The discontinuation of domestic flights in Austria: a case study on the impact on passenger routings, regional airports and the environment

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Short-haul or domestic flight bans are sometimes demanded as (potential) measures to reduce the air transport sector's carbon footprint. Using an example from Austria as a case study, we assess some key effects of stopping such services. After illustrating alternative routing options, we apply publicly available data to identify key traffic and financial impacts of the suspension of the Linz–Vienna route in the year 2018. Demand data at the origin–destination level suggest that approximately 25% of former Linz–Vienna transfer passengers have switched to flights via Frankfurt instead of using alternative transport modes to either reach Vienna or an alternative departure airport. Approximately 50% of former route passengers now seem to use the train to Vienna as part of their air ticket (AIRail Rail and Fly). For the operator of Linz Airport, these shifts indicate a reduction of 31,000 departing passengers and approximately 1,500 flights per year, representing a possible decline of €3.5 million in aeronautical revenues according to the current airport charges regulation. We finally discuss implications for a (potential) discontinuation of other domestic routes in the country as well as the possible environmental impact of such measures.

Keywords:
air transport,
short-haul flight ban,
airport revenues,
traffic impact,
air–rail inter-modality,
air–rail modal shift,
case study,
Austria

Introduction

Short-haul or domestic flight bans are sometimes seen as measures to reduce the air transport sector's carbon footprint. An actual implementation of such a measure happened in France where scheduled flights on (so far three) domestic routes with high-speed rail (HSR) alternatives below 2.5 h have been banned since May 2023, subject to 'conditions' and based on 'serious environmental problems' according to Article 20 of Regulation (EC) 1008/2008 (BBC 2023, Ministère de la Transition Écologique et de la Cohésion des Territoires 2023).

European Union (EU) states where similar bans are being discussed include Austria, Germany and Spain (Cunningham 2022) while Belgium collects a €10 departure tax on routes below 500 km in an attempt to incentivise travellers to switch to ground transport (Chambre des Representants de Belgique 2022).

Route bans undoubtedly have effects on stakeholders such as airports, airlines, passengers or ground transport providers and may also impact regional accessibility and development or the environment. Given the novelty of such measures, the academic literature on such bans is relatively limited, and primarily focuses on the potential to shift existing air travel demand to ground modes, particularly railways (Avogadro et al. 2021, Szymczak 2021), whereas empirical research on the actual effects of route suspensions at the airport or routing levels is scarce.

In a case study approach, using Austria as an example, this study assesses the key effects of short-haul (or domestic) route discontinuations on stakeholders in tackling the following research questions:

– What kinds of alternative routing options exist for air passengers affected by a route suspension, and which alternative routings can actually be observed following the discontinuation of the Linz–Vienna route?
– What is the impact of this route discontinuation on Linz Airport's revenues?
– What conclusions can be drawn for other domestic routes in Austria?
– What environmental benefit can be expected from the route suspension?

Our approach and the study's structure are as follows: after the introduction the study provides some (political) background information and a literature review. Then we identify alternative routing options and affected key stakeholders at a generic level, followed by an overview of the methodology and data used for the case study analysis. Then the study's results are presented: first, an analysis of the general situation on domestic flights in Austria is provided. Second, we look into the actual traffic effects of the suspension of the Linz–Vienna route, which had been terminated in October 2018 (Liu 2018). This analysis involves comparing passenger routings at the origin–destination level before and after the route's (gradual) discontinuation to identify the number and share of passengers that seem to have switched to alternative air services or to 'ticket-integrated' train connections via Vienna, an Austrian Airline product called 'AIRail Rail and Fly'. Third, the projected decrease in passenger traffic departing from or arriving at Linz is then employed to assess the potential revenue loss for the airport operator. Fourth, these findings are utilised to briefly discuss the impact of potentially discontinuing other domestic routes in Austria, such as the Vienna to Salzburg route (which was discontinued during Covid-19) or Graz (potentially in the future). In the final section the environmental effects of a shift of domestic flights to rail are discussed. The study concludes with a summary and outlook on further research.

We acknowledge that the Linz–Vienna operation was already reduced and eventually discontinued before the current discussion on route bans; however, as the route was suspended before the pandemic, the potential impact can be determined without Covid-19 bias.

Background

Policy background

Air transport facilitates worldwide mobility yet also contributes approximately 3%–5% to global warming, both as an emitter of CO_2 and in generating additional non-CO_2 effects (Lee et al. 2021, Simorgh et al. 2022). Without implementing any countermeasures, this contribution to global warming would continue to rise due to the expected growth of the air transport market (German Aerospace Center 2021).

Hence, several measures with a focus on reducing CO_2 emissions have been introduced at different geographical levels in an attempt to reduce the sector's climate impact. At the international level, the International Civil Aviation Organisation (ICAO; 2019) introduced its 'basket of measures' concept which combines different fields of action such as enhanced aircraft technologies, operational improvements, the introduction of sustainable aviation fuels and economic or market-based measures like the Carbon Offsetting and Reduction Scheme for International Aviation.

Achieving a reduced-emission aviation market in the long term requires technological improvements focusing on low-emission engines and energy-efficient aircraft (German Aerospace Center 2021); however, the transition to new generations of aircraft and engines will take time, as it involves replacing the current fleets. This situation emphasizes the importance of operational and economic measures, as well as sustainable fuels, as key areas for immediate action.

Europe is an example of a world region implementing stronger measures to mitigate aviation emissions like the EU emission trading scheme (EU ETS) or – in some countries – ticket taxes (air passenger duties/levies). For a comparison between the EU ETS and ticket taxes in terms of demand impact, see Oesingmann (2022).

However, stronger measures would be needed to effectively reduce the sector's own emissions, such as kerosene taxes, as proposed by environmental organisations (Transport & Environment 2020) or, as politically pushed in Austria, minimum fares (EURACTIV.com with Reuters 2021).

The most advanced measures in this regard are probably domestic flight bans. In December 2022, the European Commission approved a revised version of a French decree banning domestic flights on routes where railway alternatives of less than 2.5 h exist, subject to further conditions and with reference to serious environmental problems outlined in Art. 20 of EU-Regulation 1008/2008 (EC 2022a). Only three routes are currently affected: Paris Orly to Bordeaux (train travel time from the central station to the central station from 2 h 6 min), Lyon (1 h 49 min) and Nantes (2 h). Airport train stations are understood as destinations 'in their own right' instead of the city's (main) train station in cases in which the larger airport of a route is directly served by HSR. This way, flights from Bordeaux or Nantes to Paris Charles de Gaulle Airport (CDG) are still allowed to operate as the trip duration by train to CDG's airport train station exceeds 2.5 h in both cases. Reiter et al. (2022) identified two reasons for exempting certain hub feeders from this ban: HSR may not adequately substitute for long-haul flight feeders, and long-haul critically relies on feeders to achieve sufficient load factors. In addition, it is reasonable to assume that the French government wanted to find a way to introduce a ban without harming the national carrier too much.

In the context of its €600 million governmental bailout aimed at mitigating the financial impacts of the Covid-19 pandemic, Austrian Airlines agreed to suspend domestic operations on routes that can be substituted by rail with a travel time of less than 3 h. Consequently, the airline has not yet resumed the Vienna–Salzburg route after the pandemic (Morgan 2020).

Environmental organisations advocating for such bans include Greenpeace, which supports bans on routes where trains operate within 6 h (Greenpeace European Unit 2021), and a joint initiative by 14 German non-governmental organizations, led by Robin Wood (2022), advocating for bans on routes where train alternatives within 4 h are available.

Literature

The academic literature on (the effects of) route suspensions or flight bans is still limited and mostly contains *ex ante* assessments of the potential to shift existing flight supply and passenger volumes to rail, as well as forecasts of the amounts of CO_2 that could be (directly) saved in this way.

Szymczak (2021) estimates the effects of potential short-haul flight bans on flight movements and seat supply at European airports, based on the assumption that bans would be introduced on routes with railway alternatives below 3 h, 4 h, 5 h or 6 h, respectively. Baumeister–Leung (2021) conducted an analysis to determine if and where non-HSR in Finland could replace domestic flights against the background that HSR investments usually require 'considerable investments in time and infrastructure'. They find that switching to the railways could reduce carbon emissions significantly by 95%, and they expect the traditional railway network to remain competitive against air transport on routes not exceeding 400 km. The authors likely have not considered the life-cycle emissions of the railway infrastructures. Although these life-cycle emissions may indeed be less relevant for the traditional railway network as considered by the authors in the case of Finland, they should be considered when assessing the impacts of new HSR rail construction projects (Jiang et al. 2021).

Avogadro et al. (2021) study to what extent short-haul routes in Europe could be substituted by ground transport, considering both increasing travel time and resulting impacts on generalised travel costs. They find that flight operations accounting for approximately 3% of intra-European seat supply could be discontinued without any significant increase in travel time.

Referring to schedule and actual passenger booking data for Germany, Reiter et al. (2022) investigate to what extent flight supply could be banned without compromising connectivity, how many passengers would consequently shift to rail and which airlines and airports would become affected the most. They also predict the possible impacts on passengers (such as increase in travel time) and on the environment (in terms of carbon savings). As a basis for their calculations, the authors also present a meta-analysis of the literature on the thresholds − in terms of travel time or distance − of air–rail competition. They observe a trade-off between direct CO_2 savings and travel time losses as both increase with increasing degrees of substitution.

A view outside Europe is taken by Robertson (2016) who assesses the scope for CO_2 mitigation by switching to HSR in Australia. Based on several assumptions and considering life-cycle emissions, for example from the infrastructure, he calculates a potential 18% reduction in CO_2 for the Sydney–Melbourne axis for the target year 2056.

In addition, there is existing literature on airline network planning investigating the factors behind route suspension, as well as general literature on airline and (high-speed) rail competition. De Wit–Zuidberg (2016) observe that low-cost carriers (LCC) often suspend existing routes rather quickly and switch to other destinations from a given airport (known as route churn), complementing an earlier study by Dobruszkes (2013) who, among other aspects, illustrates the share of discontinued routes formerly served by LCC before the year 2012. In the research field of airline and HSR competition, numerous studies, mostly from Asia, address issues such as airline network choice (Jiang−Zhang 2016), impact on airline pricing strategies (Su et al. 2019) or on-time performance (Jiang et al. 2022).

Literature on the (seamless) integration of airline and (high-speed) rail services is still relatively scarce. A recent study by Huan et al. (2023) provides scheduling options for improving synchronous operations of air and HSR.

Alternative travel options and affected stakeholders

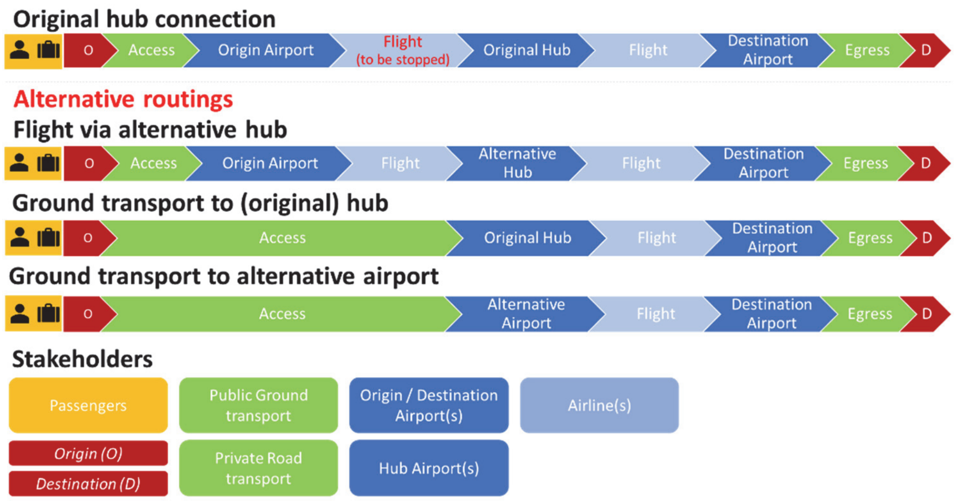
In this section, we illustrate the key effects of route suspensions on travel patterns using a conceptual approach, considering the two archetypical network types – point-to-point (P2P) and hub-and-spoke (H&S) (Cook–Goodwin 2008) – as well as the impacts on key stakeholders.

Suspension of H&S feeder services

Figure 1 illustrates the most obvious alternative routing options and affected stakeholders for discontinuation of an H&S service. Passengers normally use such a service either to fly from their origin airport to the hub or to travel via the hub (and potentially additional hubs) to a final destination, or vice versa.

Figure 1

Suspension of an H&S route – alternative travel options



If the hub feeder is suspended, passengers will essentially have the following options:

- Flying from the original departure airport but changing planes at an alternative hub, provided these flights are not banned.
- Using ground transport to reach the hub city (for local, non-transfer passengers; not depicted in Figure 1) or the original hub and flying from there. For the latter, two basic contractual options are generally applicable: the ground segment can either be part of an (integrated) air ticket. Examples of this are Austrian Airlines' 'AIRail Rail and Fly' or Lufthansa's 'Express Rail' products where the ground segment has its own, dedicated 'flight number' and the passenger has a 'connection' guarantee, meaning free rebooking in case of

a missed connection). Alternatively, it is organised individually (usually by car, bus/coach or train), without any connection guarantee.
– Using ground transport to reach an alternative departure airport.

Other options not illustrated in the figure include a complete switch to ground transport, flying to an alternative destination airport and/or region or not travelling at all.

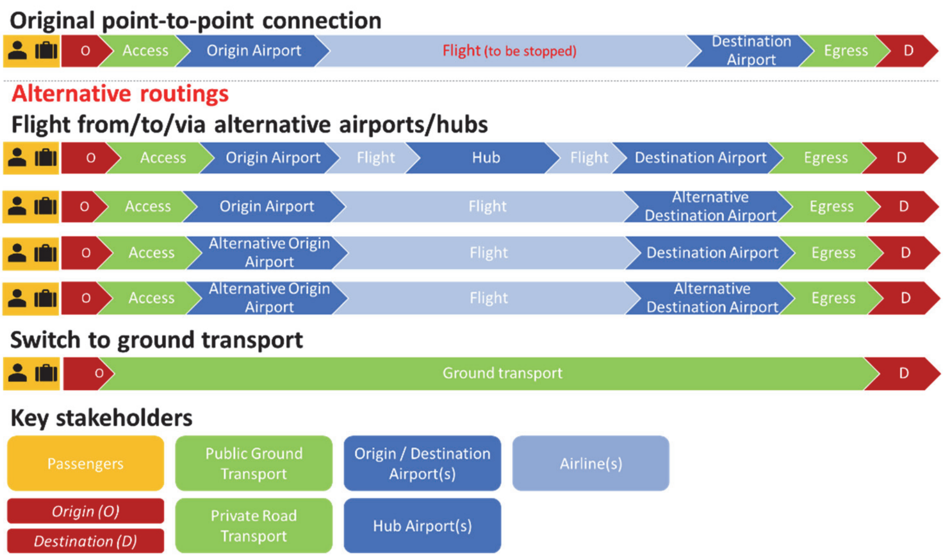
Suspension of P2P services

Figure 2 illustrates the most obvious alternative routing options and affected stakeholders for the discontinuation of a P2P service. If such a route is stopped, passengers will essentially have the following choices:
– Flying from the original origin airport but using a hub routing instead.
– Flying from the original origin airport to an alternative destination airport.
– Flying from an alternative departure airport to the original destination airport.
– Flying from an alternative departure airport to an alternative destination airport.
– Fully switching to ground transport.

Other options not illustrated in the figure can include switching to an alternative destination region, or not travelling at all.

Figure 2

Suspension of a P2P route – alternative travel options



Affected stakeholders

The following stakeholders can be affected if a route is discontinued:

- airport operators, which may be affected by increasing (alternative airports) or decreasing (original airports) passenger numbers and associated aeronautical and non-aeronautical revenues (for an overview of airport revenues see Yokomi et al. 2017),
- airlines, which may be affected by increasing or decreasing passenger numbers and associated revenues, as well as operating cost decreases or increases,
- firms operating in the ground transport markets, which may be affected by increasing or decreasing passenger numbers and possibly operating cost decreases or increases,
- passengers, for whom travel times, fare levels, the number of stops, the risk of delays and missed connections or frequency of travel may change.

Compared with the cost and revenue effects on the above-listed stakeholders, determining whether a (mandatory) shift to ground transport represents an improvement or a deterioration for a passenger is more challenging. For example, longer feeder segment travel times associated with railway connections might be compensated by (a) increased frequencies, resulting in shorter layover times between the train and the flight segments, and (b) more productive travel time onboard the train compared to the plane (on the concept of productive versus dead time see Gripsrud−Hjorthol 2012).

In addition, decreasing (or increasing) airport revenues may have various implications. These include decreasing or increasing amounts of dividends or subsidies to be paid to airport owners. Furthermore, there may be different (regional) employment and monetary effects along the airport value chain compared with before.

Methodology and data

The actual case study in this section consists of the following steps:

- First, background information and descriptive passenger volume and flight movement statistics at the airport and route levels in Austria.
- Second, descriptive comparison of the development of passenger numbers on routings from Linz via Vienna and via Frankfurt (the only alternative hub airport served from Linz), respectively, indicating how several passengers have switched to ‘via Frankfurt’-connections as a replacement for Vienna. We assume that the remaining passengers now use ground transport modes to get to Vienna or alternative departure airports like Munich. In this context, we also look at the development of passenger numbers for ‘ticket-integrated’ train connections via Vienna Airport from Linz Central Station, where the airline

sells the feeder train to Vienna Airport and the connecting flight on the same ticket (AIRail Rail and Fly).
- Third, application of airport charges unit rates to conduct rough estimations of resulting revenue impacts at the Linz Airport operator level.
- Fourth, qualitative discussion of the potential for other route discontinuations in Austria, based on current and predicted future train travel times.

We use the following data and information sources:
- Sabre Market Intelligence segment and origin–destination data (Sabre MI 2023),
- Linz Airport, Civil Aerodrome Conditions of Use, Part II, Charges Regulation, in force as of January 1st, 2022 as approved on December 20th, 2021 by the Federal Ministry of Transport, Innovation and Technology, Department of Civil Aviation (Linz Airport 2022).

Except for a 10% sample of airline tickets published by the US Bureau of Transportation Statistics (n.d.) (Airline Origin and Destination Survey DB1B), covering the US market only, detailed passenger numbers at the airline and routing levels are not freely available. Hence, we use passenger figures provided by the chargeable Sabre Market Intelligence (Sabre MI) database, which consolidates Marketing Information Data Tapes booking data from global distribution systems with additional data from external sources and estimates for increasingly important direct bookings. Sabre MI provides monthly passenger number aggregates and other information like average fares both at the segment, that is direct route, and origin–destination (OD), that is routing levels. As described in Maertens (2018), Sabre MI data have been used in several studies. Overall, the dataset's market size information can be considered reliable at least for markets that are not dominated by LCC with a high share of direct sales. Furthermore, data quality seems to generally increase with aggregation level.

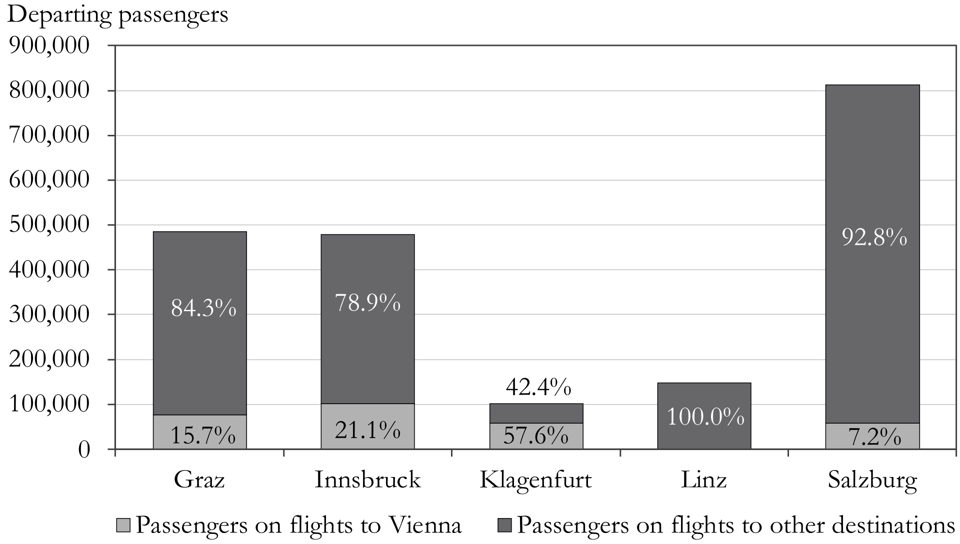
Results

Background

In Austria, scheduled air transport is provided at the hub Vienna (VIE) and at five secondary airports with less than 1 million departing passengers each in 2019. These secondary airports are usually referred to as *Bundesländerflughäfen* (which can be translated as 'federal state airports'). Figure 3 shows that, except for Linz (LNZ), flights to VIE play an important role at almost all of these airports in 2019 with passenger shares between 7% (in Salzburg) and 58% (in Klagenfurt), equalling between 50,000 and 100,000 departing passengers per year.

Figure 3

Federal state airports in Austria – departing passengers and Vienna shares, 2019



Data source: Sabre MI.

Table 1 lists current train travel times from key regional cities in Austria (which have their own regional airport) and VIE. Currently, VIE can be reached only from Linz and Salzburg in less than 2 h and 3 h, respectively, by train, but travel times from Graz and Klagenfurt are likely to be reduced significantly over the forthcoming years as will be further discussed in the study's qualitative discussion of the potential for other route discontinuations in Austria.

Table 1

Domestic railway travel times to Vienna Airport

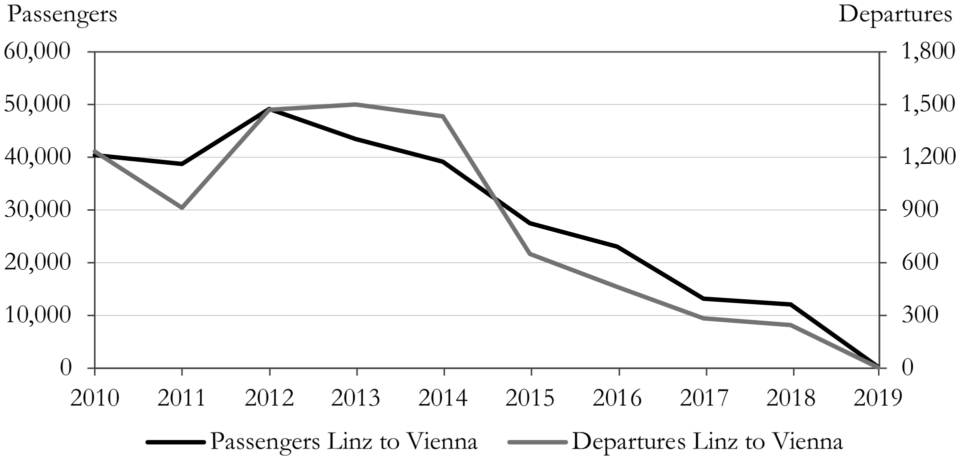
Relation	Number of direct trains, daily, 2021	Shortest trip duration, 2021	Expected trip duration, 2028
Linz → Vienna Airport	25	1 h 41 min	1 h 41 min
Salzburg → Vienna Airport	22	2 h 49 min	2 h 49 min
Graz → Vienna Airport	5	3 h 1 min	~ 2 h 30 min
Klagenfurt → Vienna Airport	2/7	4 h 8 min	~ 3 h 15 min
Innsbruck → Vienna Airport	11	4 h 40 min	4 h 40 min

Source: own compilation of travel times derived from oebb.at. Future travel times are taken from ÖBB Infra (2022). The fastest travel options between Klagenfurt and Vienna Airport in 2021 were seven daily Railjet connections with a change at Vienna Central Station. The two direct connections with no changes have a journey time of approximately 6 h 40 min.

Figure 4 shows that the supply on the route Linz–Vienna had been step-wise reduced between 2015 and 2019, from 1,500 annual movements (up to 4 flights per day) and 41,000 passengers in 2013–2014 to less than 1 daily flight (~260 annual movements) and about 12,500 passengers in 2017–2018 before the route was fully ceased in 2018.

Figure 4

Flight and passenger number development Linz–Vienna



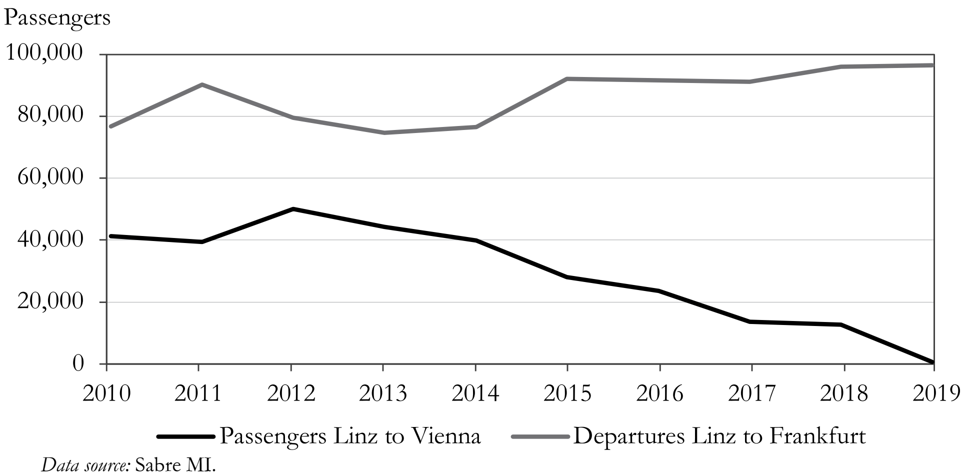
Data source: Sabre MI.

Impact on passenger routings

Figure 5 illustrates the passenger flow development from Linz via the Star Alliance hubs Vienna and Frankfurt over the timeframe 2010 to 2019. The data indicates a significant decline in travel via VIE following the service reduction, eventually ceasing altogether by 2019. At the same time, however, the figure suggests a moderate increase in passengers flying to, or via, Frankfurt.

Figure 5

Passenger number development, Linz–Vienna and Linz–Frankfurt



Data source: Sabre MI.

Table 2 compares key traffic figures for the routes Linz–Vienna and Linz–Frankfurt in the periods 2013–2014 and 2019: Due to the suspension of the VIE route (which had accounted for almost 40,000 connecting passengers in 2013–2014), the number of connecting passengers flying from LNZ decreased massively, from 112,000 in 2013–2014 to 78,000 in 2019. Linz Airport, however, seems to have kept a portion of former 'via Vienna' travellers – as about 10,000 additional connecting passengers are now counted on the Frankfurt route.

Table 2

Passenger and movement effects Linz–Vienna/Frankfurt

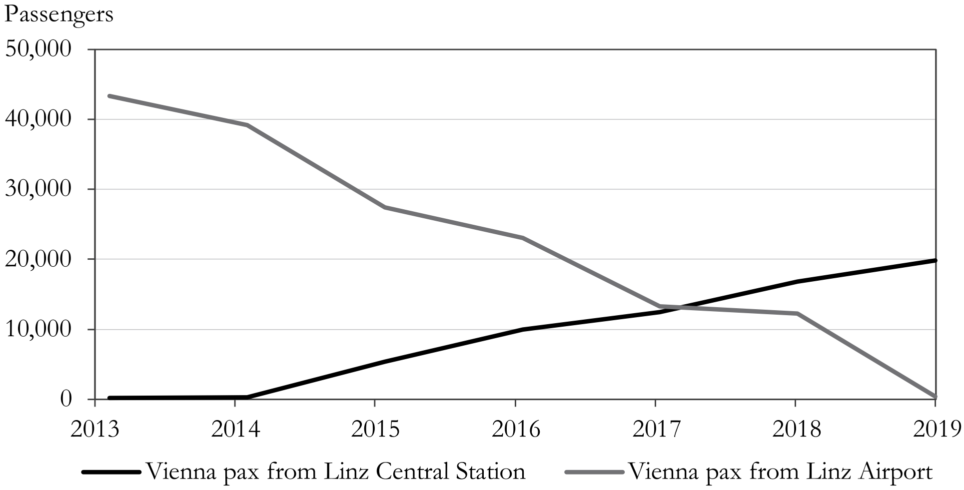
Denomination	Mean 2013–2014	2019	Effect
Passengers Linz–Vienna	41,305	0	route suspension
Movements Linz–Vienna	1,468	0	route suspension
Total number of connecting passengers flying from Linz via any hub	112,097	77,973	decrease in connecting passengers via Vienna
Connecting passengers Linz–Vienna–World	39,788	0	switch to ground transport and via FRA
Connecting passengers Linz–Frankfurt–World	66,201	76,268 (+10,085)	generation of ~10,000 former 'via Vienna' passengers
Passengers Linz Central Station (LZS)–Vienna	119	19,648	generation of almost 20,000 railway passengers LZS–VIE travelling on a flight ticket

Data source: Sabre MI.

Drawing from these observations, the authors conclude that up to 25% of the connecting passengers who previously flew via VIE have switched to flights via Frankfurt. The remaining passengers who previously flew via VIE are likely to have switched to ground transport options (car or train) to reach either VIE or alternative departure airports like Munich, or they have switched to ground transport completely or refrained from travelling.

Those who have switched to rail for the Linz–Vienna segment largely use the integrated 'AIRail Rail and Fly' product offered by Austrian Airlines and ÖBB. Figure 6 shows the development of these passengers from Linz Central Station to Vienna. Close to 20,000 travellers – or about 50% of former (2013–2014) Linz–Vienna air passengers – made use of this option in 2019.

Figure 6
Passenger number development, Linz Central Station–Vienna Airport versus Linz Airport–Vienna Airport



Data source: Sabre MI.

From the standpoint of airlines, most of the former Linz–Vienna passengers still fly with Lufthansa Group, which is the only airline group offering connecting services out of Linz – both before and after the discontinuation of the Vienna service.

Financial impacts on the airport operator

Table 2 indicates a loss of about 1,468 departing flights to Vienna with 41,305 passengers and 10,085 additional passengers on the Frankfurt route in 2019. Sabre MI data show that the aircraft size and the number of frequencies on the route Linz–Frankfurt remained constant (2015: 1,378 departures and 138,030 seats offered; 2019: 1,363 departures and 137,192 seats offered).

This means a net loss of 31,219 annual passengers in addition to the 1,468 departing flight movements, which had been previously operated by DHC8-Q400 aircraft with a maximum take-off mass (MTOM) of about 30 tons.

Based on the official airport charges regulation (Linz Airport 2022), the following charges unit rates would currently apply to the discontinued route to Vienna and the passengers carried there:

– aircraft landing charge of €19.91 per ton MTOM subject to a 'regional air traffic' multiplier of 85%,
– infrastructure charge 'air-side' of €139.72 for tariff group 5 aircraft (29–45 t MTOM) subject to a 'regional air traffic' multiplier of 85%,

- infrastructure charge 'land-side' of €2.09 per passenger subject to a 'regional air traffic' multiplier of 85%,
- passenger service charge of €18.15 per departing passenger subject to a 'regional air traffic' multiplier of 85%,
- security charge of €18.41 per departing passenger,
- ground handling services charges of €963.80 (ramp handling) and €643.40 (traffic handling) for tariff group 5 aircraft (29–45 t MTOM), each subject to a 'regional air traffic' multiplier of 85%.

These unit rates are applied to the calculated net loss in traffic volumes to get a rough estimate for the airport operator's annual revenue loss caused by the discontinuation of the Vienna route:

- landing charge loss:
  1,468 movements × €19.91/t MTOM × 30 t × 0.85 = €745,311,
- infrastructure charge 'air-side' loss:
  1,468 movements × €139.72 × 0.85 = €174,343,
- infrastructure charge 'land-side' loss: 41,305 × €2.09 × 0.85 = €73,378,
- passenger service charge loss: 41,305 × €18.15 × 0.85 = €710,604,
- ground handling service charges loss:
  1,468 movements × (€963.80 + €643.40) × 0.85 = €2,005,464,
- sum (overall revenue decrease, LNZ–VIE): €3,709,099.

This gross loss has to be adjusted by additional revenues generated from the 10,085 additional passengers observed on the Frankfurt route where the 15% 'regional traffic' discount does not apply:

- additional infrastructure charge 'land-side': 10,085 × €2.09 = €21,079,
- additional passenger service charge: 10,085 × €18.15 = €183,051,
- sum (revenue increase, LNZ–FRA): €204,129.

Overall, this rough estimation indicates a net decline of €3,709,099 − €204,129 = €3,504,970 in airport revenues, not including security charges and not considering non-aeronautical revenues (e.g. from parking, food and beverage or retail), which compares to a gross income (gross profit) of the airport operator of about €23–25 million in 2018–2019 (Dun & Bradstreet 2023).

Other domestic routes in Austria

Table 3 provides an overview of the development of domestic scheduled passenger routes in Austria for the period 2019–2020. In addition to the Vienna–Linz route, the other domestic routes have also either already been discontinued (Salzburg–Vienna), or they could be subject to suspension in the future.

Table 3

Domestic passenger air routes from Vienna, 2019/2022

Destination from Vienna	Great circle distance (km)	Scheduled passenger flights	Seats offered	Average aircraft size (seats per flight)	Scheduled passenger flights	Seats offered	Average aircraft size (seats per flight)
		2019			2022		
Graz	151	1,253	106,976	85.4	663	74,256	112.0
Innsbruck	403	1,561	152,889	97.9	821	93,502	113.9
Klagenfurt	235	1,180	89,680	76.0	426	47,712	112.0
Salzburg	269	909	78,467	86.3	0	0	0

Data sources: Sabre MI, Great Circle Mapper.

The route Vienna–Salzburg, which had formerly been served at a frequency of about three flights per direction and weekday, was discontinued in March 2020, initially caused by Austrian Airlines' complete standstill following the outbreak of the Covid-19 pandemic. As part of the government bailout package, it was then agreed that domestic flights should in the future be discontinued on routes with rail connections of less than 3 h of travel time. This phenomenon is the reason why the Salzburg route was not reinstated when overall traffic was recovering (Kleine Zeitung 2020).

At the operational level, with an improvement of rail frequencies on the route Vienna–Salzburg, Austrian Airlines has engaged in a partnership with the Austrian rail operator ÖBB, with a total of 31 trains per day and direction, of which up to 10 are offered in a codeshare partnership and can be booked in global reservation systems in combination with air tickets (Hodoschek 2020).

Travel time between Vienna Airport and Salzburg is at minimum 2 h 50 min. Due to the discontinuation during the pandemic and the fact that Salzburg is connected with several hubs (e.g. London Heathrow, Paris CDG, Frankfurt and Istanbul), any traffic figure analysis can be considered as relatively difficult to identify the effects on demand. However, unlike Linz, passengers clearly have the choice to switch to routings via different alternative hubs.

With an average of four daily flights before the Covid-19 pandemic, Vienna–Graz was the second busiest domestic route in Austria as measured by flights offered and passengers, despite a great circle distance of just 151 km. Due to the topography, rail travel time from Vienna Airport to Graz is at a minimum of 3 h and 1 min, so the route is not affected by the agreement between Austrian Airlines and the government. However, Austrian Airlines has engaged in a codeshare partnership with ÖBB on two daily train connections (Austrian Airlines n.d.), complementing the re-instated, up to 3 daily flights (September, 2023). With the completion of the Semmering Base Tunnel in 2030, rail travel time could be reduced to about 2.5 h (ÖBB Infra 2022), which will most likely result in a discontinuation of the flight connection. Apart from Vienna, Graz Airport is also connected to the hubs of Amsterdam, Frankfurt, Munich and Zurich. As with Salzburg, this means that passengers would have the choice between several alternative hubs if the Vienna route was discontinued.

The route Vienna–Klagenfurt was also operated about four times daily before the Covid-19 pandemic and is currently (September, 2023) only operated once or twice daily. With the completion of the Koralm Tunnel and a reduced travel time of about 45 min by rail to Graz, the complete journey to Klagenfurt–Graz–Vienna Airport is supposed to take about 3 h 15 min from 2030 (ÖBB Infra 2022). Apart from the Austrian Airlines service to Vienna, Klagenfurt is currently not served by any alternative hub carrier.

The only domestic air route where train connections below 3 h are out of sight is Vienna–Innsbruck, with a distance of 403 km, which also the longest route in the Austrian domestic network. The route has also been the busiest, with an average of five daily departures per day before the Covid-19 pandemic. Currently, the route is served three times on weekdays and Saturdays and twice daily on Sundays (September 2023). Due to the geography of the country, the minimum rail travel time between Innsbruck and Vienna Airport is 4 h 41 min.

Discussion of environmental effects

Contrary to the original political intention, the current regulatory setting in most of Europe raises questions about whether the environment (in terms of the sector's CO_2 emissions and resulting climate impact) would actually benefit from the suspension of domestic or short-haul flights in Austria or other European countries.

The reason for this statement, which may sound counterintuitive, is that CO_2 emissions from flights within the European Economic Area (EEA) are already subject to the EU ETS. The EEA comprises the EU, Norway, Liechtenstein and Iceland and thus represents the largest part of (geographical) Europe in terms of population. A good overview of how the EU ETS operates for aviation is provided by the German Emissions Trading Authority (DEHSt 2022).

From a technical perspective, overall CO_2 emissions within the EU ETS are capped anyway, meaning that the discontinuation of a particular intra-EEA service may not necessarily result in lower overall emissions as the previously required allowances have a high likelihood of being used either for other flights or by other sectors participating in the EU ETS. The applicability of this so-called 'waterbed effect' depends on several factors, such as the design of the market stability reserve, which aims at cancelling unused emission allowances (Appunn 2019). However, airlines are unlikely to leave allowances unused because the airline sector receives far less allowances than needed. This situation is likely to become even more evident in the years to come when the EU ETS for aviation will be getting increasingly tightened (e.g. in phasing out free allowances to airlines by 2026) as part of the EU's green deal decisions (EC 2022b).

To eliminate the risk of a possible waterbed effect when introducing a (national) measure like a flight ban, member states could buy (and cancel) the then unused allowances that would otherwise have been used for the operations on the banned route.

In addition, any alternative use of aircraft, personnel and slots previously used for a now prohibited route is likely to play a role, acknowledging that air transport is a global industry where key assets (like aircraft) can easily be moved around the world. If supply (and thus emissions) is shifted from the EU ETS area (like from a domestic routing in Austria or another intra-EEA route) to a region where no ETS or similar measure is applied (e.g. to a route from Vienna to Belgrade), total CO_2 emissions are likely to increase. This phenomenon called carbon leakage is also acknowledged by environmental organisations (Transport & Environment 2022) and could become relevant if flight operations within the EU ETS were replaced by routes to or between countries not participating in the EU ETS or if aircraft were completely transferred to the non-ETS world.

In addition, the ban of flights to a hub in the immediate proximity of a spoke airport (like Vienna being relatively close to the regional airports in Austria) may result in passengers flying longer detours in cases in which a more distant hub is chosen as replacement (e.g. Linz–Vienna–Dubai with 4,404 km versus Linz–Frankfurt–Dubai with 5,304 km according to the Great Circle Mapper 2023), increasing specific average emissions per passenger.

In the scenario of a ban on domestic flights, slots, staff and aircraft previously used for such flights at Vienna Airport might be used for other flights within the EEA, or even for routes from, to or between destinations outside the EEA.

Regardless of the above, the absolute impact of a (complete) ban on domestic flights in Austria would be very limited anyway as domestic flights under instrument flight rules (IFR) represented just about 1.3% of the CO_2 emissions all IFR flights departing from airports in Austria in 2019 (Umweltbundesamt 2022). This last aspect applies not only to Austria but also to Europe as a whole. In the EUROCONTROL area, flights of 500 km and less accounted for 30.6% of flights but only for 4.3% of fuel consumption and CO_2 emissions in 2020 (Eurocontrol 2021). These numbers are roughly in line with Dobruszkes et al. (2022) who estimate that flights of 500 km and less departing from 31 European countries account for 27.9% of departures but only for 5.9% of fuel burned. Based on this, these authors conclude that targeting short-distance flight operations with policy measures like flight bans would not significantly reduce the sector's climate impact anyway.

However, as acknowledged, short flights perform relatively poor with regard to specific emissions; for example, Montlaur et al. (2021) show that fuel consumption per passenger ranges 5–6 L/100 km for short flights below 1,000 km, compared with the 3.4 L/100 km average as reported by Eurocontrol.

Conclusion

To 'do something' against the carbon footprint of aviation, first European countries have introduced – or are discussing – bans on short-haul flights. We have assessed the key effects of such measures on traffic flows, affected airports and other stakeholders like the environment, both conceptually and empirically for the 'case study' route Linz–Vienna with a road distance of 210 km.

We are aware that this particular route has already been discontinued voluntarily, prior to the current discussion about route bans on the societal and political levels. However, the cessation of this enables us to evaluate the impact of discontinuing the route without any bias from Covid-19, such as reduced overall demand.

Our descriptive analysis of Sabre MI origin – destination level air traffic demand data indicate that up to 25% of the former transfer passengers between Linz and Vienna have switched to flights via Frankfurt. Approximately 20,000 or 50% of former passengers now use the train to Vienna as part of their air ticket (AIRail Rail and Fly). The remaining 25% of former Linz–Vienna passengers presumably use either motorised private transport or separately booked train tickets to reach Vienna Airport or alternative departure airports such as Munich.

For the operator of Linz Airport, the resulting loss of 31,000 departing passengers and almost 1,500 flights are likely to translate into a drop in aeronautical airport revenues of about €3.5 million per year based on the unit rates of the current charges regulation – additional non-aeronautical revenues not yet counted.

Financial effects on other stakeholders were beyond the scope of this study. For example, railway companies like ÖBB are likely to benefit from additional passengers and associated revenues on routes to and from Vienna Airport, whereas Vienna Airport is potentially losing transfer passengers not willing to use the railway connection. In turn, the discontinuation of domestic routes like Linz–Vienna is expected to result in the use of valuable slots at Vienna Airport for alternative routes. Another dimension probably affected by the route discontinuation is the regional economy of the Linz region, which may also depend on tourists (previously) using the airport. For example, input–output analyses could be used to assess corresponding impacts on regional gross value added and employment.

Effects at other Austrian airports, which have already lost (Salzburg) or may lose their connection to Vienna in the future (e.g. Graz) are supposed to vary, depending on the network structure and alternative hub connections from these airports. In general, airlines could be affected asymmetrically by a ban on short-haul flights. In our particular case, the Austrian Airlines loses transfer passengers at their Vienna hub, whereas Lufthansa gains for connections via Frankfurt. In this case, the total impact at the airline level may be considered marginal, as both airlines are part of the same group. For other airports and airlines, the competitive situation could be more serious when a competitor is allowed to serve a more distant hub, whereas flights to closer hubs fall under a ban. In future research, these – and probably additional – effects could be assessed in more detail, using primary survey data. Either existing air passenger surveys collected by airports could be used, if made available to researchers, or new data would need to be collected.

From an environmental perspective, we have argued that a symbolic ban on short-haul flights within the EU is unlikely to lead to a reduction in CO_2. In the EEA (EU, Norway, Iceland and Liechtenstein), the United Kingdom and Switzerland, most short-haul flights are subject to emission trading, which puts a cap on total CO_2 emissions. If a specific flight is no longer operating, the required allowances are likely to be used for other flights or by other sectors participating in the scheme. In addition, airport slots and aircraft of former short-haul flights could even be used for new extra-European flights, which are not subject to emission trading at all. To ensure that a route ban within and between the EEA, United Kingdom and Switzerland actually leads to a genuine reduction in total CO_2 emissions; that is, to reduce the risk of a waterbed effect, the member state introducing the ban could purchase and cancel emission allowances in an amount that would have been necessary to operate the route.

Such environmental effects and trade-off should also be evaluated more carefully in forthcoming research. For example, airline fleets and actual flight movement data, which could be retrieved from providers such as flightradar24, could help identify the extent aircraft were shifted to extra-EEA routes in reaction to route discontinuations.

Remark

An early draft of this study was presented at the International Aviation Management Conference 2022 in Dubai. This (final) version has been significantly extended and revised, e.g. by adding routing effects at the railway level and by discussing the situation of domestic routes other than Linz–Vienna.

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