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Transportation Research Procedia 78 (2024) 103–110

Transportation Research Procedia

www.elsevier.com/locate/procedia

25th Euro Working Group on Transportation Meeting (EWGT 2023)

Airspace closures following the war of aggression in Ukraine: The impact on Europe-Asia airfares

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Abstract

The Russian war of aggression in Ukraine and subsequent sanctions imposed by Western countries has resulted in the withdrawal of overflight rights over Russian territory for most Western airlines. On Europe-Asia routes, this causes substantial detours for European airlines and, in turn, increases travel times and operational costs. This paper investigates the impact of the Russian and Ukrainian airspace closures on airfares between Western Europe and Asia. To identify a causal impact, fares on affected routes from Northern Europe are compared with fares on similar unaffected routes from Southern Europe using a difference-in-differences approach. The results show that the airspace closures increase fares for Europe-Asia flights from European airports above the 50th degree of latitude. On average, the fare effect for these flights is USD 43. Furthermore, the findings indicate that, in general, for each additional minute of flight time due to the airspace closures, fares increase by USD 1.56.

Keywords: air transport; airspace closure; airfare; cost pass-through

1. Introduction

The war of aggression in Ukraine and the associated sanctions policy have a major impact on air transport between Europe and Asia. Since 28 February 2022, Russia has withdrawn overflight rights for most European airlines over Russian territory (Reuters, 2022). In addition, Ukrainian airspace and Russian airspace near the Ukrainian border are closed to all civil aviation. As a result, some flights have to take long detours, for example, for the Finnair connection Helsinki-Beijing the increase in distance is 1,729 NM resulting in extra travel time of almost four hours

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10.1016/j.trpro.2024.02.014

(EUROCONTROL, 2022a). Data on origin-destination passenger traffic suggests that the importance of Europe-Asia traffic has declined. While Europe-Asia passengers accounted for 25.7% of European intercontinental traffic in 2019, this figure was only 15.4% in 2022 (Sabre, 2023).

Flight detours mean additional costs for airlines, especially due to an increase in fuel consumption and associated fuel costs (Seymour et al., 2020). According to economic theory, increased airline costs would be passed on to passengers at a rate of 0% to more than 100% (Koopmans and Lieshout, 2016). This tends to lead to higher ticket prices. However, since Russia has sold the overflight rights at a profit, it is not clear to what extent lower overflight fees might compensate for higher operating cost. Furthermore, customers' willingness to pay may decline due to an increase in travel time. Therefore, it is difficult to predict how prices have changed.

This paper analyses the impact of Russian and Ukrainian airspace closures on airfares between Western Europe and Asia. For the analysis, we use monthly fare data from a global distribution system provider for air tickets over the period between October 2021 and October 2022. In order to identify a causal effect, affected airport pairs between northern Europe and Asia are compared with similar unaffected airport pairs between southern Europe and Asia. The external shock on specific airport pairs motivates a difference-in-difference strategy, where we regress airfares on a binary indicator of airport pairs being affected by detours. It has a value of one if the connection has no overflight rights in a given month and zero otherwise. Additionally, use is made of a continuous treatment indicator based on the latitudes of origin airports. The further north an airport is located, the greater the treatment is. The assignment of this indicator follows EUROCONTROL's analysis of the impact of the war on flight distance, highlighting the impact on northern European airports (EUROCONTROL, 2022b).

For the vast majority of connections, we construct a continuous indicator for actual increases in travel time. Finally, time and connection fixed effects capture any time-invariant connection characteristics as well as seasonal or general trends. To visually check whether the assumption of parallel trends for the difference-in-difference estimation is fulfilled, we plot the development of indexed airfares between the control and treatment group before and after the start of the airspace closures. Different trends in recovery from the COVID-19 pandemic could bias the results. A priori, there is no clear indication that COVID-19 recovery trends differ between northern and southern European countries.

The study utilizes the subscription-based Sabre Market Intelligence (Sabre MI) database, which covers monthly airline bookings and offers three crucial features for the analysis. Firstly, Sabre MI provides reliable data on airfare and passenger numbers for global flights, which is distinct from other data sources used in similar studies. Secondly, the panel structure of the data allows to identify the causal impact of the withdrawal of overflight rights on flight connections from northern European countries, while using flight connections from southern European countries as a control group. Thirdly, the dataset provides monthly observations separated by airline, booking class, and origin and destination airport pair, enabling a heterogeneous analysis under diverse market conditions.

In general, this paper contributes to the literature on the transmission of commodity input prices on product prices (Bonnet et al., 2013; Fabra and Reguant, 2014; Wadud, 2015; Ganapati et al., 2020). For example, analyzing several industries, Ganapati et al. (2020) showed that 70% of energy price-driven changes in input costs get passed through to consumers in the short to medium run. More specifically, Wadud (2015) find evidence of asymmetry and hysteresis in cost pass-through from jet fuel prices to airfares, showing rapid increases in airfares when fuel prices increase. Furthermore, to the best of our knowledge, the paper is the first to causally quantify the effect of the Russian war in Ukraine and the resulting airspace closures on airfares. One of the few related studies is Ostroumov et al. (2022), which, among other things, estimates the additional fuel burn and associated fuel costs for selected Europe-Asia and USA-Asia connections. Beyond this, there are studies on the economic impacts of previous airspace closures on aviation, analyzing, for example, the effects of the eruption of the Eyjafjallajökull volcano (Budd et al., 2011; Miller, 2011) or the 9/11 terrorist attacks (Ito and Lee, 2005).

The remainder of this paper is structured as follows. Section 2 shows background information about the sanctions policy – resulting from the Russian war of aggression – affecting air transport and the data used for the identification strategy. Following that, Section 3 outlines the empirical strategy, while Section 4 presents the obtained results. Finally, the paper concludes in Section 5.

2. Data and background information about the airspace closure

2.1. Background information about the airspace closure

Following Russia's invasion of Ukraine on 24 February 2022, 36 Western countries have responded by closing their airspace to Russian airlines as a sanctions measure. These countries include all EU member states, the United States, Canada and other European countries such as the United Kingdom, Norway, and Switzerland. In retaliation, Russia has banned airlines from most of these countries from flying to or over Russia from 28 February 2022. The ban on overflights over Russian territory for European airlines makes significant detours on Europe-Asia routes necessary. Added to this is the closure of the Ukrainian airspace due to the danger to civil air transport by the ongoing combat operations.

The additional flight time and thus the affectedness of the route differs greatly according to the geographical location of the origin and destination city in Europe and Asia (see Fig. 1 and also EUROCONTROL, 2022a; EUROCONTROL, 2022b; Rowland, 2022). For example, for the Finnair connection Helsinki-Beijing the increase in distance is 1,729 NM resulting in extra travel time of almost four hours. In comparison, the increase in distance is 710 NM for the Lufthansa connection Frankfurt-Beijing resulting in an extra travel time of 90 minutes (EUROCONTROL, 2022a). Fig. 2 shows the relative increase in travel time depending on the latitude of the origin/destination airport in Europe. As can be seen from the figure, European airports north of the 50th degree of latitude experience significant increases in flight time of more than 100 minutes on some routes. Frankfurt is one of these airports with a latitude of just over 50 degrees. Airports north of the 57th degree of latitude are even more affected, with flight time increases on some routes of more than 200 minutes. The group of these airports includes Oslo, Stockholm, and Helsinki.

Asian airlines are generally not subject to the overflight ban over Russia. However, some Japanese and Korean airlines have stopped voluntarily using Russian airspace, citing safety concerns as the reason (IATA, 2022). Chinese and Indian airlines, on the other hand, continue to use Russian airspace for routes to Europe.

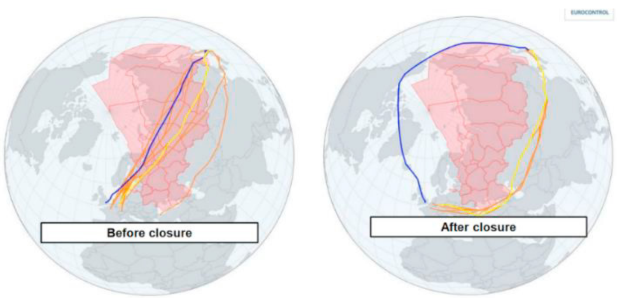

Fig. 1. Flight trajectories before and after withdrawing overflight rights. Source: EUROCONTROL (2022c)

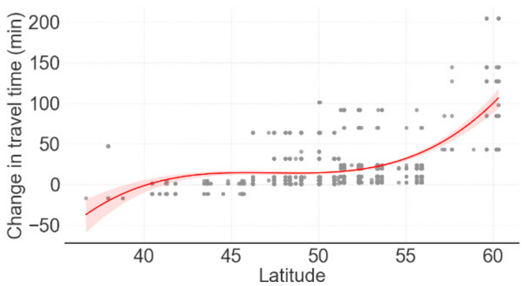

Fig. 2. Average increase in travel time of direct connections between Western Europe and Asia between February 2022 and after by latitude. Source: Own representation based on Sabre (2023) data

2.2. Data

This paper employs proprietary airfare panel data obtained from Sabre Market Intelligence to analyze the impact of airspace closures. The dataset consists of validated raw bookings sourced from major global distribution systems like Sabre, Travelport, and Amadeus, and is aggregated on a monthly basis. These systems act as intermediaries between travel agents and airlines. The observations in the dataset are aggregated monthly connections within the air travel network, which can be multiple flights, including connecting flights operated by different airlines.

The dataset provides airfare information for connections originating from Western Europe[1] to Asia[2], specifically covering the period between October 2021 and October 2022. It includes average airfare values for each connection. We exclude Eastern European countries from our estimation sample due to strong economic and cultural ties to Russia, which could bias airfare estimations.

The analysis focuses on a balanced sample of connections available throughout the investigation period, excluding seasonal or charter connections. The final sample consists of 1,691 mutually exclusive observations per month separated by airline, cabin class, origin and destination airport, and (possibly) transfer airports – totaling 21,983 connection-month observations. Sabre MI does provide travel time information for non-stop flights. Therefore, for each city-pair-month combination, we calculate the average travel time increase compared to the level before the airspace closures in February 2022. In order to obtain an approximate travel time increase for most of the connections – which includes stop-over connections as well – we first divide the group of origin and destination airports into ten equally sized separate bins according to the airports latitude. For each combination of origin and destination latitude group, we then measure the average travel time increase between February 2022 and after. Lastly, we transfer the increase in travel time between travel time groups to those airport pairs without direct connectivity but connecting flights within travel time groups.

Table 1 shows substantial variation in the characteristics of the 21,983 connection-month observations. Airfares range from \$124.39 to \$22,561.50 with a mean of \$806.23. Increases in travel time range between -16.67 to 204.80 minutes with a mean of 22.38 minutes. The number of observations differs for changes in travel time as we are unable to interpolate all airport pairs with our approximation approach. The mean latitude of the origin airports is 49.61 but ranges between 24.22 and 60.32. Business class and economy class account for 11% and 89% of the observations in the data set, respectively. The Herfindahl-Hirschman Index (HHI) measures the market concentration of carried persons based on the average competition at city-pair level in October 2021. The average level of 0.61 of the HHI indicates oligopolistic competition.

Table 1: Descriptive statistics

Variable	Mean	Std. dev.	Min.	Max.	Observations
Airfare (USD)	806.23	808.51	124.39	22,561.50	21,983
Change in travel time (minutes)	22.38	32.32	-16.67	204.80	18,473
Latitude (°) (origin airport)	49.61	5.04	24.22	60.32	21,983
Business class (%)	0.11	0.31	0.00	1.00	21,983
Economy class (%)	0.89	0.31	0.00	1.00	21,983
Herfindahl-Hirschman index	0.61	0.27	0.18	1.00	21,983

2.3. Trends before the airspace closure

The empirical approach's assumption of causal inference relies on the assumption that the development of airfares would have been similar in both the treatment and control groups if there had been no airspace closure. This assumption can be supported by examining a common trend in the outcome variable prior to the treatment. To assess whether the treatment and control groups displays similar trends before the airspace closure, the indexed airfare developments of connections above and below the 50th degree of latitude are compared. Fig. 3 illustrates the average monthly indexes of airfares for the control and treatment groups. The base value is the corresponding average of October 2021. The analysis of these indices reveals that, prior to the airspace closure, airfares in the control and treatment group exhibited remarkably similar patterns. Any discrepancies between the two groups before the airspace closure were negligible in magnitude. This similarity persists even in the months immediately preceding the shock, indicating that, as expected, the air transport sector did not adjust in anticipation of the airspace closure. Thus,

[1] Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, United Kingdom

[2] Bangladesh, Brunei, Cambodia, China, Hong Kong, India, Indonesia, Japan, Kazakhstan, Malaysia, Maldives, Nepal, Pakistan, Philippines, Singapore, South Korea, Sri Lanka, Taiwan, Thailand, Vietnam

connections from European airports below the 50th degree of latitude can be considered a plausible counterfactual scenario.

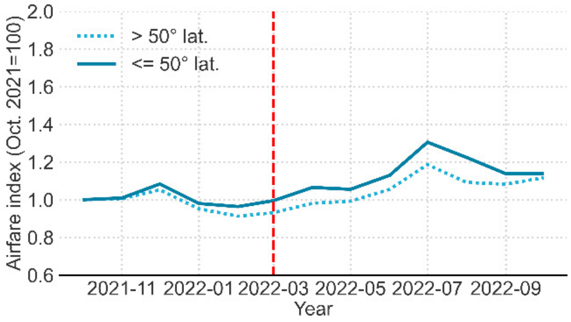

Fig. 3. Airfare development for control and treatment group.
Source: Own representation based on Sabre (2023) data

3. Empirical strategy

This paper estimates the causal impact of the airspace closures after Russia's war of aggression in Ukraine on airfares. We follow a regression approach to disentangle the impact of airspace closures from other factors influencing airfares. The geographic scope of the airspace closures motivates a difference-in-differences estimation strategy with the following empirical model, which is applied to flights departing from Western Europe to Asia over the period October 2021 to October 2022. The basic model reads:

$$y_{it} = \alpha + \beta(Closure)_{it} + \delta_i + \delta_t + \epsilon_{it} \quad (1)$$

where y_{it} indicates the outcome of interest for connection i which are airfares at time t. The term α represents a constant. The main variable of interest is $\beta(Closure)_{it}$ and captures the treatment of connection i at time t by the airspace closures, i.e., a binary indicator with a value of one if connection i is affected by the airspace closures at time t and zero otherwise. We start with a binary indicator, as Fig. 2 shows a non-linear relationship between the latitude of the origin airport and changes in travel time. However, we test for different functional forms later on. Connection fixed effects δ_i capture any time-invariant connection characteristics such as the travel distance and historical links between countries leading to structural differences in airfares. Controlling for connection fixed effects reduces unobserved heterogeneity between different flight connections. Not including connection fixed effects could bias our results if, for example, airfares are generally different between treated and untreated connections. Time fixed effects δ_t control for any time-specific effects that are uniform across all observation units i such as variations in fuel prices. For example, if fuel prices increase in the observation period, not considering this trend would bias the results upwards. To account for cross-sectional correlation in the error terms, we cluster the standard errors at the city-pair level of origin and destination airports. Given the narrow observation period, we do not control for time-varying characteristics such as population density or GDP.

4. Results

In this section, the estimation results for the impact of the airspace closures on airfares are presented. The estimates of the β coefficient quantify the overall effect of the airspace closures on airfares, encompassing both demand and supply responses. Hence, the results represent reduced-form effects. Table 2 displays the OLS results for the impact of the airspace closure on airfares. Each cell in the table corresponds to an estimate for β, as per Equation 1, derived from a separate regression of airfares on different indicators showing whether connections were affected by the airspace closures. All regressions incorporate fixed effects for connections and time to capture any connection-specific characteristics that are constant over time, as well as any time-varying changes that are consistent across connections (e.g., business cycle fluctuations, policy or fuel price adjustments).

Column 1 of Table 2 shows, that airfares of connections departing above the 50th degree of latitude are more affected than below. On average, the increase in airfares is \$43.47 or 5.4% of the mean. In Column 2, a linear functional form is employed using a continuous indicator for latitude. The coefficient of Column 2 is significantly different form zero and shows that an increase in latitude of the departing airport location by one increases the airfare by \$3.78. However, employing a non-linear relationship in Column 3, using latitude bins shown at the left-hand side of the table, we again see that the impact of the airspace closure only occurs above the 50th degree of latitude. Above the 57th degree of latitude, the increase in airfare is \$90.33 or almost 15% of the mean. Given these results, we conclude that the 50th degree of latitude is a reasonable threshold of being affected by the airspace closures. In Column 4, we analyze the impact of changes in travel time on airfares. According to Column 4, an increase in travel time of one-minute results in an increase in airfares of \$1.56. The linear relationship between travel time and latitude of the origin airport is challenged by the findings in Column 5. Changes in travel time above 5 minutes and below 60 minutes increases airfares by \$59. Between 60- and 120-minutes travel time increase, airfares increase by \$190. Above 120 minutes travel time increase, additional increases in travel have a diminishing impact on airfares, which would be explained by the negative demand effect of high travel time. As travel time changes might suffer from endogeneity bias, we prefer latitude as indicator despite possible attenuation bias.

Table 2. Main estimation results

Variable	(1)	(2)	(3)	(4)	(5)
>50° latitude	43.469**				
	(20.074)				
Latitude (°)		3.775**			
		(1.655)			
[43°–50°) latitude			29.220		
			(27.405)		
[50°–57°) latitude			52.862**		
			(25.359)		
≥57° latitude			90.333**		
			(42.029)		
Travel time increase (min.)				1.561***	
				(0.337)	
[5–60) min. travel time increase					59.479**
					(28.627)
[60–120) min. travel time increase					189.533***
					(35.860)
≥120 min. travel time increase					232.261**
					(105.079)
Controls:					
Connection FE	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes
Adjusted R^2	0.84	0.84	0.84	0.84	0.84
Observations	21,983	21,983	21,983	18,473	18,473

Notes: This table displays the main estimation results. Each coefficient is the result of a separate regression of monthly-level airfares on different indicator variables for airport-pairs being treated by the airspace closure, controlling for the variables indicated below. Standard errors, clustered at the city-pair level, are displayed in parentheses. Significance levels: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table 3 explores whether the impact of the airspace closure on airfares differs between market structures. For each set of groups, the binary indicator for the airspace closure above the 50th degree of latitude is interacted with continuous and binary indicators listed on the left-hand side. According to Column 1, an increase in the Herfindahl-Index, which implies higher market concentration at city-pair level, does not change the effect of the airspace closure above the 50th degree of latitude. On the contrary, Column 2 shows that the impact of the airspace closure above the 50th degree of latitude on airfares is higher for business class passengers. The increase in airfares is \$226.77 higher for business class passengers compared to economy class passengers or 9.7 percent of the mean airfare of business class passengers.

Thus, even in relative terms business class passengers are stronger affected as the relative airfare increase of the mean is 5.4 percent.

Table 3. Estimation results for additional regressions

Variable	(1)	(2)
>50° latitude	19.296	10.260
	(46.484)	(14.648)
HHI	2.308	
	(41.485)	
HHI × (>50° latitude)	39.975	
	(67.368)	
Business class		198.467***
		(57.286)
Business class × (>50° latitude)		226.772***
		(78.958)
Controls:		
Connection FE	Yes	Yes
Time FE	Yes	Yes
Adjusted R^2	0.84	0.84
Observations	21,983	21,983

Notes: This table displays the estimates from OLS regressions of the monthly level airfare on interactions of airspace closures with continuous indicator for the HHI on an airport-pairs and a binary indicator for business class. Control variables listed at the bottom. Standard errors, clustered at the city-pair level, are displayed in parentheses. Significance levels: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

5. Conclusions

This paper examines the impact of airspace closures following the war of aggression in Ukraine on airfares between Western Europe and Asia. The findings indicate that the airspace closures have a significant positive effect on airfares for connections departing from European airports above the 50th degree of latitude. On average, airfares increased by about USD 43 or 5.4% of the mean for connections above this threshold. Furthermore, when considering the additional flight time, each additional minute of flight time leads to an average fare increase of around USD 1.56.

The results suggest that the additional costs arising from the longer flight time and distance, such as fuel costs, are to some extent passed on to passengers. Moreover, this positive fare impact appears to dominate negative fare impacts associated with avoiding Russian airspace. These negative effects include savings in high overflight charges for using Russian airspace and a lower willingness to pay on the part of passengers due to longer flight times. Economic theory under oligopoly implies that the cost pass-through tends to be higher in more competitive airline markets. However, we do not find a negative effect of market concentration on cost pass-through. One possible explanation for this result is that even with high market concentration, there is sufficient potential competition from alternative connections, such as those involving other neighboring origin-destination airports or other transfer airports. Another possible explanation for this result could be the relatively short observation period during which market equilibriums were unable to unfold their full effect. On the contrary, airfares for business class increase stronger than for economy class, even in relative terms. On the one hand, this is due to the higher costs of the premium product, which increase in line with the longer flight time and distance. On the other hand, business customers are less price sensitive because business trips are harder to substitute compared to a tourist trip. Therefore, the lower price elasticity of business class passengers could allow airlines to pass on a larger share of the costs. In conclusion, this paper sheds light on the consequences of the sanction-related airspace closures for European air passengers and airlines. It shows, for example, the heterogeneity of the burden in the individual member states of the European Union. Policy makers can thus better assess the need for policy support measures for airlines with a high share of Asian traffic or businesses with close ties to Asia.

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