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The Nexus Between COVID-19 Government Responses and Aviation Stock Prices in Turkey: OxCGRT Stringency Index-Based Analysis

Dilşad Tülgen Çetin[1*]

[1*] Burdur Mehmet Akif Ersoy University, Transportation Services Department, Burdur, Türkiye. (dtozturk@mehmetakif.edu.tr)

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Corresponding Author: *Dilşad Tülgen Çetin*

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Abstract

Air transportation is the significant mode of transmission, enabling the worldwide spread of infectious diseases through the mobility of infected persons. Therefore, governments applied the most comprehensive restrictions and preventions in civil aviation during COVID-19. The industry is one of the most economically impacted due to travel, and flight restrictions. This paper aims to investigate the long- and short-term nexuses between government responses to COVID-19 and the aviation stock prices traded in Borsa Istanbul. The OxCGRT stringency Turkey index is used to measure the Turkish government responses and policies to COVID-19. In the study, the daily data of Turkish Airlines, Pegasus Airlines, Do&Co Catering, TAV Airport Holding, Celebi Ground Handling stock prices, and the OxCGRT stringency Turkey index for the 24.01.2020-11.11.2021 period were used, and Granger causality and Engle-Granger cointegration tests were applied to reveal the nexuses. In conclusion, there is a cointegration nexus and one-way causality from the index to all Turkish aviation stock prices, except the Celebi Ground Handling stock prices. The contribution of this study is that it is probably the first one in Turkey to reveal the nexus between the government's policy and responses to COVID-19 and aviation stock prices.

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1. Introduction

In recent years, the aviation industry has shown steady growth due to the increase in tourism and cargo demand around the world. In many regions, the aviation industry has become a strategic sector that contributes to social development and economic growth. In 2019, the total number of scheduled passengers in the world was 4.5 billion, while the operating income of the global aviation industry was approximately 900 billion dollars (IATA, 2020).

The increase in international passenger and cargo traffic has also increased the risk of the spread of infectious diseases. The industry has often had to deal with biosecurity threats and faced various epidemics and pandemics in history such as SARS, MERS, H1N1, H5N1, as it is the fastest route for human and cargo mobility globally (Amankwah-Amoah et al., 2021; Chung, 2015). The outbreaks have dramatically demonstrated the key role of aviation in mitigating the spread of infectious diseases and their impact on global public health and the economy. Lastly, the COVID-19 emerged in China in the last months of 2019 and spread rapidly worldwide, initiated one of the biggest crises experienced by the global aviation industry.

On December 31, 2019, the World Health Organization (WHO) reported the existence of a virus that spreads in an epidemic in China, and on January 7, 2020, stated that this virus is a new type of Corona virus and announced the name of the disease as "COVID-19". On January 30, the WHO declared a global emergency, and on March 11, a "pandemic", which means a global epidemic. After the declaration of the pandemic, in order to slow the spread of the epidemic, countries first decided to stop international flights and then imposed restrictions on domestic flights (WHO, 2021). The COVID-19 has brought business operations to a standstill in all industries worldwide. Air transport was one of the first to be interrupted and thus most affected, because it would increase the spread of the disease on a global scale. The market values of airlines have decreased significantly with the onset of the pandemic.

The paper aims to reveal the nexus between COVID-19 restrictions and policies on aviation stock prices in Turkey. For this purpose, the long- and short-term nexus between the OxCGRT stringency index (SI) and the aviation stock prices traded in Borsa Istanbul analyzed through Granger causality and Engle-Granger cointegration tests.

This study contributes to the literature by revealing the economic and operational effects of COVID-19 on the aviation industry after 16 months in the pandemic, as well as the long and short-term nexuses between the Turkish government responses to COVID-19 and aviation stock prices through the causality and cointegration tests. Thus, it is revealing the impact of the COVID-19 on the civil aviation industry from a different viewpoint. This is probably the first study revealing the nexus between the OxCGRT stringency index and aviation stock prices in Turkey.

The study consists of six sections: The first section includes the introduction, the second section explains the operational and economic effects of COVID-19 on the aviation industry in the world and in Turkey, the third section summarizes literature studies on the subject, the fourth section describes the dataset and method used in the research, the fifth section presents the findings and the final section discusses the conclusion of the research.

2. Impact of COVID-19 on Civil Aviation

COVID-19 has posed major challenges to human health and economies worldwide. In addition to the high mortality rates, the supply chain disruptions, inflation, and global economic recession it causes are estimated to be the worst global economic crisis since the Great Depression of the 1930s. The restrictions implemented to prevent the spread of the disease and the anxiety of the disease in people led to a decrease in flight traffic worldwide and caused the aviation industry to suffer significant economic losses. Obviously, the aviation industry is one of the sectors most affected due to travel and flight restrictions. Thus, COVID-19 is the preeminent crisis experienced in the history of civil aviation.

2.1. The Global Impact of COVID-19 on Civil Aviation

Although the aviation industry has been repeatedly tested by infectious diseases (SARS, MERS, avian flu and swine flu) over the past 20 years, it is for the first time facing a major crisis of the scale created by COVID-19. The most significant feature that distinguishes COVID-19 from other epidemics is that the rate of contagion is very fast and high (Gössling, 2020). According to the data of the WHO, as of March 30, 2022, the number of confirmed cases worldwide is 483.556.595 and the number of deaths is 6.132.461(WHO, 2022).

In order to reveal the dramatic impact of COVID-19 on the aviation industry in a striking way; The oil crisis, Iran-Iraq War, the Gulf Crisis, the Asian Crisis, the 9/11 attack, the SARS, the 2008 financial crisis and COVID-19 period the global airline passenger numbers are displayed in Figure 1 (ICAO, 2022).

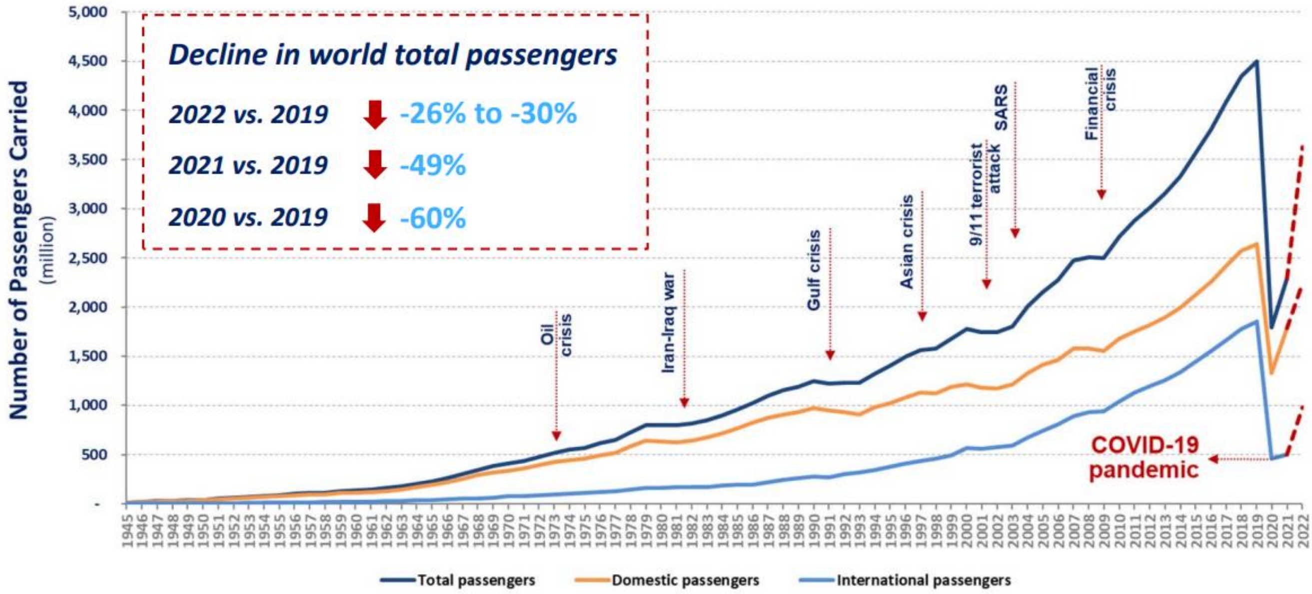

Figure 1. The Global Air Passenger Traffic in Crisis Periods (1945- March 2022).
Source: ICAO, (2022),8th March, "Effects of Novel Coronavirus (COVID-19) on Civil Aviation: Economic Impact Analysis".

Fig. 1 displays the decreasing impact of the major crises affecting the global civil aviation industry on the total number of passengers carried. However, no crisis since 1945 has caused such a great decline as COVID-19.

During the COVID-19 pandemic, the decrease in seat supply, number of passengers and gross operating income in global civil aviation in 2020, 2021 and estimation for 2022 compared to 2019 presented in Table 1.

Table 1: Global Civil Aviation in 2020-2021-2022* Compared to 2019

	2020	2021	2022*
Seat supply	-50%	-40%	-20-23%
Number of passengers	-60%	-49%	-26-30%
Operating income (billion $)	-372	-324	-182-205

Note: *Estimated data.
Source: ICAO, (2022),8th March, "Effects of Novel Coronavirus (COVID-19) on Civil Aviation: Economic Impact Analysis".

Compared to 2019, the COVID-19 caused a 60% decrease in the total number of passengers in 2020 and 49% in 2021. Estimates indicate that the decrease will continue between 26-30% in 2022. Hence, the operating income of the industry decreased by 372 billion dollars in 2020 and 324 billion dollars in 2021 compared to 2019. In 2022, it will close with approximately 182-205 billion dollars loss of revenue. The table clearly reveals that the civil aviation industry is facing the biggest crisis in the history of the world. Monthly global air passenger numbers for January 2020-February 2022 compared to 2019 are displayed in Figure 2 (ICAO, 2022).

In Figure 2, the number of international airline passengers decreased significantly by 74% in 2020, and decreased by 49% in 2021 compared to 2019. While the number of domestic airline passengers decreased by 50% in 2020 compared to 2019, it approximately reduced to 26% in February 2022 (ICAO, 2022). Estimation studies on how long the effects of this crisis can be eliminated are that the industry will not reach 2019 traffic and passenger figures before 2024-2025 (Çetin, 2021).

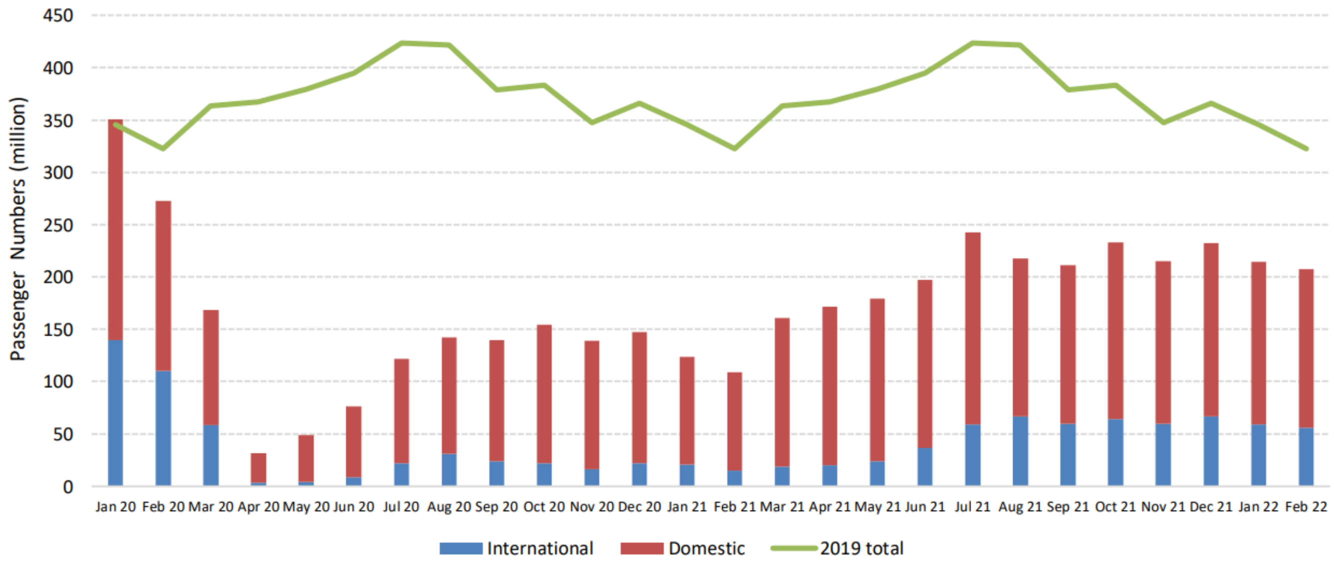

Figure 2. Monthly Global Air Passenger Numbers (January 2020- Feb 2022, compared to 2019)
Source: ICAO, (2022),8th March, "Effects of Novel Coronavirus (COVID-19) on Civil Aviation: Economic Impact Analysis".

2.2. Impact of COVID-19 on Turkish Civil Aviation

The Turkish aviation industry has achieved a steady growth momentum in last decade; a striking fracture experienced in 2020 with the effect of the pandemic. Turkey closely followed the course of the COVID-19 and took precautions by acting pro-actively before the first case detected on 11th March 2020. In response to COVID-19, it was decided to phase out international flights from 3rd February 2020 on international flights and only restarted after June 2020 with a low seat supply. Curfews and travel restrictions implemented in this process caused a serious decrease in airline passenger demand as well as all over the world. The change in passenger traffic in 2021 compared to 2019 is presented in Table2 (DHMI, 2021).

Table 2: Aircraft, Passenger and Freight Traffic in Turkey (2020, compared to 2019)

Years	2019	2021	Comparing to 2019	2022*	Comparing to 2019	2023*	Comparing to 2019
Passenger Traffic (Including Direct Transit)	208,911,338	123,026,132	-41.1%	178,761,572	-14.4%	203,679,026	-2.5%
Passenger Traffic	208,373,696	122,645,456	-41.1%	178,287,562	-14.4%	203,095,824	-2.5%
- Domestic line	99,946,572	64,876,212	-35.1%	91,805,844	-8.1%	100,785,844	0.8%
- International line	108,427,124	57,769,244	-46.7%	86,481,718	-20.2%	102,309,980	-5.6%
Direct Transit Passenger	537,642	380,676	-29.2%	474,010	-11.8%	583,202	8.5%
All Aircraft (Including Overflight)	2,034,430	1,359,194	-33.2%	1,716,947	-15.6%	1,982,480	-2.6%
Aircraft Traffic	1,556,417	1,109,406	-28.7%	1,378,492	-11.4%	1,561,043	0.3%
- Domestic line	839,894	646,403	-23.0%	791,175	-5.8%	874,099	4.1%
- International line	716,523	463,003	-35.4%	587,317	-18.0%	686,944	-4.1%
Overflight Aircraft Traffic	478,013	249,788	-47.7%	338,455	-29.2%	421,437	-11.8%
Freight Traffic (Ton) (Cargo+Mail+Baggage)	4,090,168	3,454,700	-15.5%	3,972,102	-2.9%	4,134,992	1.1%
- Domestic line	833,768	713,238	-14.5%	814,382	-2.3%	841,690	1.0%
- International line	3,256,399	2,741,462	-15.8%	3,157,720	-3.0%	3,293,302	1.1%
Cargo Traffic	1,522,404	1,282,556	-15.8%	1,476,733	-3.0%	1,539,536	1.1%
- Domestic line	65,667	56,174	-14.5%	64,140	-2.3%	66,291	1.0%
- International line	1,456,737	1,226,382	-15.8%	1,412,593	-3.0%	1,473,245	1.1%

*Estimated data.
Source: DHMI (2021), Airports in Turkey Aircraft, Passenger and Freight Traffic Statistics (2002-2023), Turkey.

In Table 2, the total number of airline passengers across Turkey decreased by 60% in 2020 compared to 2019. Due to travel restrictions, the decrease in international flights was much higher and was 70.6%. With the effect of the controlled normalization period that started in May 2020 in domestic routes, the decrease occurred compared to 2019 was 50.2%. In the table, the most dramatic decrease in the number of passengers in 2020 was in the number of transit passengers with 83.7%.

Based on the statistics published by the General Directorate of State Airports Authority (DHMI), the number of airline passengers in Turkey for the period of 2011-2020 is displayed in Figure 3, showing the numbers of domestic and international passengers separately (DHMI, 2021).

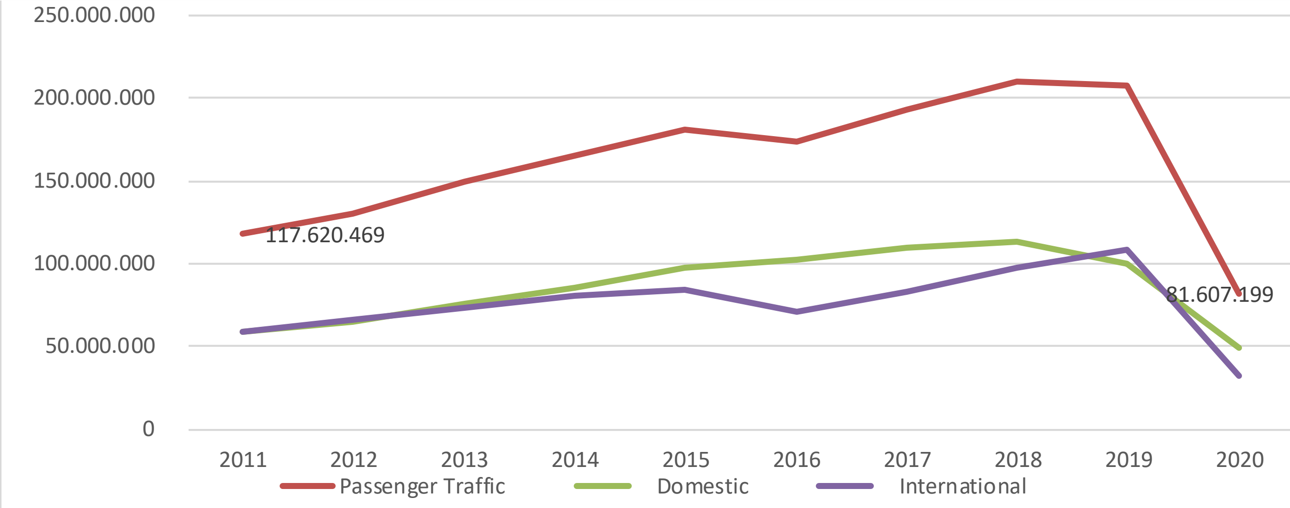

Figure 3. Turkey Air Passenger Numbers (2011-2020)
Source: DHMI (2021), Airports in Turkey Aircraft, Passenger and Freight Traffic Statistics (2002-2023), Turkey.

Figure 3 limpidly shows the decline in the number of airline passengers caused by the COVID-19 in Turkey. The total number of passengers decreased in 2020 with a major break compared to the number of passengers in 2019. On the other hand, the decrease in international flights is much more striking than the number of domestic passengers.

3. Literature Review

The civil aviation industry has survived a wide variety of crises (SARS epidemic, tsunamis, etc.) in the last few decades, but none has exposed civil aviation to such a profound shock from the travel restrictions and border closures imposed by governments due to Covid-19. The civil aviation industry has survived a wide variety of crises (SARS epidemic, tsunamis, etc.) in the last few decades, but none has exposed civil aviation to such a profound shock from the travel restrictions and border closures imposed by governments due to COVID-19 (Gössling et al., 2020). Considering that international air transportation is a significant factor in the spread of the disease, restricting air travel has been accepted as one of the most effective measures (Boldog et al., 2020; Chinazzi et al., 2020; Nikolaou & Dimitriou, 2020).

Civil aviation operations have decreased significantly due to travel bans and curfews. The social distancing rule imposed due to COVID-19 has resulted in further reductions in seat capacity supply and passenger volume due to the spaced seating arrangement in the cabin (Beh & Lin, 2022; Gössling, 2020). Tourists, who take into account the highly contagious and deadly effects of the COVID-19 virus, avoided traveling during the periods when the cases were high (Teeroovengadum et al., 2021; Yang et al., 2021). Increasing vaccination rates worldwide has led many countries to reopen their borders and relax international travel restrictions (Zhang et al., 2020). Still, some studies suggest that the negative impact of COVID-19 on global civil aviation will continue in the long term (Czerny et al., 2021; Dube et al., 2021; Škare et al., 2021).

Early studies conducted at the beginning of the pandemic revealed that COVID-19 has led to a decline: in passenger traffic was 70-80% (Macilree & Duval, 2020), on the number of flights was more than 89% in EU (Nižetić, 2020). In addition, it has led to a decline in the market value of airlines was 22% on average (Maneenop & Kotcharin, 2020), in market share value was 49% on average (Dube et al., 2021)as of April 2020. When the relationship between COVID-19 cases and airline passenger traffic was analyzed, it was determined that there was a 92% correlation in domestic flights and 98% in international flights (Lau et al., 2020) in global civil aviation. Maneenop & Kotcharin, (2020) investigated the short-term impact of COVID-19 on 52 listed airlines worldwide and found that airline stock returns decreased more than stock market returns after COVID-19 announcements.

Due to COVID-19, a decrease of 64.07% in the number of passengers, 54.75% in the number of traffic and 43.99% in the amount of cargo carried was detected in Turkey's six largest airports (Taşdemir, 2020). Although there are many theoretical or case studies (Akca, 2020; Kalkın, 2021; Keskin & Ercoşkun Yalçıner, 2021; Şen & Bütün, 2021) investigating the effects of COVID-19 on the aviation industry in the national literature, there are few empirical studies. The existence of a long-term relationship between the number of deaths caused by COVID-19 and BIST Tourism and BIST Transportation Indices was revealed by ARDL Boundary Test (Gümüş & Hacievliyagil, 2020) and RALS Engle and Granger Cointegration Test (Güngör et al., 2021). Deveci et al., (2022), revealed in their studies that COVID-19 affected the Turkish civil aviation industry to a large extent and it was reshaped with fewer carriers during the recovery phase. Airline workers have faced significant salary cuts due to the decline in airlines' revenues. However, there is an increase in air cargo traffic in Turkey.

Scherf et al., (2022) used the OXCGRT index to measure the effect of government interventions in their study where they analyzed the responses of OECD and BRICS country stock markets to the COVID-19 quarantine restrictions. The results revealed that the Covid-19 restrictions caused an overall decline in stock markets of all analyzed countries. Markets overreacted to the first national-level restrictions, while later a few days delayed and more controlled responses to the announcement of restrictions. When restrictions were relaxed, stock markets reacted differently. While it reacted negatively to the easing decisions in January and end of March, it reacted positively to the later ones. In addition, the study revealed that there is no relationship between the number of COVID-19 cases and stock market returns. In studies with OxCGRT stringency index; it was determined that COVID-19 restrictions positively affects the market quality of Vietnam

(Vo & Doan, 2021). It restrains the exchange rate volatility of 20 developed countries (Feng et al., 2021), and reduces herd behavior in Indian stock market (Bharti & Kumar, 2021).

4. Data and Methodology

4.1. Dataset

The closing prices of Turkish Airlines (THYAO), Pegasus Airlines (PGSUS), THY Do&Co Catering (DOCO), TAV Airport Holding (TAV), and Celebi Ground Handling (CLEBI) traded on Borsa Istanbul (BIST) was used to investigate the nexus between the Turkish government COVID-19 restrictions and policies and aviation stocks.

To measure the impact of government restrictions and policies, we used the OxCGRT Stringency Turkey Index (SI-Turkey). The index, calculated by the University of Oxford (OxCGRT), scales the restrictions and policies implemented by countries across thirteen categories from 0-100. These restriction and policy categories are: (1) school closures, (2) workplace closures, (3) cancel public events, (4) restrictions on gatherings, (5) close public transport, (6) public information campaigns, (7) stay at home, (8) restrictions on internal movement, (9) international travel controls, (10) testing policy, (11) contact tracing, (12) face coverings, (13) vaccination policy (Hale et al., 2021).

The analysis period covers the daily data between 24.01.2020, when the index started to be calculated for Turkey, and 11.11.2021, when the data was analyzed. In order to avoid the effects of extreme increases in exchange rates, interest rates and geopolitical risks on stock market prices, taking into consideration the dates of 12 November 2021, when the dollar/TRY exchange rate suddenly increased, and 24 February 2022, the date of Russia's invasion of Ukraine, analysis period is limited to 24.01.2020-11.11.2021. After removing the missing data, 449 daily data obtained. Five datasets consisting of each aviation stock prices and SI-Turkey values created. The detailed information regarding the variables presented in Table 3.

Table 3: Variables

Ticker	Variables	Data Type	Data Source
SI_TURKEY	OxCGRT Stringency Index-Turkey	Index value	OxCGRT*
THYAO	Turkish Airlines	Closing price	BIST**
PGSUS	Pegasus Airlines	Closing price	BIST**
TAV	TAV Airport Holding	Closing price	BIST**
CLEBI	Celebi Ground Handling	Closing price	BIST**
DOCO	THY Do&Co Catering	Closing price	BIST**

*Source: OxCGRT, (2021), The Oxford COVID-19 Government Response Tracker

**Source: Investing Database, https://tr.investing.com/.

Table 4 shows the descriptive statistics for the data used in the study.

Table 4: Descriptive Statistics

	SI_Turkey	THYAO	PGSUS	TAVHL	CLEBI	DOCO
Mean	58.1052	14.4757	69.8084	151.9119	23.4891	659.0445
Median	62.5000	12.6850	71.0500	163.5000	22.5300	612.5500
Maximum	87.0400	29.9600	111.0000	330.0000	41.2000	1465.0000
Minimum	2.7800	7.7100	23.6200	47.0200	13.7900	221.0000
Std. Dev.	17.2723	5.1943	18.8341	69.2407	6.5151	318.3220
Skewness	-1.1043	1.7085	0.0775	0.3577	0.8415	0.8433
Kurtosis	4.0114	4.8644	2.3656	2.1290	3.0102	2.8132
Jarque-Bera	134	345	10	29	64	66
Probability	0.0000	0.0000	0.0078	0.0000	0.0000	0.0000
Observations	449	449	449	449	449	449

According to Table 4, only the SI Turkey data skewed to the left, while the data of THYAO, PGSUS, TAV, CLEBI and DOCO slightly skewed to the right. In terms of kurtosis values, SI Turkey and THYAO data have thicker tails compared to the normal distribution, while other data have thinner tails. The results of the Jarque-Bera test performed to test the normality assumption reveal that all series are not normally distributed.

To analyze the long-run nexus between the SI-Turkey index and the aviation stock prices, the Engle and Granger (1987) co-integration test and for the short-run nexus, the VAR-based Granger (1969) causality test applied for each dataset. The stationarity of the series tested before applying these tests. In the study, Augmented Dickey and Fuller (ADF) (1981) and Phillips-Perron (PP) (1988) unit-root tests used to determine the stationarity of the series.

4.2. Stationarity

In order to detect econometrically meaningful relationships between the variables, the series should be stationary. Stationarity can be briefly defined as converge of variables towards a certain value over time. If there is a trend in the time series of the variables and this trend is caused by permanent shocks, the series will not converge to a certain value. It is generally accepted that series cannot be evaluated with standard statistical theory when they are not stationary (Gujarati & Porter, 1999). ADF and PP unit root tests are commonly used to determine whether the variables are stationary (Chris, 2014).

Dickey and Fuller (1981) stated that if the residuals obtained by estimating the equations have autocorrelation, the unit-root test results applied would be misleading. Therefore, they developed the ADF test, in which the lagged value of the dependent variable added to the right side of the equation. The ADF formula is in Equation 1.

$$\Delta Y_t = \alpha + \beta_t + \gamma Y_{t-1} + \sum_{i=1}^{k} \delta_i \Delta Y_{t-i} + \varepsilon_t \quad (1)$$

In Equation 1, α denotes a constant, β_t denotes the coefficient of a time trend. Equation aims to include the difference term in the model with enough lag to ensure that the error term is free from autocorrelation.

Phillips and Perron (1988) developed a unit root test that widely used in financial time series. The regression model used by the PP test is presented in Equation 2 (Çelik et al., 2021).

$$Y_t = \alpha + \beta\left(t - \frac{1}{2}T\right) + \delta y_{t-1} + u_t \quad (2)$$

In Equation 2, α denotes a constant, β_t denotes the coefficient of a time trend, T refers to t-statistics. This test differs from ADF in solving the problem of autocorrelation and varying variance in errors. Instead of adding lagged values to the equation for avoiding autocorrelation, they reorganized the t statistics by estimating the Dickey-Fuller equation (Neusser, 2016).

4.3. Long-Term Nexus: Engle-Granger Cointegration Test

The spurious regression problem is encountered in analyzes with non-stationary time series. When the difference of the series is taken to make it stationary, information loss occurs in the original observations (Dufour & Raj, 2012). Thus, cointegration analysis is applied, which states that non-stationary series can have a stationary composition. Co-integration explains the existence of a long-run equilibrium nexus of the variables by providing a stable relationship between two or more non-stationary variables (Chris, 2014). According to Engle and Granger (1987), if there is a tendency to move together in long-run term between two and more datasets that become stationary at the first difference (I_1), then these datasets could be analyzed with raw data.

Engle Granger cointegration test prioritizes testing the stationarity of the error term obtained from the regression equation to determine the long-term relationship between two variables. A two-stage predictor, which is asymptotically efficient, proposed in the test.

In the first step, the stationarity degrees of the variables investigated with unit root tests. If the variables are stationary at the first difference, the error terms obtained by predicting the Ordinary Least Squares (OLS) using the cointegration regression model. If not, it means that there is no cointegration nexus between the variables (Engle & Granger, 1987). The OLS predicted regression model of the Engle Granger cointegration test presented in Equation 3. In Equation 3, r_t^y and r_t^z variables are stationary at the I_1 level.

$$r_t^y = \beta_0 + \beta_1 r_t^z + \varepsilon_t \quad (3)$$

In the second step, the error terms of the variables with the I_1 stationarity degree tested for stationarity. The model used to test the stationarity of the error terms is formulated in Equation 4 (Çelik et al., 2021).

$$\Delta\varepsilon_t = \psi\varepsilon_{t-1} + v_t \quad (4)$$

In case of the error-terms are stationary; it means there is a long-run equilibrium relation within the series, otherwise, not.

4.4. Short-Term Nexus: Granger Causality Test

The Granger causality test designed to find the short-run nexus between the pairs of variables. It is a statistical hypothesis test whether one time series is useful in predicting another time series. The test used to determine the direction of causality statistically if there is a time-lagged relationship between two variables.

Granger causality is the correlation between the current value of one variable and the past values of others, and it does not mean that the movements of one variable cause the movements of another. "X is the Granger cause of Y," if using the past values of the variable X for the prediction of variable Y provides better performance than not using it (Freeman, 1983). Granger's definition of causality based on the following assumptions (Granger, 1969):

• The future cannot be the cause of the past. Exact causation is possible only when the past causes the present or the future. The cause always precedes the effect. This necessitates a time delay between cause and effect.

• For series that are completely deterministic, that is, non-stochastic and that can be predicted exactly from the past terms, there is no causality effect other than its own history effect.

The Granger equations presented in Equations 5 and 6.

$$Y_t = \alpha_0 + \sum_{i=1}^{k} \alpha_i Y_{t-i} + \sum_{i=1}^{k} \beta_i X_{t-i} + \varepsilon_{1t} \quad (5)$$

$$X_t = \theta_0 + \sum_{i=1}^{k} \theta_i X_{t-i} + \sum_{i=1}^{k} \gamma_i Y_{t-i} + u_{2t} \quad (6)$$

In equations five and six, $\alpha_i, \beta_i, \theta_i, \gamma_i$ are the delay coefficients, k is the common lag length for all variables, ε and u are uncorrelated white noise error terms. It assumed that the error terms are independent of each other in the equations.

5. Findings

In the research, the impacts of the policies and restrictions applied in Turkey during the COVID-19 period on aviation stocks were investigated. The OxCGRT Stringency Turkey Index is used to represent the COVID-19 policy and restrictions variable. Datasets were analyzed using the EViews 12 program.

Before examining the nexus between the SI Turkey index and aviation stock prices, the stationarity of the series is tested. It is possible to encounter the problem of spurious regression in econometric analyzes with non-stationary series. This affects the reliability of the research results. The stationarity of the series examined by ADF and PP unit root tests and the results presented in Table 5.

Table 5: Augmented Dickey-Fuller (ADF) and Phillips Perron (PP) Unit Root Tests

	Variables	Level (I_0)		First Difference (I_1)	
	t-Statistics *Prob.*	ADF	PP	ADF	PP
Trend& Intercept	SI_Turkey	-2,7459	-2,8126	-17,2287	-17,2699
	Prob.	(0,2189)	(0,1938)	(0,0000)	(0,0000)
	THYAO	-2,5086	-2,8966	-16,6291	-17,1225
	Prob.	(0,3238)	(0,1650)	(0,0000)	(0,0000)
	PGSUS	-2,4796	-2,6850	-16,0234	-16,2238
	Prob.	(0,3381)	(0,2436)	(0,0000)	(0,0000)
	TAV	-2,7922	-2,8370	-16,8227	-17,0245
	Prob.	(0,2013)	(0,1851)	(0,0000)	(0,0000)
	CLEBI	-1,8984	-2,0513	-15,0076	-15,4442
	Prob.	(0,6530)	(0,5704)	(0,0000)	(0,0000)
	DOCO	-2,0595	-2,1269	-14,3818	-14,8749
	Prob.	(0,5659)	(0,5283)	(0,0000)	(0,0000)

In Table 5, it observed that the series are not stationary at level (I_0) and contain a unit root. For this reason, the first differences of the series were taken and their stationarity was retested and it was determined that all series were stationary in the first order (I_1).

It is possible to determine whether there is a long-term nexus between the two series with the Engle Granger cointegration test in case the series are stationary at the same level. In the test, the stationarity of the error term obtained from the regression equation to be set between two variables is tested. If the error term is stationary, it concluded that the two series tend to move together in the long-run term, that is, there is a cointegration relationship. Engle Granger cointegration test results regarding the long-term relationship between each aviation stock and SI Turkey given in Table 6.

Table 6: Engle Granger Co-integration Test Results

Series	tau-statistic	Prob.*	z-statistic	Prob.*
THYAO & SI_Turkey	-4.409864	0.0008	-94.36896	0.0194
PGSUS & SI_Turkey	-4.258743	0.0137	-93.12037	0.0199
TAV & SI_Turkey	-3.881398	0.0019	-97.26261	0.0183
CLEBI & SI_Turkey	*-2.466380*	*0.4820*	*-34.93908*	*0.0612*
DOCO & SI_Turkey	-3.968917	0.0304	-93.58762	0.0198

*MacKinnon (1996) p-values.

In Table 6, the Engle Granger cointegration test results revealed that there is a cointegration relationship between all aviation stocks and SI Turkey, except for Celebi Ground Handling (CLEBI) stocks. Upon determining that there is a long-term relationship between aviation stock prices and SI Turkey, Pairwise Granger causality test applied to the series in order to determine whether there is a short-term nexus between the series. Since a causality relationship from aviation stock prices to SI Turkey is theoretically illogical, only causality results from SI Turkey to aviation stock prices given in Table 7.

Table 7: Pairwise Granger Causality Test Results

Null Hypothesis	F-Statistics	p-Probability	Lag Length
The SI_Turkey Index is not the Granger cause of THYAO.	4.2747	0.0148	2
The SI_Turkey Index is not the Granger cause of PGSUS.	5.0409	0.0070	2
The SI_Turkey Index is not Granger cause of TAV.	3.4554	0.0336	3
The SI_Turkey Index is not the Granger cause of DOCO.	5.3019	0.0054	2

Since there is no long-term nexus between CLEBI and SI Turkey in the cointegration analysis, it was not necessary to conduct a causality analysis for CLEBI. In Table 7, Pairwise Granger causality test results proved that SI Turkey is the Granger cause of the THYAO, PGSUS, TAV, and DOCO. In other words, there is a short-term relationship between SI Turkey and Turkish aviation stocks.

6. Conclusion and Discussion

In the last 20 years, the aviation industry has struggled with epidemics many times. The whole world has embarked on a tough fight against COVID-19 since the WHO declared a pandemic on March 11, 2020. The rapid and easy transmissions of the disease and its deadly effects have required governments to take strict restrictive and prohibitive measures. COVID-19 has brought many sectors to a standstill all over the world, but it has affected the civil aviation industry the most because it will increase the spread of the disease. While the global civil aviation industry closed the year 2021 with a 49% decrease in the total number of passengers and a loss of 324 billion dollars in operational income, it will close the year 2022 with approximately182-205 billion dollars loss of revenue (ICAO, 2022). The operational losses caused by COVID-19, described as the biggest economic crisis in aviation history. In this process, the course and predictability of aviation stock prices have become more significant than ever for investors have.

In this study, the short- and long-term relationship between the restrictions and policies implemented in Turkey due to

COVID-19 and the aviation stock prices listed on the Istanbul stock exchange examined. The OxCGRT Stringency Index used to measure restrictions and policies regarding COVID-19. The nexus between the variables analyzed separately for each stock with Engle Granger cointegration and Granger causality tests. The findings revealed that there is a long-term cointegration nexus between all aviation stocks and the index, except for CLEBI Ground Handling (CLEBI) stock. In addition, the causality test examined the short-run nexus to the variables and it concluded that there was a one-way causality relationship from the index to aviation stock prices in all.

Co-integration tests reveal the existence of a long-term equilibrium nexus between the variables and the tendency of the variables to act together. Causality tests, on the other hand, mainly express the ability of one variable to predict another variable. In this context, according to the results of cointegration and causality tests, OxCGRT Stringency Index is a predictor in forecasting aviation stock prices.

In future works, based on the results of this study, the prediction performance of the index could be evaluated by designing a forecasting model for aviation stock prices with the OxCGRT Stringency Index as the input variable.

Ethical approval

Not applicable.

Conflicts of Interest

The authors declare that there is no conflict of interest regarding the publication of this paper.

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