Available online at www.sciencedirect.com

ScienceDirect

Transportation Research Procedia 65 (2022) 265–274

Transportation Research Procedia

www.elsevier.com/locate/procedia

11th International Conference on Air Transport – INAIR 2022, Returning to the Skies

COVID-19: Impacts on air fares and air connectivity in the European Union

David Ennen[a,*], Florian Wozny[a]

[a]German Aerospace Center (DLR), Institute of Air Transport and Airport Research, Linder Hoehe, 51147 Koeln, Germany

Abstract

Air transport in the European Union was particularly affected by the COVID-19 pandemic. This paper investigates in detail the impact of the pandemic on air fares and connectivity indicators in the European Union using data from a global distribution system provider for air tickets for the period between 2018 and 2021. In order to identify heterogeneous effects of COVID-19 on air fares and connectivity, separate analyses are conducted for different destination regions and airline types. The results of this paper reveal that connectivity was stronger affected than air fares. For most indicators, a steady recovery is observable after a sharp initial shock in April 2020. A regression analysis indicates that the impact of COVID-19 on air fares and connectivity in 2020 differed considerably seasonally and geographically.

Keywords: COVID-19; air transport; European Union

1. Introduction

The COVID-19 pandemic led to a historic decline in global air passenger traffic. In Europe, the consequences were particularly severe. In the European Union, traffic declined by more than 69% in 2020 compared to 2019, whereas in the US, for example, traffic declined by only about 59% in the same period (Sabre, 2022). Air transport organizations and associations such as ICAO, IATA, and EUROCONTROL regularly publish reports and statistics on the state of the industry in the crisis (see, e.g., ICAO, 2022; IATA, 2022; EUROCONTROL, 2022). However, these organizations and associations analyze the impacts of the pandemic predominantly from their perspective or that of their members.

* Corresponding author. Tel.: +49-2203-601-2075; fax: +49-2203-601-2377.
E-mail address: david.ennen@dlr.de

10.1016/j.trpro.2022.11.031

For example, IATA, as an airline association, gives attention to airline revenues and costs. EUROCONTROL, as the European organization for air traffic control, focuses on aircraft movements. The impact of the crisis on air passengers, by contrast, has not, to our knowledge, been extensively studied. If policymakers want to ensure the mobility of their citizens with efficient measures, detailed knowledge of the impact on air passengers is necessary.

Air passenger are affected in several ways. On the one hand, the discontinuation of routes and reduction of frequencies leads to lower connectivity. Passengers may have to travel to other airports, switch to connecting flights instead of non-stop flights, or accept an earlier departure time in order to reach their destination on time. On the other hand, the global decline in demand and the resulting reduction in supply has an impact on air fares. In particular, higher fares are to be expected at route level if the discontinuation of routes by some airlines reduces the intensity of competition.

This paper investigates in detail the impact of the pandemic on air passengers in the European Union. For this purpose, we calculate a fare index and several connectivity indicators for the period between 2018 and 2021 and discuss their development over time. In order to identify heterogeneous effects of COVID-19 on air fares and connectivity, separate analyses are conducted for different destination regions (Europe, Asia-Pacific, North America, Latin America/Caribbean, Africa) and airline types (full-service, low-cost, regional, leisure). In addition, we analyze drivers of these developments such as the impact of the competition intensity between airlines on air fares. Finally, we conduct regression analyses to estimate the importance of factors such as seasonality and origin/destination country in explaining variations in the impacts of COVID-19 on fares and connectivity.

Data on air fares and passenger itineraries are obtained for the period between 2018 and 2021 from Sabre, a global distribution system provider for air tickets. The Sabre Market Intelligence data are not freely available, but only through a paid subscription. However, they are some of the few sources of global air passenger and fare data at origin-destination level. Due to this fact, they are used in various academic analysis of air transport (see, e.g., Maertens, 2018; Gelhausen et al., 2021; Sun et al., 2022). For each itinerary and month, the Sabre data show the origin and destination airports, possible transfer airports, number of passengers, operating airline, and average fare paid. For the connectivity analysis, flight data are used in addition to the passenger data, which are also obtained from Sabre. The flight data show, for each flight route and month, the origin and destination airports, number of flights, available seats, and operating airline. From the flight and passenger itinerary data, we calculate connectivity indicators such as the number of routes served at a given airport and the number of flight departures per route.

The paper is structured as follows. Section 2 covers the airfare analysis and Section 3 the connectivity analysis. Section 4 draws conclusions from the results.

2. Air fare analysis

The development of air fares is analyzed using an air fare index, which we calculate on the basis of fare data from Sabre. The fare index is a weighted average of the fares in each city-pair market, with the weighting factors being the passenger numbers in each city-pair market in 2019. This price index of the Laspeyres type has the advantage that index changes only reflect price changes and not changes in passenger demand in individual markets. A general disadvantage of Laspeyres-type price indices is, however, that they overstate the severity of price changes, since substitution reactions of consumers, e.g. from expensive to cheap flight destinations, are not taken into account.

Fig. 1 shows the development of the price index in the period from 2018 to 2021 for flights from the EU to the regions Europe, Asia-Pacific, North America, Latin America/Caribbean, Middle East, and Africa. At the beginning of the pandemic, air fares decreased significantly on average. Fare decreases were particularly strong for flights to North America and the Middle East, at -23% and -24% respectively compared to 2019. For flights within the EU and to the rest of Europe, fare decreases were more moderate at -12%. In the second half of 2020 and the first half of 2021, fares increased again significantly in most markets, exceeding levels of 2019 for Europe, Asia-Pacific, and the Middle East. The fare increase for flights to Asia-Pacific was particularly pronounced, peaking in September 2021 with a plus of 68% compared to 2019. However, it should be noted that countries such as China and Australia had very restrictive entry requirements in 2021 due to COVID-19. The resulting substantial drop in traffic was accompanied by significant fare increases, which have a major impact on the Asia-Pacific price index, as the index weighting is based on traffic levels in 2019. Flights within the EU and to the rest of Europe also became significantly more expensive with a maximum price increase compared to 2019 of 26% in March 2021. As the recovery progressed in the second half of

2021, average prices in many markets approached 2019 levels again, with Asia-Pacific and Latin America/Caribbean being an exception.

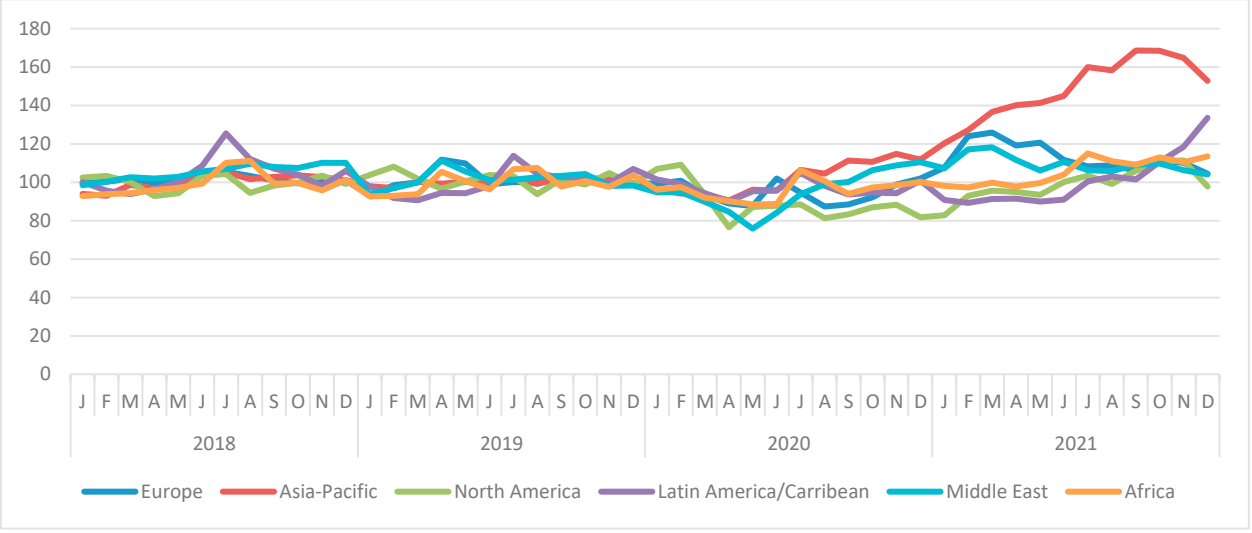

Fig. 1. Air fares on routes between the EU and world regions 2018-2021 (2019=100).
Source: Authors' analysis based on Sabre (2022) data.

Fig. 2 presents the fare development for flights within the EU differentiated by airline type (FSC, LCC, regional, leisure). The collapse in demand as a result of the pandemic led to significant price declines for all airline types. This was most pronounced for full-service carriers with an average decline of more than 20% in April 2020 compared to 2019. Leisure carriers, on the other hand, saw the smallest fare decline in the first half of 2020, with a drop of just under 7% in May 2020 compared to the previous year. Average fares then increased for all airline types in late 2020/early 2021. As the recovery progressed and seat capacity expanded, fares for FSC and LCC almost returned to the average level of 2019 by the end of 2021. Fares for regional and leisure carriers, on the other hand, remained significantly above 2019 levels, with a plus of 17% and 15%, respectively.

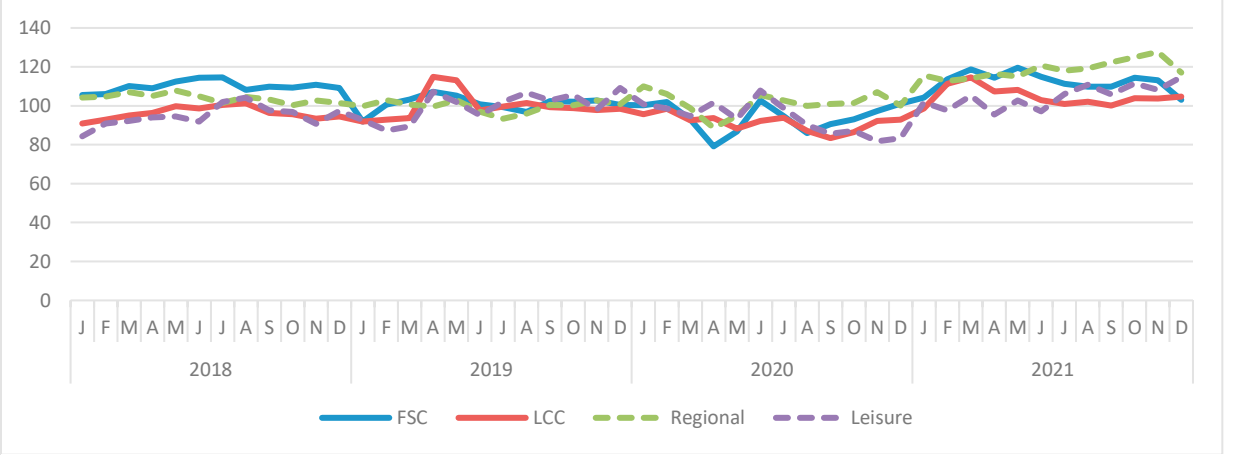

Fig. 2. Air fares on intra-EU routes by airline type 2018-2021 (2019=100).
Source: Authors' analysis based on Sabre (2022) data.

Air fares are a result of demand, supply, and market structure in airline markets. In the following, we analyze whether the capacity reduction by airlines resulted in an increase in market concentration and thus could have been a driver of air fares. The common indicator for measuring market concentration is the Herfindahl-Hirschman index (HHI). It is also applied to airline OD markets and regression analyses show a positive correlation between the HHI and average air fares in a market (Borenstein, 1989, Kim and Singal, 1993). The HHI is defined as the sum of squared market shares of the firms in a market. It indicates the intensity of competition on a scale from zero to one. A number close to zero indicates perfect competition with no market power of firms, while a number of one indicates a monopoly with maximum market power. The market definition in air transport is usually based on flight connections with the same origin and destination. In our analysis, origin and destination are defined as the same origin city and destination city. The assignment of airports to cities is taken from Sabre. The flight connections in a market can thus differ in terms of their origin and destination airports and can include direct as well as connecting flights. In calculating the HHI for each individual city-pair market and month, we consider jointly owned airlines as one firm (for example, Ryanair UK, Ryanair Sun (Buzz), Malta Air, and Lauda Europe as parts of Ryanair Holdings). The HHIs of the individual markets are then weighted by their passenger numbers in 2019 to obtain an average HHI for all markets.

In 2019, the average HHI in intra-EU markets was 0.57. The average market thus had a slightly higher market concentration than a duopoly market with two equally sized airlines. With the beginning of the pandemic and the subsequent discontinuation of many flight connections, the average HHI increased significantly in April 2020 and reached a peak of 0.74 in May 2020. Market concentration was thus 29% greater than in the same month the year before. After a decline in market concentration in the summer of 2020, the average HHI increased again in the winter of 2020/2021, reaching an annual peak of 0.70 in February 2021. As air traffic continued to recover, market concentration also declined and was with an average HHI of 0.60 at the end of 2021 only 0.5% above the value at the end of 2019. The analysis of the HHI development provides a potential explanation for the high intra-EU fares at the beginning of 2021, as well as for the return to 2019 levels at the end of 2021. However, at the beginning of the pandemic in 2020, the effect of collapsing demand seems to have dominated the effect of increasing market concentration, resulting in falling fares overall.

Fig. 3 shows the average market concentration differentiated by the airline types serving the markets. Unsurprisingly, regional airlines experience the least competition, as they are often the only carriers offering non-stop services in a city-pair market. However, interestingly, regional and leisure airlines faced less competition at the end of 2021 than they did at the end of 2019, with an average market HHI 5% and 4% higher, while market concentration in FSC and LCC markets has largely returned to end-2019 levels. This could explain why regional and leisure airlines are able to impose higher fares than in 2019, while the fare level of FSC and LCC has returned to the level of two years ago.

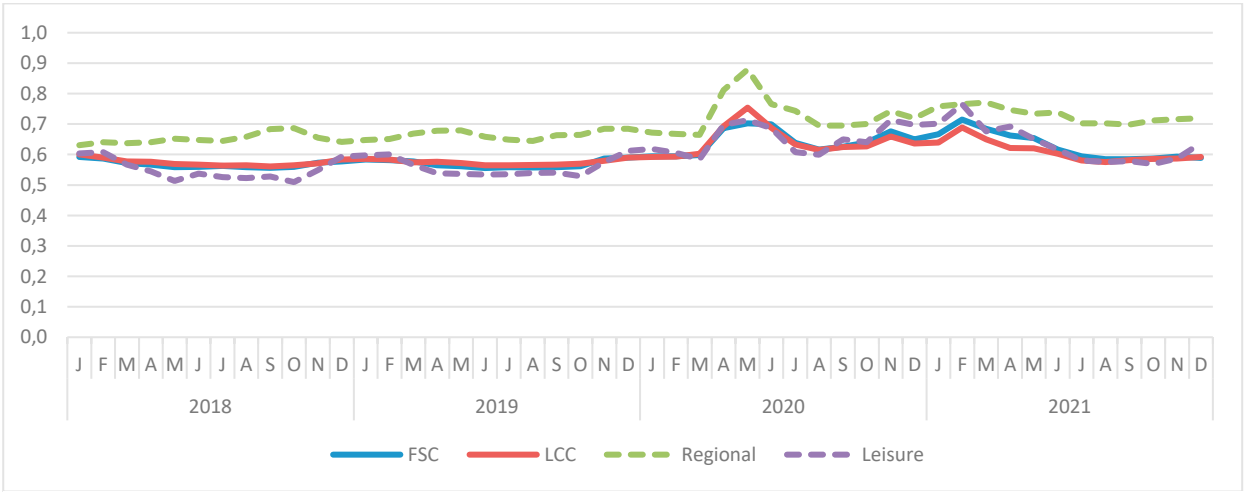

Fig. 3. Market concentration (HHI) on intra-EU27 routes by airline type (2019=100).
Source: Authors' analysis based on Sabre (2022) data.

The market concentration is driven by the seat capacity of the individual airlines. Fig. 4 shows the development of the seat capacity of the individual airline types on intra-EU routes compared to the respective month in 2019. As can be seen, airlines reduced seat capacity the most at the beginning of the pandemic in 2020, and capacity was also reduced significantly in winter 2020/2021 as a result of the high COVID infection numbers. These two developments can explain the peaks in market concentration in May 2020 and February 2021.

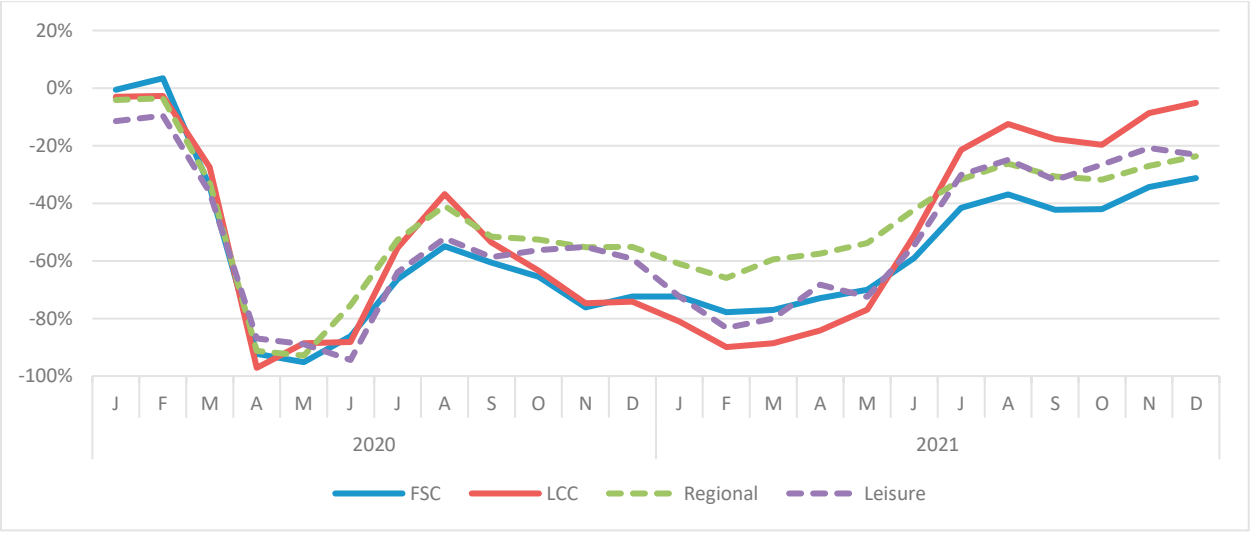

Fig. 4. Seat capacity on intra-EU routes by airline type (change compared to month in 2019).
Source: Authors' analysis based on Sabre (2022) data.

To understand the impact of COVID-19 on air fares in more detail, we regress the difference in average fares between 2019 and 2020 on different route, airline, airport, and seasonal characteristics. The sample is restricted to 2020 as COVID-19 affected air transport in 2020 the most. In both years we drop January because COVID-19 did not affect EU air transport before February 2020. In the regression, one observation is the difference in air fares between a month in 2020 and the same month the year before for a specific airline and route. The explained variation by the independent variables is calculated as the R^2 for separate OLS regressions. As shown in Fig. 5, independent variables such as destination country dummies are added to the regression from left to right, increasing its explanatory power. It starts with a regression where fare changes are regressed on month fixed effects only.

The monthly, destination country, and country-pair dummies contribute substantially to the explanatory power of the regression. The monthly dummies capture the effect of the seasonally fluctuating COVID infection numbers. The destination country and country pair dummies capture the different severity of the pandemic in the individual countries as well as country-specific responses such as travel bans. The airline type dummies, however, increase the explanatory power of the regression only to a limited extent. The dummies for each airline, on the other hand, increase the R^2 significantly, indicating considerable heterogeneity of the airlines within the type groups. The route dummies increase the explanatory power the most, which is not surprising given their high number.

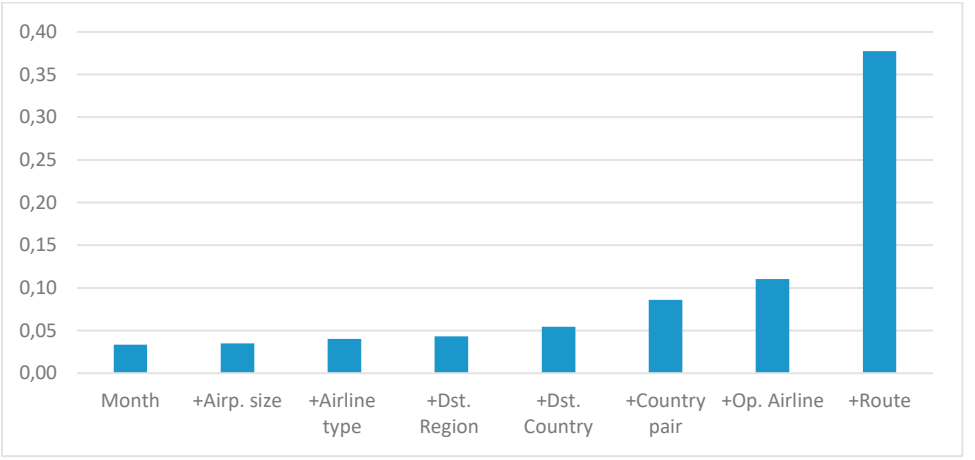

Fig. 5- Explained variation in fare differences between 2019 and 2020.
Source: Authors' regression analysis based on Sabre (2022) data. Note: This figure shows the R^2 of separate regressions where we include more variables starting from a left-hand-side with month dummies

3. Air connectivity

The pandemic affected EU air traffic when air connectivity was on a rather stable trend. Fig. 6 shows the development of connectivity from the EU using the monthly development of mean number of operated direct routes per airport and the mean number of departures per operated direct route. Values are indexed by the corresponding monthly mean of 2019. In 2018 and 2019, the mean number of departures per route were on a relative constant level, showing minor seasonality or general trends. However, the mean number of operated routes per airport had strong seasonality with peaks in the summer season but no general trend.

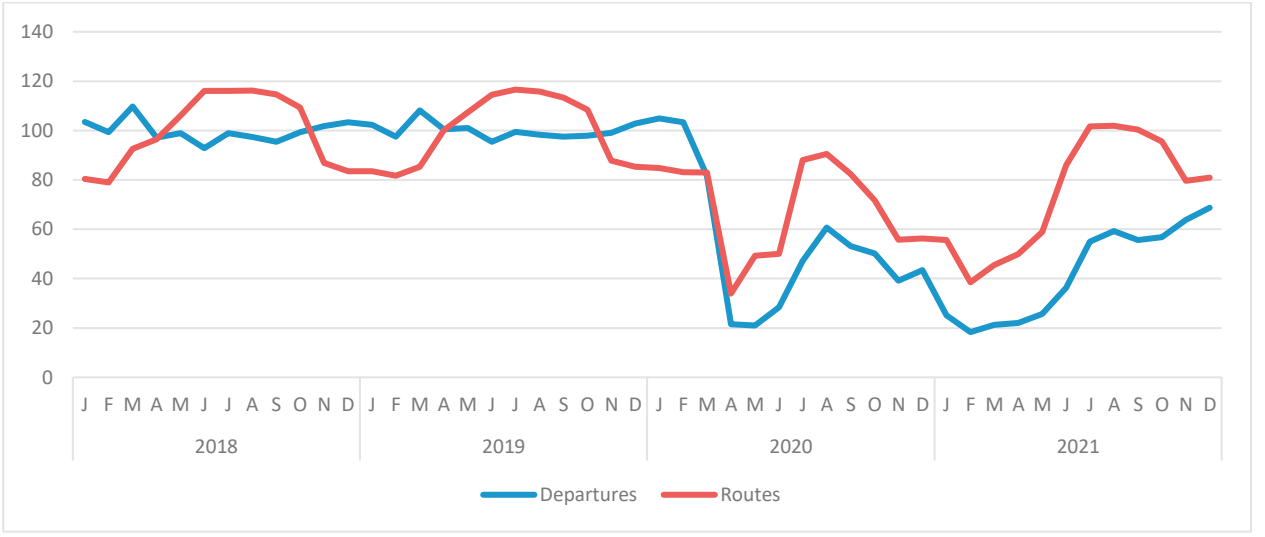

Fig. 6. Routes per airport and departures per route 2018-2021 (2019=100).
Source: Authors' analysis based on Sabre (2022) data.

EU connectivity in air transport declined significantly at the beginning of the pandemic. The mean number of departures per route fell significantly more than the number of routes served. In April 2020, the mean number of departures was 80% lower than in April 2019, while the mean number of routes operated was 65% lower. The difference between routes and departures in the initial drop might be explained by the fact that the first COVID-19 wave hit air transport in the EU when fewer routes were severed in general due to seasonality. Furthermore, not operating a route is an extreme event of a decrease in departures and thus less frequent. With the subsequent recovery of air traffic connectivity increased again. In December 2021 the mean number of routes served already reached the pre-COVID-19 level of December 2019. Nevertheless, the mean number of departures per route were still 30% below the pre-COVID-19 level.

In the post-COVID-19 period, the seasonality of the mean number of operated routes per airport and the mean number of departures per route has increased. Whereas there was hardly any seasonality in the mean number of departures per route in the summer season it is now comparable with the seasonality of the mean number of operated routes. This can be explained by the seasonality of COVID-19 in the EU with peaks in the winter period and accordingly increasing containment measures.

For targeted policy interventions, for example, it is important to know heterogeneity in the extent of connectivity losses depending on factors such as the destination countries or the operating airlines. Fig. 7 shows the development of monthly overall direct departures between 2018 and 2021 from the EU to separated world regions indexed on the monthly average of 2019. This figure combines the information of the two previous departure and route indexes as it shows changes in departures based on routes that have been operated as well as changes in departures as a result of route closures.

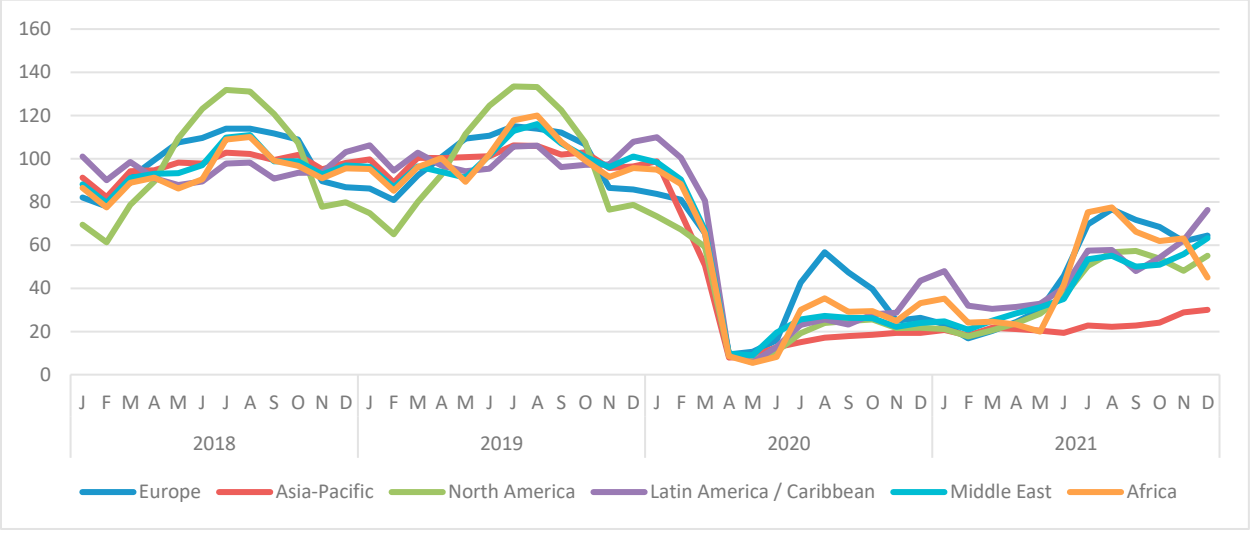

Fig. 7. Departures between the EU and world regions 2018-2021 (2019=100).
Source: Authors' analysis based on Sabre (2022) data.

In the pre-COVID-19 period, seasonality was stronger for destinations in North America or Europe compared to Latin America or Asia-Pacific. Thus, at the beginning COVID-19 affected destination regions at different seasonal trends. Especially destinations in North America were affected when seasonality was relatively low. However, the lower bound that was reached in April and May 2020 was comparable for all destination regions, despite general differences in seasonality. Compared to the 2019 average, overall departures dropped between 90% and 95%.

In the post-COVID-19 period, there is higher seasonality for European destinations and less in case of North American destinations. While there is only slight recovery of departures to Asia-Pacific countries, all other regions significantly recovered between 75% and 43% of the average 2019 departures.

Fig. 8 shows the development of the monthly mean of overall direct EU departures separated by airline type indexed on the monthly mean of 2019. Not surprisingly, seasonality in the pre-COVID-19 period is the highest for leisure airlines, followed by low cost airlines. In April and Mai 2020 the monthly mean number of departures decreased between 97% (LCC) and 87% (leisure). While LCC had the strongest decline in the monthly mean number of departures at the beginning of COVID-19 they recovered fastest in the first post-COVID-19 summer season. In the post-COVID-19 period seasonality is amplified especially in case of LCC and leisure airlines. Until December 2021 airlines types operate between 50% and 65% of the average monthly departures in 2019.

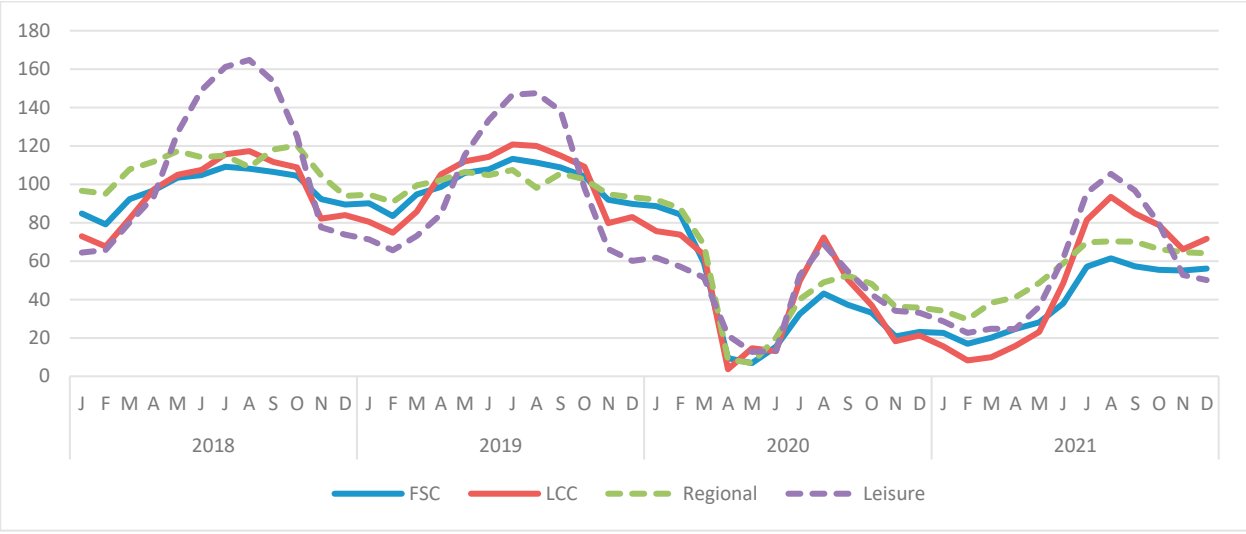

Fig. 8. Departures by airline type 2018-2021 (2019=100).
Source: Authors' analysis based on Sabre (2022) data.

At the first glance, heterogenous effects by COVID-19 exists in case of destination regions and airline types. However, differences in seasonality, for example, could bias these findings. Therefore, we perform a regression analysis analogous to the one for airfares in Section 2. Fig. 9 shows the explained variation in the monthly differences between 2019 and 2020 for the mean number of departures per route and the mean number of operated routes per airport. This figure highlights air transport characteristics that should be considered when assessing the individual impact of COVID-19 on the air transport sector.

In comparison to differences for operated routes, most of the variation in the difference in departures between 2019 and 2020 is already explained by month-fixed-effects. This is in line with the findings in Fig. 6 showing stronger monthly variation in the mean number of departures in the post-COVID-19 period compared to the mean number of routes.

Including the destination region in the regression does not increase the explained variation. However, including destination country dummies slightly increase the explained variation for the mean number of departures and strongly increase the explained variation of the mean number of operated routes. Thus, the variation in routes between 2019 and 2020 is much more destination country specific than the variation in departures. Including country pair dummies (origin and destination country) does not add much to the explained variation. This is also true for the size of the departing airport. Including route dummies increases the explained variation for routes and destinations significantly again. Besides regional characteristics, these dummies also capture route specific differences such as the passenger flow. Thus, in order to fully understand the specific connectivity effects of COVID-19 broad regional clusters are imprecise.

Airline characteristics can be another important aspect in explaining COVID-19 driven changes in connectivity, given differences in the financial situation before COVID-19 or differences in state aid during COVID-19 for example. By adding airlines types into the regression in Fig. 9 no significant increases in explained variation can be observed

for the mean number of routes and departures. However, if we add operating airline fixed-effects we observe an additional increase in the explained variation for the mean number of departures and especially for the mean number of routes. As a result, we cannot conclude that COVID-19 affected the air transport sector equally and it is thus important to analyze the air transport development in more detail to identify those particularly affected.

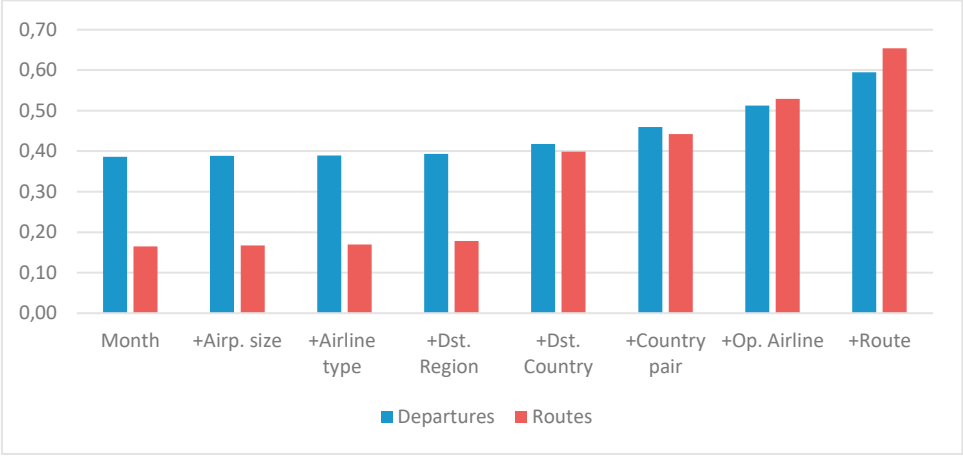

Fig. 9. Explained variation in differences in departures and number of routes between 2019 and 2020.
Source: Authors' regression analysis based on Sabre (2022) data. Note: This figure shows the R^2 of separate regressions where we include more variables starting from a left-hand-side with month dummies.

4. Conclusion

This paper investigates the impact of COVID-19 on air passengers in the European Union, using a fare index and connectivity indicators for the period between 2018 and 2021. This paper identifies heterogenous effects of COVID-19 by differentiating the analyses by destination regions and operating airline types. For targeted policy interventions ensuring the mobility of citizens, it is important to know the extent of the impact of the pandemic on air passengers.

The airfare analysis shows that average airfares fell notably at the start of the COVID-19 pandemic. For flights within the EU and to the rest of Europe, the decrease was 12% in May 2020 compared to 2019. However, due to the strong capacity reductions by airlines, the intensity of competition in the individual air transport markets also decreased on average, as the analysis of the Herfindahl-Hirschman index shows. On intra-EU routes, the average HHI increased from 0.57 in 2019 to 0.74 in May 2020 and, after a decline in the following summer 2020, reached a new maximum value of 0.70 in February 2021. This increase in market concentration seems to be partly responsible for the high observable fares on intra-EU markets in winter 2020/21, which were 26% higher in March 2021 compared to 2019. As the recovery progressed in 2021 and seat supply increased, both average market concentration and price levels fell largely to end-2019 levels.

In the case of connectivity, COVID-19 affected EU air traffic on a rather stable trend. EU connectivity in air transport declined significantly at the beginning of the pandemic. In April 2020, the mean number of departures per route in the EU was 80% lower than in April 2019, while the mean number of direct routes operated from EU airports was 65% lower. However, connectivity increased steadily. In December 2021, the mean number of direct routes operated from EU airports already reached the pre-COVID-19 level of December 2019. Nevertheless, at the same time the mean number of departures per route were still 30% below the pre-COVID-19 level. In the post-COVID-19 period, the seasonality of the mean number of routes per airport and the mean number of departures per route has increased.

Heterogenous effects show that COVID-19 affected the air transport sector unequally and it is thus important to analyze the air transport development in more detail to identify those particularly affected. For example, there is sizable heterogeneity in the COVID-19 induced connectivity decreases within destination regions or countries.

References

Borenstein, S., 1989. Hubs and high fares: dominance and market power in the US airline industry. The RAND Journal of Economics 20(3), 344–365.

EUROCONTROL, 2022. Comprehensive Assessment – European Aviation, 20 July 2022. https://www.eurocontrol.int/publication/eurocontrol-comprehensive-aviation-assessment

Gelhausen, M. C., Berster, P., Wilken, D., 2021. Post-COVID-19 Scenarios of Global Airline Traffic until 2040 That Reflect Airport Capacity Constraints and Mitigation Strategies. Aerospace 8(10), 300.

IATA, 2022. Industry Statistics – Fact Sheet, June 2022. https://www.iata.org/en/iata-repository/pressroom/fact-sheets/industry-statistics/

ICAO, 2022. Effects of Novel Coronavirus (COVID-19) on Civil Aviation: Economic Impact Analysis, 10 June 2022, Montréal, Canada.

Kim, E. H., Singal, V., 1993. Mergers and market power: Evidence from the airline industry. The American Economic Review 83(3), 549–569.

Maertens, S., 2018. A metric to assess the competitive position of airlines and airline groups in the intra-European air transport market. Research in Transportation Economics 72, 65–73.

Sabre, 2022. Sabre Market Intelligence, Databank. https://www.sabre.com/

Sun, X., Wandelt, S., Zhang, A., 2022. Ghostbusters: Hunting abnormal flights in Europe during COVID-19. Transport Policy 127. 203–217.