ORIGINAL RESEARCH

Curr Res Soc Sci (2025), 11(1) • 206-224

# Analysis of the Causality between Airline Price Index and Dollar and Oil Prices

Havayolu Fiyat Endeksi ile Dolar ve Petrol Fiyatları Arasındaki Nedensellik Analizi

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**Abstract**

The Airline Price Index is a stock market index that monitors the stock prices of companies within the airline industry, reflecting the overall value of these airline companies. This index is an important tool for assessing the financial health, economic status, and market performance of the airline industry. This study aims to explore the causal relationships between the Airline Price Index (AIR), the Dollar Index (DXY), and Oil Prices (OIL), thereby contributing to a deeper understanding of the dynamics influencing the airline industry. In this study, a number of different Granger causality tests are employed, including the Granger causality test, the Fourier Toda-Yamamoto causality test, the Fourier Standard Granger causality test, and the Fourier Toda & Yamamoto test, as well as the cumulative frequency test and the Hatemi-J (2012) causality analysis. These are used to examine the causality relationship between AIR, OIL and DXY. The results of the analysis indicate that the expected causality relationship from OIL to AIR is not supported by the entire analysis method. In contrast, the Granger causality test results indicate that there is a unidirectional causal relationship from AIR to OIL and DXY. Furthermore, the results of the Fourier-Toda-Yamamoto and Fourier standard Granger analyses are consistent with one another. Considering these findings, it can be concluded that there is bidirectional causality between DXY and AIR. The findings of the Fourier-Toda & Yamamoto (cumulative frequency) analysis indicate the presence of a causality relationship from AIR to OIL and DXY. These findings are consistent with the results of Granger causality tests.

**Keywords:** Airline Index, Oil Prices, Dollar Index, Causality, Asymmetric Causality.

**Öz**

Havayolu Fiyat Endeksi, havayolu sektöründeki şirketlerin hisse senedi fiyatlarını izleyen ve bu havayolu şirketlerinin genel değerini yansıtan bir borsa endeksidir. Bu endeks, havayolu endüstrisinin mali sağlığını, ekonomik durumunu ve piyasa performansını değerlendirmek için önemli bir araçtır. Yakıt maliyetleri, havayolları için en önemli operasyonel giderlerden birini temsil eder ve yakıt fiyatları ile havayolu performansı arasında potansiyel bir ilişki olduğunu gösterir. Bu çalışma, Havayolu Fiyat Endeksi (AIR), Dolar Endeksi (DXY) ve Petrol Fiyatları (OIL) arasındaki nedensel ilişkileri araştırmayı ve böylece havayolu endüstrisini etkileyen dinamiklerin daha iyi anlaşılmasına katkıda bulunmayı amaçlamaktadır. Bu çalışmada, Granger nedensellik testi, Fourier Toda-Yamamoto nedensellik testi, Fourier Standart Granger nedensellik testi ve Fourier Toda & Yamamoto testinin yanı sıra kümülatif frekans testi ve Hatemi-J (2012) nedensellik analizi de dahil olmak üzere bir dizi farklı Granger nedensellik testi kullanılmıştır. Bunlar AIR, OIL ve DXY arasındaki nedensellik ilişkisini incelemek için kullanılmıştır. Analiz sonuçları, OIL'den AIR'e doğru beklenen nedensellik ilişkisinin tüm analiz yöntemi tarafından desteklenmediğini göstermektedir. Buna karşın, Granger nedensellik testi sonuçları AIR'den OIL ve DXY'ye doğru tek yönlü bir nedensellik ilişkisi olduğunu göstermektedir. Ayrıca, Fourier-Toda-Yamamoto ve Fourier standart Granger analizlerinin sonuçları birbiriyle tutarlıdır. Bu bulgular göz önünde bulundurulduğunda, DXY ile AIR arasında çift yönlü nedensellik olduğu sonucuna varılabilir. Fourier-Toda & Yamamoto (kümülatif frekans) analizinin bulguları AIR'den OIL ve DXY'ye doğru bir nedensellik ilişkisinin varlığına işaret etmektedir. Bu bulgular Granger nedensellik testlerinin sonuçları ile tutarlıdır.

**Anahtar Kelimeler:** Havayolu Endeksi, Petrol Fiyatları, Dolar Endeksi, Nedensellik, Asimetrik Nedensellik.

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*Article Info / Makale Bilgileri:*
Received / Gönderim: 08.11.2024 Accepted / Kabul: 02.04.2025

*To cite this article / Atıf için:*
Kiracı, K., Yaşar, M., Zelka, A., & Angay, C. (2025). Analysis of the causality between airline price index and dollar and oil prices. *Curr Res Soc Sci, 11*(1), 206-224.

*To link to this article / Bağlantı için:*
http://dx.doi.org/10.30613/curesosc.1581792

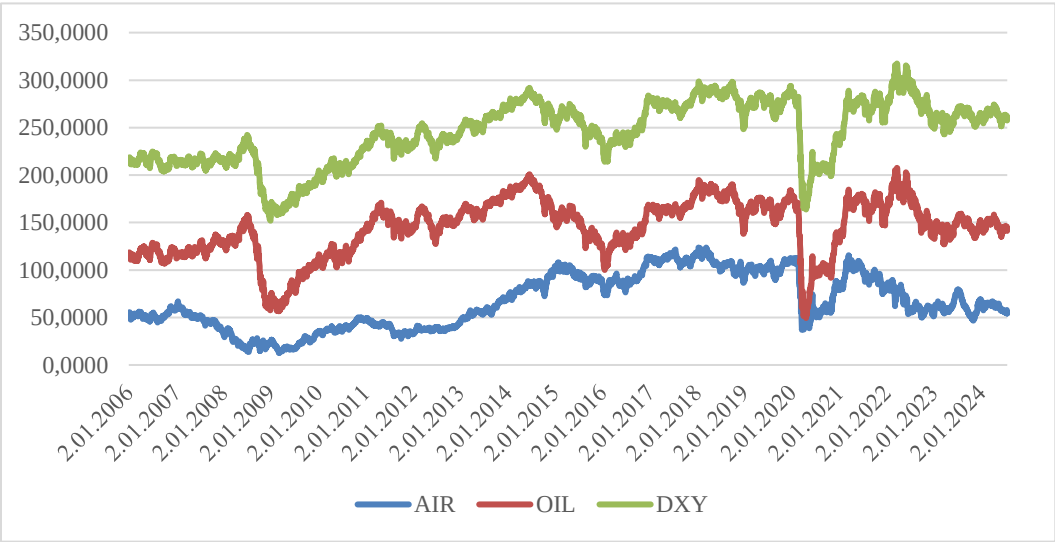
**Analysis of the Causality between Airline Price Index and Dollar and Oil Prices**

Among the various expenses faced by airlines, labour and jet fuel emerge as the two most significant cost drivers. Historically, labour has constituted the largest portion of an airline's overall costs. However, there has been a notable shift in this balance, with jet fuel increasingly becoming the largest cost. The rise in the cost of jet fuel has been accompanied by a notable increase in price volatility. This has resulted in not only a significant rise in fuel costs as a percentage of total expenditure, but also a marked acceleration in the growth of fuel expenditure in both nominal and real terms (Turner & Lim, 2015). Given the significant role that fuel prices play in the cost structure of airlines, fluctuations in these prices have a direct impact on the profitability, pricing strategies and overall performance of the industry. The price of fuel is set in U.S. dollars on a global scale. Consequently, the dollar index, which indicates the strength or weakness of the dollar relative to other currencies, will also exert an influence on fuel prices. These facts provide insights into the potential causal relationships between fuel prices, the dollar index, and the airline price index. It is reasonable to posit that an increase in the price of oil will have a negative effect on the price of airline stocks. This is because an increase in fuel prices will result in higher operational costs for airlines, which will in turn lead to a decline in the value of airline shares. The extent of the change in airline share prices is contingent upon the proportion of airline costs represented by the price of oil (Kristjanpoller & Concha, 2016).

The global economy has experienced a series of exceptional periods of expansion and contraction over the past decade. Periods of exceptional economic expansion have been succeeded by severe crises (Shehzad et al., 2020). These cycles of high volatility have a differential impact on each market, with the fuel and financial markets being particularly susceptible. The production and price of fuels have reached unprecedented levels, with repercussions across different markets and sectors (Peng et al., 2020). The financial market has been subjected to numerous assaults as a consequence of global events and has also played a pivotal role in this tumultuous period. Furthermore, technological advancement has facilitated the acceleration and expansion of transactions, thereby enabling speculation and capital investment across diverse sectors (Sukharev, 2020). Figure 1 presents a graphical representation of the relationship between the airline index, oil prices and the dollar index.

**Figure 1**

*AIR, OIL, DXY volumes (2006-2024)*




*Source:* Thomson Reuters, 2024

Figure 1 illustrates the temporal evolution of three distinct variables. The airline index has demonstrated a general upward trajectory since 2006, although it did experience a significant decline in 2020. This period also coincides with the global impact of the SARS-CoV-2 pandemic, which had a detrimental effect on the airline industry. While there has been a degree of recovery since that time, it is acknowledged that the global level has not yet returned to its previous position. The orange line, which represents oil prices, also demonstrates a comparable degree of volatility. In 2008, the price of oil reached its highest point, after which it declined sharply. In 2020, a notable decline was once again observed, followed by a subsequent recovery. These fluctuations are typically contingent upon global economic conditions and the equilibrium between supply and demand for oil. The DXY is a measure of the relative strength of the US dollar against other major currencies. The chart demonstrates that this index demonstrated greater stability than the other two variables, yet still exhibited a notable decline in 2020. Subsequently, the index exhibited a rapid recovery, attaining a higher level than that observed prior to the decline. In conclusion, the chart illustrates the influence of global occurrences in 2020 on these three variables. While sectors such as AIR and OIL exhibited substantial declines, the DXY index demonstrated greater resilience and a more rapid recovery. In general, the declines and rises occurred in parallel during the period under observation.

The existing literature includes studies that examine the relationship between airline stock prices and various macroeconomic variables. In these studies, the relationships between airline stock prices and oil prices and gold prices (Kaya, 2021), between airline stock returns and fuel price fluctuations (Kristjanpoller & Concha, 2016), and between airline stock prices and oil prices (Saleh, 2012; Kathiravan et al., 2019; Asadi et al., 2023) have been examined. Furthermore, additional studies have been conducted which examine the relationship between the Transportation Index and variables such as oil, exchange rate change and GDP (Zelka & Yıldırım, 2022). Another area of study is the relationship between exchange rate, interest rate and stock index (Alıcı, 2020). Similar studies have been conducted in other industries. For example, Ruan et al., (2016), Xu et al., (2022) and Chen et al., (2023) examine the relationship between the Baltic Dry Index, a widely used measure of maritime transportation costs, and crude oil prices. Bai & Koong (2018) concentrate on the interrelationship between real oil prices, exchange rate fluctuations and stock market returns.

While there are studies in the literature that examine the causal relationships between selected variables, there is a dearth of research that investigates the interconnections between AIR, OIL, and DXY simultaneously, particularly with the inclusion of the airline index as a direct variable. In light of the aforementioned information, the objective of this study is to elucidate the causal relationships between the AIR, OIL and DXY. In order to achieve this, the causality tests that are most commonly used in the literature are employed, and the results are then interpreted in comparison.

This study has the potential to contribute to the existing literature in terms of the time period it covers and the number of observations used. The existing literature has examined the relationship between the stocks of one or more airlines and oil prices. This study, unlike the studies in the literature, examines the relationship between the Airline Price Index, which represents a significant portion of airlines, and oil prices. In addition, it contributes to the literature in terms of integrating the dollar index into the Airline Price Index. To the best of our knowledge, no previous study has examined the causal relationships in a holistic manner by integrating the dollar index and oil price variables together. In this context, this study aims to fill the gap in the existing literature by offering a new perspective that facilitates a deeper understanding of the connections between macroeconomic variables through the integration of a new variable.

This study, which employs an empirical methodology to examine the causal relationship between AIR and OIL and DXY, is divided into four sections. In the second section, the existing literature on this

subject is reviewed in order to contextualise the present study. The third section comprises a description of the data, variables and methods employed in the study. The fourth section presents the empirical findings, which test the causality between variables. The final section presents the conclusions and recommendations pertaining to the research.

## Literature Review

This study examines the causal relationship between AIR and OIL and DXY. The literature is divided into two sections. In the initial phase of the study, a comprehensive review was conducted to identify studies that analyse airline stocks from diverse perspectives. This study is therefore expected to fill this gap in the existing literature. In the second part of the literature, studies examining the relationship between stock market index, dollar index and oil prices are presented in a table (see Table 1). As illustrated in table, a considerable number of studies in the existing literature examine the relationship between the stock market index and the dollar index and oil prices. On the other hand, our review of the literature did not find any study analysing the relationship between the airline index and the dollar index and oil prices in terms of causality. Therefore, this study is expected to make a valuable contribution to the existing literature.

In their study of investor confidence in airline stocks, Goh & Rasli (2014) employed the CAPM beta and event study methodologies to examine the confidence placed in the shares of Air Asia and Singapore Airlines during the Asian crisis that spanned from 2007 to 2009. The study yielded the conclusion that investor confidence in Air Asia was higher. Additionally, the study revealed that Air Asia's stock return is less susceptible to adverse stock market conditions. Kristjanpoller & Concha (2016) investigated the correlation between the stock returns of 56 airlines affiliated with the International Air Transport Association (IATA) and traded on the stock exchange and the change in WTI crude oil prices using the GARCH model for the period between January 2008 and October 2013. The findings of the study indicate that daily fluctuations in oil prices exert a positive influence on the performance of airline stocks. Yun & Yoon (2019) investigated the relationship between the stock prices of airlines in China and South Korea (Korean Air, Asiana Airlines, Air China and China Eastern Airlines) and international crude oil prices (WTI, Brent, Dubai) utilising the VAR-GARCH-BEKK model based on data spanning from 03.09.2007 to 14.08.2017. The return spillover effect between the variables is analysed with the Vector Autoregression (VAR) model, whereas the volatility spillover effect is analysed with the generalized autoregressive conditional heteroscedasticity-based exponential generalized autoregressive conditional heteroscedasticity model. The findings of the study indicate that the stock prices of small airlines in South Korea and China exhibit heightened sensitivity to fluctuations in oil prices. Furthermore, it was determined that the stock prices of airlines in China are more susceptible to fluctuations in oil prices. Kathiravan et al., (2019) investigated the relationship between the stock price of six Indian airlines (Air India, Go Air, IndiGo, Jet Lite, Jet Airways and Spice Jet) and the global crude oil price (Brent, Dubai and WTI). The study employed Granger causality analysis based on data spanning from 1 January 2007 to 30 November 2018. Consequently, the researchers concluded that there is a causal relationship between oil prices and airline stocks. In their study, Alıcı & Sevil (2020) investigated the relationship between the stock prices of 28 airline companies and their internal financial factors, including total assets, financial leverage, acid-test ratio, operating profit margin, and beta value. They employed panel data analysis and panel VAR analysis methods based on data from 2005 to 2018 to examine these relationships. The panel data analysis revealed that the total assets factor exerts a positive influence on airline stock prices, whereas the financial leverage factor exerts a negative influence. The panel VAR causality results indicate a bidirectional relationship between the total assets variable and the airline stock price. Conversely, the results demonstrate a unidirectional causality between the beta value and the acid test ratio variables and the stock price. Özdurak (2020) examined

the effect of crude oil price on Turkish Airlines and Pegasus Airlines stock prices and BIST transport index. VAR-VECH-TARCH models were used in the study and daily data between 02.01.2015 and 03.06.2020 were taken as basis. According to the results of the study, there is no return spillover effect between crude oil prices and airline stock prices. In addition, the volatility spillover effect between crude oil prices and airline stock returns is more pronounced than the return spillover effect. Killins (2020) examined the relationship between stock returns of railways and airlines in Canada and the USA and oil price movements based on the period between 2000:01-2018:08. Fama-French 5-factor model was used in the study. As a result of the study, it was found that railways in Canada and airlines in the United States were negatively affected by the price increase in WTI (West Texas Intermediate). It is also observed that airlines' stock returns respond asymmetrically to oil price fluctuations and that information about oil price movements diffuses over time.

Mollick & Amin (2021) conducted an analysis of the relationship between seat occupancy growth rate and oil price return (WTI) and airline stock returns of 33 airlines in the US. The analysis was based on data from 1990 to 2019 and employed the Fama–French 5-factor model. The study revealed that an increase in seat occupancy growth rate and airline stock returns is associated with a positive effect on airline stock returns, whereas an increase in oil prices is associated with a negative effect on stock returns. Kang et al., (2021) employed the Structural Vector-Autoregressive (SVAR) model to analyse the impact of oil prices and economic policy uncertainty on stock returns in the US air transportation sector, utilising both industry-level and firm-level data. The analysis is based on data from the period 1985 to 2017. The findings of the study indicated that the rise in oil prices and economic policy uncertainty had a detrimental impact on the stock returns of airline companies in the US, both at the industry level and the firm level. In a study conducted by Jeon (2021), the impact of tourism uncertainty, including economic policy uncertainty (EPU) and travel crises caused by epidemics and terrorism, on airline stocks in Korea was examined over the period 2001-2018. The application of the Quantile Regression (QR) method revealed that EPU and travel crises had a detrimental impact on the valuation of airline stocks in Korea. Kaya (2021) analysed the relationship between the stocks of Turkish Airlines and Pegasus Airlines and gold prices, exchange rate and oil prices. The study was based on daily data between 26.04.2013-03.02.2021 and analysed using the Hatemi-J (2012) asymmetric causality test. As a result of the study, it was determined that there is a significant asymmetric causality relationship from selected macroeconomic variables to stocks. Atems (2021) investigated the effects of shocks in the global crude oil and US jet fuel markets on the US airline industry by separating demand and supply shocks. In the study, the Structural Vector Autoregressive (VAR) method was used based on the data between 2000:1 - 2019:12. According to the findings, it is determined that jet fuel demand shocks have positive effects on the US aviation industry, but the effects of jet fuel supply shocks are generally negative.

Dar (2022) employed the wavelet methodology to investigate the potential sustainable relationship between oil prices and the stocks of three Indian airlines (Interglobe Aviation, Jet Airways and Spicejet) traded on the Indian stock exchange. The study yielded no evidence of a sustainable relationship between crude oil prices and airline stocks over the long term. Guliyev (2022) investigated the relationship between the stock prices of airline companies in Turkey and the stock prices of US and European airline companies. In the study, the researchers employed the techniques of Cointegration Analysis and Causality Tests, specifically the Toda & Yamamoto Granger Causality Test and the Flexible Toda & Yamamoto Causality Test, based on the daily closing stock price data between 2016:01-2020:06. The results of Maki's (2012) cointegration test with multiple unknown structural breaks indicate the existence of a long-run relationship. Furthermore, a unidirectional causal relationship is identified from the US and European airline markets to the Turkish airline market, while a bidirectional causal relationship is observed between the US and European airline markets. Hoş & Özbek (2022) employed the volatility

spillover effect between Brent oil prices and airline stock returns using the Diagonal VECH-GARCH method based on the data for the period 29.07.2013-31.10.2022. As a result of the study, it is found that there is a significant volatility spillover from Brent oil volatility to Aegean, AirFrance, Lufthansa, Turkish Airlines and Pegasus Airlines. In their 2022 study, Horobet et al., (2022) examined the relationship between oil price risk and the stock prices of 25 passenger airlines and 5 cargo airlines. In the study, a panel ARDL model and PMG estimator were employed based on data from 2007 to 2020. The study revealed that the stock prices of airline companies were adversely impacted by oil price risk. Asadi et al., (2023) employed the ARMA-MFE model to examine the relationship between the Brent oil price and the stocks of eight airline companies, utilising data from 27.04.2007 to 01.07.2021. The study's findings indicate that short-term (daily) fluctuations in oil prices exert a negative influence on airline stock returns, whereas long-term (weekly) oil price changes exert a positive influence. Furthermore, low-cost carriers are more susceptible to fluctuations in oil prices. Felix et al., (2023) analysed the impact of various futures instruments against oil price risk on the stock returns of 22 Asia Pacific airline companies in the time period covering 2010:09 - 2019:09. Accordingly, fixed effect panel and quantile regressions were used. According to the findings, oil price risk has negative effects on airline stock returns. In addition, it is concluded that gold futures have an effective hedging feature on airline stock returns compared to oil and VIX futures in mitigating oil price risk. Choi & Choi (2023) aimed to present a model that predicts the stock price of American Airlines (AA). In this context, the oil price data between 04.01.2016-14.04.2023 is taken as a basis. LSTM (Long Short-Term Memory) method was used by determining the economic and technical information of oil as a feature. As a result of the analyses, the MSE (Mean Squared Error) value for American Airlines stock closing price forecasts was 0.00049.

The impact of economic factors, including global energy prices, the Brent crude oil price, the BIST100 index, the price of gold, the USD exchange rate, and inflation, on the stock prices of Turkish Airlines was examined by Akusta (2024) over the period between November 2011 and July 2023. The study employed the Autoregressive Distributed Lag (ARDL) method to ascertain whether there were statistically reliable and significant links between THY's stock price performance and economic factors. Yüzbaşıoğlu (2024) examined the relationship between the stock prices of Turkish and some European airlines (Turkish Airlines, Air France, Swiss International Air Lines, Lufthansa, KLM Royal Dutch Airlines, Finnair, Aegean Airlines) and the fluctuations in crude oil prices using the ARDL method based on data from the period 2012 to 2022. The study revealed a statistically significant cointegration relationship between the fluctuations in crude oil prices and the stock prices of airline companies. Cai et al., (2025) investigated the effects of oil price shocks on both the return and volatility of aviation stocks. Generalized Forecast Error Variance Decomposition (GFEVD) method was used in the study and the data between 2005:11-2023:09 were taken as basis. According to the findings, economic activity shocks have a greater impact on airline stock returns than other oil price shocks. Ullah et al., (2025) analysed the volatility spillover relationship between oil returns and airline sectors in G2 economies (China and the United States) in the context of three major crisis events: US-China trade tensions, COVID-19 and Russia-Ukraine conflict. Based on daily data from January 2014 to November 2023, the analysis was carried out using asymmetric DCC-GARCH, BEKK-GARCH and continuous wave fit analysis methods. According to the analyses based on the GARCH model family, it is found that the G2 airline industries are based on past volatility and oil market fluctuations have a long-term impact on the aviation industry.

Although previous studies have examined the relationships between oil prices, currency indices, and airline indices using causality tests, these analyses have primarily been conducted at a bilateral level, such as DXY-OIL, DXY-stock prices, or OIL-stock prices. To the best of our knowledge, no prior research has simultaneously investigated the causality among DXY, OIL, and AIR within the same

framework. This study addresses this gap by exploring the tripartite causal relationships among these variables, providing a more comprehensive understanding of their interconnected dynamics. Moreover, by utilizing a daily dataset and an extended time period, our analysis offers a more granular perspective, contributing to the literature beyond standard bilateral causality assessments.

## Data and Methodology

The objective of this study is to examine the causal relationship between the Airline Price Index (AIR), the Brent Crude Oil (OIL) price, and the Dollar Index (DXY). The study employs data from the variables on a daily basis, spanning the period between 2 January 2006 and 19 July 2024. The study employed a total of 4,840 observations for each series. The data employed in the study were sourced from the Thomson Reuters Refinitiv database. To ensure consistency in the study, multiple causality analyses were employed. In this context, the Granger causality test, the Fourier-Toda-Yamamoto causality test, the Fourier standard Granger causality test and the Fourier-Toda-Yamamoto test (cumulative frequency) were employed. Furthermore, the asymmetric causality test proposed by Hatemi-J (2012) was employed to investigate the causal relationship by decomposing the positive and negative shocks in the series, thereby elucidating the impact of positive or negative shocks in the series.

In order to examine the causality relationship between the variables and to correctly identify this relationship, it is also necessary to examine the stationarity of the series. As stated by Brooks (2008), a stationary series must exhibit a constant mean, variance, and autocovariance. Prior to commencing the causality analyses, the stationarity of the series is evaluated, that is to say, whether the series contain unit roots. The Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) tests, which are the most commonly employed unit root tests, were employed in the stationarity analysis. The ADF test is a parametric unit root test, whereas the PP test is a non-parametric test (Phillips & Perron, 1988; Zelka & Yıldırım, 2022).

Similar methods were used to confirm the model's accuracy, and the relationship between the variables was tested this way. Granger causality analysis is a frequently used and useful model that enables the determination of causality between series. Furthermore, it should be noted that Granger causality analysis requires the series to be stationary at the same level. Additionally, the result obtained may vary according to the lag length initially selected (Yılancı & Bozoklu, 2014; Kiracı, 2019). This requirement and the model's inability to overcome situations with structural breaks are the weaknesses of the model. While ignored structural breaks may cause misspecification in the test model of Granger causality, the Fourier form is helpful in testing for smooth structural change in a VAR model, increasing test reliability under nonlinearity (Enders & Jones, 2015). In the Froudier-Toda-Yamamoto causality analysis, the validity of the causality analysis was supported by the internal detection of structural changes and their incorporation into the model (Emek, 2024). In contrast, Fourier standard Granger causality analysis represents an enhanced iteration of the Granger causality analysis, as it facilitates the estimation and incorporation of previously undocumented structural breaks into the model (Enders & Jones, 2015). The Fourier Toda-Yamamoto cumulative frequency test was developed as a useful model that eliminates the issues that may arise from unit root and cointegration tests in Granger causality analyses (Zapata & Rambaldi, 1997; Kazak, 2023). The Hatemi-J causality analysis, which is another method employed in the study, is a useful model in terms of distinguishing between cumulative negative and cumulative positive shocks and facilitating the examination of asymmetric causality (Büberkökü & Şahmaroğlu, 2016).

**Table 1**

*Studies Analysing the Relationship between Stocks and Dollar Index and Oil Prices*

| Authors | Period | Index | Variables | Methodology | Causality |
|---|---|---|---|---|---|
| Seshaiah & Behera (2009) | 02.01.1991-12.12.2007 | Indian stock market prices (BSE Sensex) | Exchange rates<br>Crude oil prices | Engel-Granger cointegration test | Crude oil price ⇨ BSE Sensex<br>Exchange rates ⇨ BSE Sensex |
| Gazel (2016) | 2006:M01-2016:M02 | BIST100 | Gold Price | Granger causality test | Gold Price ⇨ BIST 100 |
| Jain & Biswal (2016) | 2006–2015 | BSE Sensex 30 | Gold price<br>Crude oil prices<br>USD/INR exchange rate | Krystou–Labys non-linear causality test | BSE Sensex30 ⇔ Gold price<br>Crude oil price ⇨ INR<br>Crude oil price ⇨ BSE Sensex 30 |
| Kendirli & Çankaya (2016) | 04.01.2000-30.04.2015 | BIST 100<br>XULAŞ | Crude oil prices | Granger causality test | BIST 100 ⇨ Oil price<br>BIST 100 ⇨ XULAŞ<br>XULAŞ ⇨ Oil price |
| Coşkun et al., (2016) | 2005:M01-2015:M09 | BIST (Istanbul stock exchange index) | Interest rate<br>Exchange rate<br>Exports<br>Imports<br>Industrial production index<br>Gold price | Granger causality test | BIST ⇨ Industrial production index<br>BIST ⇨ Export<br>BIST ⇨ Import<br>Exchange rate ⇨ BIST |
| Sandal et al., (2017) | 2005:M01-2015:M12 | BIST 100 | Crude oil prices<br>Gold prices | Granger causality test | Gold prices ⇨ BIST 100 |
| Bakhsh & Khan (2019) | 1997:M09-2018:M04 | Pakistan stock index | Gold price<br>Crude oil price<br>Exchange rate | Granger causality test | Exchange rate ⇨ Stock index<br>Crude oil price ⇨ Exchange rate<br>Gold price ⇨ Exchange rate |
| Kiracı (2020) | 03.01.2000-24.07.2018 | XULAŞ | Dollar index (DXY)<br>Oil price (PETRL) | Granger causality test<br>Hatemi -J (2012) asymmetric causality test | DXY ⇨ XULAŞ<br>$XULAS^{+}$ ⇨ $DXY^{+}$<br>$PETRL^{-}$ ⇨ $XULAS^{-}$<br>$PETRL^{+}$ ⇨ $XULAS^{+}$<br>$DXY^{-}$ ⇨ $XULAS^{-}$ |
| Alıcı (2020) | 04.07.2006 - 31.12.2019 | XULAS<br>BIST 100 | Exchange rate<br>Interest rate | Toda-Yamamato causality test | Exchange rate ⇨BİST 100<br>Exchange rate⇨ XULAŞ |
| | | | | Hatemi -J (2012) asymmetric causality test | $DKUR^{+}$⇔$BIST100^{+}$<br>$DKUR^{-}$⇔$BIST100^{-}$<br>$XULAS^{-}$ ⇨ $DKUR^{-}$<br>$FAİZ^{+}$ ⇨ $BIST\ 100^{+}$ |
| Ocaklı (2020) | 2000:M01-2019:M12 | BIST 100 | Gold price<br>Oil price | Granger causality test | BIST 100 ⇨ Gold price<br>Gold price ⇨ Oil price |

**Table 1** ***(continue)***

*Studies Analysing the Relationship between Stocks and Dollar Index and Oil Prices*

| Authors | Period | Index | Variables | Methodology | Causality |
|---|---|---|---|---|---|
| Ali et al., (2021) | 2003:M01-2018:M12 | KSE 100 index | Oil prices<br>Gold prices<br>Foreign exchange rate | Pairwise Granger causality test | KSE 100 ⇨ Exchange rate<br>Oil price ⇨ Gold price |
| Demirkale & Can (2021) | 2008:M01-2020:M12 | BIST tourism index | Interest rate<br>Oil price<br>USD/TL | Granger causality test | Interest rate ⇔ BIST tourism |
| Kelesbayev et al., (2022) | 2016:M01-2021:M06 | Kazakhstan stock exchange (KASE)<br>Real exchange rate | Brent crude oil prices | Granger causality test | Real exchange rate ⇨ KASE closing price<br>Oil price ⇨ Real exchange rate |
| Zelka & Yıldırım (2022) | 2002/Q1-2020/Q4 | BIST transportation index | GDP<br>Exchange rate<br>Brent oil price | Granger causality test | Oil price ⇨ GDP<br>GDP ⇨ BIST transportation index<br>Exchange rate ⇨ BIST transportation index |
| | | | | Hsiao causality test | GDP ⇨ BIST transportation index<br>Exchange rate ⇨ BIST transportation index<br>Oil price ⇨ BIST transportation index |
| Tuna (2022) | 11.03.2020-13.09.2021 | BIST 100 | Oil price<br>Gold price<br>VIX index | Toda-Yamamoto causality test | Oil price, ⇔ BIST 100<br>Gold price ⇔ BIST 100<br>VIX index⇔ BIST 100 |
| Hawiwika et al., (2022) | 2016:M01 - 2021:M04 | Indonesia composite index (ICI) | Brent oil prices<br>Gold prices<br>Exchange rates (USD/IDR) | VECM model<br>Granger causality test | ICI ⇨ Exchange rate |
| Soyu-Yıldırım (2023) | 1997:M02-2022:M09 | BIST tourism index | VIX (Volatility index)<br>GEPU index<br>Brent oil index<br>Dollar index | Fourier TY causality analyses | Dollar index⇨ BİST tourism |
| | | | | Fractional Fourier TY causality analyses | VIX ⇨ BIST tourism index<br>Dollar index ⇨ BIST tourism index<br>BIST tourism index ⇔Brent oil index<br>BIST tourism index ⇔ GEPU index |
| Das (2023) | 1.04. 2013 - 30.09.2022 | Indian stock market | Crude oil price<br>Exchange rates | Pairwise Granger causality test | Exchange rates ⇔ Crude oil price<br>Sensex ⇔ Crude oil price<br>Sensex ⇔ Exchange rate |
| Coşkuner & Özer (2024) | 2010:M01-2021:M12 | BIST 100 | Exchange rate<br>Inflation | Granger causality test | BIST100 ⇨ Exchange rate<br>BIST 100 ⇨ Inflation |
| Sizer (2024) | 2003: Q1-2023: Q3 | BIST 100 | Exchange rates (USD)<br>Gold prices (GOLD)<br>Interest rates (INT) | Hatemi-J (2012) asymmetric causality test | $BIST100^{+}$ ⇨ $GOLD^{+}$<br>$USD^{-}$ ⇨ $BIST100^{-}$<br>$INT^{-}$ ⇨ $BIST100^{-}$ |

Some important changes that could lead to structural breaks have occurred during the study period. The mortgage crisis that started in the USA in 2008 later turned into a global financial crisis, wars in different parts of the world, and travel restrictions imposed due to the COVID-19 pandemic that started at the end of 2019 are some of the events that are estimated to have had a significant impact on air transportation. Therefore, employing a Granger causality analysis, which does not handle structural breaks well, is not enough, and it would be helpful to use the Fourier models.

Under the contiditon of nonlinearity of data and possible structural breaks, all three of Fourier models are useful. With the Fourier causality approach, it is possible to accurately predict the number of breaks, the form, and the date of breaks and to continue the analysis accordingly (Enders & Jones, 2015). The Fourier Standard Granger causality test is similar with Fourier causality but enhances traditional Granger causality by allowing smooth nonlinear break. The cumulative frequency approach of Fourier is helpful in modelling structural breaks with the ability to capture them without requiring prior knowledge about numbers, dates, and forms of breaks (Nazlioglu et al., 2016). As mentioned above, The Hatemi-J causality analysis is beneficial because it distinguishes between cumulative negative and cumulative positive shocks and facilitates the examination of asymmetric causality (Büberkökü & Şahmaroğlu, 2016).

Within the scope of the study, structural breaks were detected using the Akaike Information Criterion. Since models that take structural breaks into account were used, the problems caused by structural breaks in this data set were resolved with Fourier models. The period in which daily data for the variables in the study data set could be reached constitutes the analysis period.

A brief explanation of the methods given below.

**Granger (1969) Causality Test**

Granger causality analysis is used to test whether the information in one variable series can be estimated using the information in another variable series. Granger (1969) explains $y_t$ as an exogenous variable and $z_t$ as an endogenous variable if $y_t$ is the cause of $z_t$. The F-statistic is used to test whether the hypothesis $H_0$, which states that there is no causality between the variables, is accepted (Zelka & Yıldırım, 2022). The equation used for Granger causality analysis is given below, where T is the time value and p is the number of unknown parameters (Zelka & Yıldırım, 2022).

$$F\left(p, T-2p-1\right)=\frac{\sum_{i=1}^{T}\hat{\mu}_{2t}{}^{2}-\sum_{i=1}^{T}\hat{\mu}_{1t}{}^{2}/p}{\sum_{i=1}^{T}\hat{\mu}_{1t}{}^{2}/(T-2p-1)}$$

Prior to conducting a Granger causality analysis, it is essential to ensure that the series in question is stationary at the requisite level and that the appropriate lag length has been determined. The effects of negative and positive shocks in the series included in the analysis are considered to be the same in the analyses performed with this method, which may lead to misleading results (Yılancı & Bozoklu, 2014; Kiracı, 2019).

**Fourier Toda–Yamamoto Causality Test (Enders & Jones, 2015)**

In the Fourier Toda-Yamamoto causality test, it is recommended that, following the determination of appropriate lag length and frequency values, the hypotheses, which states that there is no causality

relationship between the variables and is to be tested using the F-test statistic (Konat, 2021; Nazlioglu, 2016).

**Fourier Standard Granger Causality Test (Enders & Jones, 2015)**

Enders & Jones (2015) integrate Gallant's (1981) Fourier methodology with the conventional Granger causality assessment to develop a model that permits the representation of structural breaks through the utilisation of a few low-frequency components, even in the absence of prior awareness of structural breaks.

**Fourier Toda & Yamamoto Test - Cumulative Frequency (Nazlioglu et al., 2016)**

Toda and Yamamoto (1995) eliminate the test problems in Granger causality analysis according to the power and size characteristics of unit root and cointegration tests. They provide a useful method by ignoring stationarity mismatch or cointegration, which are problems encountered in Granger causality analysis (Zapata & Rambaldi, 1997; Kazak, 2023). The single-frequency Toda–Yamamoto test is the preferred option when the number of samples is approximately 50, whereas the cumulative frequency Toda–Yamamoto test is deemed more reliable when the number of samples is 100 or greater (Gormus et al., 2018).

**Hatemi-J (2012) Causality Test**

In the Hatemi-J (2012) test and the Toda-Yamamoto (1995) causality test, the level value of the series is taken into account. However, in the Hatemi-J causality analysis, the asymmetric causality relationship between the variables is permitted, that is, the cumulative negative and cumulative positive shocks belonging to the original series can be separated from each other, allowing for an examination of whether an increase in one variable causes an increase in another, and a decrease in one causes a decrease in the other (Büberkökü & Şahmaroğlu, 2016).

## Empirical Findings

In this study, the Granger (1969) causality test, the Fourier Toda-Yamamoto causality test (Enders & Jones, 2015), the Fourier Standard Granger causality test (Enders & Jones, 2015), the Fourier Toda & Yamamoto test - cumulative frequency (Nazlioglu et al., 2016) and the Hatemi-J (2012) causality analyses were employed to investigate the causal relationship between the Airline Price Index (AIR) and Brent Crude Oil (OIL) and the Dollar Index (DXY). In the context of causality analysis, it is essential to ascertain whether the series in question are integrated at the same level. In this context, the Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) unit root tests, which are widely used in the literature, were employed to ascertain the stationarity of the variables.

The descriptive statistics of the variables are presented in Table 2. The mean value of the Airline Price Index is 66.678, with a maximum value of 123.65 and a minimum value of 12.700. The lowest recorded value of the Airline Price Index was observed during the 2008-2009 global financial crisis. The highest value of the Airline Price Index is observed in 2018, which precedes the outbreak of the global pandemic caused by the SARS-CoV-2 virus. Brent Crude Oil is a significant determinant of global oil prices. The data for this variable exhibits a maximum value of 143.60 and a minimum value of 5.620. The highest value of Brent Crude Oil was reached in July 2008. In March 2022, the value approached the maximum value. The lowest value was reached in 2020, when production activities were almost entirely halted due to the global impact of the SARS-CoV-2 pandemic. The maximum value of the Dollar Index was 125.12, while its minimum value was 81.348. The Dollar Index reached its lowest point in 2011, when

the US Federal Reserve maintained interest rates at 0.25%. It can be observed that the Dollar Index reached its highest level in late 2022 as a consequence of the Federal Reserve's recent interest rate hike, which was implemented in order to control the rising inflation that was caused by the global pandemic of Coronavirus.

**Table 2**

*Descriptive Statistics*

| | AIR | OIL | DXY |
|---|---|---|---|
| Mean | 66.678 | 77.791 | 100.776 |
| Median | 60.480 | 74.925 | 102.648 |
| Maximum | 123.65 | 143.60 | 125.12 |
| Minimum | 12.700 | 5.620 | 81.348 |
| Std. Dev. | 28.761 | 25.100 | 10.702 |
| Skewness | 0.1212 | 0.1749 | -0.0296 |
| Kurtosis | 1.8233 | 2.2214 | 1.6960 |
| Jarque-Bera | 291.09 | 146.92 | 343.61 |
| Probability | 0.0000 | 0.0000 | 0.0000 |
| Observations | 4840 | 4840 | 4840 |

**Table 3**

*Unit Root Test Results*

| | ADF - Test Statistics (Level) | | ADF - Test Statistics (1st Difference) | |
|---|---|---|---|---|
| | Constant | Constant and Trend | Constant | Constant and Trend |
| AIR | -1.6453 | -1.6956 | -67.6749* | -67.6708* |
| OIL | -2.3255 | -2.3666 | -66.9627* | -66.9559* |
| DXY | -1.0419 | -3.0451 | -69.0607* | -69.0648* |
| | **PP - Test Statistics (Level)** | | **PP - Test Statistics (1st Difference)** | |
| | Constant | Constant and Trend | Constant | Constant and Trend |
| AIR | -1.7559 | -1.8535 | -3.4315* | -67.7378* |
| OIL | -2.3255 | -2.3666 | -3.4315* | -66.9396* |
| DXY | -1.039 | -3.0431 | -3.4315* | -69.0634* |
| | **KPSS - Test Statistics (Level)** | | **KPSS - Test Statistics (1st Difference)** | |
| AIR | 4.3396 | 1.1584 | 0.0975* | 0.0741* |
| OIL | 0.8539 | 0.5595 | 0.0574* | 0.0561* |
| DXY | 6.4726 | 0.6335 | 0.1411* | 0.0636* |

Table 3 presents the results of the Augmented Dickey-Fuller (ADF), Phillips-Perron (PP), and Kwiatkowski-Phillips-Schmidt-Shin (KPSS) unit root tests. The results indicate that all variables are non-stationary at their level values. Consequently, the stationarity of the series was reassessed by taking the first difference of the variables. Based on these recalculations, it can be concluded that the series became stationary after the first difference was applied.

Table 4 presents the results of the causality analysis. The Airline Price Index is a stock market index that tracks the stock prices of companies in the airline transport industry and thus represents the total value of airline companies. This index may be regarded as a valuable indicator for gauging the collective financial and economic standing, as well as the market performance, of the airline transport industry. One of the most significant operational expenses for airlines is fuel costs. It may therefore be expected that there is a relationship between fuel prices and airline performance. Nevertheless, a multitude of factors influence the stock index. The findings of the analysis indicate that there is no causal relationship between oil and airline prices, contrary to the expectation based on the entire analysis method. The results of the Granger causality test indicate that AIR is the Granger cause of OIL and DXY. The results of the Fourier-Toda-Yamamoto and Fourier standard Granger analyses are in accordance with one

another. It can be demonstrated that there is a bidirectional causality relationship between the US dollar exchange rate (DXY) and the airline index (AIR), as well as between the AIR and the DXY.

**Table 4**

*Causality Test Results*

| Causality test | | | | Test stat. | p-value |
|---|---|---|---|---|---|
| Granger causality | OIL | ⇏ | AIR | 14.768 | 0.2540 |
| | DXY | ⇏ | AIR | 13.058 | 0.3650 |
| | ***AIR*** | ***⇏*** | ***OIL*** | ***32.915*** | ***0.0010*** |
| | ***AIR*** | ***⇏*** | ***DXY*** | ***66.749*** | ***0.0000*** |
| Fourier Toda–Yamamoto | OIL | ⇏ | AIR | 14.803 | 0.2520 |
| | ***DXY*** | ***⇏*** | ***AIR*** | ***32.883*** | ***0.0010*** |
| | AIR | ⇏ | OIL | 13.008 | 0.3680 |
| | ***AIR*** | ***⇏*** | ***DXY*** | ***67.029*** | ***0.0000*** |
| Fourier Standard Granger | OIL | ⇏ | AIR | 14.432 | 0.2740 |
| | ***DXY*** | ***⇏*** | ***AIR*** | ***33.609*** | ***0.0010*** |
| | AIR | ⇏ | OIL | 12.91 | 0.3760 |
| | ***AIR*** | ***⇏*** | ***DXY*** | ***67.589*** | ***0.0000*** |
| Fourier Toda & Yamamoto (cumulative frequency) | OIL | ⇏ | AIR | 8.683 | 0.2760 |
| | DXY | ⇏ | AIR | 2.296 | 0.3170 |
| | ***AIR*** | ***⇏*** | ***OIL*** | ***27.888*** | ***0.0000*** |
| | ***AIR*** | ***⇏*** | ***DXY*** | ***62.17*** | ***0.0000*** |

**Table 5**

*Hatemi-J (2012) Asymmetric Causality Test Results*

| Direction of Causality | | | MWALD Stat | Bootstrap Critical Values | | |
|---|---|---|---|---|---|---|
| | | | | 1% | 5% | 10% |
| $OIL^{++}$ | ⇏ | $AIR^{++}$ | *4.582* | 9.827 | 5.859 | 4.551 |
| $DXY^{++}$ | ⇏ | $AIR^{++}$ | *9.099* | 8.233 | 6.023 | 4.476 |
| $AIR^{++}$ | ⇏ | $OIL^{++}$ | 0.343 | 9.159 | 5.629 | 4.420 |
| $AIR^{++}$ | ⇏ | $DXY^{++}$ | 0.868 | 11.052 | 6.362 | 4.769 |
| $OIL^{--}$ | ⇏ | $AIR^{--}$ | 4.419 | 12.62 | 8.468 | 6.428 |
| $DXY^{--}$ | ⇏ | $AIR^{--}$ | 11.685 | 8.546 | 5.779 | 4.497 |
| $AIR^{--}$ | ⇏ | $OIL^{--}$ | 10.379 | 11.032 | 7.341 | 6.196 |
| $AIR^{--}$ | ⇏ | $DXY^{--}$ | 2.332 | 8.939 | 5.847 | 4.667 |

The study also encompassed an investigation into the impact of cumulative positive and negative shocks on the variables. In this context, the results of the asymmetric causality analysis conducted by Hatemi-J (2012) are presented in Table 5. The results of the analysis indicate the presence of a unidirectional causality relationship from positive shocks in OIL to positive shocks in AIR at the 10% significance level. At the 1% level of significance, a unidirectional causality relationship is observed, whereby positive shocks in DXY lead to positive shocks in AIR. Furthermore, at the same level of significance, a unidirectional causality relationship is identified from negative shocks in DXY to negative shocks in AIR. Ultimately, the results of the analysis indicate that there is a unidirectional causality relationship from negative shocks in AIR to negative shocks in OIL at the 5% significance level. The occurrence of sudden developments (shocks) in global markets has the potential to exert an influence across a range of sectors. A number of factors, including war, pandemic, fluctuations in oil supply, interest rate decisions by central banks, and market intervention, can simultaneously influence a range of variables. In this context, it is anticipated that shocks in the markets will have an impact on variables. The results of the study offer substantial evidence that the DXY and AIR variables interact in an asymmetric causality relationship, as evidenced by the analysis of the causality relationship.

## Discussion

The findings of this study elucidate the causal relationship between the airline index (AIR), the dollar index (DXY) and oil prices (OIL). A comparison of the findings with those of similar studies in the literature reveals both consistency and the contribution of this study to the existing literature. Firstly, the relationship between oil prices and the airline index has been the subject of extensive examination in the existing literature. Kilian & Park (2009) demonstrate that the real stock returns in the United States exhibit divergent reactions contingent on whether the surge in oil prices is driven by supply or demand forces. This study lends further support to this finding by demonstrating that fluctuations in oil prices exert a Granger causality relationship on AIR. Similarly, Bagirov & Mateus (2019) conducted an analysis of the impact of oil prices on firm markets and stocks, and their findings indicated that changes in energy costs have a direct impact on sectoral performances. Asadi et al., (2023) evaluate the link between airline stock returns and fuel prices based on airline business models, emphasising that the business model may play an important role in this relationship and that low-cost airlines are more sensitive to changes in oil prices. Yun & Yoon (2019) posited that the impact of crude oil prices on industries is contingent upon the level of dependence on crude oil within each sector. They further emphasised that the airline industry, which bears a significant portion of its costs in fuel, is particularly susceptible to fluctuations in crude oil prices. The related research indicated that the stock prices of small airline companies exhibit a relatively stronger response to changes in oil prices. The results of our study also demonstrate the impact of oil price shocks on the airline index.

The discovery of a bidirectional causal relationship between the U.S. dollar index and the airline industry index represents a significant contribution to the existing literature on this topic. Oum & Yu (1998) highlight those fluctuations in exchange rates exert a considerable influence on the cost structure of airline companies, with this impact being particularly pronounced for firms engaged in international operations. The existence of a bidirectional causality relationship indicates that the airline industry is not only affected by changes in the dollar exchange rate, but also that the performance of the airline industry can affect the dollar exchange rate. Kang et al., (2021) corroborate the assertion that the escalation in oil prices, economic uncertainty and volatility in jet fuel prices exert a considerable negative influence on the tangible stock returns of airlines at both the sector and the firm level. Alıcı (2024) identifies a significant relationship between the dollar exchange rate and oil price variables and the stock prices of airline companies. In the separate causality analyses conducted for each airline in the study, it was observed that the dollar exchange rate was the cause of stock prices for nine airlines. In the case of two airlines, there is evidence of bidirectional causality. The present study offers a more comprehensive insight into the interaction between the exchange rate and the airline index, conceptualising this relationship as bidirectional.

Furthermore, the financial performance of the airline sector during periods of crisis is corroborated by the findings of this study. For example, Maneenop & Kotcharin (2020) examined the impact of the Covid-19 pandemic on airline companies and concluded that crisis periods make the financial vulnerabilities of companies more apparent. The findings of our study indicate that positive and negative shocks during crisis periods (such as the global financial crisis, the impact of the SARS outbreak, and the Russia-Ukraine conflict) give rise to significant causal relationships within the sector. This finding corroborates the assertion that the airline sector is particularly susceptible to substantial economic and political shocks, as emphasised by Sobieralski (2020). Concurrently, substantial fluctuations in oil prices give rise to considerable cost constraints within the sector, as evidenced by historical precedent (Wang & Gao, 2020).

The results of the Hatemi-J (2012) asymmetric causality test also indicate that shocks have asymmetric effects on the airline index. In particular, the observation that the effects of positive and negative shocks

are in opposite directions suggests that the vulnerabilities and recovery processes of the sector may vary depending on the type of shock. This finding is consistent with the results of previous studies that have examined the financial performance of airline companies during periods of crisis. For instance, as indicated in the IATA (2020) report, the abrupt declines and subsequent recovery processes of the global pandemic in the airline industry have exhibited notable variations contingent on the specific type of external shock. The findings of our study align with those of previous research on crisis phases and exogenous shocks.

The impact of changes in oil prices on the airline industry is clear. Fluctuations in oil prices can directly affect the operational costs of airline companies and put pressure on ticket prices and profitability. This situation can be more pronounced, especially for airlines with higher operational costs. In addition, the relationship between oil prices and the airline index emphasizes the importance of airline companies using fuel price protection strategies (hedging) in risk management. Therefore, it is strategically important for airlines to take measures to stabilize energy prices in addition to protection strategies. For investors, the future performance of stocks in the airline industry can be examined based on the relationship between exchange rates and oil prices. Especially for airlines operating internationally, changes in the dollar index can affect stock performance.

The airline industry is significantly impacted by fluctuations in oil prices, which can have significant implications for financial planning and risk management. The bidirectional causality between the U.S. dollar index and the airline index indicates that exchange rate fluctuations affect airline financial performance and the overall health of the airline sector. This is particularly relevant for international operations, where firms must consider exchange rate dynamics when making strategic decisions. The strong causal relationship between oil prices and airline stocks underscores the need for robust risk management strategies, integrating both currency exchange rates and oil price trends to mitigate financial risks. Policymakers should consider exchange rate interventions or fuel price stabilization mechanisms to reduce cost pressures on airlines during economic uncertainty. Financial regulators and central banks should also consider the aviation sector's vulnerabilities when designing macroeconomic policies.

## Conclusion

The objective of this study is to elucidate the causal relationship between the airline index, the dollar index and oil prices. The study employs data from the variables on a daily basis, spanning the period between 2 January 2006 and 19 July 2024. Accordingly, 4,840 observations of each series were subjected to analysis. The study employed a range of causality tests, including the Granger causality test, the Fourier-Toda-Yamamoto causality test, the Fourier standard Granger causality test, and the Fourier-Toda-Yamamoto test (cumulative frequency) causality tests. The current study is different from similar studies in the literature and is expected to contribute to the literature. The study employed daily data for each series, which allowed for a greater number of observations and more robust results. Finally, the study employed multiple causality analyses with different econometric backgrounds.

The results of the Granger causality analysis indicate that AIR is the Granger cause of OIL and DXY. Furthermore, the outcomes of the Fourier-Toda-Yamamoto and Fourier-standard Granger analyses were found to be concordant with one another. The results of both analyses indicate the presence of a bidirectional causality relationship between DXY and AIR, as well as between AIR and DXY. The findings of the Fourier Toda & Yamamoto (cumulative frequency) analysis indicate the presence of a causality relationship from AIR to OIL and DXY. These findings are consistent with the results of the Granger causality test. In light of these findings, it can be concluded that the results of the causality analysis are generally consistent with one another. The bidirectional causality between the airline index

and the foreign exchange index stems from the direct impact of exchange rate fluctuations on the financial structure of airline companies. Changes in exchange rates affect the costs (e.g. fuel, leasing and maintenance expenses) and revenues of airline companies, thereby fluctuating stock prices. Moreover, the main reason for the causality from oil prices to the airline index is that fuel costs are one of the largest operational expenses for airlines. Increases in oil prices can negatively affect market values by reducing the profitability of companies.

The findings of the asymmetric causality analysis conducted by Hatemi-J (2012) indicate that there is a unidirectional causal relationship between positive shocks in OIL and positive shocks in AIR at a 10% significance level. Furthermore, the results indicate a unidirectional causality from positive shocks in DXY to positive shocks in AIR at the 1% significance level. In addition, at the 1% significance level, a unidirectional causality relationship is identified from negative shocks in DXY to negative shocks in AIR. The impact of economic crises and geopolitical events on the sector is related to the tendency of investors to avoid risky assets in times of uncertainty, with the airline industry being highly sensitive to demand fluctuations. Large-scale shocks, such as global financial crises and pandemics, directly affect the revenues and operations of the airline industry, leading to significant fluctuations in market values.

In consideration of the findings, several policy and strategic implications can be proposed. In view of the bidirectional causality between the airline index and the dollar index, it is recommended that airline companies and policymakers closely monitor currency fluctuations and hedge against exchange rate risks in order to maintain financial stability. Furthermore, the identified causality from oil prices to the airline index suggests that fluctuations in global oil prices significantly impact airline stock performance. It is therefore recommended that airlines implement effective fuel hedging strategies and explore alternative energy sources in order to mitigate risks associated with oil price volatility. Furthermore, the results highlight the impact of economic crises and geopolitical events on the airline industry. Consequently, policymakers and relevant stakeholders within industry are compelled to formulate more resilient financial strategies and establish contingency plans to ensure the sustainable growth of the aviation sector.

There are some limitations to this study. Although the Airline Price Index (AIR) includes many airlines, the findings cannot be generalized to all airlines, as each has a unique financial structure and operates within different market dynamics. Consequently, policy implications may vary across airlines. Additionally, the Airline Price Index (AIR) does not encompass the stock prices of all airlines. Repeating the analysis for a broader range of airlines, including state-owned carriers and those not publicly traded, may yield different results. Therefore, this study acknowledges these limitations while striving to maximize the insights derived from the available data.

## Compliance with Ethical Standards

### Ethical Approval

Ethics committee approval is not required for this study.

### Author Contributions

The contributions to the manuscript are as follows: M.Y. was responsible for the Introduction and Data Collection, and contributed to Writing – Original Draft Preparation and Writing – Review and Editing. C.A. contributed to the Literature Review, Writing – Original Draft Preparation, and Writing – Review and Editing. K.K. handled the Empirical Findings, Discussion, and Formal Analysis, and contributed to Writing – Original Draft Preparation and Writing – Review and Editing. A.Z. contributed to the Methodology, Writing – Original Draft Preparation, and Writing – Review and Editing.

**Declaration of Conflicting Interests**

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

**Funding**

The authors received no financial support for the research, authorship, and/or publication of this article.

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