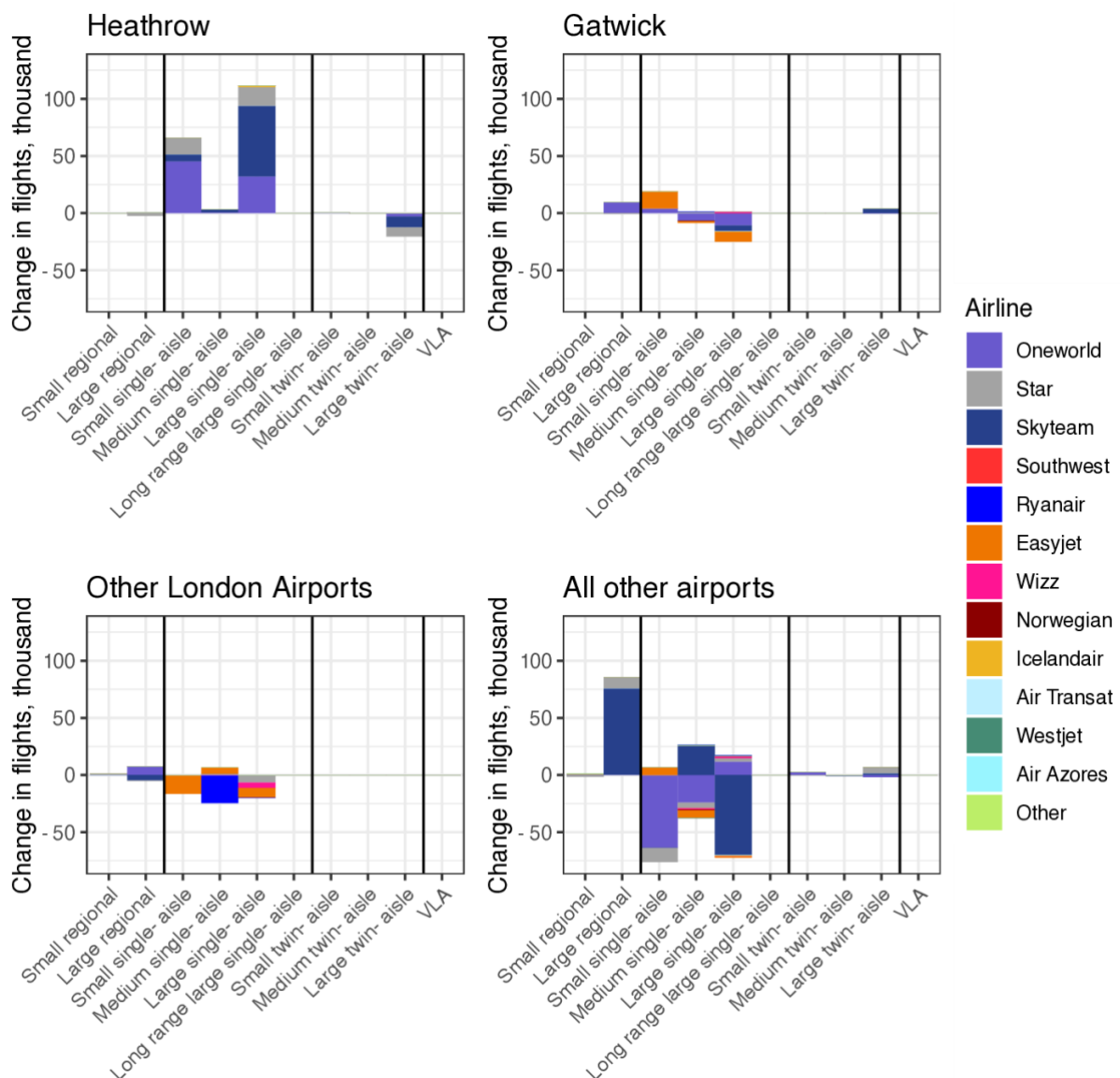


Figure 12 Change in year-2050 number of flights by size and airline/allyance: 2R vs. 3R scenario

Heathrow is a major hub airport with many connecting passengers. Although the current model scope (intra-Europe + Transatlantic) excludes modelling many of these passengers directly, we can also examine how Heathrow's role as a hub changes in the different scenarios for the route groups examined. Figure 13 shows flow centrality (Rodriguez-Deniz et al. 2013), the percentage of total system passengers who hub via a given airport. This is a measure of how important each airport is as a hub. In the 3R case, Heathrow's flow centrality increases by approximately 30% over the 2R case. Impacts on other airports are relatively small, though there are small decreases in the flow centrality of competing airports such as Frankfurt and Amsterdam.

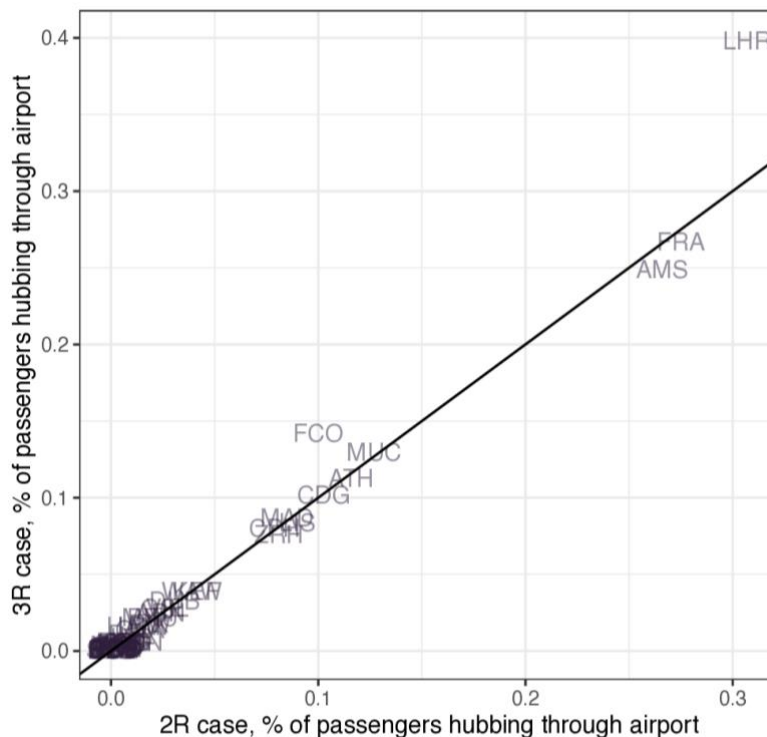


Figure 13 Importance of Heathrow as a hub: 2R vs 3R scenario

Finally, we examine the economic impacts of expanding Heathrow. It should be noted that these are not measured on a fully comparable scope, and are affected by the overall model set of route groups. Consumer surplus is derived from the top-level logsums of the itinerary choice model, with the value of utility obtained by calculating the derivative of the itinerary choice model with respect to fare for each city-pair. It includes changes in utility for passengers who switch to or from ground transport modes, under the assumption that the utility of the ground transport modes themselves does not change between the different scenarios. Only itineraries to and from the UK are included, and freight is also excluded. Airline producer surplus is calculated as the change in airline profits across their whole network; profits in other sectors (including airport profits and ground transport providers) are excluded. Totals are not discounted.

For these scenarios, there are two distinct phases of economic impact. Initially, Heathrow has higher landing charges but has not yet expanded. The increase in landing charges is not fully passed through. Airlines experience this as a decrease in profit, leading to negative producer surplus. However, there is still passthrough on some routes, leading to an increase in fares that reduces the overall utility of travelling and leading to a negative consumer surplus. After Heathrow expands, the fare-increasing impact of constrained capacity is removed. Fares

decrease and new itineraries are offered, leading to an increase in the overall utility of air travel and hence an increase in consumer surplus. However, these same fare decreases lower airline profit margins, leading to negative producer surplus. As the time after expansion increases, the impact of increased landing charges becomes smaller as landing charges drop back down closer to their original values. However, the impact of capacity change on fares increases as in the 2R case capacity pressures worsen over time.

Table 11 Consumer and producer surplus: 2R vs 3R scenario

		3R vs. 2R case				
Metric		2030	2035	2040	2045	2050
Change in consumer surplus, 2025 £bln		-1.08	-0.31	1.27	1.72	3.05
Change in producer surplus*, 2025 £bln		-0.67	-1.64	-1.34	-0.93	-1.16

Table 12 shows the system-wide airline operating profit margins in the core 2R and 3R cases. To calculate these, indirect operating costs are derived from separate estimated relationships with airline-level available seat-km for ground staff costs and distribution/marketing/other indirect costs, using data from airline yearly financial reports. Estimating profit margins also requires accounting for costs and revenues from passengers whose full journey starts or ends outside the set of routes modelled (for example, passengers who start their journey on an Asia-Europe leg which is not modelled, and transfer onto a Europe-North America leg which is). For these calculations, revenue for these passengers is not included, and costs are adjusted downwards to reflect that these passengers are not included in revenues. In practice, actual airline profit margins are cyclical with often large year-on-year variation (e.g. ICAO, 2025), so these figures should be viewed as averages.

Table 12 System-wide airline operating profit margins

	System-wide airline operating profit margin, %						
Scenario	2019	2025	2030	2035	2040	2045	2050
2R	4.5	4.7	3.2	3.1	3.8	6.1	8.6
3R	4.5	4.7	3.0	2.7	3.3	5.2	7.9

Airline profit margins present a similar picture to the other economic metrics discussed. Profit margins are lower when Heathrow is expanded. However, with or without expansion they are greater in 2050 than they were in 2025. In between (around 2030-2040) there is a period of lower profits which reflects mainly the rise in assumed effective fuel prices over this time period.

2.1.3 Carbon and carbon leakage

Carbon leakage occurs when a policy applied in one region of the world produces a change in CO₂ outside that region. It can be defined as

$$Leakage = \frac{-\text{Change in CO}_2 \text{ outside policy area}}{\text{Change in CO}_2 \text{ within policy area}}$$

and is usually expressed as a percentage. For example, a policy that decreases CO₂ by 1 Mt within a policy area but increases it by 1 Mt outside the policy area would have leakage of 100%. For UK policy, the policy area is typically all flights whose CO₂ can be attributed to the UK.

Country-level CO₂ can be measured in different ways, with different consequences for how the impact of a system change on emissions is distributed between countries. Expanding Heathrow increases the number of flights between Heathrow and many other countries, on routes covered by a range of different carbon policies, so CO₂ outcomes in other countries are strongly affected by the scope on which they are considered.

Table 13 UK departing within-set kerosene and SAF use, and CO₂: 2R vs. 3R scenario in 2050

Metric	2019 baseline	2050 scenarios	
		2R	3R
Within-set UK departing kerosene use, Mt ¹	5.74	6.03	6.37
Of which domestic	0.47	0.55	0.57
Within-set UK departing SAF use, Mt	0.0	4.27	4.51
Of which domestic	0.0	0.39	0.40
Within-set UK departing aviation CO ₂ , Mt	18.15	8.25	8.72
Of which domestic	1.5	0.77	0.79

¹ All kerosene, including SAF.

The UK government typically considers UK CO₂ emissions on a departing flights basis. Table 13 shows UK-attributable aviation CO₂ emissions within the modelled set of routes on this basis. Emissions reductions from SAF are included under the assumption of an 80% decrease in SAF lifecycle emissions compared to those from fossil Jet A. Other emission reductions from outside the sector, for example from the UK ETS or CORSIA credits, are not included. Because a RefuelEU-level SAF mandate is assumed to apply to departing flights, CO₂ emissions are more than halved from year-2019 totals despite overall demand growth. On this scope, UK-attributable aviation CO₂ increases by about 0.5 Mt when Heathrow is expanded, compared to the scenario where it is not.

Figure 14 shows how the CO₂ attributable to other countries changes on this scope. Several factors affect how CO₂ attributable to other countries changes:

- The majority of passengers take direct return journeys, and most air routes are symmetric. An increase in outbound flights means an increase in inbound flights, so CO₂ attributable to the destination country for a given route increases by a similar amount to CO₂ attributable to the origin country for that route, all else equal.
- If passengers on indirect itineraries switch from using a hub airport in country A to one in country B, emissions attributable to country A will go down and emissions in country B

will go up (all else equal). Similarly passengers switching from a hubbing route to a direct one will lower CO₂ emissions for the hub airport country and increase them for the origin country.

- If passengers switch from a route that has smaller average aircraft size or lower load factor to one with larger average aircraft size or higher load factor, CO₂ per passenger may decrease.
- For many routes, SAF policy is asymmetric and based on departing flights. For example, Westbound Transatlantic flights are assumed covered by SAF mandates, while Eastbound ones are not. A symmetric increase in demand on Transatlantic routes can cause significant leakage for the UK, because emissions from the inbound flight, which does not use SAF and is outside UK emissions scope, increase by much more than those on the outbound flight, which does use SAF and is within UK emissions scope.

The combination of these effects can be seen in Figure 14 for the 3R scenario compared to the 2R scenario.

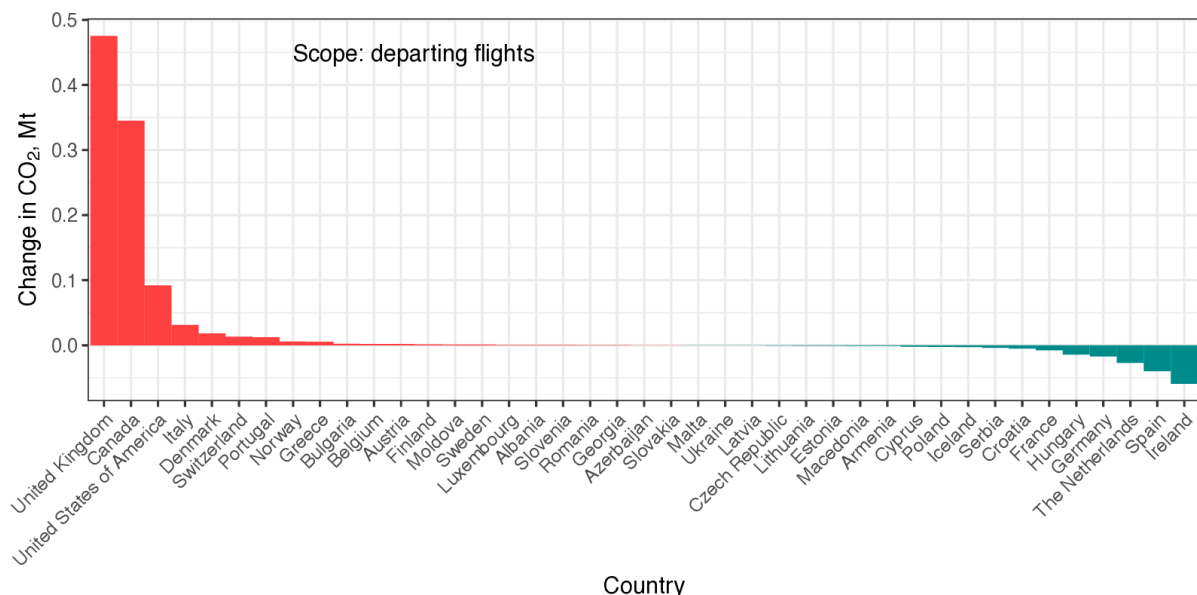


Figure 14 2R vs. 3R scenario: change in CO₂ by country, on a departing flights scope

Expanding Heathrow reduces overall CO₂ attributable to some countries with competing hub airports, including the Netherlands, Germany, and France. It increases UK-attributable emissions, as well as emissions attributable to North American countries. For these countries, leakage effects are magnified by asymmetric SAF mandates, as discussed above. On expansion, passengers on UK-US routes increase by more than those on UK-Canada routes. However, there is more of a switch towards smaller aircraft on routes to Canada, leading to higher emissions per passenger and a larger leakage effect overall. For other countries with increases in CO₂ such as Italy and Denmark, the impact of direct demand increases has outweighed any impact from changes in hubbing or aircraft size. However, routes to European countries from the UK are assumed to be covered by SAF mandates in both directions and so the CO₂ impact of increasing demand is small.

Figure 15 shows the corresponding change in emissions by country if emissions are attributed to countries based on half of the total of arriving and departing flight CO₂. In this case, the impact of asymmetric SAF mandates is smaller. However, Transatlantic routes still have a larger CO₂ impact on expansion than others as their average SAF use is lower. As such, the largest amount of positive leakage is still to North American countries.

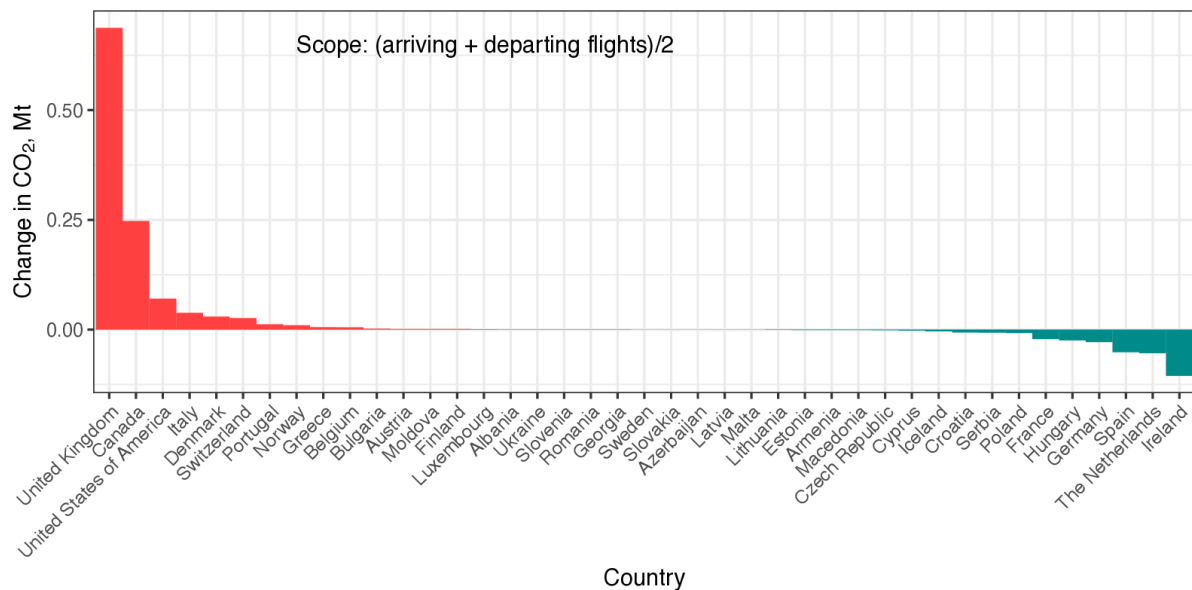


Figure 15 2R vs. 3R scenario: change in CO₂ by country, on a half departing flights plus arriving flights scope

2.2 2R vs. 3R at lower economic growth

The above results are based on the reasonable optimistic scenario (see Table 3). This section examines the outcome of lower economic growth assumptions in the UK for both 2R and 3R scenarios. Other world regions use the same growth rate assumptions as the core scenarios. In practice this means:

- Fewer passengers on UK origin/destination itineraries;
- A smaller impact on demand for routes via the UK, with non-UK passengers taking a greater relative role in driving demand growth;
- Larger impacts on UK airports that serve more domestic demand; and
- Slower/lower growth in new fleet and new route growth.

For the UK as a whole, the lower economic growth scenario leads to departing flight RPK growth between 2025-2050 of 1.3% (2R), and 1.4% (3R), in comparison to RPK growth rates of 1.4% and 1.6% respectively in the core 2R and 3R scenarios.

Figure 16 and Figure 17 show within-set aircraft and passenger movements at London airports for the lower economic growth 2R and 3R scenarios, similarly to Figure 7 and Figure 11 for the core 2R and 3R scenarios. Table 14 and Table 15 report year-2050 totals in the same metrics for these scenarios, with totals split by route group included in Annex A.2. Under lower economic growth assumptions, passenger demand growth for UK-originating routes is lower as anticipated. However, it is not low enough to affect capacity constraints at Heathrow and Gatwick pre-expansion, and both airports still add significant numbers of operations when expanded. For Gatwick, growth in new operations is slower than in the core 2R and 3R cases, with more years spent not at full capacity. Similarly, in the lower economic growth 3R scenario new capacity at Heathrow is taken up more slowly than in the core 3R case. For all airports, the amount of route-switching is reduced, i.e. airlines are less willing to take up routes at new airports. In part, this is because capacity constraints are less severe in these scenarios and airlines who want to add

routes can more easily do so at their first choice airports. Where route switching does occur, it typically occurs at later years than in the core 2R and 3R scenarios.

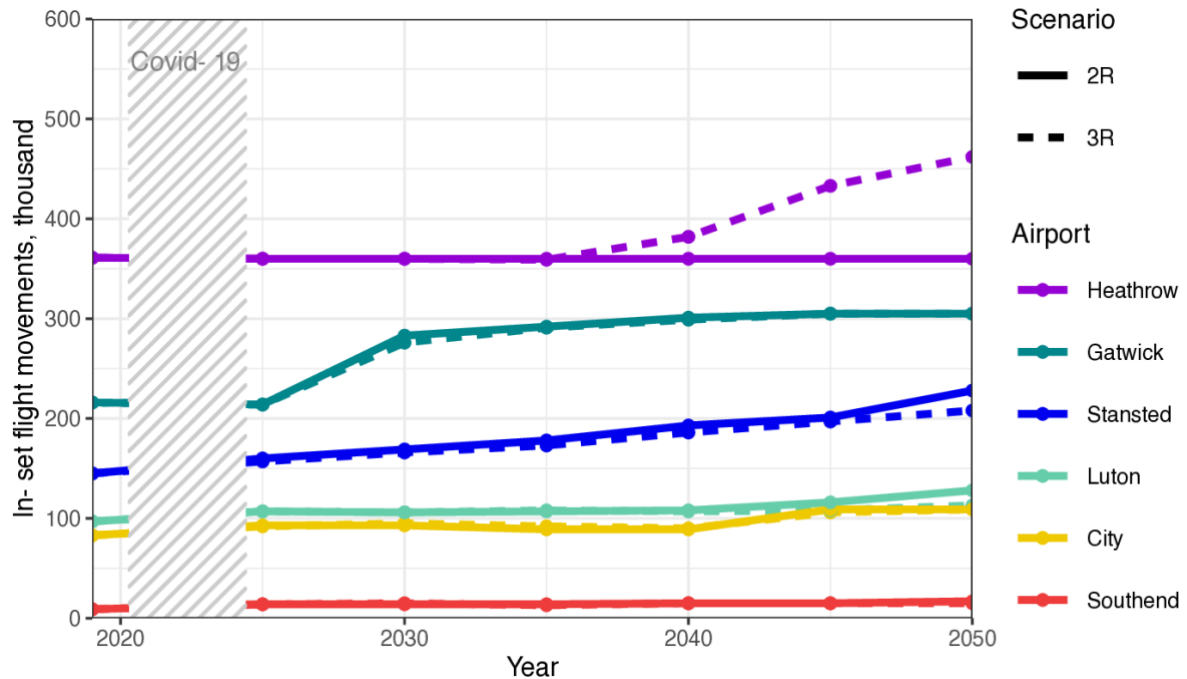


Figure 16 Within-set flight movements at London airports: 2R vs. 3R scenario

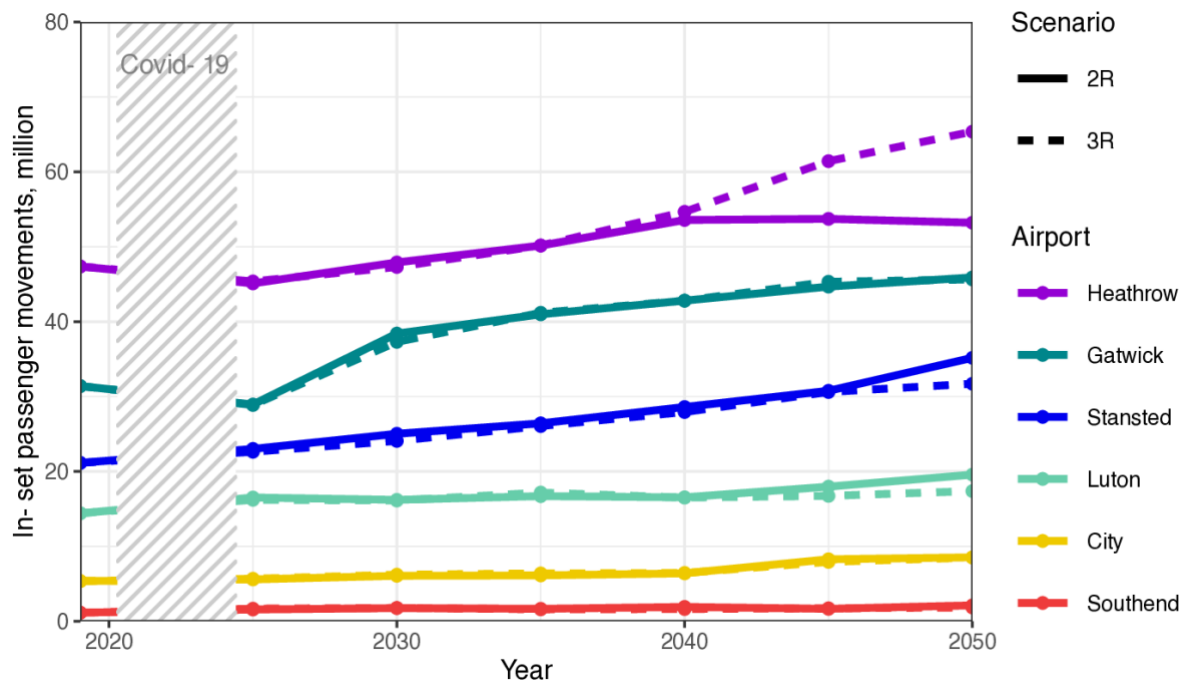


Figure 17 Within-set passenger movements at London airports: 2R vs. 3R scenario

Table 14 Year-2050 within-set number of flights at London airports: 2R vs. 3R scenario at lower economic growth

Metric	2019 baseline	2050 scenarios	
		2R case	3R case
Europe + Transatlantic flights at LHR, thousand	360	360	462 +102
Europe + Transatlantic flights at LGW, thousand	217	305	305 +0
Europe + Transatlantic flights at STN, thousand	149	228	208 -20
Europe + Transatlantic flights at LTN, thousand	91	128	113 -15
Europe + Transatlantic flights at LCY, thousand	71	109	109 +0
Europe + Transatlantic flights, all London airports, thousand	900	1146	1211 +65

For passengers in particular, the amount of substitution between airports is reduced in the lower economic growth scenarios compared to the core 2R and 3R scenarios. At a London level, this means that the overall growth in passengers becomes more similar to the growth of Heathrow airport on its own. As with growth in numbers of flights, this reflects a much more limited impact of capacity constraints in driving route switching.

Table 15 Year-2050 within-set number of passengers at London airports: 2R vs. 3R scenario at lower economic growth

Metric	2019 baseline	2050 scenarios	
		2R case	3R case
Europe + Transatlantic passenger movements at LHR, million	47.6	53.2	65.4 +12.2
Europe + Transatlantic passenger movements at LGW, million	31.9	45.9	45.6 -0.3
Europe + Transatlantic passenger movements at STN, million	21.2	35.2	31.7 -3.5
Europe + Transatlantic passenger movements at LTN, million	13.7	19.6	17.4 -2.2
Europe + Transatlantic passenger movements at LCY, million	4.3	8.5	8.5 +0
Europe + Transatlantic passenger movements, all London airports, million	120	164.5	170.4 +5.9

At lower economic growth, there are still changes in fares and fare revenue at London airports from expanding Heathrow (Table 16). As in the core scenarios, these arise both from the removal of scarcity rents and from changes in the type of routes offered by that airport. In general, these changes are smaller in the lower economic growth scenarios than they were in the core scenarios, reflecting both that capacity constraints are less stringent, and that there is less change in the routes and frequencies offered. One exception is at London Gatwick; in the lower economic growth scenario, expanding Heathrow strongly reduces the number of transatlantic flights at Gatwick, decreasing both average fares and overall fare revenue.

Table 16 Change in within-set fares and fare revenue at London airports between the 2R and 3R scenarios at lower economic growth

Airport	Year-2050 3R vs. 2R, change in:	
	Average economy class fare, %	Fare revenue, %
Heathrow	-8.3	15.1
Gatwick	-6.5	-14.1
Stansted	-1.1	-10.9
Luton	-1.5	-12.4
City	-0.8	-1.7

Finally, in Table 17 we show changes in consumer and producer surplus between the 2R and 3R scenarios at lower economic growth. As in the core 2R and 3R case, it should be noted that these numbers are not fully comparable due to scope differences. Because there is less pressure on capacity than in the core 2R and 3R cases, scarcity rents are lower, passthrough is higher, and impacts on airlines are generally of smaller magnitude. Two main system changes affect how the consumer and producer surplus develop over time. The first is the availability of new capacity and its impact on fares, which tends to produce positive consumer surplus and negative producer surplus. This effect is larger in the core 2R and 3R cases, but steadily grows after expansion in the lower economic growth cases. The second is the impact of increased landing charges at Heathrow to fund expansion, which are not present in the 2R case. These act to decrease both consumer and producer surplus, with the balance between the two affected by the amount of passthrough. However, in the lower economic growth scenario their impact on bringing demand closer to capacity, which acts to increase consumer surplus, is also important.

Table 18 shows the corresponding system-wide airline operating profit margins, under the same assumptions around transfer passengers and indirect operating costs as for the core 2R and 3R cases. For the lower economic growth cases, there is less impact on airline profit margins from expanding Heathrow, and profit margins increase less to 2050. However, the same broad trends in profit margin over time as in the core 2R and 3R cases apply: profit decreases across the 2030-2040 period as effective fuel prices increase and recovers over the 2040-2050 period, ending at a higher level than in 2025.

Table 17 2R vs. 3R case at lower economic growth: consumer and producer surplus

		3R vs. 2R case at lower economic growth				
Metric		2030	2035	2040	2045	2050
Change in consumer surplus, 2025 £bln		-0.06	0.30	0.31	1.50	2.74
Change in producer surplus*, 2025 £bln		-0.10	-0.22	-0.54	-0.85	-2.05

Table 18 2R vs. 3R case at lower economic growth: system-wide airline operating profit margins

System-wide airline operating profit margin, %							
Scenario	2019	2025	2030	2035	2040	2045	2050
2R	4.5	4.7	3.5	3.2	3.6	5.8	8.3
3R	4.5	4.7	3.5	3.1	3.4	5.2	7.7

2.3 3R sensitivity to landing charge levels

The following scenarios simulate situations where the landing charge increase to fund Heathrow expansion is lower or higher than anticipated. All other model input assumptions, including economic growth rates, remain identical to the core 3R scenario. We run two variant scenarios, one in which landing charges are 20% higher, and one in which they are 20% lower. For simplicity, we scale all components of the landing charge at the same rate in each case, maintaining the overall ratio between charges on a per-passenger and per-flight basis. In the case that landing charges are 20% lower, they rise over the 2030-2040 time period and then return to close to the current level by 2050, and are also similar to those assumed for the core 2R scenario by 2050. In the case that landing charges are 20% higher, they peak at around double those assumed for the 2R scenario. Consequences of different landing charges include several effects.

- Airlines will experience higher or lower operating costs to operate from Heathrow, while their operating costs for using other airports will not change.
- Airlines can choose to pass on changes in operating costs to passengers or absorb them. Their decision on the extent of passthrough will depend on factors such as whether the airport is at capacity, the level of competition for passengers, and the extent to which competitor airlines also experience the operating cost increase.
- If costs are passed through, this will affect demand for Heathrow flights. It may also affect the fares of (and demand for) competing itineraries at other airports.
- Landing charges are different for different sizes of aircraft. Changing landing charges may change the balance between the sizes of aircraft that it is most economic for airlines to operate from Heathrow. This may also change the balance of routes that airlines decide to operate.

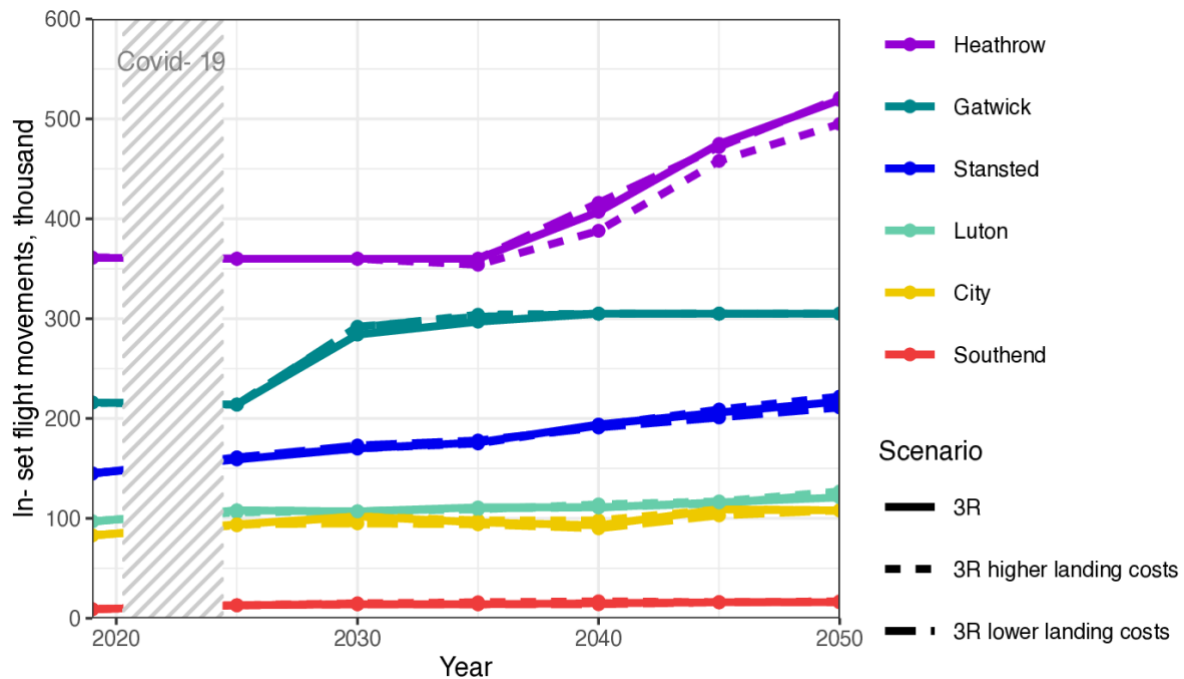


Figure 18 Variant landing charge scenarios: within-set flight movements at London airports over time

Figure 18 and Figure 19 show the within-set change in aircraft and passenger movements at London airports over time in the variant landing charge scenarios compared to the core 3R scenario. Table 19 shows metrics for 2050. In these model runs, the impact of changing landing charges is different at different points in time, and depends on whether the change is an increase or decrease. In the pre-expansion period, passthrough of landing charge changes at Heathrow is limited, reflecting capacity constraints. There is a small amount of passthrough on European routes, however, and this affects the fares of competing routes at other London airports, particularly Gatwick in 2030 (which is not at capacity). In 2035, there is still limited passthrough at Heathrow in the lower landing charge scenario. However, in the higher landing charge scenario, operating costs at Heathrow have increased enough to push the airport slightly below capacity, increasing the level of passthrough. This type of outcome is also seen in the DfT (2026) forecasts of Heathrow expansion. After expansion, the impacts of the increased and decreased landing charge scenarios remain asymmetric. In the increased landing charge scenario, average economy class fares at Heathrow are 4% higher than in the core 3R scenario by 2050. This reflects two factors: first, the increased operating costs, and second, that airlines choose to drop shorter-haul flights and keep longer-haul ones. Of the 24,000 fewer flights at Heathrow in 2050, 17,000 are intra-European and 3,000 UK domestic.

In the case that landing charges are lower, airlines instead focus more on shorter-haul flights. By 2050, average economy class fares at Heathrow are 1.6% lower. The overall number of flights at Heathrow increases by 2,000, but this reflects a complex underlying picture: fewer, larger flights are used to carry transatlantic passengers, while flight frequencies increase on European and UK domestic routes.

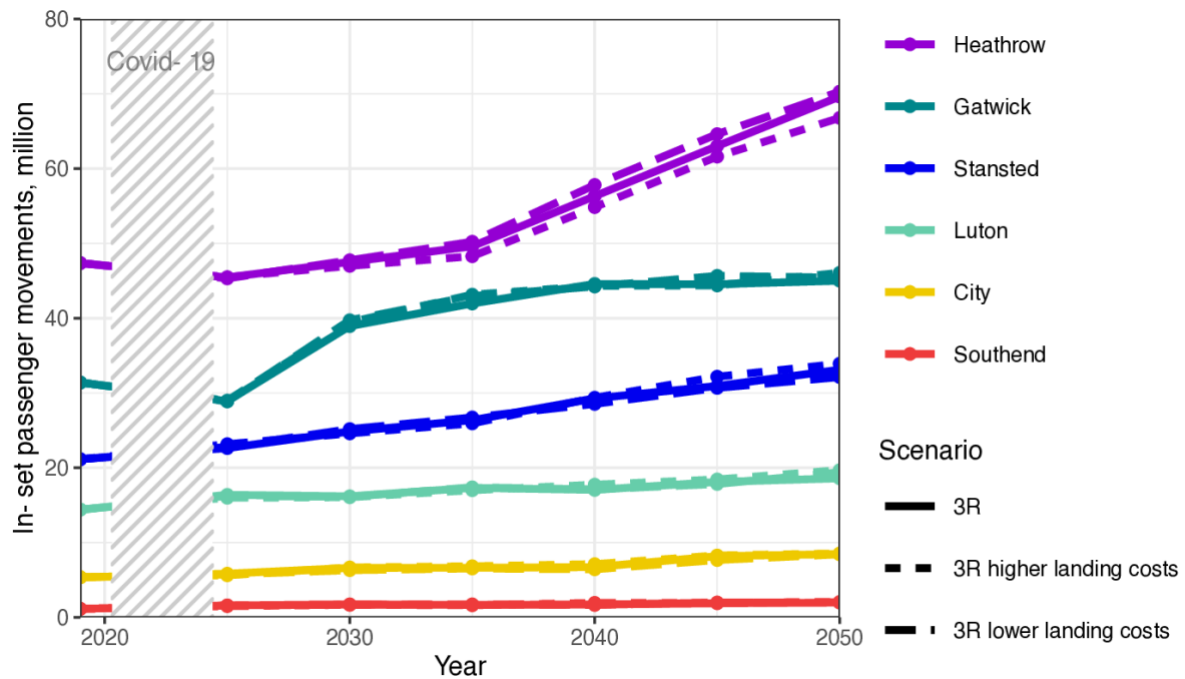


Figure 19 Variant landing charge scenarios: within-set passenger movements at London airports over time

Table 19 Variant landing charge scenarios: year-2050 flight and passenger movements in comparison to core 3R scenario

Airport	Year-2050 within-set flight movements, thousand			Year-2050 within-set passenger movements, million		
	3R low charges	3R	3R high charges	3R low charges	3R	3R high charges
Heathrow	521 +2	519	495 -24	70.3 +0.7	69.6	66.8 -2.8
Gatwick	305 +0	305	305 +0	45.4 +0.4	45.0	46.1 +1.1
Stansted	211 -6	217	222 +5	32.1 -1.0	33.1	33.9 +0.8
Luton	125 +4	121	127 +6	19.4 +0.8	18.6	19.7 +1.1
London City	108 +0	108	108 +0	8.4 -0.1	8.5	8.6 +0.1
All London Airports	1286 +0	1286	1274 -12	177.7 +0.9	176.8	177.1 +0.3

Landing charge changes also have complex impacts at other London airports, as competing airlines decide whether to change their fares and operations in response to changes at Heathrow. For example, if Heathrow lowers landing charges, passengers may switch to Heathrow itineraries. However, airlines operating at other airports may decrease fares on competing

routes, potentially leading to increases in demand there. Increases in demand may also add pressure on capacity, which in turn will also affect fares. And airlines may change their decisions about whether to prioritise routes with fewer, higher-yield passengers versus more, lower-yield passengers. In combination, these effects lead to increases in passengers at a London level in 2050 in both the low charge and high charge scenarios. In the low charge scenario, demand increases at Heathrow and also at some of its competitor airports, as they reduce fares on competing routes. In the high charge scenario, airlines add successful new routes at Gatwick and Luton airports in response to airlines at Heathrow cutting back on shorter-haul flights, leading to a much smaller overall increase in passenger demand.

Table 20 shows the impact of the higher and lower landing charge scenarios on fares and fare revenue at London airports by 2050. In all cases, these charges are calculated relative to the core 2R scenario, i.e., no expansion. At Heathrow, fares decrease more on expansion if landing charges are lower, while overall airline revenue remains at a similar level due to changes in the number of passengers. Impacts at other airports are more complex. In general, fares and fare revenues decrease more at other London airports if Heathrow landing charges are lower, as airlines reduce fares there to compete with lower fares at Heathrow. Gatwick's situation is more complex as there is more potential for switching of routes between Heathrow and Gatwick, including long-haul and indirect traffic. This route switching can both increase Gatwick average fare (if longer routes are added) and fare revenue (if routes and passengers move from Heathrow to Gatwick). In practice, however, all outcomes related to landing charges will depend on the exact way that any landing charge increase is distributed between passengers and different sizes of aircraft.

Table 20 3R variant landing charge change scenarios: change in average economy class fare and fare revenue at London airports from the core 2R scenario

Airport	Year-2050 3R lower charges vs. 2R, change in:		Year-2050 3R higher charges vs. 2R, change in:	
	Average economy class fare, %	Fare revenue, %	Average economy class fare, %	Fare revenue, %
Heathrow	-18.2	12.6	-13.9	12.1
Gatwick	+1.7	-0.2	-0.1	1.9
Stansted	-0.4	-16.2	-0.2	-11.4
Luton	-2.4	-15.4	-1.9	-13.7
City	-3.0	-10.3	-3.0	-10.1

2.4 Sensitivity to fleet availability

This case simulates a situation where airlines cannot fully adapt their fleet to ideal operations at an expanded Heathrow due to reduced availability of new aircraft. This could arise because manufacturers have underestimated demand when planning production capacity, because of groundings or delays to production programmes, or because of constraints around supply chains and material availability. We implement this as a 50% reduction in the pool of aircraft that airlines have available to choose from between timesteps. In practice, there are several likely consequences.

- Airlines with homogeneous fleets, such as low-cost carriers, may not be able to expand as fast as they would like.
- Airlines with heterogeneous fleets also have the option of using non-optimal aircraft sizes for a route, if aircraft of the ideal size are not available but other aircraft are.
- Instead of getting rid of older, less fuel-efficient aircraft, airlines may have to keep using them.
- Orders and deliveries will have a less peaked structure as there are no time periods when airlines have enough fleet for their needs (e.g. Dray, 2013).

Lower fleet availability has system-wide impacts. At a system level, year-2025-2050 RPK growth routes are reduced by 0.1% per year across all route groups.

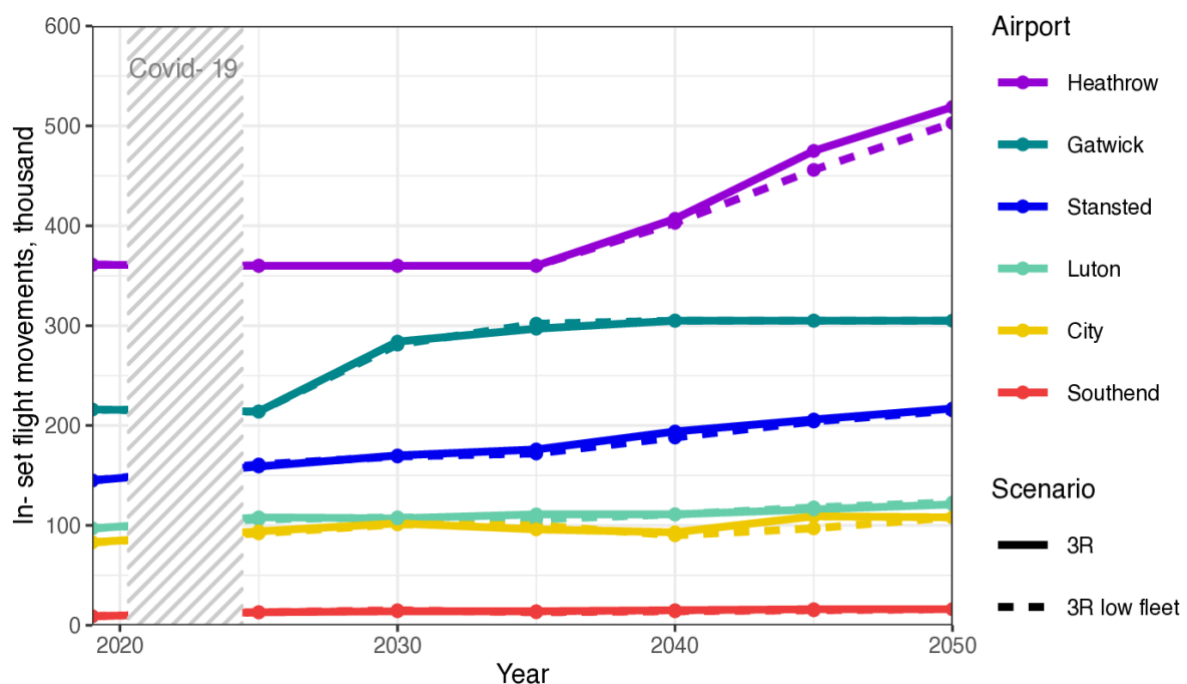


Figure 20 Low fleet availability scenario compared to baseline 3R scenario: in-set flight movements

Figure 20 and Figure 21 show impacts on the London airport system, in terms of aircraft and passenger movements. Table 21 gives totals for both metrics by airport in 2050. Because airlines use more non-optimal and older fleet, fares are higher than in the core 3R scenario. For example, average economy class fares at Heathrow are around 3% higher, and at other London airports around 1% higher, when the fleet is constrained. At a whole-London level, passenger movements fall by 1.4%, and there are some shifts of demand between airports. The shortfall in available fleet compounds over time, so Gatwick expansion, which happens relatively early in the simulation, is not affected as much as Heathrow expansion, which happens later. Other impacts on airlines are heterogeneous and depend on their existing fleet structures and profiles of demand over time. This in turn leads to heterogeneous impacts per airport.

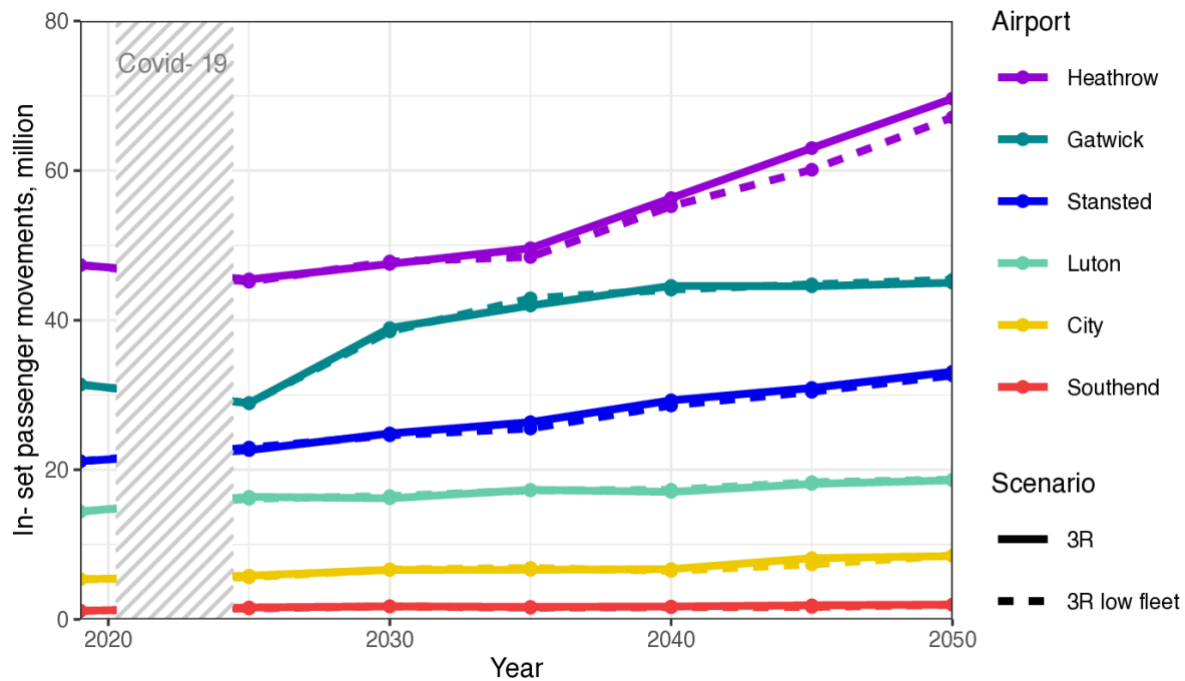


Figure 21 Low fleet availability scenario compared to baseline 3R scenario: in-set flight movements

Table 21 Low fleet scenario compared to baseline 3R scenario: changes in passenger and flight movements

Airport	Year-2050 within-set flight movements, thousand		Year-2050 within-set passenger movements, million	
	3R	3R low fleet	3R	3R low fleet
Heathrow	519	503 -16	69.6	67.1 -2.5
Gatwick	305	305 +0	45.0	45.4 +0.4
Stansted	217	215 -2	33.1	32.6 -0.5
Luton	121	123 +2	18.6	18.7 +0.1
London City	108	108 +0	8.5	8.5 +0
All London Airports	1286	1271 -15	176.8	174.3 -2.5

Figure 22 shows how fleet constraints affect the aircraft sizes that are used per airport, compared to the core 3R scenario. Impacts are significant and system-wide. In particular, shifts over time in typical aircraft sizes that occur in the core scenarios are reduced. For example, the core scenarios see a system-wide shift towards the use of larger narrowbody aircraft. Not enough new large narrowbody aircraft are available in the low fleet scenario, so airlines have to keep using

medium narrowbody aircraft that they would otherwise retire. Similarly, airlines that would like to expand operations in faster-growing regions, such as Southwest in North America, are not able to do so to the extent that they would like, leading to lower fleet use overall. This means that adding other, faster-growing route groups to the simulation is likely to increase the overall impact of fleet constraints.

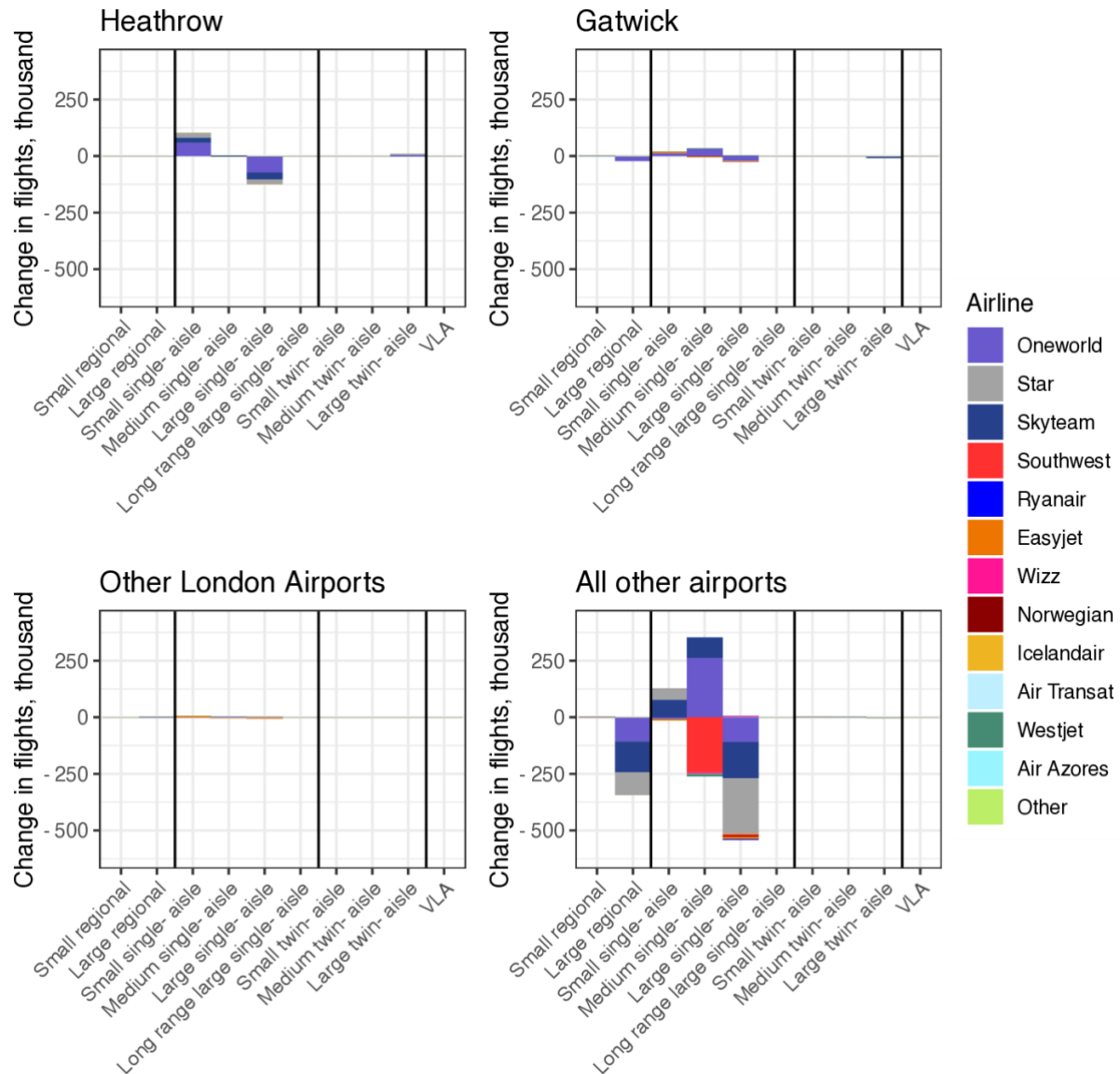


Figure 22 Low fleet availability scenario compared to baseline 3R scenario: changes in aircraft size used at London airports

2.5 Sensitivity to fuel prices

This case simulates a situation where fuel prices are significantly higher than in the core 3R scenario. We implement this using a higher SAF price trajectory combined with SAF mandates. However, in practice, similar outcomes will occur in any situation that leads to high effective fuel prices, including increases in the price of fossil Jet A, high carbon prices, or requirements to use Direct Air Capture (DAC) at high DAC prices.

Future SAF prices are uncertain and depend on production costs, policy and producer profit margin, which in turn depend on the extent to which supply is able to match mandated demand. Because mandated SAF blend levels are assumed to increase over time, the impact of SAF prices being higher than anticipated is a steady additional increase in effective fuel price in regions that have SAF mandates. In practice, there are several likely consequences.

- Airline operating costs on routes with SAF mandates will increase, which may be fully or only partially passed on to passenger ticket prices. At airports with capacity constraints, passthrough is more likely to be limited, but this may change as capacity constraints are removed.
- All else equal, longer-haul routes will be more affected, as fuel is typically a higher fraction of their operating costs.
- Routes that are only covered one-way by SAF mandates (here, Transatlantic routes) will be impacted less than routes of the same length that are covered both ways.
- Routes with no SAF mandate will see only second-order impacts (e.g., fewer transfer passengers).

The impacts of higher fuel prices apply system-wide. At an overall system level, intra-North America RPK growth rates are unchanged, Transatlantic average RPK growth rates 2025-2050 are reduced by 0.2%/year, and intra-European RPK growth rates over the same period are reduced by 0.4%/year.

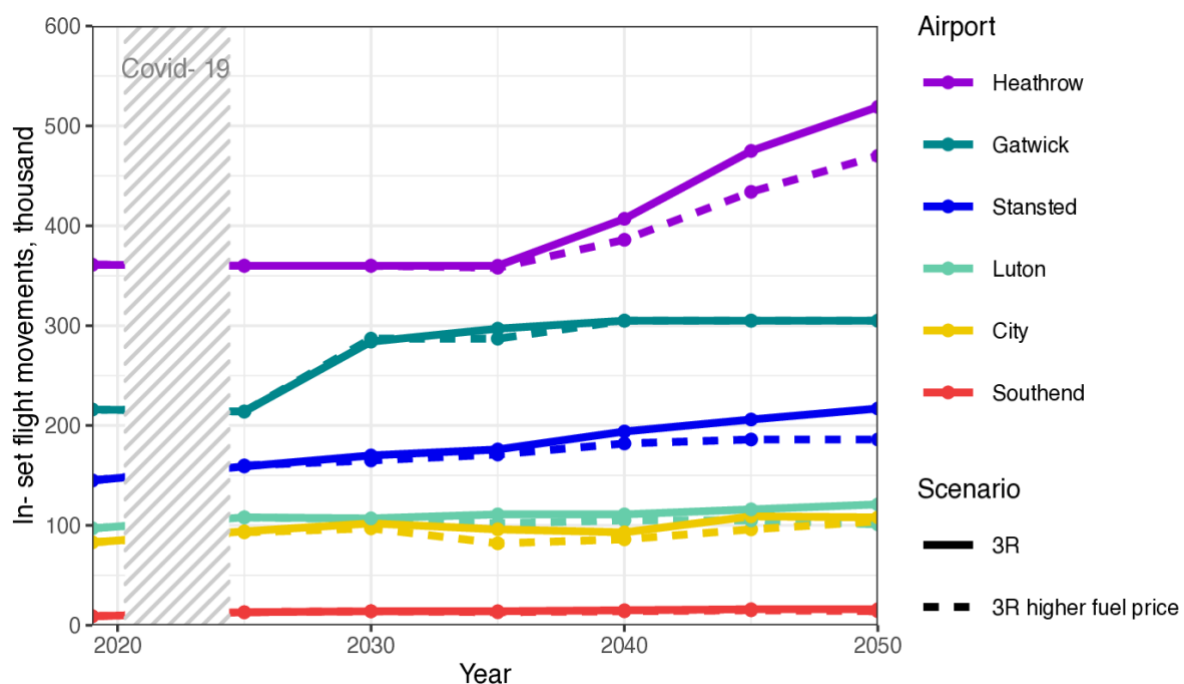


Figure 23 High fuel price scenario compared to baseline 3R scenario: in-set flight movements

Figure 23 and Figure 24 show impacts on the London airport system, in terms of aircraft and passenger movements. Table 22 gives totals for both metrics by airport in 2050. Airlines respond to higher effective fuel prices by increasing the average aircraft size they use, where they can, as this reduces per-passenger fuel costs. This means that impacts in number of flights are larger than those on passengers. Average economy class fare increases are of order 5-10%, depending on route and airport. As well as London-wide decreases in passengers and flights, there is also some switching between airports. In general this benefits Gatwick airport, which is able to offer

long-haul connections at lower landing costs than Heathrow and therefore represents one avenue that airlines can use to try and reduce their overall costs.

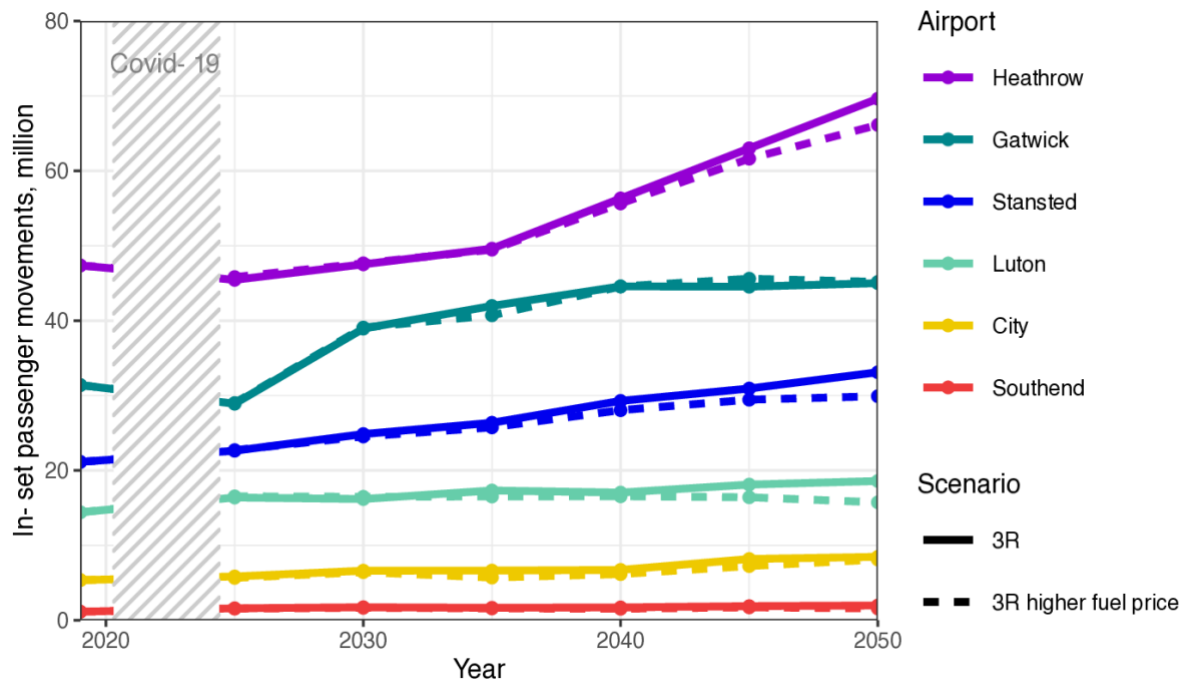


Figure 24 High fuel price scenario compared to baseline 3R scenario: in-set passenger movements

Table 22 High fuel price scenario compared to baseline 3R scenario: changes in year-2050 passenger and flight movements

Airport	Year-2050 within-set flight movements, thousand		Year-2050 within-set passenger movements, million	
	3R	3R high fuel price	3R	3R high fuel price
Heathrow	519	470 -49	69.6	66.1 -3.5
Gatwick	305	305 +0	45.0	45.2 +0.2
Stansted	217	186 -31	33.1	29.9 -3.2
Luton	121	101 -20	18.6	15.7 -2.9
London City	108	104 -4	8.5	8.1 -0.4
All London Airports	1286	1179 -107	176.8	166.6 -10.1

In general, increased effective fuel price amplifies trends that were already present in the baseline scenarios. Airlines face even more pressure to increase average aircraft size, where they are able to. For low-cost carriers, increasing effective fuel prices further has a larger impact than on other carriers, as fuel is a greater fraction of their operating costs and their passengers are typically more price-sensitive. Figure 25 shows how flights by airline type change over time at different airports in the high fuel price scenario. Growth is dominated by full service carriers, with the level of low-cost carrier operations static or decreasing at most airports by 2050. In turn, airports that are dominated by low-cost carriers, such as Stansted and Luton, see the largest relative decline in passengers from the baseline scenario.

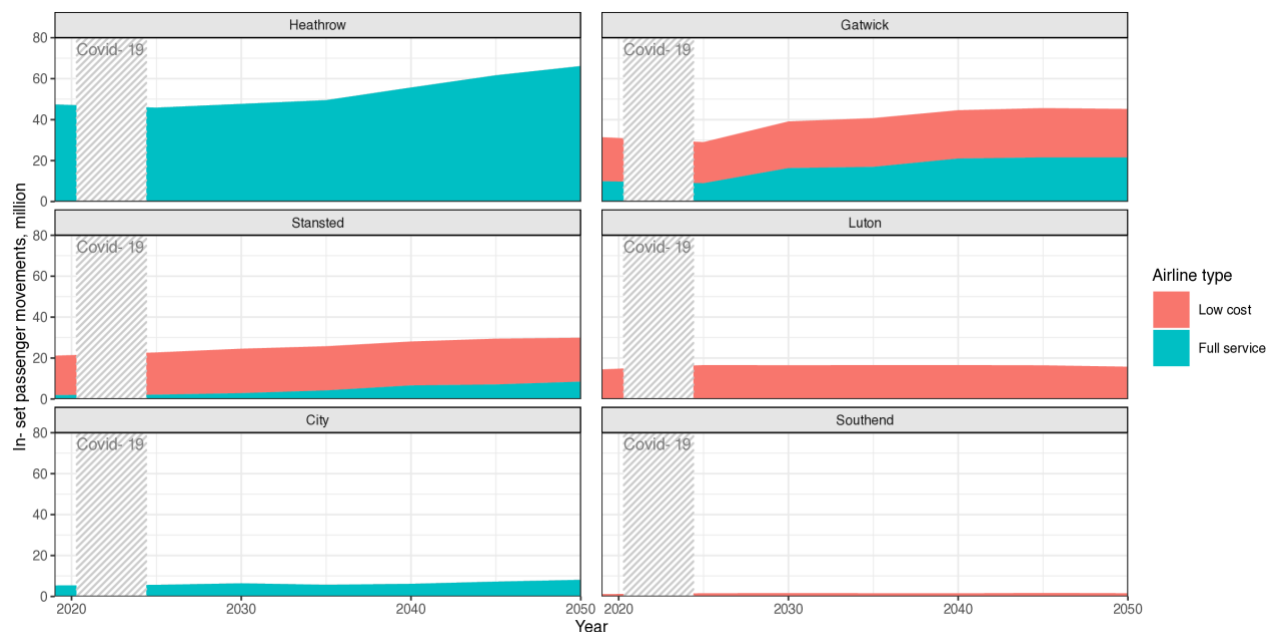


Figure 25 High fuel price scenario compared to baseline 3R scenario: impact on low-cost carriers compared to full-service carriers

2.6 Tapered APD scenario

This case simulates a situation where Heathrow is expanded as in the core 3R scenario, and additionally the UK government tapers APD downwards between 2040 and 2050, after expansion has occurred. APD is assumed decrease linearly, starting in 2040, to fall to two-thirds of its original values by 2050. In practice, there are several likely consequences.

- Ticket prices for UK itineraries are likely to decrease, while fares for routes that do not involve the UK will experience only second-order impacts.
- APD is applied at different rates per destination and ticket class. Therefore the fare effect will also differ by destination and ticket class.
- Because APD has a banded structure and is charged at the same rate for all destinations within a band, the relative impact will be greater for flights at the bottom end of a band's distance range than at the top.

The impacts of tapered APD apply UK-wide, but have smaller impacts elsewhere. The average UK-originating RPK growth rate 2025-2050 increases from 1.6%/year to the core 3R scenario to 1.8%/year.

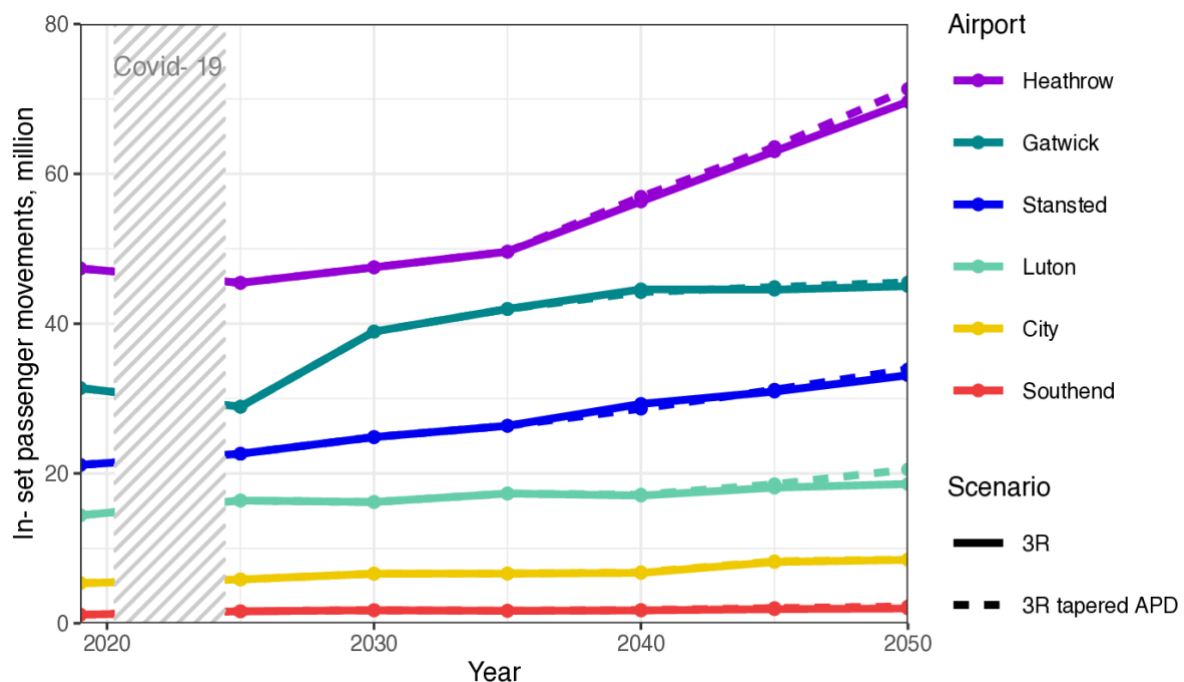
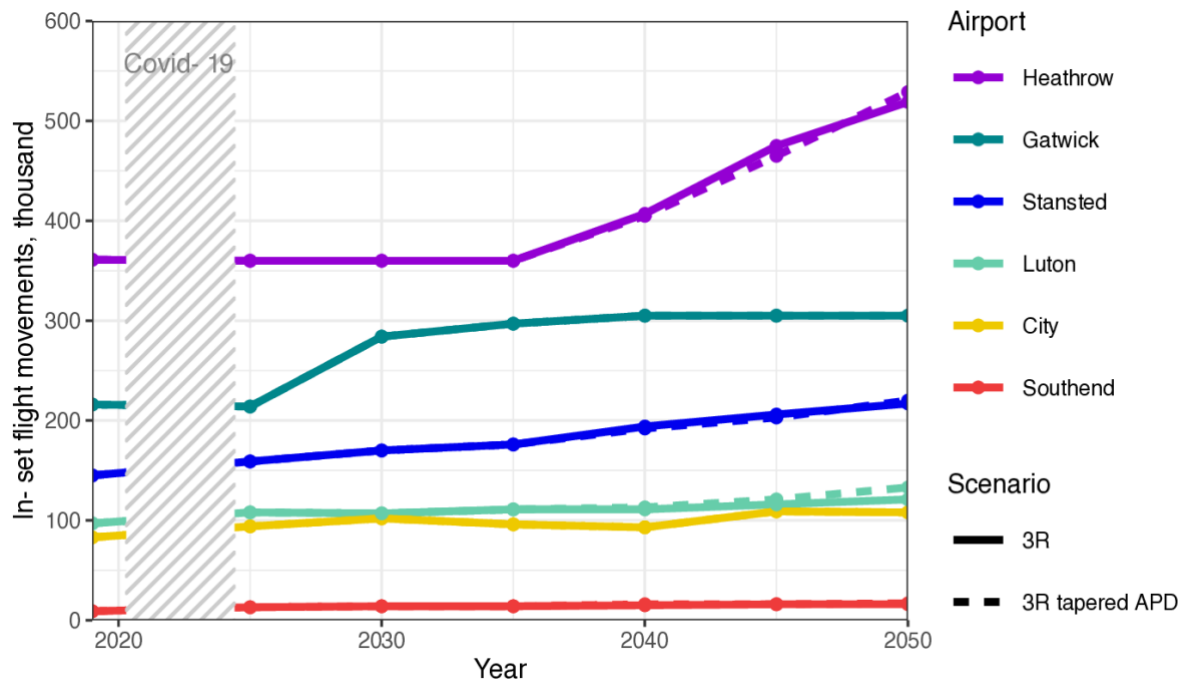


Figure 26 and Figure 27 show impacts on the London airport system, in terms of aircraft and passenger movements. Table 23 gives totals for both metrics by airport in 2050. The main impact of tapering APD at London airports is an increase in passengers. There is less of an impact on flight numbers, because APD is charged on a per-passenger rather than per-flight basis. This leads to a small increase in aircraft size. In total, across London airports, flight movements increase by 2.1% and passenger movements increase by 2.8%.

Table 23 Tapered APD scenario compared to baseline 3R scenario: changes in year-2050 passenger and flight movements

Airport	Year-2050 within-set flight movements, thousand		Year-2050 within-set passenger movements, million	
	3R	3R tapered APD	3R	3R tapered APD
Heathrow	519	529 +10	69.6	71.3 +1.7
Gatwick	305	305 +0	45.0	45.5 +0.5
Stansted	217	220 +3	33.1	33.9 +0.8
Luton	121	133 +12	18.6	20.5 +1.9
London City	108	108 +0	8.5	8.5 +0
All London Airports	1286	1314 +28	176.8	182.0 +5.2

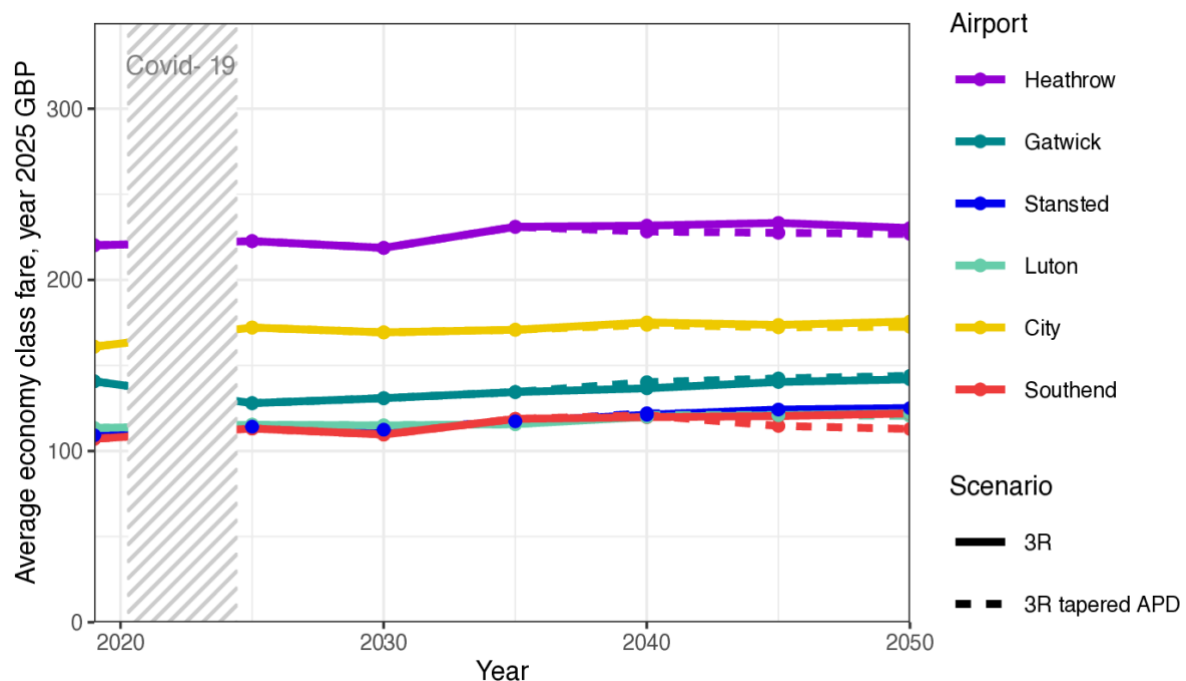


Figure 28 Tapered APD scenario compared to baseline 3R scenario: changes in average economy class fare per airport

Because APD is higher relative to ticket price for low-cost carrier flights, and because low-cost carrier passengers are generally more fare-sensitive, there is a larger increase in low-cost carrier demand than for full-service carriers. This affects the distribution of impact between airports.

Figure 28 shows how average economy-class fares vary at an airport level. Fares are affected by lower APD; by any change in the distribution of destinations from an airport resulting from lower APD; and by whether the APD-influenced demand increase interacts with any capacity constraints. For low-cost carriers, the overall impact of fare changes is an increase in UK-origin passengers by 4.3%. For full-service carriers, the corresponding increase is 1.8%.

3. Summary of outcomes

The objective of this work was to provide a better understanding of the economic impacts of Heathrow Expansion on airlines and passengers, including how competing airlines respond to capacity increases by changing their operations and the itineraries and fares they offer, how passengers respond to these changes, and the carbon leakage implications. A summary of outcomes in terms of flight and passenger movements at Heathrow and across the whole London airport system for all scenarios explored is given in Table 24.

Table 24 Summary of outcomes across all scenarios

Scenario	Year-2050 within-set flight movements, thousand, at:		Year-2050 within-set passenger movements, million, at:	
	Heathrow	All London airports	Heathrow	All London Airports
Core 2R	360	1178	51.9	170.0
Core 3R	519	1286	69.6	176.8
2R lower economic growth	360	1146	53.2	164.5
3R lower economic growth	462	1211	65.4	170.4
3R lower charges	521	1286	70.3	177.7
3R higher charges	495	1274	66.8	177.1
3R low fleet	503	1271	67.1	174.3
3R high fuel price	470	1179	66.1	166.6
3R tapered APD	519	1314	71.3	182.0

The core 2R and 3R scenarios examine what may happen with (3R) and without (2R) expansion under reasonable optimistic assumptions for economic growth, and expected trajectories for other uncertain variables. Expanding Heathrow both increases passenger demand at Heathrow and also increases demand at the overall London/UK level, reflecting induced demand from reductions in ticket prices and changes in itineraries offered. For Heathrow alone, expansion increases flights on the modelled route group set by 45%, and passenger movements by 34%. At a London level, flights increase by 9.3% and passengers increase by 3.6% when Heathrow is expanded. The average economy class fare at Heathrow is 17.2% lower in the 3R scenario than in the 2R scenario. This reflects both a decrease in scarcity rents due to removal of capacity constraints, and a greater proportion of intra-European flights (which have lower average fares) in the 3R case. In the 2R scenario, increasing capacity constraints over time lead to a decrease in European flights compared to Transatlantic ones. Average aircraft size similarly decreases in the 3R scenario compared to the 2R scenario. Heathrow expansion also leads to a 0.5-3%

decrease in average economy class fare at other London airports as competing itineraries respond to changes in fares at Heathrow.

We also explored how these outcomes would change if external scenario variables that affect demand and competition took different trajectories into the future. If UK economic growth is lower than in the reasonable optimistic scenario used for the core model runs, demand growth at UK airports is slower and more driven by passengers from outside the UK. In this case, takeup of new capacity is slower and there is less route switching between airports. However, new capacity is still taken up, there is still an overall induced demand effect at the London and UK levels of expanding Heathrow, and average fares still fall on Heathrow expansion. This reflects that Heathrow still remains capacity constrained until expansion in this scenario. In this case, expansion leads to a 28% increase in flight movements at Heathrow and a 23% increase in passenger movements, with London-area flight and passenger movements increasing by 5.7% and 3.6% respectively.

The impact of landing charge increases at Heathrow to fund expansion being smaller or larger than anticipated depends on the size of the change, how it is applied, and whether it is an increase or decrease. In general, changing Heathrow's landing charges affects the balance of demand between different London airports and between flights with different aircraft sizes. In the case where landing charge changes are passed through onto ticket prices, it can also affect fares on competing itineraries at other London airports. If landing charges are 20% above anticipated values, Heathrow drops slightly below unexpanded capacity in 2035. A larger dip below capacity is likely if landing charges are high and economic growth is also low. Once new capacity is provided, however, there is still growth at Heathrow above the non-expanded level of flights, although it is slower than in the case where landing charges increase less. If landing charges are 20% lower, not all of this change may be passed through to ticket prices. Passengers increase particularly on shorter-haul routes. However, in general outcomes around flight distance and aircraft size are complex and will depend on the exact way that any landing charge increase is distributed between passengers and different sizes of aircraft.

Constraints on fleet availability and high fuel prices both reduce the overall level of demand growth. Demand still increases at Heathrow on expansion in both cases. Where not enough fleet is available, airlines respond by using older aircraft and aircraft that are not an optimal size for a given route. Trends towards use of larger narrowbody aircraft are weaker, and operations may be constrained because airlines do not have enough fleet to increase frequency. In this case, passenger movements at Heathrow are 3.6% lower than in the core 3R scenario, and 1.4% lower in London as a whole. Where fuel prices are higher, outcomes depend on the exact level of fuel price increase, but values within feasible literature ranges can have a significant impact on growth rates. Airlines switch to using larger aircraft where they can to reduce per-passenger fuel costs. Low-cost carriers, for whom fuel costs are a relatively high fraction of total operating cost, are particularly disadvantaged in this scenario. The difference in passenger movements between the two different fuel price scenarios explored in this study was 5.8% at a London level and 5.0% at Heathrow, reflecting that airports with a low-cost carrier focus are more-impacted.

We also explored a scenario where UK Air Passenger duty is tapered down to 2/3 of its year-2025 values between 2040 and 2050. This modestly increases demand growth at a UK level (1.6%/year average RPK growth rate 2025-2050 to 1.8%/year). The largest passenger increases for this policy are on low-cost carriers, as APD represents a larger fraction of a typical low-cost carrier ticket price and their passengers are typically more fare-sensitive. Therefore, although Heathrow sees an increase in demand (by 2.4% in passenger movements) on tapering APD by 2050, larger increases occur at airports that mainly serve low-cost carriers.

Overall, these runs suggest that overall demand at a London and UK level is likely to increase on expansion. However, the extent of the increase is dependent on uncertain variables such as economic growth, fuel prices, and the extent to which landing charges need to increase to fund expansion. The results shown here include only intra-European and Transatlantic routes, so outcomes may also change as other flights (particularly Europe to Asia) are added in. Because these route groups are faster-growing, they are likely to increase the capacity pressure on the London system. This in turn will likely increase demand growth on expansion and the fare impact of expanding Heathrow. However, assessing the extent to which this occurs requires extending the geographic scope of the analysis.

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Annex A Supplementary tables and figures

Annex A.1 2R vs 3R scenarios

This annex contains extra tables and figures for the core 2R and 3R scenarios.

Table 25 Within-set flight movements at London airports: 2R vs. 3R case split by route group

Flights, thousand, at:	UK domestic			Intra-Europe			Transatlantic		
	2019 baseline	2050 scenarios		2019 baseline	2050 scenarios		2019 baseline	2050 scenarios	
		2R case	3R case		2R case	3R case		2R case	3R case
Heathrow	38	34	40 +6	230	163	279 +116	93	163	200 +37
Gatwick	26	35	45 +10	179	253	239 -14	11	17	20 +3
Stansted	13	38	34 -4	132	206	183 -23	0	0	0 +0
Luton	13	28	24 -4	84	116	97 -19	0	0	0 +0
City	18	35	37 +2	64	70	69 -1	0	2	2 +0
All London Airports	11.3	173	185 +12	697	823	880 +57	104	181	222 +41

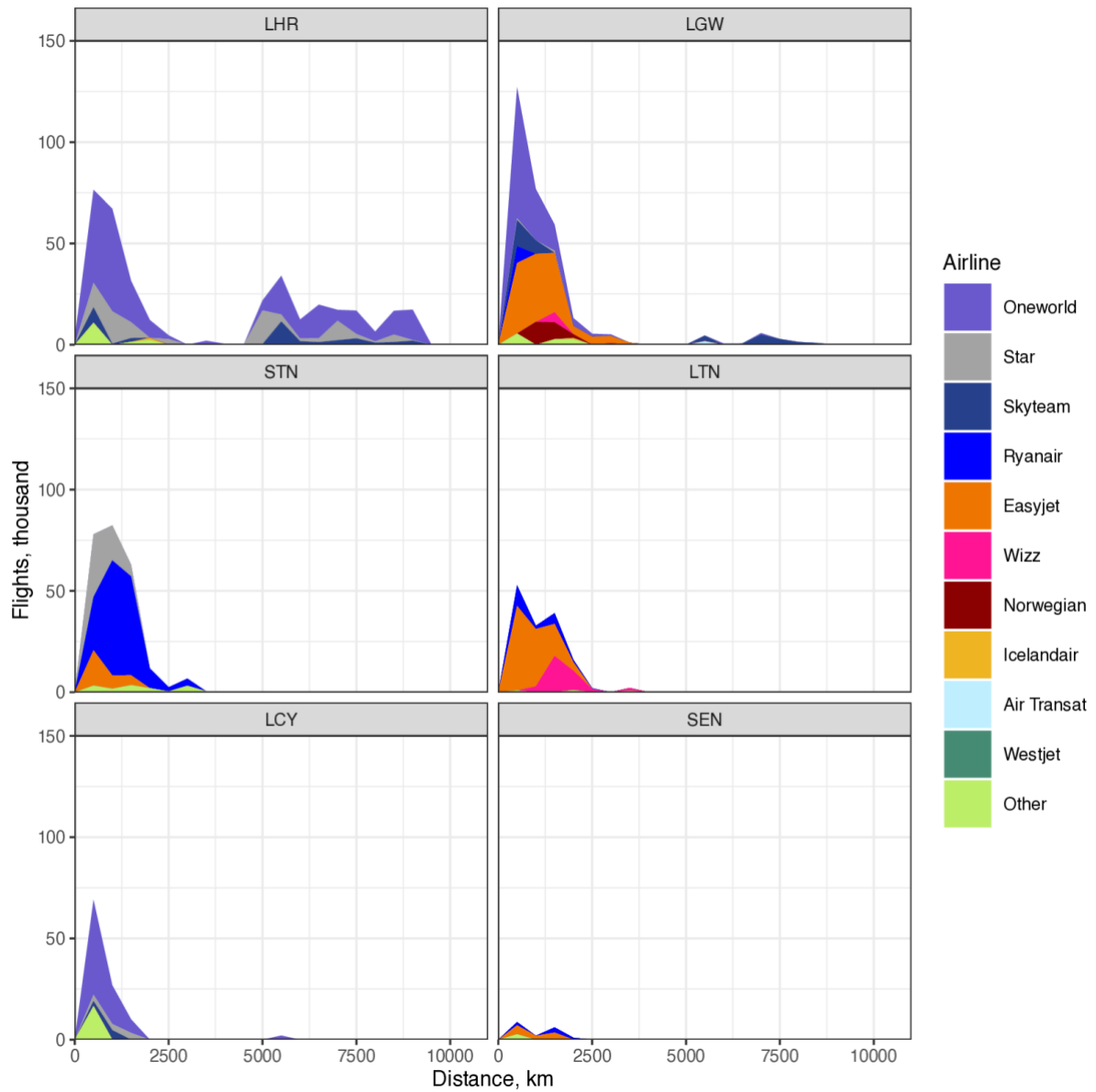


Figure 29 2R scenario: distribution of flights by airport, airline/allyance and distance

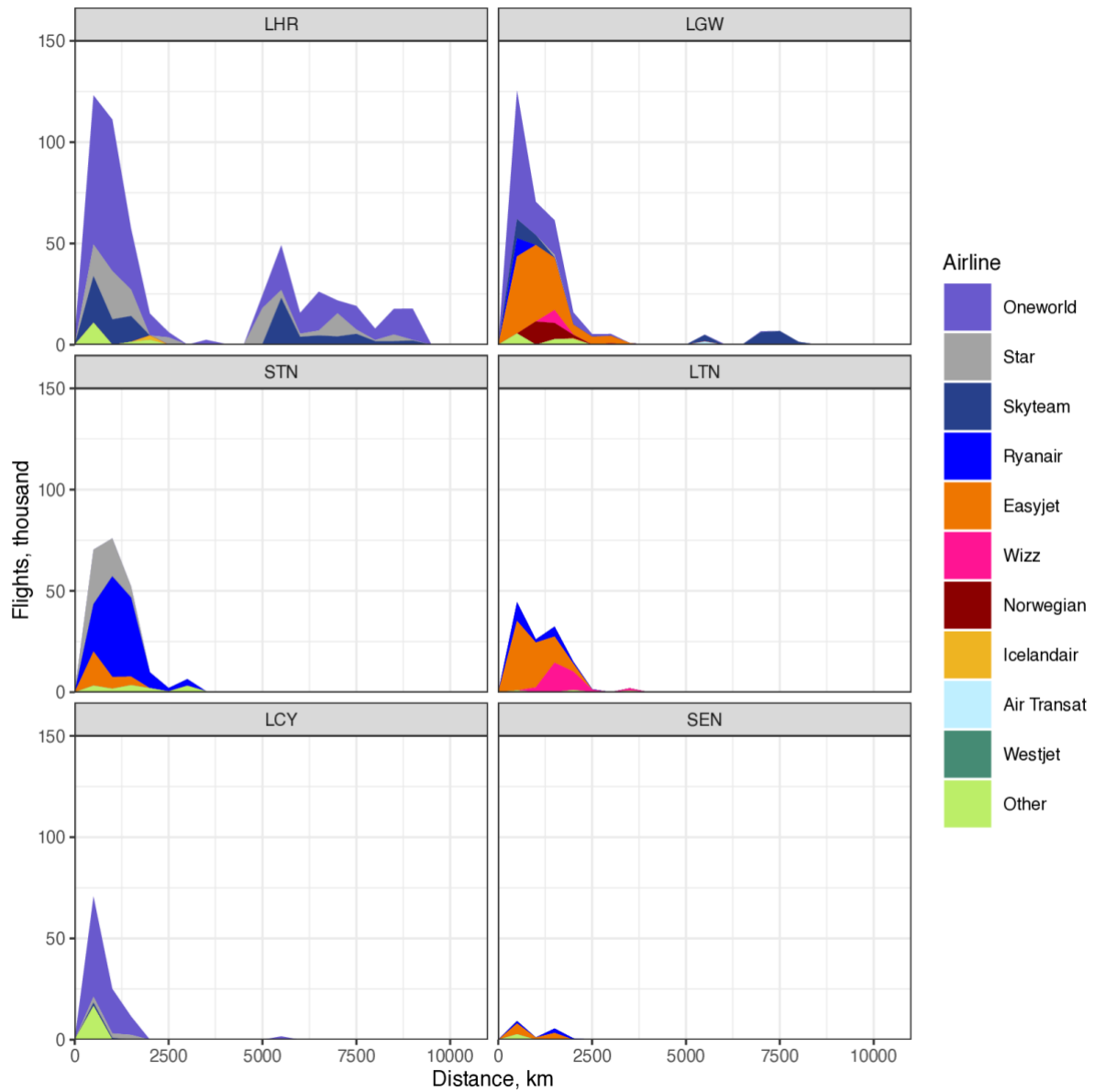


Figure 30 3R scenario: distribution of flights by airport, airline/alliance and distance

Table 26 Within-set passenger movements at London airports: 2R vs. 3R case split by route group

Passenger movts, million, at:	UK domestic			Intra-Europe			Transatlantic		
	2019 base- line	2050 scenarios		2019 base- line	2050 scenarios		2019 base- line	2050 scenarios	
		2R case	3R case		2R case	3R case		2R case	3R case
Heathrow	4.3	4.7	5.6 +0.9	26.9	27.4	43.1 +15.7	16.1	19.8	21.0 +1.2
Gatwick	3.2	5.2	6.4 +1.2	25.2	39.7	36.5 -3.2	3.0	2.0	2.2 +0.2
Stansted	1.1	5.8	5.0 -0.9	20.0	32.4	28.1 -4.2	0	0	0 +0
Luton	1.3	3.5	2.9 -0.5	13.1	18.9	15.6 -3.2	0	0	0 +0
City	1.2	2.5	2.6 +0.1	4.2	5.7	5.6 -0.1	0	0.2	0.2 +0
All London Airports	11.3	21.8	22.6 +0.8	90.4	126.1	130.9 +4.7	19.1	20.4	23.3 +1.4

Annex A.2 2R vs 3R scenarios at lower economic growth

This annex contains extra tables for the 2R and 3R scenarios at lower economic growth.

Table 27 Within-set flight movements at London airports: 2R vs. 3R case with lower economic growth split by route group

Flights, thousand, at:	UK domestic			Intra-Europe			Transatlantic		
	2019 baseline	2050 scenarios		2019 baseline	2050 scenarios		2019 baseline	2050 scenarios	
		2R case	3R case		2R case	3R case		2R case	3R case
Heathrow	38	35	39 +4	230	185	257 +72	93	140	166 +26
Gatwick	26	35	44 +9	179	254	253 -1	11	15	7 -8
Stansted	13	33	33 +0	132	194	175 -19	0	0	0 +0
Luton	13	26	22 -4	84	102	91 -11	0	0	0 +0
City	18	35	35 +0	64	72	72 +0	0	1	1 +0
All London Airports	11.3	169	177 +8	697	820	860 +40	104	157	174 +17

Table 28 Within-set passenger movements at London airports: 2R vs. 3R case with lower economic growth split by route group

Passenger movts, million, at:	UK domestic			Intra-Europe			Transatlantic		
	2019 base- line	2050 scenarios		2019 base- line	2050 scenarios		2019 base- line	2050 scenarios	
		2R case	3R case		2R case	3R case		2R case	3R case
Heathrow	4.3	4.9	5.6 +0.7	26.9	29.9	39.5 +9.5	16.1	18.3	20.3 +2.0
Gatwick	3.2	4.9	6.3 +1.4	25.2	38.5	38.1 -0.4	3.0	2.5	1.2 -1.3
Stansted	1.1	4.9	4.7 -0.2	20.0	30.3	27.0 -3.3	0	0	0 +0
Luton	1.3	3.0	2.8 -0.2	13.1	16.5	14.6 -1.9	0	0	0 +0
City	1.2	2.5	2.4 -0.1	4.2	5.9	5.9 +0	0	0.2	0.2 +0
All London Airports	11.3	20.4	22.0 +1.6	90.4	123.2	126.8 +3.6	19.1	21.0	21.6 +0.6