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# ANALYSIS OF MACROECONOMIC FACTORS AFFECTING AIRLINE STOCK PRICES

# *ANÁLISIS DE FACTORES MACROECONÓMICOS QUE AFECTAN LA COTIZACIÓN DE ACCIONES DE LAS COMPAÑÍAS AÉREAS*

Abdulkadir Alici
*aalici@erbakan.edu.tr*
*Necmettin Erbakan University, Turquía*
https://orcid.org/0000-0002-4796-6385

**Abstract**

Change in stock prices and development of the market vary depending on decisions made by investors. Decisions made by investors are determined by corporate performance, the country's economic situation, political developments and changes in macroeconomic factors. In this study, the relationship between stock prices of airlines and macroeconomic variables was analyzed. To accomplish this, daily macroeconomic data of 14 airlines covering the years 2009-2018 were analyzed by Toda Yomamato and Hatemi-J asymmetric causality tests, and macroeconomic factors (Brent oil price, dollar exchange rate and interest rate) determining stock prices were identified. According to the results of the Toda and Yomamato causality test, it was found that there was a significant relationship among variables of the dollar exchange rate, the price of oil and stock prices of airlines. Except for one airline, there was no significant relationship between interest rate and stock price. According to the results of the Hatemi-J asymmetric causality test, it was found that there were significant relationships among variables of the dollar exchange rate, oil price, interest rate, and airline stock prices. In light of these findings, innovation and adoption of alternative fuel technology by the aviation industry and airlines can be a successful alternative to oil price risk. Results on exchange rate and interest rate changes indicate that airlines and related governments should focus on policies that increase growth of the aviation industry.

**Keywords:** Air transportation, Airline performance, Toda Yomamato causality test, Hatemi-J asymmetric causality test.

***Resumen***

*La evolución de las cotizaciones bursátiles y el desarrollo del mercado varían en función de las decisiones tomadas por los inversores. Las decisiones de los inversores vienen determinadas por los resultados de las empresas, la situación económica del país, la evolución política y los cambios en los factores macroeconómicos. En este estudio se analizó la relación entre los precios de las acciones de las compañías aéreas y las variables macroeconómicas. Para ello, se analizaron los datos macroeconómicos diarios de 14 aerolíneas correspondientes a los años 2009-2018 mediante las pruebas de causalidad asimétrica Toda Yomamato y Hatemi-J, y se identificaron los factores macroeconómicos (precio del petróleo Brent, tipo de cambio del dólar y tipo de interés) que determinan los precios de las acciones. Según los resultados de la prueba de causalidad de Toda y Yomamato, se constató que existía una relación significativa entre las variables del tipo de cambio del dólar, el precio del petróleo y las cotizaciones bursátiles de las compañías aéreas. Excepto en el caso de una compañía aérea, no existía una relación significativa entre el tipo de interés y el precio de las acciones. Según los resultados de la prueba de causalidad asimétrica de Hatemi-J, se constató que existían relaciones significativas entre las variables del tipo de cambio del dólar, el precio del petróleo, el tipo de interés y el precio de las acciones de las compañías aéreas. A la luz de estos resultados, la innovación y la adopción de tecnología de combustibles alternativos por parte de la industria de la aviación y las compañías aéreas puede ser una alternativa acertada al riesgo del precio del petróleo. Los resultados sobre las variaciones del tipo de cambio y el tipo de interés indican que las aerolíneas y los gobiernos relacionados deberían centrarse en políticas que aumenten el crecimiento de la industria de la aviación.*

***Palabras clave:*** *transporte aéreo, desempeño de las aerolíneas, prueba de causalidad Toda Yomamato, prueba de causalidad asimétrica Hatemi-J.*

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## 1. Introduction

One of the main goals of companies is to maximize the market value by increasing the stock price. The economic situation of the countries is of great importance in determining the stock price of companies. The relationship between the general economic situation and stock prices has been of interest to experts for many years. Some researchers tried to predict the rise or fall in stock prices with the help of economic indicators. There are many studies[1] that reveal the relationship between macroeconomic factors and the stock price.

Theoretically, the value of a firm's stock should equal the expected present value of the firm's future cash flow, and its future cash flow depends on the firm's performance. Airline companies face operational, financial, strategic and unpredictable (hazard) risks (Zea, 2002, s.2). As airlines' future cash flows are exposed to these risks, it is of great importance to manage risks. Airlines have a fragile structure against economic fluctuations and negativities. Therefore, there are many financial risk factors that affect airlines. The most common financial risks in the literature are; fuel price, exchange rate, interest rate, liquidity risks (Morrell, 2007; Vasigh, 2015; Budd and Ison, 2017; Fernando, 2006; Loudon, 2004; Tsai, 2008). Thus, a change in any macroeconomic variable can potentially affect stock prices.

There are many studies in different sectors that reveal the relationship between macroeconomic factors and stock price, and a meaningful relationship can be mentioned. However, although there are not enough studies on the airline industry, studies in the literature prove the existence of a relationship between macroeconomic factors and stock returns. Unsystematic risks in the airline industry can cause many damages to businesses. The biggest unsystematic financial risk factor is oil price. Increases in the prices of jet fuel (which increases in parallel with the price of Brent oil) negatively affect the stock prices by reducing the profitability of airlines (Vasigh, 2015, s. 149; Morrell and Swan, 2006, s. 3). It is understood that there are significant relationships between oil price volatility and stock price, especially in studies conducted in the transportation sector (Hammoudeh ve Li, 2005; Nandha ve Brooks, 2009; Narayan ve Sharma, 2014; Aggarwal vd. 2012). In four studies (Loudon, 2004; Tsai, 2008; Elyasiani et al, 2011; Kristjanpoller & Concha, 2016) conducted in the airline industry, it was concluded that oil prices have significant effects on stocks. Airlines generally report that foreign exchange movements have a negative impact on profits (Morrell, 2007, p. 178). Global airlines often generate revenue in multiple currencies and pay for fuel, labor and other costs. As such, they are exposed to exchange rate fluctuations (Pyke and Sibdari, 2018, p. 293). In the study conducted by Yashodha et al., 2011, it was concluded that the exchange rate risk is effective on stock prices for Cathay Pacific and China Airways airlines. While interest rates are not as volatile as fuel prices or exchange rates, the amounts of debt accrued by global airlines are a serious risk from adverse changes in interest rates. If market interest rates rise, airlines will have to pay higher interest rates. For example, at the end of 2012, American Airlines had outstanding debts of around $7 billion (Vasigh vd., 2014, s. 491-491). 1% increase in the interest rate would increase American Airlines' interest expenses by $70 million. The increase in interest expenses may reduce the profitability and negatively affect the value of the company's stock. In the study by Tsai, (2008), it was concluded that the stock price of the South African Airways is affected by the interest rate. However, in the study of Loudon (2004), no significant relationship was found between the interest rate and the stock price for Qantas and Air New Zealand airlines.

1 The literature summary about the studies is available in the annex2-3

The subject of this study is the mutual financial relationships between the stock prices of airline companies and macroeconomic factors. In this context, the main objective of the study is to determine the macroeconomic factors affecting the stock prices of airline companies around the world. Many studies have been conducted in different sectors examining the relationship between macroeconomic factors and stock prices and significant results have been obtained. There are several studies on the airline sector. In most of these studies, a few (2-3) airline companies were examined in the research sample. In this study, 14 airline companies were analysed. Therefore, it is thought to make a great contribution to the literature. Another contribution of this study to the literature is that Toda-Yamamato (1995) causality test and Hatemi-J (2012) asymmetric causality test are analysed together. In addition, another point that distinguishes the study from similar studies is that a large period (2009-2018) is analysed by using daily data. Thus, it is aimed to obtain more reliable results.

There are many factors affecting the stock prices of airlines. The study investigates the effect of macroeconomic factors on stock prices. Before the analysis, the relationship between macroeconomic factors and stock price was explained in a conceptual framework, and also the relevant literature was addressed. After that, analysis method was presented. In the analysis part of the study, the findings were reached and comments were made about the findings.

### 1.1. Conceptual Framework and Literature

The aim of the study is to estimate the relationship between stock price of airlines and macroeconomic factors. In this context, it is necessary to decipher the conceptual relationship between stock prices and macroeconomic factors. Macroeconomic factors used in the study include Brent oil price, Dollar exchange rate, and interest rate.

After the collapse of the Bretton Woods system, almost all countries soon switched to a floating exchange rate regime, and fluctuations in exchange rates began to affect financial markets. In addition, a large increase in world trade volume and capital movements has made the exchange rate one of the important determinants of operating profitability and stock prices (Yilmaz et al., 2006, p.5). Sudden ups and downs in exchange rates negatively affect the capital market and can cause large losses to businesses and investors (Korkmaz and Ceylan, 2015).

Due to a higher-valued currency, companies can buy the raw materials they need for production cheaper. This results in reducing the costs of the business and increasing its earnings. In low exchange rate environments, interest rates fall while foreign exchange reserves and money supply increase. This, in turn, reduces the financing costs of businesses. Reductions in financing costs and prices of imported goods increase future cash flows of businesses (Candan, 2015). Therefore, a decrease in the exchange rate can raise stock prices.

Most of the revenue generated by airlines is exposed to exchange rate risk. Airlines sell tickets to many countries and in many currencies. Airline operations in foreing countries results in an additional exchange risk. For example, revenues from the operations of South Africa Airways operating in Rwanda must be converted into US dollars and then into the South African currency Rand (Tsai, 2008). Exchange rate fluctuations affect the profitibility of airlines. For example, Turkish Airlines flies to many international routes. Due to exchange rate changes(increase/decrease) in dollar and Euro currencies, there is an increase/decrease in the profitability of Turkish Airlines. Here, currency fluctuations and the number of international passengers are the determining factors affecting profitability.

A rise in oil prices means an increase in raw material prices and production costs. High production costs lead to a decline in the profit of businesses. This reduces cash flow in stock markets and leads to a decline in stock returns (Saygan and Süslü, 2011). A rise in oil prices can cause prices to rise in the market, that is, inflation. Such a situation could lead the country's central banks to increase interest rates in order to control the increase in the inflation rate. High interest rates can cause stock returns to fall (Basher and Sadorsky, 2006).

Fuel price management is very important for airlines as jet fuel costs include an important component of airline operating costs. In a study conducted by Koopmasn and Lieshout (2016), they found that fuel costs were 20% -50% of total costs in 2014. Therefore, jet fuel price risk makes economic sense for airlines. Likewise, Loudon (2004) suggested that short-term cash flows may be directly related to changes in fuel prices due to price change inertia.

One of the key factors affecting stock returns is interest rates. Changes in interest rates can affect the prospects of expected returns. If interest rates fall, a certain increase in stock prices occurs, as businesses will have the opportunity to find cheaper loans (Ercan and Ban, 2008). Based on this, it can be said that changes in the interest rate have a negative impact on stock prices. An increase in interest rates leads to an increase in the expected rate of return and a decrease in stock prices. Likewise, a rise in interest rates increases the opportunity cost of holding cash. In this case, investors turn to other securities that provide a return on interest, rather than holding capital. This, in turn, can be reflected as a decline in stock returns (Gan et al., 2006). Interest rates are the most important factor affecting competition between stock market and the bond market (Kalmanbetova, 2010). When interest rates rise, investors sell equity investment instruments, preferring alternative securities investment instruments. Investors, in particular, tend to turn to bond markets (Brigham, 2006; Süslü, 2011).

Interest rate risk is an important factor for airlines, as they borrow heavily for financing the purchase of aircraft. High leverage ratios are common in the airline industry due to capital intensity and relatively high cost of equity. In the airline industry, attracting capital may be more difficult due to high earnings volatility (Loudon, 2004; Tsai, 2008). In summary, as airlines borrow heavily, interest rates increase, as well as the interest cost incurred by airlines increases. Increased interest expenses can reduce profitability and therefore stock prices.

There are many studies in the literature on the subject, except for the airline industry. There are several studies examining this relationship in the airline industry (Loudon, 2004; Fernando, 2006; Tsai, 2008; Puncreobutr and Sowaros (2016); Yashodha (2016)). Details of these studies are given below.

Loudon (2004) investigated the exposure to interest rate, exchange rate and fuel price risks of Qantas and Air New Zealand, using weekly stock price and independent variables between 1995-2003. According to linear and nonlinear regression model analysis, Qantas and Air New Zealand airlines were not exposed to interest rate and currency risk in the short term, but were negatively exposed to fuel price volatility. In the long term, it was stated that the incidence of all risks increased.

Fernando (2006) examined 15 airlines' risk exposures and usage of derivatives to mitigate these risk exposures specifically volatility in jet fuel prices. The data was obtained from financial reports of airlines. As a result of the analysis, it was stated that fuel price risk is the most important risk indicator and that protection instruments should be used more against this risk.

Tsai (2008) analysed the impact of financial risk factors, including interest rate exposures, currency fluctuations, and fuel price changes on the airline industry. This study investigated risk exposures in the South African airline industry and used data on South African Airways (SAA) and Comair to calculate the impact of risk factors on exposure significance. According to the linear and non-linear regression model results, one of the most prominent findings of the study is that South African Airways was affected by all risk factors in all time periods, all risk factors significantly affected financial performance to a certain extent when losses rather than profits were observed. Another important finding is that Comair was exposed to fuel price risk in the short term.

Puncreobutr and Sowaros (2016) aimed to study the risk factors affecting the low-cost carrier industry and also to provide guidelines to reduce the risk. The research was conducted by studying the documents, in depth interviews with personnel at the airports in Thailand. It was found that the risk affecting the low-cost carriers industry consists of 2 main factors.

Yashodha et al. (2016) examined relationships between the stock price of Cathay Pacific Airways and China Airlines against key determinants of financial risks exposure confronting the airline industry, which include interest-rate, exchange rate and fuel price risk exposures for the period of January 1996 to December 2011. The study suggests that exchange rate movements have a substantial impact, compared to the fuel price and interest rate exposures against the stock price of the analysed airline.

In addition, fuel price, interest rate and exchange rate risks are considered among the most important risks in the ranking of risks in the airline industry according to IATA (2017) report.

Thorbecke (2020) investigated the impact of the Covid-19 pandemic on the stock market in the US and analyzed the effects of macroeconomic factors such as oil price, exchange rate, interest rate and inflation on stocks. As a result of the regression analysis, it was determined that airline stock prices were driven by idiosyncratic factors rather than macroeconomic factors.

According to Horobet et al. (2022) in their work, this study explores the impact of oil price volatility on the stock returns of global airlines, with a focus on the long and short-term effects of oil price risk on the airline industry. The authors use a macroeconomic framework to analyze various risk factors and employ a panel ARDL model and PMG estimator to estimate long-term and short-term coefficients for the relationship between variables. The study finds that oil price volatility has a significant and negative impact on airlines' stock returns, and this impact has particularities when the long versus short-run perspective is considered. The authors suggest that investors and stakeholders in the airline industry need to be aware of the potential risks associated with oil price fluctuations and consider them when valuing companies in the stock market. The study also highlights the need for airline companies to rethink their operational and financial policies to cope with the challenges posed by oil price volatility, particularly in the post-pandemic world.

Apart from these studies, there are several studies (Samunderu et al., 2023; Wang and Gao, 2020; Kang et al., 2021; Felix et al., 2023; Atems, 2021) investigating the effect of oil price volatility on stock returns in airline companies. Most studies have found that oil prices negatively affect airline stock prices. It is also stated that it is possible to get rid of the negative effect with the hedging strategy.

Within the scope of the literature on the airline industry, it has been observed that oil price, exchange rate and interest rate variables have significant relationships with stock prices in the context of macroeconomic factors. Three studies (Loudon (2004); Tsai (2008) and Yashodha et al. (2016)) related to macroeconomic factors affecting the stock prices of airlines were reached. Fernando (2006) and Puncreobutr and Sowaros (2016) determined risk factors in airlines. Examining the literature, there are a few studies examining the relationship of macroeconomic factors with the stock prices of airlines. Therefore, further research is needed. There are several studies on the airline sector. In most of these studies, a few (2-3) airline companies were examined in the research sample. In this study, 14 airline companies were analysed. In addition, Toda-Yamamato (1995) causality test and Hatemi-J (2012) asymmetric causality test are used in the study. Finally, another point that distinguishes the study from similar studies is that a wide period (2009-2018) is analysed by using daily data. Thus, it is aimed to obtain more reliable results.

## 2. Research Methodolgy

The subject of this study is the mutual financial relations of airlines' stock prices and macroeconomic factors. In this context, the main purpose of the study is to determine the macroeconomic factors that affect the stock prices of airlines. Many studies in different sectors have examined the relationship between macroeconomic factors and stock price and proved the relationship. There are several studies examining this relationship in the airline industry (Loudon, 2004; Fernando, 2006; Tsai, 2008; Puncreobutr and Sowaros (2016); Yashodha (2016)). In most of these studies, research sample was composed of a few (2-3) airlines. In this study, 14 airlines were examined. Therefore, it is thought that it will make great contributions to the literature. Another contribution of this study to the literature is that the Toda-Yamamato (1995) causality test and the Hatemi-J (2012) asymmetric causality test were used together. In addition, another aspect that distinguishes the study from similar studies is the consideration of a wide period (2009-2018) using daily data. Thus, it is aimed to obtain better results.

The study has three main research questions: (i) What is the impact of exchange rate changes on global airlines' stock returns? (ii) What is the impact of changes in oil prices on global airlines' stock returns? (iii) What is the impact of interest rate changes on global airlines' stock returns? However, is there a significant difference between symmetrical and asymmetrical macroeconomic effects? The hypothesis of this study is that macroeconomic factors (exchange rate, oil price and interest rate) have a significant and negative effect on stock returns

In this study, factors affecting airline stock prices were examined. 14 airlines whose financial data showed continuity in the period 2009-2018 were included in the study. Stock price of airlines and macroeconomic data included in the sample were obtained from the Thomson Reuters Datastream. In the analysis, the VAR model will be estimated and dynamic relationships will be analyzed with Toda and Yamamoto (1995) causality analysis and Hatemi-J (2012) asymmetric causality analysis.

Toda-Yamamoto causality test, as in traditional causality tests (Granger causality test, etc.), without depending on cointegration condition (Erbaykal and Okuyan, 2007), causality can be established and causality analysis with VAR model regardless of whether the series is stationary or not. It is a test that minimizes the risks that can be made and that the series can be wrongly evaluated due to integration (Mavrotas and Kelly, 2001).

Toda and Yamamoto (1995) causality test is carried out through the Vector Autoregressive (VAR) model, which includes the level values of the variables. By determining the optimal lag length (p) of the VAR model and the maximum degree of integration *(dmax),* which is the highest stationarity level of the variables, the VAR (p+*dmax)* system is estimated by SUR (Seemingly Unrelated Regression) method. Then, it is decided to determine the causality with the MWALD test whether the coefficients of the p lags in the VAR (p+*dmax)* system are equal to zero as a group. (Tandoğan and Genç, 2016). The rejection of the *H*o hypothesis, which was established as the coefficients are equal to zero as a group, shows that there is a causality relationship. In the causality analysis between the stock prices of the airlines and the macroeconomic indicators, logaritms of the stock prices of the companies (LASP), the currency value of the countries against the dollar (LDER), the brent oil price (LBOP) and the 10-year bond interest rates (LFAIZ) of the countries were used. Binary VAR systems consisting of LASP and LDER, LBOP and LFAIZ variables are shown in equations (4.1), (4.2), (4.3), (4.4), (4.5) and (4.6):

$$LHSF_t = \alpha_0 + \sum_{i=1}^{p+d} \alpha_{1(i+d)} LHSF_{t-(i+d)} + \sum_{i=1}^{p+d} \alpha_{2(i+d)} LDLKUR_{t-(i+d)} + \varepsilon_{1t} \tag{4.1}$$

$$LDLKUR_t = \beta_0 + \sum_{i=1}^{p+d} \beta_{1(i+d)} LDLKUR_{t-(i+d)} + \sum_{i=1}^{p+d} \beta_{2(i+d)} LHSF_{t-(i+d)} + \varepsilon_{1t} \tag{4.2}$$

$$LHSF_t = \delta_0 + \sum_{i=1}^{p+d} \delta_{1(i+d)} LHSF_{t-(i+d)} + \sum_{i=1}^{p+d} \delta_{2(i+d)} LBPETROL_{t-(i+d)} + \varepsilon_{1t} \tag{4.3}$$

$$LBPETROL_t = \omega_0 + \sum_{i=1}^{p+d} \omega_{1(i+d)} LBPETROL_{t-(i+d)} + \sum_{i=1}^{p+d} \omega_{2(i+d)} LHSF_{t-(i+d)} + \varepsilon_{1t} \tag{4.4}$$

$$LHSF_t = \varphi_0 + \sum_{i=1}^{p+d} \varphi_{1(i+d)} LHSF_{t-(i+d)} + \sum_{i=1}^{p+d} \varphi_{2(i+d)} LFAIZ_{t-(i+d)} + \varepsilon_{1t} \tag{4.5}$$

$$LFAIZ_t = \theta_0 + \sum_{i=1}^{p+d} \theta_{1(i+d)} LFAIZ_{t-(i+d)} + \sum_{i=1}^{p+d} \theta_{2(i+d)} LHSF_{t-(i+d)} + \varepsilon_{1t} \tag{4.6}$$

p VAR represents the number of lags in the VAR model, and p+d represents the maximum degree of integration of the variables included in the model. The basic idea of this approach is to increase the number of lags in the VAR model by the maximum degree of integration of the variables entering the model (Erbaykal and Okuyan, 2007).

Causality tests, which are frequently used in the literature (Granger, 1969; Hsiao, 1981; Sims, 1972; Hacker and Hatemi, 2006; Toda and Yamamoto, 1995) have causality results by ignoring positive and negative shocks between the series. Hatemi-J (2012) asymmetric causality test focuses on the relationship between positive and negative shocks between series. It was first suggested by Granger and Yoon (2002) that this relationship may differ from the relationship between variables. On the other hand, Hatemi-J (2012) developed the Granger and Yoon (2002) method for causality analysis. In summary, in the Hatemi-J (2012) asymmetric causality test, it is aimed to observe the different causal effects of positive and negative shocks and to find the hidden structure that will allow for the development of foresight for the future (Yılancı & Bozoklu, 2014; Contuk & Güngör, 2016).

In the Hatemi-J causality and Toda-Yamamoto causality tests, analyzes are performed by considering the level values of the series. In the Toda-Yamamoto causality test, symmetrically relationships are analyzed, while in the Hatemi-J causal test, asymmetric relationships are analyzed. With the Hatemi-J causality analysis method, it is possible to test whether an increase in one dependent or independent variable causes an increase/decrease in another variable and/or whether a decrease in any variable causes a decrease/increase in another variable by separating the positive and negative shocks of the series (Büberkökü and Şahmaroğlu, 2016).

In the study, independent variables determining stock prices were selected from macroeconomic variables used in the literature. In this context, Brent oil price, interest rates, and exchange rates were used as independent variables. All variables in the study were normalized by taking their natural logarithms. Details about the variables used in the study are listed in Table 1. Stock price of airlines and macroeconomic data included in the sample were obtained from the Thomson Reuters Datastream.

**Table 1. Details About Variables**

| Variables | Symbol | Measurement Indicator | Measurment Method |
|---|---|---|---|
| **Dependent Variables** | **LASP** | Airlines Stock Price | Reel Stock Price |
| **Inde-pendent Variables** | **LBOP** | Brent Oil Price | Reel Brent Oil Price |
| | **LDER** | Dolar Exchange Rate | Exchange Rate Between the Currency of the Countries and the US Dollar (Ex: TL_USD) |
| | **LIR** | Interest Rate | 10-Year Bond Interest Rates of Countries |

As a result of the literature review, it is desired to examine the relationship between the variables in Table 1 above. The hypothesis regarding the related variables is as follows:

Ho: There is a relationship between macroeconomic indicators (dollar exchange rate, oil price and interest rate) and stock prices.

H1: There is no relationship between macroeconomic indicators (dollar exchange rate, oil price and interest rate) and stock prices.

## 3. RESEARCH FINDINGS

Using the data of this study, the relationship between the stock prices of the airlines and the macroeconomic factors was investigated using the daily data between 2009 and 2018, and the dynamic relationship between stock price, Dollar exchange rate, Brent oil price and Interest rate was examined. In the study, the model was established by taking the logarithm of all variables. In the analysis, the VAR model will be estimated and dynamic relationships will be analyzed with Toda and Yamamoto (1995) causality analysis and Hatemi-J (2012) asymmetric causality analysis.

In order to achieve more accurate causality results in the Toda-Yamamoto causality test, it is necessary to correctly determine the delay length and maximum integration level of the variables in the established model. In the study, the integration levels of the series were determined using the Augmented Dickey Fuller unit root test. Delay length of series was determined using SC, HQ, FPE, LR and ACI information criteria.

When the series of all airline companies are examined according to the unit root test results, it has been determined that the independent variables are not stationary at the level, and they become stationary when the first difference of the series is taken[2]. In the Toda-Yamamoto causality test, the series are included in the analysis without the need to make them stationary. This allows series of variables to have more information and thus obtain better results from analysis (Çil Yavuz, 2006, p. 169). In Hatemi-J (2012) asymmetric causality analysis, the analysis was performed by taking the first differences of the variables. The study firstly gives the results of the Toda-Yamamoto (1995) causality test. Only significant relationships are shown in the table. All Toda-Yamamoto Causality Analyzes are annex.

**Table 2.** Toda-Yamamoto Causality Analysis

| Airlines | Direction of Causality | $x^2$Stat | Var (p+d) | Probability Value |
|---|---|---|---|---|
| United Airlines | LASP ⇏ LDER* | 5.454473 | 2+1 | 0.0654 |
| | | | | |
| Turkish Airlines | LDER ⇏ LASP | 23.00338 | 5+1 | 0.0003 |
| | LBOP LASP | 12.72166 | 5+1 | 0.0261 |
| | LASP ⇏ LIR | 12.28137 | 5+1 | 0.0311 |
| | | | | |
| Singapore Airlines | LASP ⇏ LDER* | 4.613838 | 2+1 | 0.0996 |
| | LDER ⇏ LASP | 14.28926 | 2+1 | 0.0008 |
| | | | | |
| Qantas Airways | LDER ⇏ LASP* | 19.15354 | 11+2 | 0.0584 |
| | LBOP ⇏ LASP | 22.47271 | 11+2 | 0.021 |
| | | | | |
| Lufthansa Airlines | LDER ⇏ LASP | 12.08459 | 4+1 | 0.0167 |
| | LASP ⇏ LBOP* | 9.412552 | 4+1 | 0.0516 |
| | LBOP ⇏ LASP | 14.71976 | 4+1 | 0.0053 |
| | LASP ⇏ LIR | 10.41648 | 4+1 | 0.034 |
| | | | | |
| Air China | LDER ⇏ LASP | 8.574296 | 2+1 | 0.0137 |
| | LBOP LASP | 11.20648 | 2+1 | 0.0037 |
| | | | | |
| Aeroflot | LDER ⇏ LASP | 22.90321 | 10+2 | 0.0111 |
| | | | | |
| Air Canada | LBOP LASP | 8.734665 | 2+1 | 0.0127 |
| | | | | |

2 Related unit root test results are included in the annex-4

| Airlines | Direction of Causality | $x^2$*Stat* | Var (p+d) | Probability Value |
|---|---|---|---|---|
| **Easyjet** | LDER $\nRightarrow$ LASP | 11.57768 | 2+1 | 0.0031 |
| | LIR $\nRightarrow$ LASP | 7.755625 | 2+1 | 0.0207 |
| | | | | |
| **Gol Linhas Aeras** | LDER $\nRightarrow$ LASP | 9.666582 | 2+1 | 0.008 |
| | | | | |
| **JetBlue** | **No significant result could be reached.** | | | |
| | | | | |
| **Norwegian** | LASP $\nRightarrow$ LDER | 4.622919 | 2+1 | 0.0991 |
| | LDER $\nRightarrow$ LASP | 5.914692 | 2+1 | 0.052 |
| | | | | |
| **Southwest** | LASP $\nRightarrow$ LBOP | 7.848946 | 2+1 | 0.0198 |
| | LBOP $\nRightarrow$ LASP* | 5.423005 | 2+1 | 0.0664 |
| | | | | |
| **Westjet** | LBOP $\nRightarrow$ LASP* | 13.0928 | 8+1 | 0.0987 |
| | | | | |

**Note1:** The $\nRightarrow$ sign indicates the null hypothesis that there is no causality. In the estimated VAR model, different lag lengths (p) were used, which were determined as the most appropriate according to LR, FPE, ACI, SC and HQ criteria. Note 2: The causalities marked with * are those at the 10% significance level.

In order to investigate the causality relationship between stock price and macroeconomic (brent oil, interest, dollar exchange rate) variables, a Toda Yamamoto (1995) causality test was performed for all airlines separately, and the findings are shown in Table 3. Analysis comments were made by evaluating all airlines together. A holistic causality interpretation was made in the context of the variable.

As a result of the analysis of the relationship between the dollar exchange rate variable (LDER) and the stock price variable (LASP), it was found that the dollar exchange rate was the cause of the stock prices for 9 airlines (Turkish Airlines, Singapore Airlines, Qantas Airways, Lufthansa Airlines, Air China, Aeroflot, Easyjet, Gol Linhas Aeras and Norwegian).  It has been observed that there is bidirectional causality for Norwegian and Singapore Airlines. Accordingly, changes in exchange rate can have a significant impact on the stock prices of airlines.

As a result of the analysis of the relationship between the Brent oil price variable (LBOP) and stock price variable (LASP), it was found that the Brent oil price variable was the cause of the stock prices for 7 airlines (Turkish Airlines, Qantas Airways, Lufthansa Airlines, Air China, Air Canada, Westjet, and Southwest). It has been observed that there is a bidirectional causality relationship for Southwest and Lufthansa Airlines.  In this context, changes in brent oil prices could have significant effects on airline stock prices.

As a result of the analysis of the relationship between the 10-year bond interest rate variable (LFAIZ) and the stock price variable (LASP), it has been determined that the interest rate variable is the cause of the stock price variable in only 1 airline (Easyjet). Accordingly, we can say that interest rates do not have a significant impact on airline stock prices.

Examining asymmetric causality in cases where symmetric causality cannot be explained is important in terms of revealing possible relationships between variables. Hatemi-J (2012) asymmetric causality test findings are given in Table 4. In Table 4, only the findings (variables) with causality are given. All asymmetric causality test results are included in the annex.

**Table 3. Hatemi-J (2012) Asymmetric Causality Test Results**

| Hatemi-J (2012) Asymmetric Causality Analysis | | | | | |
|---|---|---|---|---|---|
| **Airlines** | **Direction of Causality** | **Wald Stat.** | **Critical Bootstrap Value** | | |
| | | | **1%** | **5%** | **10%** |
| **United Airlines** | LASP- ≠ > LDER- | 3.777* | 7,089 | 3,952 | 2,751 |
| | LDER- ≠ > LASP+ | 5.525** | 6,934 | 3.88 | 2,754 |
| | LASP- ≠ > LBOP+ | 5.089** | 6,805 | 4,001 | 2,839 |
| | LBOP+ ≠ > LASP+ | 4.109** | 6,847 | 3,886 | 2,785 |
| | LBOP+ ≠ > LASP- | 4.932** | 7,149 | 4,033 | 2.68 |
| | LASP- ≠ > LIR- | 3.777* | 7,131 | 4,027 | 2,728 |
| | LIR+ ≠ > LASP+ | 4.109** | 6,847 | 3,886 | 2,785 |
| | LIR+ ≠ > LASP- | 4.932** | 7,149 | 4,033 | 2.68 |
| | | | | | |
| **Turkish Airlines** | LASP+ ≠ > LDER+ | 5.641** | 6,505 | 3,846 | 26,330 |
| | LASP- ≠ > LDER- | 37.128*** | 9,482 | 6,016 | 4,679 |
| | LDER+ ≠ > LASP- | 13.245*** | 6,607 | 3,968 | 2.68 |
| | LASP- ≠ > LBOP- | 4.509** | 4.51 | 3,842 | 2,753 |
| | LASP+ ≠ > LIR+ | 15.025*** | 13,804 | 9,569 | 7,864 |
| | LIR+ ≠ > LASP+ | 13.368** | 14,051 | 9,456 | 7,645 |
| | LIR- ≠ > LASP- | 19.144*** | 9,954 | 6,128 | 4,726 |
| | LIR- ≠ > LASP+ | 7.235* | 15,147 | 9,597 | 7,736 |
| | | | | | |
| **Singapore Airlines** | LASP- ≠ > LDER- | 22.330*** | 9,948 | 43,714 | 4,562 |
| | LDER- ≠ > LASP- | 13.059** | 13,317 | 8,061 | 6,406 |
| | LDER- ≠ > LASP+ | 3.539* | 6,819 | 3,892 | 2,758 |
| | LASP+ ≠ > LBOP+ | 8.135*** | 6,914 | 3,957 | 2,765 |
| | LASP- ≠ > LBOP- | 2.931* | 6.96 | 3.86 | 2,657 |
| | LBOP- ≠ > LASP- | 3.799** | 7,161 | 3,804 | 2,596 |
| | LIR- ≠ > LASP+ | 2.838* | 8,253 | 3,594 | 2,339 |
| | | | | | |

| Hatemi-J (2012) Asymmetric Causality Analysis | | | | | |
|---|---|---|---|---|---|
| Airlines | Direction of Causality | Wald Stat. | Critical Bootstrap Value | | |
| | | | 1% | 5% | 10% |
| Qantas Airways | LASP- ≠ > LDER+ | 2.786* | 8,417 | 3.56 | 2,393 |
| | LASP+ ≠ > LBOP+ | 22.021*** | 9,002 | 5,961 | 4,582 |
| | LASP- ≠ > LBOP- | 24.621*** | 15,124 | 9,745 | 7,806 |
| | LASP- ≠ > LBOP+ | 8.201*** | 7,055 | 3,784 | 2,762 |
| | LBOP- ≠ > LASP- | 7.392* | 14,828 | 9,466 | 7,269 |
| | LBOP+ ≠ > LASP- | 5.937** | 7,137 | 3,927 | 2,642 |
| | LASP+ ≠ > LIR+ | 3.147* | 6,976 | 35,125 | 2,728 |
| | LIR- ≠ > LASP+ | 16.062*** | 14,578 | 9,797 | 7,717 |
| | | | | | |
| Lufthansa Airlines | LASP- ≠ > LDER- | 4.633** | 6,702 | 4,042 | 2,771 |
| | LASP- ≠ > LDER+ | 6.181** | 6,565 | 3,785 | 2,687 |
| | LASP+ ≠ > LDER- | 4.215** | 6,541 | 3,749 | 2,638 |
| | LASP- ≠ > LBOP+ | 2.984* | 6,337 | 3,736 | 2,682 |
| | LBOP+ ≠ > LASP- | 5.383** | 6,944 | 24,532 | 2,655 |
| | LASP- ≠ > LIR- | 3.041* | 6,871 | 4.00 | 2.80 |
| | LIR- ≠ > LASP+ | 20.236*** | 11,527 | 7,776 | 6,163 |
| | | | | | |
| Air China | LDER+ ≠ > LASP+ | 2.749* | 6,711 | 3,769 | 2,661 |
| | LDER+ ≠ > LASP- | 3.226* | 6,776 | 3,821 | 2,704 |
| | LASP- ≠ > LBOP- | 4.318** | 7,038 | 3,817 | 2,618 |
| | LBOP+ ≠ > LASP+ | 3.727* | 6,765 | 3,953 | 2,762 |
| | LBOP- ≠ > LASP- | 4.155** | 6,944 | 3,676 | 2,601 |
| | LIR+ ≠ > LASP+ | 7.707** | 9,567 | 6,261 | 4,771 |
| | | | | | |
| Aeroflot | LASP- ≠ > LDER- | 5.869* | 10,001 | 5,958 | 4,491 |
| | LASP+ ≠ > LDER- | 10.903*** | 9.72 | 6,256 | 4,563 |
| | LDER- ≠ > LASP+ | 2.574* | 6,997 | 3,945 | 2.53 |
| | LASP- ≠ > LBOP+ | 4.612** | 7,157 | 3,862 | 2,646 |
| | LASP+ ≠ > LBOP- | 4.530** | 7,036 | 4,125 | 2,737 |
| | LASP+ ≠ > LIR+ | 34.060*** | 26,365 | 16.97 | 13,778 |
| | LASP- ≠ > LIR+ | 4.564** | 7,634 | 3,792 | 2,572 |
| | LASP+ ≠ > LIR- | 7.258*** | 7,199 | 3,603 | 2,499 |
| | LIR+ ≠ > LASP+ | 18.413** | 23,567 | 16,782 | 13,796 |
| | LIR- ≠ > LASP- | 3.058* | 7,162 | 3,804 | 2,623 |
| | LIR- ≠ > LASP+ | 27.380*** | 21,663 | 16,031 | 13,538 |
| | LIR+ ≠ > LASP- | 41.742*** | 24,123 | 16,821 | 13,878 |
| | | | | | |

| Hatemi-J (2012) Asymmetric Causality Analysis | | | | | |
|---|---|---|---|---|---|
| Airlines | Direction of Causality | Wald Stat. | Critical Bootstrap Value | | |
| | | | 1% | 5% | 10% |
| Air Canada | LASP- ≠ > LBOP- | 4.318** | 6,623 | 3,955 | 2,736 |
| | LBOP+ ≠ > LASP+ | 3.727* | 6,765 | 3,953 | 2,762 |
| | LBOP- ≠ > LASP- | 4.155** | 6,944 | 3,676 | 2,601 |
| | | | | | |
| EasyJet | LASP+ ≠ > LDER+ | 2.766* | 6,892 | 3,821 | 2,688 |
| | LASP- ≠ > LDER- | 13.416*** | 6,861 | 3.95 | 2,753 |
| | LDER- ≠ > LASP+ | 5.312** | 6,662 | 3,938 | 2,747 |
| | LASP- ≠ > LBOP- | 2.773* | 6,663 | 3,795 | 2,527 |
| | LBOP+ ≠ > LASP+ | 10.269*** | 6,715 | 3,622 | 2,556 |
| | LIR- ≠ > LASP+ | 2.480* | 7,263 | 3,776 | 2.42 |
| | | | | | |
| Gol Linhas Aeras | LASP- ≠ > LDER- | 8.732*** | 6,882 | 3,828 | 2,641 |
| | LASP+ ≠ > LDER- | 7.050*** | 6.91 | 3.90 | 2.66 |
| | LDER- ≠ > LASP+ | 6.053** | 6,351 | 3,629 | 2,611 |
| | LASP- ≠ > LBOP+ | 3.979** | 6,681 | 3,915 | 2,675 |
| | LASP+ ≠ > LIR- | 5.293** | 7,185 | 4,083 | 2,803 |
| | LIR+ ≠ > LASP+ | 3.738* | 7.40 | 3.98 | 2.76 |
| | | | | | |
| Jetblue | LASP- ≠ > LDER- | 9.698*** | 6,923 | 3,875 | 2,713 |
| | LDER- ≠ > LASP- | 2.736* | 6,618 | 3,762 | 2,681 |
| | LDER- ≠ > LASP+ | 14.209*** | 6,321 | 3,773 | 2,701 |
| | LASP+ ≠ > LBOP+ | 2.974* | 7,338 | 3,731 | 2,664 |
| | LASP- ≠ > LBOP+ | 6.998** | 7,509 | 4,223 | 2,949 |
| | LBOP+ ≠ > LASP+ | 5.290** | 7,198 | 3,893 | 2,765 |
| | LBOP- ≠ > LASP+ | 4.757** | 7,073 | 4,039 | 2,781 |
| | LASP- ≠ > LIR- | 6.329** | 7,401 | 4,053 | 2,717 |
| | LASP- ≠ > LIR+ | 13.986*** | 10,377 | 6,033 | 4.48 |
| | LASP+ ≠ > LIR- | 8.513** | 9,511 | 6,006 | 4.63 |
| | LIR- ≠ > LASP+ | 9.916*** | 6,642 | 3,941 | 2,702 |
| | | | | | |
| Norwegian | LASP- ≠ > LDER- | 12.904*** | 6,205 | 3,576 | 2,625 |
| | LDER- ≠ > LASP+ | 5.777** | 7,076 | 3,868 | 2.71 |
| | LBOP- ≠ > LASP+ | 5.598* | 9.70 | 6,214 | 4,547 |
| | | | | | |

| Hatemi-J (2012) Asymmetric Causality Analysis | | | | | |
|---|---|---|---|---|---|
| Airlines | Direction of Causality | Wald Stat. | Critical Bootstrap Value | | |
| | | | 1% | 5% | 10% |
| Southwest | LDER- ≠ > LASP- | 10.894*** | 7,265 | 3,892 | 2.66 |
| | LDER- ≠ > LASP+ | 7.986*** | 6,692 | 3,756 | 2,727 |
| | LASP- ≠ > LBOP+ | 4.616** | 7.01 | 3.77 | 2.65 |
| | LBOP- ≠ > LASP- | 4.335** | 7,075 | 4,048 | 2,776 |
| | LIR- ≠ > LASP+ | 47.711*** | 15,775 | 11,199 | 9,275 |
| | LIR+ ≠ > LASP- | 12.711** | 15.78 | 11,492 | 9,384 |
| | | | | | |
| WestJet | LASP+ ≠ > LDER+ | 2.521* | 7,438 | 3,621 | 2,391 |
| | LBOP+ ≠ > LASP+ | 7.184*** | 68,616 | 3,957 | 2,807 |

Note: The ⇏ sign indicates the null hypothesis of no causality. *,** and *** values indicate that the test statistic is significant at 10%, 5% and 1% significance levels, respectively. The optimal lag length was decided according to the HJC information criterion. Bootstrap count is 10,000

Hatemi-J (2012) asymmetric causality test was applied to all airlines in order to investigate the causality relationship between stock price and macroeconomic (brent oil price, interest rate, dollar exchange rate) variables, and the findings are shown in Table 5.7. Analysis comments were made by evaluating all airlines together. A holistic causality interpretation was made in the context of the variable.

According to the test results on the dollar exchange rate, a causality relationship between negative shocks in the dollar rate and positive shocks in the stock price was determined for 8 Airlines (United Arlines, Singapore, Aeroflot, Easyjet, Gol Linhas Aeras, Jetblue, Norwegian and Southwest). It has been determined that there is a causality relationship from positive shocks in the dollar exchange rate to positive shocks in the stock price for Air China. It was concluded that there is a causality relationship from positive shocks in the dollar exchange rate to negative shocks in the stock price for 2 airlines (Turkish Airline, Air China), while there is a causality relationship from negative shocks in the dollar exchange rate to negative shocks in the stock price for 3 airlines (Singapore, Jetblue and Southwest). Based on the analysis results, there was a significant relationship between the dollar exchange rate and the stock price, regardless of the positive or negative shocks, for 10 airlines. Based on this, it can be said that there are significant relationships between the dollar exchange rate and the stock price, especially negative changes in the dollar exchange rate positively affect the stock prices in airlines.

According to the findings on the Brent oil price variable, a causality relationship was determined from positive shocks in Brent oil prices to positive shocks in stock price for 6 Airlines (United Airlines, Air China, Air Canada, Easyjet, Jetblue, and Westjet). A causality relationship was found from negative shocks in Brent oil prices to negative shocks in stock prices for 5 Airlines (Singapore, Qantas, Air China, Air Canada, and Southwest). A causality relationship was determined from negative shocks in Brent oil prices to positive shocks in stock prices for two airlines (Jetblue and Norwegien). A causality relationship was found from positive shocks in Brent oil prices to negative shocks in stock prices for 3 airlines (United Airlines, Lufthansa, and Qantas Airways). Based on the analysis results, there was a significant relationship between the oil price and the stock price, regardless of the positive or negative shocks, for 10 airlines.

Based on this, it can be said that there are significant relationships between the oil price and the stock price, especially positive changes in the oil price positively affect the stock prices in airlines. Similarly, decreasing oil prices negatively affects the share prices of airlines.

According to the findings on the interest rate variable, a causality relationship was determined from positive shocks in interest rate to positive shocks in stock price for 4 Airlines (United Airlines, Air China, Turkish Airlines, and Aeroflot). A causality relationship was found from negative shocks in interest rate to negative shocks in stock price for two airlines (Turkish Airlines and Aeroflot). A causality relationship was found from negative shocks in interest rate to positive shocks in stock price for 8 airlines (Turkish Airlines, Singapore, Qantas Airways, Lufthansa, Jetblue, Qatar Airways, easyJet, and Southwest). A causality relationship was determined from positive shocks in interest rate to negative shocks in stock price for 3 airlines (United Airlines, Qatar Airways, and Southwest). Based on the analysis results, there was a significant relationship between the interest rate and the stock price, regardless of the positive or negative shocks, for 10 airlines. Based on this, it can be said that there are significant relationships between the exchange rate and the stock price, especially negative changes in the dollar exchange rate positively affect the stock prices in airlines.

According to the results of Toda and Yomamato (1995) causality test, it was found that there was a significant relationship between variables of the dollar exchange rate and oil price and stock prices of airlines. A significant relationship was not determined between interest rate and stock price, except for one airline.

According to the Hatemi-J (2012) asymmetric causality test results, significant relationships were determined between variables of the dollar rate, oil price, and interest rate and stock prices of airlines. According to the results of the asymmetric causality test, in particular, decreasing the dollar rate, increasing Brent oil prices, and decreasing interest rates positively affect the stock prices of airlines.

## 4. CONCLUSIONS AND RECOMMENDATIONS

The subject of this study is the mutual financial relations of airlines' stock prices and macroeconomic factors. In this context, the main purpose of the study is to determine the macroeconomic factors that affect the stock prices of airlines.

The change in stock prices and the development of the market vary depending on the decisions taken by investors. The decisions taken by the investors are determined according to the performance of the enterprises, the economic situation of the country, political developments and changes in macroeconomic factors. Determining what these factors are and revealing their power to influence stock prices is extremely important for the formation of prices and investment decisions. In this direction, three macroeconomic factors that may have a high impact on stock prices of airlines have been studied. These are the Brent oil price, dollar exchange rate and interest rate. In application, the relationship between the daily macroeconomic data of 14 airlines covering the years 2009-2018 and the stock prices of airlines was analyzed with the Toda Yomamato causality and Hatemi-J asymmetric causality tests, and significant relationships were determined regarding the macroeconomic factors determining the stock prices.

According to the results of Toda and Yomamato (1995) causality test, it was found that there was a significant relationship between variables of the dollar exchange rate and oil price and stock prices of airlines. A significant relationship was not determined between interest rate and stock price, except for one airline. According to the results of Hatemi-J (2012) asymmetric causality test, it was found that there were significant relationships between variables of the dollar exchange rate, oil price, and interest rate, and airline stock prices.

According to the results of both causal analyses, it can be said that there are significant relationships between the DER variable and the stock price, especially negative changes in the dollar exchange rate positively affect the stock prices in airlines. It is understood that fluctuations in the exchange rates are reflected in the stock price of airlines. As a result of the analysis, it was found that falls in the dollar exchange rate in 8 airlines led to an increase in stock prices. The result confirms the theory of the inverse relationship between the exchange rate and the stock price. Given the impact of exchange rate changes on the stock price, hedging strategies can be used more effectively to optimize the costs caused by exchange rates. Countries with high import rates, especially those that import with foreign currency, are very affected by fluctuations in the exchange rate. In this context, most of the airlines buy jet fuels in dollar. The increase in the dollar exchange rate indirectly increases the cost of jet fuels. In the opposite case (a decrease in the dollar exchange rate), fuel costs decrease. Decreasing jet fuel costs will have a positive impact on financial performance. The result of the analysis confirms the thesis.

According to the results of both causal analyses, it was found that there were significant relationships between the BOP variable and the stock price. In line with the hypothesis, 5 airlines have been identified that the increase or decrease in oil prices is inversely related to stock prices. But contrary to this conclusion and inconsistent with the theory, 9 airlines have been identified that the increase or decrease in oil prices is directly related to stock prices. According to these two results, it was observed that changes in oil prices affect stock prices differently. According to the first result, 5 airlines can minimize the increase in fuel costs by implementing effective hedging strategies or operating fuel-efficient aircraft. According to the second result, the existence of a linear relationship between oil prices and stock price indicates that 9 airlines effectively implement hedging strategies and/or control fuel costs. Studies (Carter et al., 2006; Morrell and Swan, 2006; Treanor et al. 2014 and Hanninen, 2017) on the efficiency of fuel hedging strategy support this. Further studies may elaborate on the fuel hedging performance of these 9 airlines.

According to the results of the Hatemi-J asymmetric causality test, it was determined that the interest variable is the cause of stock prices. In line with the hypothesis, a causality relationship from negative shocks in interest rates to positive shocks in stock prices was found for 8 airlines. In summary, it can be said that the share price of airlines increases when interest rates fall. This result is also consistent with the theory. Reductions in interest rates can also increase liquidity, as well as reduce interest expenses of airlines. At the same time, with a decrease in interest rates, airline companies can benefit from cheap loans. The availability of cheap credit positively affects profitability and stock value. Financing aircraft purchase is the biggest financial burden for airlines. Airlines borrow heavily during the purchase or leasing of aircraft. As a result of decreasing interest rates, capital costs will also fall, and as a result, airlines' stock prices will increase.

As a result of the analysis, the result that negative changes in the dollar exchange rate positively affect the stock prices of airline companies supports the studies in the literature (Tsai, 2008 and Yashodha, 2016). The result that an increase or decrease in oil prices has an inverse relationship with stock prices supports the studies in the literature (Loudon, 2004; Fernando, 2006 and Tsai, 2008). Finally, the finding that there is a causality relationship from negative shocks in interest rates to positive shocks in stock prices is similar to the study in the literature (Tsai, 2008).

In summary, this study; provides evidence of the volatility of oil prices, exchange rate and interest rate changes on global airlines, both at the firm level and collectively. There are several policy implications for airlines, practitioners, policy makers and investors to manage the relevant macroeconomic risks. First, as the importance of oil prices to the airline industry emerges, airline managers, private and institutional investors should pursue policy uncertainty, assuming oil price uncertainty is a driving force in stock returns. However, airlines should review their financial hedging strategies against fuel price risk. In addition, the innovation and adoption of alternative fuel technology by the aviation and airline industry can be a successful alternative to oil price risk. Exchange rate changes and interest rate mismatches always lead to variable earnings. The results on changes in exchange rate and interest rate indicate that airlines and related governments should focus on policies that will increase the growth of the aviation industry. In order to better manage these risks, financial managers need to more carefully examine the effects of macroeconomic risk increases and changes in related stock prices. Finally, it is thought that the findings obtained as a result of the study will contribute to the determination of the factors affecting the stock prices of the airline companies, to determine the variables that determine the investment decisions and stock prices. In addition, it is thought that it will provide positive contributions to the financial performance of airline companies by bringing new solutions to airline companies in the context of maximizing stock prices.

The study has some limitations that will affect the research results. The first of these is the limitation in the number of samples, although the sample of the research is the largest compared to other studies. Another limitation is the frequency and duration of the statistical data used in the research. Another limitation is the limited number of independent variables. It is thought that conducting more frequent and long-term studies with more samples (airline operators) and variables in future studies will yield more accurate results. In addition, the effectiveness of hedging methods related to changes in exchange rates and interest rates, especially oil prices, can be measured by quantitative and qualitative study methods.

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# Annexes

### Annex 1: List of Airlines

| Airlines Sample | |
|---|---|
| Turkish Airlines | Southwest Airlines |
| United Airlines | Easyjet |
| Air Canada | Norwegian |
| Singapore Airlines | GOL Linhas Aeras |
| Qantas Airlines | Westjet |
| Lufthansa | Jetblue |
| Air China | Aeroflot |

### Annex 2: The Relationship Between Macroeconomic Factors and Stocks (International Literature)

| Study | Period / Country | Method | Findings |
|---|---|---|---|
| Aggarwal (1981) | USA (1974-1978) | Basic Regression Analysis | **Exchange rate** ⇏ Stock price |
| Solnik (1987) | (USA, Japan, Germany, UK, France Canada etc.) | Multiple linear regression analysis | **Exchange rate** ⇏ **(+)** Stock price |
| Kwan and Shin (1999) | South Korea Stock Exchange (1980-1992) | VEC Model-Cointegration | **Exchange rate** ⇏ Stock price |
| Sadorsky (1999) | USA (1974-1976) | VAR Model | **Oil price** ⇏ Stock price |
| Nasseh and Strauss (2000) | 6 European Countires (1962-1995) | Regression Analysis-Johansen Cointegration | **Interest rate** ⇏ Stock price |
| Papapetrou (2001) | Yunanistan (1989-1996) | Multiple linear regression analysis – VAR Model | **Oil price** ⇏ **(-)** Stock price |
| Wongbangpo and Sharma (2002) | 5 Far Eastern Countries (1985-1996) | VAR Model-Granger Cuasality (VECM) | **Interest rate and Exchange rate** ⇏ Stock price |
| Gan et al. (2006) | New Zeland | VAR Model –Cointegration- Impulse-Response | **Interest rate and Exchange rate** ⇏ Stock price |
| Humpe and Macmillan (2007) | Japon | VAR Model-Cointegration | **Interest rate** ⇏ **(-)** Stock price |
| Malik and Hammoudeh (2007) | USA, Bayrain, Kuwait and Saudi Arabia (1992-2001) | GARCH Model | **Oil price** ⇏ Stock price |

| Study | Period / Country | Method | Findings |
|---|---|---|---|
| Ratanapakorn and Sharma (2007) | USA (1975-1999) | VAR-Granger Causality | **Interest rate** ⇏ **(-)** Stock price **Exchange rate** ⇏ **(+)** Stock price |
| Brahmasrene and Jiranyakul (2008) | Thailand stock market (1992-2003) | VAR Model- Cointegration and Granger Causality | **Oil price and Exchange rate** ⇏ **(-)** Stock price |
| Rey (2008) | India | VAR Model-Granger Causality | **Exchange rate** ⇏ **(+)** Stock price |
| Park and Ratti (2008) | USA and13 European Countries (1986-2005) | VAR Model | **Oil price** ⇏ Stock price |
| Humpe and Macmillan (2009) | USA ve Japan Stock Markets (1968-2008) | Regression Analysis | **Interest rate** ⇏ **(-)** Stock price |
| Arfaoui et al. (2010) | 13 developed and developing countries (1986-2008) | Regression ECM Model | **Oil price and Exchange rate** ⇏ Stock price |
| Sohail (2010) | Pakistan (1991-2008) | VAR model | **Interest rate** ⇏ **(-)** Stock price **Exchange rate** ⇏ **(+)** Stock price |
| Rasiah and Ratneswory (2010) | Malaysia (1980-2006) | Multivariate VAR Model | **Exchange rate** ⇏ **(+)** Stock price |
| Shubita and Al Sharkas (2010) | USA and Japan | VAR Model –VECM | **Interest rate** ⇏ **(-)** Stock price |
| Hsing (2011) | Czech stock market (2001-2009) | GARCH Model | **Interest rate** ⇏ Stock price |
| Kuwornu and Victor (2011) | Gana Stock market (1992-2008) | Box-Jenkins ve EKK Regression Model | **Interest rate** ⇏ Stock price **Exchange rate** ⇏ Stock price **Oil price** ⇏ Stock price |
| Kavklar and Festic (2011) | 27 European Countries (2004-2010) | Model-based recursive partitioning mod. | **Interest rate** ⇏ **(-)** Stock price **Exchange rate** ⇏ **(+)** Stock price |
| Aloui et al. (2012) | 25 Developing Countries (1997-2007) | Regression model | **Oil price** ⇏ Stock price |
| Khan and Amanullah (2012) | Pakistan Karachi Stock Market (34 Companies) (2000-2009) | Linear Multiple Regression | **Interest rate** ⇏ **(+)** Stock price |
| Araori et al. (2012) | European Stock Mrkets | VAR-GARCH | **Oil price** ⇏ Stock price |
| Scholtnes and Yurtsever (2012) | European Area (38 Industry) | Dynamic VAR and Linear Multiple Regression | **Oil price** ⇏ **(-)** Stock price |
| Li et al. (2012) | China (13 Industry Indexes) (2001-2010) | Panel Cointegration-Granger Causality | **Oil price** ⇏ **(+)** Stock price |

| Study | Period / Country | Method | Findings |
|---|---|---|---|
| Talla (2013) | Sweden | Linear Multiple Regression | **Exchange rate** ⇏ **(-)** Stock price |
| Degiannakis vd. (2013) | European industrial sector (1992-2010) | Correlation Method | **Oil price** ⇏ Stock price |
| Mollick and Assefe (2013) | USA (1999-2011) | GARCH – DCC-GARCH | **Oil price** ⇏ **(-)** Stock price (before 2008) **Oil price** ⇏ **(+)** Stock price (after 2008) |
| Abdelbaki (2013) | Bahrain (1990-2007) | Autoregressive Distrubed Lag Model | **Interest rate** ⇏ Stock price |
| Kabir et al. (2014) | Malaysia (1991-2010) | VAR- VECM Model | **Interest rate** ⇏ Stock price **Exchange rate** ⇏ Stock price |
| Zhu et al. (2014) | Asya-Pacific(10 Ülke) (2010-2012) | Conditional and Unconditional Copula Model | **Oil price** ⇏ Stock price |
| Narayan and Sharma (2014) | NYSE USA (2000-2008) | GARCH | **Oil price** ⇏ **(-)** Stock price |
| Khalfaoi et al. (2015) | G-7 Countries (2003-2012) | BEKK -GARCH | **Oil price** ⇏ Stock price |
| Arshad et al. (2015) | Karaçi (Pakistan) Stock Market (2007-2013) | Linear regression analysis | **Interest rate** ⇏ **(-)** Stock price |
| Utami et al. (2015) | Indonesian construction industry (2010-2014) | Panel Data Analysis | **Interest rate** ⇏ **(-)** Stock price |
| Bukulu (2016) | Uganda MKB (2007-2014) | Multiple regression analysis | **Interest rate** ⇏ Stock price **Exchange rate** ⇏ Stock price |
| Linck and DEcourt (2016) | Brazil (2000-2010) | Stepwise multiple regression analysis | **Interest rate** ⇏ Stock price |
| Jareno and Negrut (2016) | USA (2008-2014) | Quantile Regression analysis | **Interest rate** ⇏ **(-)** Stock price |
| Subing (2017) | Indonesian-18 Companies (2008-2015) | Panel Data Analysis | **Oil price** ⇏ **(+)** Stock price |
| Malik vd. (2018) | Pakistan, India and Sri Lanka (1997-2014) | Panel GMM Approach | **Exchange rate** ⇏ **(+)** Stock price |
| Chandrosheker et al. (2018) | India and Brazil (2000-2016) | Panel Data Analysis | **Exchange rate** ⇏ **(+)** Stock price |

## Annex 3: The Relationship Between Macroeconomic Factors and Stocks (National Literature)

| Study | Period / Country | Method | Findings |
|---|---|---|---|
| Durukan (1999) | BIST100 (1986-1998) | Percentage change model and natural logaritma | **Interest rate** ⇏ Stock price |
| Albeni and Demir (2005) | ISE Financial Industry (1991-2000) | Multiple regression analysis | **Interest rate** ⇏ Stock price **Exchange rate** ⇏ Stock price |
| Yılmaz et al. (2006) | ISE (1990-2003) | EKK, VEC Model | **Interest rate** ⇏ Stock price **Exchange rate** ⇏ Stock price |
| Gençtürk (2009) | ISE (1992-1996) | Multiple linear regression analysis | **Interest rate** ⇏ Stock price **Exchange rate** ⇏ Stock price |
| Süslü (2010) | 11 Developing Countires (1999-2006) | Panel data analysis | **Interest rate** ⇏ Stock price **Exchange rate** ⇏ Stock price **Oil price** ⇏ Stock price |
| İşçan (2010) | BIST100 (2001-2009) | VAR Model | **Oil price** Stock price |
| Sayılgan and Süslü (2010) | Developing Countires (1999-2006) | Balanced panel data analysis | **Exchange rate** ⇏ Stock price |
| Büyükşalvarcı and Abdioğlu (2010) | BIST100 (2001-2010) | VAR Model – Toda-Yomamato Causality | **Exchange rate** ⇏ Stock price |
| Karacaer and Kapusuzoğlu (2010) | BIST100 (2003-2010) | VAR – Causality, Cointegration | **Exchange rate** ⇏ Stock price |
| Soytaş and Oran (2011) | BIST100 Electric Industry | VAR - EGARCH | **Oil price** ⇏ Stock price |
| Ayaydın and Dağlı (2012) | 22 Developing Countries | Panel data analysis | **Exchange rate** ⇏ **(+)** Stock price |
| Öztürk et al. (2013) | BIST100 (Manufacturing, Chemistry and Petroleum) | VAR Model | **Oil price** ⇏ Stock price |
| Şener et al. (2013) | BIST100 (2002-2012) | VAR Model | **Oil price** ⇏ Stock price |
| Yıldırım et al. (2014) | BIST Industrial (1991-2013) | VAR Model | **Oil price** ⇏ **(+)** Stock price |
| Kılıç et al. (2014) | BIST Industrial (1994-2013) | Gregory Hansen Dynamic EKK | **Oil price** ⇏ **(+)** Stock price |
| Abdioğlu and Değirmenci (2014) | BIST100 (2005-2013) | VAR Model | **Oil price** ⇏ Stock price |

| Study | Period / Country | Method | Findings |
|---|---|---|---|
| Doğru (2015) | European, MIST and BRICS (2002-2014) | VAR - EGARCH | **Oil price** ⇏ Stock price |
| Güngör and Kaygın (2015) | BIST Manufacturing (2005-2011) | Dynamic Panel Data Analysis | **Exchange rate** ⇏ **(+)** Stock price **Oil price** ⇏ **(+)** Stock price |
| Poyraz and Tepel (2015) | BIST100 (1995-2011) | Multiple linear regression analysis | **Exchange rate** ⇏ **(-)** Stock price **Interest rate** ⇏ **(-)** Stock price |
| Altınbaş et al. (2015) | BIST100 (2003-2012) | VAR Model | **Exchange rate** ⇏ **(-)** Stock price |
| Coşkun and Ümit (2016) | BIST100 (2005-2015) | VAR Causality | **Exchange rate** ⇏ Stock price |
| Kendirli and Çankaya (2016) | BIST Bank (2009-2015) | VAR Model | **Exchange rate** ⇏ **(-)** Stock price |
| Sancar et al. (2017) | BIST100 (2000-2016) | DOLS and FMOLS Analysis | **Exchange rate** ⇏ **(-)** Stock price |
| Sadaghzadeh and Elmas (2018) | BIST Commercial (2000-2017) | Panel Data Analysis | **Exchange rate** ⇏ **(-)** Stock price **Interest rate** ⇏ **(-)** Stock price |
| Demir (2019) | BIST100 (2003-2017) | ARDL Approach | **Exchange rate** ⇏ **(+)** Stock price **Oil price** ⇏ **(-)** Stock price |

## Annex 4: Causality Analysis Unit Root Test Results

| Airlines | Variables | ADF-Test Statistics(Level) | | ADF-Test Statistics(1. difference) | |
|---|---|---|---|---|---|
| | | Constant | Constant and Trend | Constant | Constant and Trend |
| United Airlines | LASP | -1.21397 (0,6706) | -2.50774 (0.3243) | -48.5567 (0.0001) | -48.5474 (0.0000) |
| | LIR | -2.21632 (0.2006) | -2.30433 (0.4309) | -54.133 0.0001 | -54.1228 0.0000 |
| | LDER | -1.68376 (0.4395) | -2.47218 (0.3421) | -51.9482 (0.0001) | -51.9384 (0.0000) |
| | LBOP | -1.54241 (0.5120) | -2.34089 (0.4110) | -54.026 (0.0001) | -54.058 (0.0000) |

| Airlines | Variables | ADF-Test Statistics(Level) | | ADF-Test Statistics(1. difference) | |
|---|---|---|---|---|---|
| | | Constant | Constant and Trend | Constant | Constant and Trend |
| Turkish Airlines | LASP | -0.95011 (0.7725) | -1.79606 (0.7067) | -55.3598 (0.0001) | -55.3518 (0.0000) |
| | LIR | -1.47155 (0.5482) | -0.98859 (0.9439) | -60.1277 (0.0001) | -60.1784 (0.0000) |
| | LDER | 1.059713 (0.9972) | -2.2711 (0.4492) | -28.7112 (0.0000) | -28.7814 (0.0000) |
| | LBOP | -1.53399 (0.5164) | -1.95498 (0.625) | -59.9069 (0.0001) | -59.9124 (0.0000) |
| Singapore Airlines | LASP | -2.08937 (0.2491) | -2.99029 (0.1351) | -52.9474 (0.0001) | -52.9479 (0.0000) |
| | LIR | -2.70664 (0.073) | -2.71232 (0.2316) | -60.3848 (0.0001) | -60.3734 (0.0000) |
| | LDER | -1.91305 (0.3265) | -1.9671 (0.6184) | -53.1502 (0.0001) | -53.1664 (0.0000) |
| | LBOP | -1.54241 (0.5120) | -2.34089 (0.4110) | -54.026 (0.0001) | -54.058 (0.0000) |
| Qantas Airways | LASP | -0.40951 (0.9052) | -1.61603 (0.7868) | -50.4062 (0.0001) | -50.4361 (0.0000) |
| | LIR | -1.08131 (0.7253) | -3.28599 (0.0687) | -51.8308 (0.0001) | -51.8281 (0.0000) |
| | LDER | -2.29739 (0.1729) | -2.64155 (0.2617) | -14.8604 (0.0000) | -14.865 (0.0000) |
| | LBOP | -1.54241 (0.5120) | -2.34089 (0.4110) | -54.026 (0.0001) | -54.026 (0.0001) |
| Lufthansa Airlines | LASP | -1.56446 (0.50079 | -2.20526 (0.4859) | -49.5213 (0.0001) | -49.5132 (0.0000) |
| | LIR | -1.68779 (0.4374) | -3.25412 (0.0743) | -20.2008 (0.0000) | -20.1969 (0.0000) |
| | LDER | -1.68343 (0.4396) | -2.47297 (0.3417) | -51.9482 (0.0001) | -51.9383 (0.0000) |
| | LBOP | -1.54241 (0.5120) | -2.34089 (0.411) | -54.026 (0.0001) | -54.058 (0.0000) |
| Air China | LASP | -2.16457 (0.2196) | -2.13241 (0.5268) | -47.3102 (0.0001) | -47.3106 (0.0000) |
| | LIR | -2.49796 (0.116) | -2.5784 (0.2904) | -36.3309 (0.0001) | -36.36 (0.0000) |
| | LDER | -0.88008 (0.795) | -0.7243 (0.9704) | -51.2119 (0.0001) | -51.2987 (0.0000) |
| | LBOP | -1.54241 (0.5120) | -2.34089 (0.4110) | -54.026 (0.0001) | -54.058 (0.0000) |

| Airlines | Variables | ADF-Test Statistics(Level) | | ADF-Test Statistics(1. difference) | |
|---|---|---|---|---|---|
| | | Constant | Constant and Trend | Constant | Constant and Trend |
| Aeroflot | LASP | -1.59872 (0.4831) | -1.58365 (0.7995) | -48.566 (0.0001) | -48.5646 (0.0000) |
| | LIR | -3.7175 (0.0039) | -3.67119 (0.0244) | -24.1436 (0.0000) | -24.1479 (0.0000) |
| | LDER | -0.43884 (0.9001) | -1.76154 (0.7232) | -51.7562 (0.0001) | -51.7512 (0.0000) |
| | LBOP | -1.54241 (0.5120) | -2.34089 (0.4110) | -54.026 (0.0001) | -54.058 (0.0000) |
| Air Canada | LASP | -2.16457 (0.2196( | -2.13241 (0.5268) | -47.3102 (0.0001) | -47.3106 (0.0000) |
| | LIR | -1.83955 (0.3615) | -2.15779 (0.5125) | -51.8502 (0.0001) | -51.8422 (0.0000) |
| | LDER | -3.338 (0.0134) | -3.61609 80.0286) | -21.3296 (0.0000) | -21.327 (0.0000) |
| | LBOP | -1.54241 (0.5120) | -2.34089 80.4110) | -54.026 (0.0001) | -54.058 (0.0000) |
| Easyjet | LASP | -1.65538 (0.454) | -1.01484 (0.9403) | -49.7491 (0.0001) | -49.7702 (0.0000) |
| | LIR | -1.57127 (0.4972) | -3.13876 (0.0975) | -52.5233 (0.0001) | -52.5135 (0.0000) |
| | LDER | -1.68343 (0.4396) | -2.47297 (0.3417) | -51.9482 (0.0001) | -51.9383 (0.0000) |
| | LBOP | -1.68343 (0.4396) | -2.47297 (0.3417) | -51.9482 (0.0001) | -51.9383 (0.0000) |
| Gol Linhas Aeras | LASP | -1.37094 (0.598) | -1.21986 (0.9054) | -49.8904 (0.0001) | -49.8891 (0.0000) |
| | LIR | -0.69097 (0.8471) | -0.90032 (0.9544) | -34.939 (0.0000) | -34.9486 (0.0000) |
| | LDER | -0.01738 (0.9559) | -2.96526 (0.1423) | -55.3418 (0.0001) | -55.3772 (0.0000) |
| | LBOP | -1.54238 (0.512) | -2.34086 (0.411) | -54.0266 (0.0001) | -54.0586 (0.0000) |
| JetBlue | LASP | -1.00447 (0.7538) | -2.57575 (0.2916) | -50.6404 (0.0001) | -50.6315 (0.0000) |
| | LIR | -2.21632 (0.2006) | -2.30433 (0.4309) | -54.133 (0.0001) | -54.1228 (0.0000) |
| | LDER | -1.68376 (0.4395) | -2.47218 (0.3421) | -51.9482 (0.0001) | -51.9384 (0.0000) |
| | LBOP | -1.68376 (0.4395) | -1.68376 (0.4395) | -51.9482 (0.0001) | -51.9384 (0.0000) |

| Airlines | Variables | ADF-Test Statistics(Level) | | ADF-Test Statistics(1. difference) | |
|---|---|---|---|---|---|
| | | Constant | Constant and Trend | Constant | Constant and Trend |
| Norwegian | LASP | -2.64129 (0.0848) | -2.17174 (0.5047) | -50.2849 (0.0001) | -50.3258 (0.0000) |
| | LIR | -7.574 (0.0000) | -7.57427 (0.0000) | -19.3165 (0.0000) | -19.3129 (0.0000) |
| | LDER | -0.72958 (0.8374) | -2.81907 (0.1904) | -52.5566 (0.0001) | -52.5745 (0.0000) |
| | LBOP | -1.54238 (0.512) | -2.34086 (0.411) | -54.0266 (0.0001) | -54.0586 (0.0000) |
| Southwest | LASP | -0.79693 (0.8193) | -1.66027 (0.7685) | -54.7848 (0.0001) | -54.7747 (0.0000) |
| | LIR | -2.21632 (0.2006) | -2.30433 (0.4309) | -54.133 (0.0001) | -54.1228 (0.0000) |
| | LDER | -1.68376 (0.4395) | -2.47218 (0.3421) | -51.9482 (0.0001) | -51.9384 (0.0000) |
| | LBOP | -1.54241 (0.512) | -2.34089 (0.411) | -54.026 (0.0001) | -54.058 (0.0000) |
| Westjet | LASP | -1.6517 (0.4559) | -1.57375 (0.8033) | -50.2391 (0.0001) | -50.2393 (0.0000) |
| | LIR | -1.83955 (0.3615) | -2.15779 (0.5125) | -51.8502 (0.0001) | -51.8422 (0.0000) |
| | LDER | -3.338 (0.01349 | -3.61609 (0.0286) | -21.3296 (0.0000) | -21.327 (0.0000) |
| | LBOP | -1.54238 (0.512) | -2.34086 (0.411) | -54.0266 (0.0001) | -54.0586 (0.0000) |

## Annex 5: Toda-Yomamato Causality Test (All)

| Airlines | Direction of Causality | | Var(p+d) | Prob. |
|---|---|---|---|---|
| United Airlines | **LASP ⇏ LDER*** | **5.454473** | **2+1** | **0.0654** |
| | LDER ⇏ LASP | 1.614422 | 2+1 | 0.4461 |
| | LASP ⇏ LBOP | 2.769781 | 2+1 | 0.2504 |
| | LBOP ⇏ LASP | 1.598040 | 2+1 | 0.4498 |
| | LASP ⇏ LIR | 0.596795 | 2+1 | 0.7420 |
| | LIR ⇏ LASP | 0.744436 | 2+1 | 0.6892 |
| | | | | |

| Airlines | Direction of Causality | | Var(p+d) | Prob. |
|---|---|---|---|---|
| Turkish Airlines | LASP ⇏ LDER | 3.439227 | 5+1 | 0.6326 |
| | **LDER ⇏ LASP** | **23.00338** | **5+1** | **0.0003** |
| | LASP ⇏ LBOP | 3.273417 | 5+1 | 0.6579 |
| | **LBOP ⇏ LASP** | **12.72166** | **5+1** | **0.0261** |
| | **LASP ⇏ LIR** | **12.28137** | **5+1** | **0.0311** |
| | LIR ⇏ LASP | 6.981030 | 5+1 | 0.2221 |
| | | | | |
| Singapore Airlines | **LASP ⇏ LDER*** | **4.613838** | **2+1** | **0.0996** |
| | **LDER ⇏ LASP** | **14.28926** | **2+1** | **0.0008** |
| | LASP ⇏ LBOP | 1.979957 | 2+1 | 0.3716 |
| | LBOP ⇏ LASP | 0.920073 | 2+1 | 0.6313 |
| | LASP ⇏ LIR | 0.099344 | 2+1 | 0.9515 |
| | LIR ⇏ LASP | 1.564555 | 2+1 | 0.4574 |
| | | | | |
| Qantas Airways | LASP ⇏ LDER | 9.586351 | 11+2 | 0.5679 |
| | **LDER ⇏ LASP** | **19.15354** | **11+2** | **0.0584** |
| | LASP ⇏ LBOP | 10.48858 | 11+2 | 0.4870 |
| | **LBOP ⇏ LASP** | **22.47271** | **11+2** | **0.0210** |
| | LASP ⇏ LIR | 9.957297 | 11+2 | 0.5342 |
| | LIR ⇏ LASP | 14.72919 | 11+2 | 0.1952 |
| | | | | |
| Lufthansa Airlines | LASP ⇏ LDER | 3.839486 | 4+1 | 0.4282 |
| | **LDER ⇏ LASP** | **12.08459** | **4+1** | **0.0167** |
| | **LASP ⇏ LBOP** | **9.412552** | **4+1** | **0.0516** |
| | **LBOP ⇏ LASP** | **14.71976** | **4+1** | **0.0053** |
| | **LASP ⇏ LIR** | **10.41648** | **4+1** | **0.0340** |
| | LIR ⇏ LASP | 7.243989 | 4+1 | 0.1235 |
| | | | | |
| Air China | LASP ⇏ LDER | 0.713048 | 2+1 | 0.7001 |
| | **LDER ⇏ LASP** | **8.574296** | **2+1** | **0.0137** |
| | LASP ⇏ LBOP | 1.456549 | 2+1 | 0.4827 |
| | **LBOP ⇏ LASP** | **11.20648** | **2+1** | **0.0037** |
| | LASP ⇏ LIR | 2.112953 | 2+1 | 0.3477 |
| | LIR ⇏ LASP | 0.233940 | 2+1 | 0.8896 |
| | | | | |

| Airlines | Direction of Causality | | Var(p+d) | Prob. |
|---|---|---|---|---|
| Aeroflot | LASP ⇏ LDER | 7.214308 | 10+2 | 0.7051 |
| | **LDER ⇏ LASP** | **22.90321** | **10+2** | **0.0111** |
| | LASP ⇏ LBOP | 12.07843 | 10+2 | 0.2798 |
| | LBOP ⇏ LASP | 15.54836 | 10+2 | 0.1133 |
| | LASP ⇏ LIR | 12.57227 | 10+2 | 0.2486 |
| | LIR ⇏ LASP | 9.418824 | 10+2 | 0.4929 |
| | | | | |
| Air Canada | LASP ⇏ LDER | 0.475302 | 2+1 | 0.7885 |
| | LDER ⇏ LASP | 1.7763 | 2+1 | 0.4114 |
| | LASP ⇏ LBOP | 1.236906 | 2+1 | 0.5388 |
| | **LBOP ⇏ LASP** | **8.734665** | **2+1** | **0.0127** |
| | LASP ⇏ LIR | 0.400624 | 2+1 | 0.8185 |
| | LIR ⇏ LASP | 0.190176 | 2+1 | 0.9093 |
| | | | | |
| Easyjet | LASP ⇏ LDER | 4.017438 | 2+1 | 0.1342 |
| | **LDER ⇏ LASP** | **11.57768** | **2+1** | **0.0031** |
| | LASP ⇏ LBOP | 0.523379 | 2+1 | 0.7698 |
| | LBOP ⇏ LASP | 2.419486 | 2+1 | 0.2983 |
| | LASP ⇏ LIR | 0.307617 | 2+1 | 0.8574 |
| | **LIR ⇏ LASP** | **7.755625** | **2+1** | **0.0207** |
| | | | | |
| Gol Linhas Aeras | LASP ⇏ LDER | 0.930101 | 2+1 | 0.6281 |
| | **LDER ⇏ LASP** | **9.666582** | **2+1** | **0.008** |
| | LASP ⇏ LBOP | 1.90757 | 2+1 | 0.3853 |
| | LBOP ⇏ LASP | 0.524288 | 2+1 | 0.7694 |
| | LASP ⇏ LIR | 0.986156 | 2+1 | 0.6107 |
| | LIR ⇏ LASP | 1.387106 | 2+1 | 0.4998 |
| | | | | |
| JetBlue | LASP ⇏ LDER | 4.138988 | 2+1 | 0.1262 |
| | LDER ⇏ LASP | 0.238096 | 2+1 | 0.295 |
| | LASP ⇏ LBOP | 1.459149 | 2+1 | 0.4821 |
| | LBOP ⇏ LASP | 1.668923 | 2+1 | 0.8878 |
| | LASP ⇏ LIR | 2.402695 | 2+1 | 0.3008 |
| | LIR ⇏ LASP | 2.441567 | 2+1 | 0.295 |
| | | | | |

| Airlines | Direction of Causality | | Var(p+d) | Prob. |
|---|---|---|---|---|
| Norwegian | **LASP ⇏ LDER*** | **4.622919** | **2+1** | **0.0991** |
| | **LDER ⇏ LASP** | **5.914692** | **2+1** | **0.052** |
| | LASP ⇏ LBOP | 0.691067 | 2+1 | 0.7078 |
| | LBOP ⇏ LASP | 1.673395 | 2+1 | 0.4331 |
| | LASP ⇏ LIR | 0.384805 | 2+1 | 0.825 |
| | LIR ⇏ LASP | 0.373598 | 2+1 | 0.8296 |
| | | | | |
| Southwest | LASP ⇏ LDER | 3.047839 | 2+1 | 0.2179 |
| | LDER ⇏ LASP | 1.577901 | 2+1 | 0.4543 |
| | **LASP ⇏ LBOP** | **7.848946** | **2+1** | **0.0198** |
| | **LBOP ⇏ LASP*** | **5.423005** | **2+1** | **0.0664** |
| | LASP ⇏ LIR | 0.781822 | 2+1 | 0.6764 |
| | LIR ⇏ LASP | 2.90079 | 2+1 | 0.2345 |
| | | | | |
| Westjet | LASP ⇏ LDER | 5.316777 | 8+1 | 0.7232 |
| | LDER ⇏ LASP | 5.195281 | 8+1 | 0.7365 |
| | LASP ⇏ LBOP | 8.260785 | 8+1 | 0.4084 |
| | **LBOP ⇏ LASP*** | **13.0928** | **8+1** | **0.1087** |
| | LASP ⇏ LIR | 6.810396 | 8+1 | 0.5572 |
| | LIR ⇏ LASP | 3.557818 | 8+1 | 0.8947 |
| | | | | |

## Annex 6: Hatemi-J (2012) Asymmetric Causality Analysis Results (All)

| Hatemi-J (2012) Asymmetric Causality Analysis | | | | | |
|---|---|---|---|---|---|
| Airlines | Direction of Causality | Wald Stat. | Critical Bootstrap Value | | |
| | | | 1% | 5% | 10% |
| United Airlines | LASP+ ≠ > LDER+ | 1.504 | 6.73 | 3.921 | 2.736 |
| | **LASP- ≠ > LDER-** | **3.777*** | **7.089** | **3.952** | **2.751** |
| | LASP- ≠ > LDER+ | 0.139 | 6.469 | 3.83 | 2.631 |
| | LASP+ ≠ > LDER- | 0.020 | 6.585 | 3.854 | 2.699 |
| | LDER+ ≠ > LASP+ | 0.252 | 6.874 | 3.884 | 2.729 |
| | LDER- ≠ > LASP- | 1.628 | 6.848 | 3.822 | 2.564 |
| | **LDER- ≠ > LASP+** | **5.525**** | **6.934** | **3.88** | **2.754** |
| | LDER+ ≠ > LASP- | 1.171 | 6.763 | 3.845 | 2.713 |
| | LASP+ ≠ > LBOP+ | 1.801 | 6.378 | 3.786 | 2.543 |
| | LASP- ≠ > LBOP- | 1.191 | 6.323 | 4.112 | 2.738 |
| | **LASP- ≠ > LBOP+** | **5.089**** | **6.805** | **4.001** | **2.839** |
| | LASP+ ≠ > LBOP- | 0.135 | 7.351 | 3.664 | 2.708 |
| | **LBOP+ ≠ > LASP+** | **4.109**** | **6.847** | **3.886** | **2.785** |
| | LBOP- ≠ > LASP- | 1.349 | 6.838 | 3.837 | 2.656 |
| | LBOP- ≠ > LASP+ | 1.196 | 6.958 | 3.868 | 2.745 |
| | **LBOP+ ≠ > LASP-** | **4.932**** | **7.149** | **4.033** | **2.68** |
| | LASP+ ≠ > LIR+ | 1.504 | 6.969 | 3.894 | 2.707 |
| | **LASP- ≠ > LIR-** | **3.777*** | **7.131** | **4.027** | **2.728** |
| | LASP- ≠ > LIR+ | 0.139 | 6.727 | 3.845 | 2.625 |
| | LASP+ ≠ > LIR- | 1.000 | 6.73 | 4.007 | 2.647 |
| | **LIR+ ≠ > LASP+** | **4.109**** | **6.847** | **3.886** | **2.785** |
| | LIR- ≠ > LASP- | 1.349 | 6.838 | 3.837 | 2.656 |
| | LIR- ≠ > LASP+ | 1.196 | 6.958 | 3.868 | 2.745 |
| | LIR+ ≠ > LASP- | **4.932**** | 7.149 | 4.033 | 2.68 |
| | | | | | |

| Hatemi-J (2012) Asymmetric Causality Analysis | | | | | |
|---|---|---|---|---|---|
| Airlines | Direction of Causality | Wald Stat. | Critical Bootstrap Value | | |
| | | | 1% | 5% | 10% |
| Turkish Airlines | **LASP+ ≠ > LDER+** | **5.641**** | **6.505** | **3.846** | **2.72** |
| | **LASP- ≠ > LDER-** | **37.128***** | **9.482** | **6.016** | **4.679** |
| | LASP- ≠ > LDER+ | 0.772 | 6.371 | 3.765 | 2.677 |
| | LASP+ ≠ > LDER- | 0.087 | 6.261 | 3.734 | 2.642 |
| | LDER+ ≠ > LASP+ | 1.796 | 6.131 | 3.843 | 2.609 |
| | LDER- ≠ > LASP- | 0.002 | 9.725 | 6.053 | 4.61 |
| | LDER- ≠ > LASP+ | 0.135 | 6.518 | 3.814 | 2.794 |
| | **LDER+ ≠ > LASP-** | **13.245***** | **6.607** | **3.968** | **2.68** |
| | LASP+ ≠ > LBOP+ | 1.289 | 6.719 | 3.803 | 2.655 |
| | **LASP- ≠ > LBOP-** | **4.509**** | **6.92** | **3.842** | **2.753** |
| | LASP- ≠ > LBOP+ | 0.271 | 7.035 | 4.138 | 2.887 |
| | LASP+ ≠ > LBOP- | 1.235 | 6.83 | 3.902 | 2.776 |
| | LBOP+ ≠ > LASP+ | 0.158 | 6.762 | 3.927 | 2.818 |
| | LBOP- ≠ > LASP- | 0.495 | 6.577 | 3.827 | 2.657 |
| | LBOP- ≠ > LASP+ | 0.054 | 6.811 | 3.932 | 2.719 |
| | LBOP+ ≠ > LASP- | 0.547 | 6.253 | 3.758 | 2.738 |
| | **LASP+ ≠ > LIR+** | **15.025***** | **13.804** | **9.569** | **7.864** |
| | LASP- ≠ > LIR- | 1.159 | 10.819 | 5.98 | 4.494 |
| | LASP- ≠ > LIR+ | 1.278 | 7.474 | 3.821 | 2.76 |
| | LASP+ ≠ > LIR- | 0.000 | 6.343 | 3.732 | 2.624 |
| | **LIR+ ≠ > LASP+** | **13.368**** | **14.051** | **9.456** | **7.645** |
| | **LIR- ≠ > LASP-** | **19.144***** | **9.954** | **6.128** | **4.726** |
| | **LIR- ≠ > LASP+** | **7.235*** | **15.147** | **9.597** | **7.736** |
| | LIR+ ≠ > LASP- | 6.980 | 13.879 | 9.568 | 7.682 |
| | | | | | |

| Hatemi-J (2012) Asymmetric Causality Analysis | | | | | |
|---|---|---|---|---|---|
| **Airlines** | **Direction of Causality** | **Wald Stat.** | **Critical Bootstrap Value** | | |
| | | | **1%** | **5%** | **10%** |
| Singapore Airlines | LASP+ ≠ > LDER+ | 1.955 | 6.699 | 3.805 | 2.726 |
| | **LASP- ≠ > LDER-** | **22.330*** ** | **9.948** | **6.09** | **4.562** |
| | LASP- ≠ > LDER+ | 0.558 | 6.906 | 3.748 | 2.665 |
| | LASP+ ≠ > LDER- | 0.131 | 7.219 | 3.861 | 2.716 |
| | LDER+ ≠ > LASP+ | 0.000 | 6.755 | 3.824 | 2.813 |
| | **LDER- ≠ > LASP-** | **13.059** ** | **13.317** | **8.061** | **6.406** |
| | **LDER- ≠ > LASP+** | **3.539* ** | **6.819** | **3.892** | **2.758** |
| | LDER+ ≠ > LASP- | 1.314 | 7.57 | 3.918 | 2.636 |
| | **LASP+ ≠ > LBOP+** | **8.135*** ** | **6.914** | **3.957** | **2.765** |
| | **LASP- ≠ > LBOP-** | **2.931* ** | **6.96** | **3.86** | **2.657** |
| | LASP- ≠ > LBOP+ | 0.736 | 6.666 | 3.891 | 2.741 |
| | LASP+ ≠ > LBOP- | 0.825 | 6.85 | 3.835 | 2.705 |
| | LBOP+ ≠ > LASP+ | 1.830 | 6.595 | 3.797 | 2.657 |
| | **LBOP- ≠ > LASP-** | **3.799** ** | **7.161** | **3.804** | **2.596** |
| | LBOP- ≠ > LASP+ | 0.401 | 6.918 | 3.827 | 2.672 |
| | LBOP+ ≠ > LASP- | 0.162 | 7.218 | 4.016 | 2.695 |
| | LASP+ ≠ > LIR+ | 0.952 | 9.153 | 3.733 | 2.47 |
| | LASP- ≠ > LIR- | 0.815 | 8.329 | 3.594 | 2.336 |
| | LASP- ≠ > LIR+ | 1.669 | 8.891 | 3.751 | 2.533 |
| | LASP+ ≠ > LIR- | 0.019 | 7.786 | 3.585 | 2.485 |
| | LIR+ ≠ > LASP+ | 0.974 | 8.595 | 3.869 | 2.47 |
| | LIR- ≠ > LASP- | 1.903 | 8.222 | 3.49 | 2.294 |
| | **LIR- ≠ > LASP+** | **2.838* ** | **8.253** | **3.594** | **2.339** |
| | LIR+ ≠ > LASP- | 0.234 | 8.43 | 3.397 | 2.275 |
| | | | | | |

| Hatemi-J (2012) Asymmetric Causality Analysis | | | | | |
|---|---|---|---|---|---|
| Airlines | Direction of Causality | Wald Stat. | Critical Bootstrap Value | | |
| | | | 1% | 5% | 10% |
| Qantas Airways | LASP+ ≠ > LDER+ | 0.034 | 8.023 | 3.545 | 2.382 |
| | LASP- ≠ > LDER- | 1.299 | 11.699 | 3.319 | 2.033 |
| | **LASP- ≠ > LDER+** | **2.786*** | **8.417** | **3.56** | **2.393** |
| | LASP+ ≠ > LDER- | 0.315 | 9.035 | 3.773 | 2.514 |
| | LDER+ ≠ > LASP+ | 0.059 | 8.769 | 3.605 | 2.532 |
| | LDER- ≠ > LASP- | 0.027 | 11.871 | 3.225 | 2.116 |
| | LDER- ≠ > LASP+ | 0.185 | 12.695 | 3.257 | 2.08 |
| | LDER+ ≠ > LASP- | 0.246 | 13.115 | 3.629 | 2.204 |
| | **LASP+ ≠ > LBOP+** | **22.021***** | **9.002** | **5.961** | **4.582** |
| | **LASP- ≠ > LBOP-** | **24.621***** | **15.124** | **9.745** | **7.806** |
| | **LASP- ≠ > LBOP+** | **8.201***** | **7.055** | **3.784** | **2.762** |
| | LASP+ ≠ > LBOP- | 2.008 | 6.892 | 3.868 | 2.698 |
| | LBOP+ ≠ > LASP+ | 1.935 | 9.505 | 6.034 | 4.632 |
| | **LBOP- ≠ > LASP-** | **7.392*** | **14.828** | **9.466** | **7.269** |
| | LBOP- ≠ > LASP+ | 0.033 | 7.368 | 3.871 | 2.743 |
| | **LBOP+ ≠ > LASP-** | **5.937**** | **7.137** | **3.927** | **2.642** |
| | **LASP+ ≠ > LIR+** | **3.147*** | **6.976** | **3.96** | **2.728** |
| | LASP- ≠ > LIR- | 0.732 | 7.25 | 3.993 | 2.728 |
| | LASP- ≠ > LIR+ | 0.178 | 6.853 | 3.998 | 2.792 |
| | LASP+ ≠ > LIR- | 0.007 | 6.652 | 3.895 | 2.756 |
| | LIR+ ≠ > LASP+ | 0.632 | 6.784 | 3.749 | 2.66 |
| | LIR- ≠ > LASP- | 0.000 | 6.941 | 3.849 | 2.654 |
| | **LIR- ≠ > LASP+** | **16.062***** | **14.578** | **9.797** | **7.717** |
| | LIR+ ≠ > LASP- | 4.388 | 14.178 | 9.79 | 7.783 |

| Hatemi-J (2012) Asymmetric Causality Analysis | | | | | |
|---|---|---|---|---|---|
| Airlines | Direction of Causality | Wald Stat. | Critical Bootstrap Value | | |
| | | | 1% | 5% | 10% |
| Lufthansa Airlines | LASP+ ≠ > LDER+ | 0.322 | 6.779 | 3.731 | 2.607 |
| | **LASP- ≠ > LDER-** | **4.633**** | **6.702** | **4.042** | **2.771** |
| | **LASP- ≠ > LDER+** | **6.181**** | **6.565** | **3.785** | **2.687** |
| | **LASP+ ≠ > LDER-** | **4.215**** | **6.541** | **3.749** | **2.638** |
| | LDER+ ≠ > LASP+ | 0.935 | 6.541 | 3.875 | 2.685 |
| | LDER- ≠ > LASP- | 0.181 | 6.864 | 3.92 | 2.778 |
| | LDER- ≠ > LASP+ | 1.715 | 6.597 | 3.796 | 2.688 |
| | LDER+ ≠ > LASP- | 1.856 | 6.718 | 3.821 | 2.605 |
| | LASP+ ≠ > LBOP+ | 0.151 | 6.755 | 3.901 | 2.704 |
| | LASP- ≠ > LBOP- | 0.930 | 6.923 | 3.946 | 2.766 |
| | **LASP- ≠ > LBOP+** | **2.984*** | **6.337** | **3.736** | **2.682** |
| | LASP+ ≠ > LBOP- | 1.161 | 6.88 | 3.893 | 2.674 |
| | LBOP+ ≠ > LASP+ | 0.278 | 6.708 | 3.825 | 2.732 |
| | LBOP- ≠ > LASP- | 1.472 | 6.622 | 3.913 | 2.688 |
| | LBOP- ≠ > LASP+ | 0.000 | 6.696 | 3.832 | 2.737 |
| | **LBOP+ ≠ > LASP-** | **5.383**** | **6.944** | **3.67** | **2.655** |
| | LASP+ ≠ > LIR+ | 1.272 | 6.892 | 3.71 | 2.635 |
| | **LASP- ≠ > LIR-** | **3.041*** | **6.871** | **4** | **2.8** |
| | LASP- ≠ > LIR+ | 0.361 | 6.548 | 3.871 | 2.726 |
| | LASP+ ≠ > LIR- | 1.210 | 6.517 | 3.811 | 2.717 |
| | LIR+ ≠ > LASP+ | 0.244 | 6.844 | 3.854 | 2.723 |
| | LIR- ≠ > LASP- | 0.001 | 6.923 | 3.993 | 2.761 |
| | **LIR- ≠ > LASP+** | **20.236***** | **11.527** | **7.776** | **6.163** |
| | LIR+ ≠ > LASP- | 3.904 | 11.731 | 7.912 | 6.392 |

| Hatemi-J (2012) Asymmetric Causality Analysis | | | | | |
|---|---|---|---|---|---|
| Airlines | Direction of Causality | Wald Stat. | Critical Bootstrap Value | | |
| | | | 1% | 5% | 10% |
| Air China | LASP+ ≠ > LDER+ | 0.310 | 6.937 | 3.906 | 2.708 |
| | LASP- ≠ > LDER- | 0.200 | 6.857 | 3.775 | 2.665 |
| | LASP- ≠ > LDER+ | 0.347 | 7.238 | 3.786 | 2.696 |
| | LASP+ ≠ > LDER- | 0.099 | 6.518 | 3.79 | 2.672 |
| | **LDER+ ≠ > LASP+** | **2.749*** | **6.711** | **3.769** | **2.661** |
| | LDER- ≠ > LASP- | 1.316 | 7.076 | 3.856 | 2.732 |
| | LDER- ≠ > LASP+ | 0.833 | 6.741 | 3.946 | 2.699 |
| | **LDER+ ≠ > LASP-** | **3.226*** | **6.776** | **3.821** | **2.704** |
| | LASP+ ≠ > LBOP+ | 0.065 | 6.356 | 3.721 | 2.543 |
| | **LASP- ≠ > LBOP-** | **4.318**** | **7.038** | **3.817** | **2.618** |
| | LASP- ≠ > LBOP+ | 0.001 | 6.925 | 3.709 | 2.556 |
| | LASP+ ≠ > LBOP- | 1.080 | 6.897 | 3.767 | 2.559 |
| | **LBOP+ ≠ > LASP+** | **3.727*** | **6.765** | **3.953** | **2.762** |
| | **LBOP- ≠ > LASP-** | **4.155**** | **6.944** | **3.676** | **2.601** |
| | LBOP- ≠ > LASP+ | 1.401 | 6.604 | 3.75 | 2.538 |
| | LBOP+ ≠ > LASP- | 0.774 | 6.558 | 3.801 | 2.633 |
| | LASP+ ≠ > LIR+ | 0.076 | 9.516 | 6.162 | 4.658 |
| | LASP- ≠ > LIR- | 0.737 | 9.154 | 5.981 | 4.584 |
| | LASP- ≠ > LIR+ | 0.647 | 9.239 | 5.935 | 4.631 |
| | LASP+ ≠ > LIR- | 0.365 | 9.536 | 5.82 | 4.412 |
| | **LIR+ ≠ > LASP+** | **7.707**** | **9.567** | **6.261** | **4.771** |
| | LIR- ≠ > LASP- | 1.011 | 9.833 | 6.323 | 4.635 |
| | LIR- ≠ > LASP+ | 2.384 | 11.152 | 7.817 | 6.115 |
| | LIR+ ≠ > LASP- | 2.559 | 11.05 | 7.816 | 6.356 |

| Hatemi-J (2012) Asymmetric Causality Analysis | | | | | |
|---|---|---|---|---|---|
| Airlines | Direction of Causality | Wald Stat. | Critical Bootstrap Value | | |
| | | | 1% | 5% | 10% |
| Aeroflot | LASP+ ≠ > LDER+ | 0.167 | 6.933 | 3.729 | 2.598 |
| | **LASP- ≠ > LDER-** | **5.869*** | **10.001** | **5.958** | **4.491** |
| | LASP- ≠ > LDER+ | 2.727 | 10.641 | 6.116 | 4.634 |
| | **LASP+ ≠ > LDER-** | **10.903*****| **9.72** | **6.256** | **4.563** |
| | LDER+ ≠ > LASP+ | 0.737 | 7.235 | 3.725 | 2.706 |
| | LDER- ≠ > LASP- | 2.363 | 9.986 | 6.229 | 4.647 |
| | **LDER- ≠ > LASP+** | **2.574*** | **6.997** | **3.945** | **2.53** |
| | LDER+ ≠ > LASP- | 0.115 | 6.463 | 3.903 | 2.684 |
| | LASP+ ≠ > LBOP+ | 1.866 | 6.801 | 3.924 | 2.785 |
| | LASP- ≠ > LBOP- | 3.331 | 9.752 | 5.997 | 4.58 |
| | **LASP- ≠ > LBOP+** | **4.612**** | **7.157** | **3.862** | **2.646** |
| | **LASP+ ≠ > LBOP-** | **4.530**** | **7.036** | **4.125** | **2.737** |
| | LBOP+ ≠ > LASP+ | 0.431 | 6.906 | 3.695 | 2.658 |
| | LBOP- ≠ > LASP- | 0.928 | 10.025 | 6.073 | 4.603 |
| | LBOP- ≠ > LASP+ | 0.865 | 9.255 | 6.047 | 4.662 |
| | LBOP+ ≠ > LASP- | 0.091 | 9.285 | 6.07 | 4.548 |
| | **LASP+ ≠ > LIR+** | **34.060***** | **26.365** | **16.97** | **13.778** |
| | LASP- ≠ > LIR- | 0.039 | 7.115 | 3.692 | 2.591 |
| | **LASP- ≠ > LIR+** | **4.564**** | **7.634** | **3.792** | **2.572** |
| | **LASP+ ≠ > LIR-** | **7.258***** | **7.199** | **3.603** | **2.499** |
| | **LIR+ ≠ > LASP+** | **18.413**** | **23.567** | **16.782** | **13.796** |
| | **LIR- ≠ > LASP-** | **3.058*** | **7.162** | **3.804** | **2.623** |
| | **LIR- ≠ > LASP+** | **27.380***** | **21.663** | **16.031** | **13.538** |
| | **LIR+ ≠ > LASP-** | **41.742***** | **24.123** | **16.821** | **13.878** |

| Hatemi-J (2012) Asymmetric Causality Analysis | | | | | |
|---|---|---|---|---|---|
| Airlines | Direction of Causality | Wald Stat. | Critical Bootstrap Value | | |
| | | | 1% | 5% | 10% |
| Air Canada | LASP+ ≠ > LDER+ | 0.127 | 8.021 | 4.016 | 2.825 |
| | LASP- ≠ > LDER- | 0.055 | 8.023 | 3.45 | 2.423 |
| | LASP- ≠ > LDER+ | 1.234 | 8.658 | 3.9 | 2.6 |
| | LASP+ ≠ > LDER- | 0.001 | 6.696 | 3.463 | 2.411 |
| | LDER+ ≠ > LASP+ | 0.032 | 7.443 | 3.666 | 2.5 |
| | LDER- ≠ > LASP- | 0.973 | 7.338 | 3.604 | 2.497 |
| | LDER- ≠ > LASP+ | 0.166 | 7.97 | 3.697 | 2.548 |
| | LDER+ ≠ > LASP- | 0.576 | 7.094 | 3.504 | 2.443 |
| | LASP+ ≠ > LBOP+ | 0.065 | 6.379 | 3.929 | 2.637 |
| | **LASP- ≠ > LBOP-** | **4.318**** | **6.623** | **3.955** | **2.736** |
| | LASP- ≠ > LBOP+ | 0.001 | 6.746 | 3.742 | 2.7 |
| | LASP+ ≠ > LBOP- | 1.080 | 6.472 | 3.576 | 2.631 |
| | **LBOP+ ≠ > LASP+** | **3.727*** | **6.765** | **3.953** | **2.762** |
| | **LBOP- ≠ > LASP-** | **4.155**** | **6.944** | **3.676** | **2.601** |
| | LBOP- ≠ > LASP+ | 1.401 | 6.604 | 3.75 | 2.538 |
| | LBOP+ ≠ > LASP- | 0.774 | 6.558 | 3.801 | 2.633 |
| | LASP+ ≠ > LIR+ | 0.240 | 6.09 | 3.71 | 2.748 |
| | LASP- ≠ > LIR- | 1.360 | 6.236 | 4.021 | 2.597 |
| | LASP- ≠ > LIR+ | 0.919 | 5.978 | 3.869 | 2.558 |
| | LASP+ ≠ > LIR- | 0.513 | 7.333 | 3.858 | 2.692 |
| | LIR+ ≠ > LASP+ | 1.127 | 6.996 | 3.813 | 2.639 |
| | LIR- ≠ > LASP- | 0.067 | 6.284 | 3.771 | 2.701 |
| | LIR- ≠ > LASP+ | 0.418 | 7.126 | 4.021 | 2.812 |
| | LIR+ ≠ > LASP- | 0.015 | 7.161 | 3.888 | 2.735 |
| | | | | | |
| | **LASP+ ≠ > LDER+** | **2.766*** | **6.892** | **3.821** | **2.688** |
| | **LASP- ≠ > LDER-** | **13.416***** | **6.861** | **3.95** | **2.753** |

| Hatemi-J (2012) Asymmetric Causality Analysis | | | | | |
|---|---|---|---|---|---|
| **Airlines** | **Direction of Causality** | **Wald Stat.** | **Critical Bootstrap Value** | | |
| | | | **1%** | **5%** | **10%** |
| EasyJet | LASP- ≠ > LDER+ | 1.415 | 7.012 | 3.843 | 2.741 |
| | LASP+ ≠ > LDER- | 0.384 | 6.993 | 3.787 | 2.685 |
| | LDER+ ≠ > LASP+ | 0.153 | 6.644 | 3.738 | 2.623 |
| | LDER- ≠ > LASP- | 0.008 | 7.262 | 3.691 | 2.649 |
| | **LDER- ≠ > LASP+** | **5.312**** | **6.662** | **3.938** | **2.747** |
| | LDER+ ≠ > LASP- | 0.453 | 6.896 | 3.892 | 2.664 |
| | LASP+ ≠ > LBOP+ | 0.010 | 6.882 | 3.785 | 2.601 |
| | **LASP- ≠ > LBOP-** | **2.773*** | **6.663** | **3.795** | **2.527** |
| | LASP- ≠ > LBOP+ | 0.243 | 6.725 | 3.742 | 2.603 |
| | LASP+ ≠ > LBOP- | 0.765 | 6.646 | 3.789 | 2.536 |
| | **LBOP+ ≠ > LASP+** | **10.269***** | **6.715** | **3.622** | **2.556** |
| | LBOP- ≠ > LASP- | 2.224 | 7.467 | 3.802 | 2.652 |
| | LBOP- ≠ > LASP+ | 0.021 | 6.718 | 3.889 | 2.676 |
| | LBOP+ ≠ > LASP- | 0.001 | 7.702 | 3.892 | 2.77 |
| | LASP+ ≠ > LIR+ | 0.230 | 6.892 | 3.69 | 2.628 |
| | LASP- ≠ > LIR- | 1.191 | 6.555 | 3.681 | 2.624 |
| | LASP- ≠ > LIR+ | 1.869 | 6.693 | 3.813 | 2.703 |
| | LASP+ ≠ > LIR- | 0.028 | 6.954 | 3.861 | 2.677 |
| | LIR+ ≠ > LASP+ | 1.725 | 6.295 | 3.788 | 2.639 |
| | LIR- ≠ > LASP- | 1.292 | 6.591 | 3.859 | 2.677 |
| | **LIR- ≠ > LASP+** | **2.480*** | **7.263** | **3.776** | **2.42** |
| | LIR+ ≠ > LASP- | 0.026 | 6.67 | 3.819 | 2.682 |
| | | | | | |
| | LASP+ ≠ > LDER+ | 1.230 | 6.609 | 3.793 | 2.65 |
| | **LASP- ≠ > LDER-** | **8.732***** | **6.882** | **3.828** | **2.641** |

| Hatemi-J (2012) Asymmetric Causality Analysis | | | | | |
|---|---|---|---|---|---|
| Airlines | Direction of Causality | Wald Stat. | Critical Bootstrap Value | | |
| | | | 1% | 5% | 10% |
| Gol Linhas Aeras | LASP- ≠ > LDER+ | 0.264 | 6.886 | 3.757 | 2.617 |
| | **LASP+ ≠ > LDER-** | **7.050*** ** | **6.91** | **3.9** | **2.66** |
| | LDER+ ≠ > LASP+ | 1.133 | 6.974 | 3.822 | 2.665 |
| | LDER- ≠ > LASP- | 0.247 | 7.005 | 3.886 | 2.699 |
| | **LDER- ≠ > LASP+** | **6.053** ** | **6.351** | **3.629** | **2.611** |
| | LDER+ ≠ > LASP- | 0.004 | 6.943 | 3.836 | 2.729 |
| | LASP+ ≠ > LBOP+ | 0.249 | 7.051 | 4.031 | 2.743 |
| | LASP- ≠ > LBOP- | 1.025 | 6.508 | 3.683 | 2.633 |
| | **LASP- ≠ > LBOP+** | **3.979** ** | **6.681** | **3.915** | **2.675** |
| | LASP+ ≠ > LBOP- | 0.050 | 6.769 | 3.795 | 2.746 |
| | LBOP+ ≠ > LASP+ | 0.282 | 6.75 | 3.939 | 2.7 |
| | LBOP- ≠ > LASP- | 0.624 | 7.088 | 3.741 | 2.542 |
| | LBOP- ≠ > LASP+ | 0.420 | 7.097 | 4.011 | 2.82 |
| | LBOP+ ≠ > LASP- | 0.573 | 7.126 | 4.015 | 2.672 |
| | LASP+ ≠ > LIR+ | 0.440 | 6.559 | 3.864 | 2.705 |
| | LASP- ≠ > LIR- | 0.014 | 6.786 | 3.817 | 2.658 |
| | LASP- ≠ > LIR+ | 0.148 | 7.018 | 3.711 | 2.633 |
| | **LASP+ ≠ > LIR-** | **5.293** ** | **7.185** | **4.083** | **2.803** |
| | **LIR+ ≠ > LASP+** | **3.738*** | **7.4** | **3.98** | **2.761** |
| | LIR- ≠ > LASP- | 0.323 | 7.103 | 3.673 | 2.592 |
| | LIR- ≠ > LASP+ | 2.047 | 6.885 | 3.746 | 2.643 |
| | LIR+ ≠ > LASP- | 0.011 | 6.689 | 3.79 | 2.721 |
| | | | | | |
| | LASP+ ≠ > LDER+ | 1.058 | 7.034 | 3.974 | 2.745 |
| | **LASP- ≠ > LDER-** | **9.698*** ** | **6.923** | **3.875** | **2.713** |

| Hatemi-J (2012) Asymmetric Causality Analysis | | | | | |
|---|---|---|---|---|---|
| Airlines | Direction of Causality | Wald Stat. | Critical Bootstrap Value | | |
| | | | 1% | 5% | 10% |
| Jetblue | LASP- ≠ > LDER+ | 1.126 | 6.718 | 3.797 | 2.73 |
| | LASP+ ≠ > LDER- | 0.394 | 6.468 | 3.979 | 2.857 |
| | LDER+ ≠ > LASP+ | 0.396 | 6.469 | 3.803 | 2.636 |
| | **LDER- ≠ > LASP-** | **2.736*** | **6.618** | **3.762** | **2.681** |
| | **LDER- ≠ > LASP+** | **14.209***** | **6.321** | **3.773** | **2.701** |
| | LDER+ ≠ > LASP- | 0.998 | 6.408 | 3.791 | 2.627 |
| | **LASP+ ≠ > LBOP+** | **2.974*** | **7.338** | **3.731** | **2.664** |
| | LASP- ≠ > LBOP- | 1.353 | 6.889 | 3.897 | 2.774 |
| | **LASP- ≠ > LBOP+** | **6.998**** | **7.509** | **4.223** | **2.949** |
| | LASP+ ≠ > LBOP- | 0.184 | 6.872 | 3.903 | 2.746 |
| | **LBOP+ ≠ > LASP+** | **5.290**** | **7.198** | **3.893** | **2.765** |
| | LBOP- ≠ > LASP- | 0.885 | 6.877 | 3.757 | 2.523 |
| | **LBOP- ≠ > LASP+** | **4.757**** | **7.073** | **4.039** | **2.781** |
| | LBOP+ ≠ > LASP- | 0.546 | 6.831 | 3.717 | 2.626 |
| | LASP+ ≠ > LIR+ | 2.241 | 6.956 | 3.866 | 2.735 |
| | **LASP- ≠ > LIR-** | **6.329**** | **7.401** | **4.053** | **2.717** |
| | **LASP- ≠ > LIR+** | **13.986***** | **10.377** | **6.033** | **4.48** |
| | **LASP+ ≠ > LIR-** | **8.513**** | **9.511** | **6.006** | **4.63** |
| | LIR+ ≠ > LASP+ | 0.219 | 6.588 | 3.947 | 2.738 |
| | LIR- ≠ > LASP- | 0.605 | 6.358 | 3.851 | 2.66 |
| | **LIR- ≠ > LASP+** | **9.916***** | **6.642** | **3.941** | **2.702** |
| | LIR+ ≠ > LASP- | 0.470 | 6.821 | 3.864 | 2.647 |
| | | | | | |
| | LASP+ ≠ > LDER+ | 0.678 | 6.803 | 4.035 | 2.79 |
| | **LASP- ≠ > LDER-** | **12.904***** | **6.205** | **3.576** | **2.625** |

| Hatemi-J (2012) Asymmetric Causality Analysis | | | | | |
|---|---|---|---|---|---|
| Airlines | Direction of Causality | Wald Stat. | Critical Bootstrap Value | | |
| | | | 1% | 5% | 10% |
| Norwegian | LASP- ≠ > LDER+ | 0.078 | 6.95 | 3.862 | 2.713 |
| | LASP+ ≠ > LDER- | 0.000 | 6.37 | 3.762 | 2.647 |
| | LDER+ ≠ > LASP+ | 0.265 | 7.092 | 3.889 | 2.737 |
| | LDER- ≠ > LASP- | 0.653 | 6.599 | 3.92 | 2.668 |
| | **LDER- ≠ > LASP+** | **5.777**** | **7.076** | **3.868** | **2.71** |
| | LDER+ ≠ > LASP- | 1.102 | 7.022 | 3.87 | 2.76 |
| | LASP+ ≠ > LBOP+ | 1.880 | 9.348 | 5.934 | 4.65 |
| | LASP- ≠ > LBOP- | 0.572 | 6.313 | 3.798 | 2.611 |
| | LASP- ≠ > LBOP+ | 1.229 | 6.546 | 3.982 | 2.765 |
| | LASP+ ≠ > LBOP- | 0.791 | 7.043 | 3.896 | 2.739 |
| | LBOP+ ≠ > LASP+ | 2.573 | 9.575 | 6.015 | 4.566 |
| | LBOP- ≠ > LASP- | 1.026 | 6.731 | 3.882 | 2.746 |
| | **LBOP- ≠ > LASP+** | **5.598*** | **9.7** | **6.214** | **4.547** |
| | LBOP+ ≠ > LASP- | 2.480 | 9.616 | 6.06 | 4.627 |
| | LASP+ ≠ > LIR+ | 0.006 | 11.589 | 4.046 | 3.232 |
| | LASP- ≠ > LIR- | 0.455 | 10.053 | 4.231 | 2.328 |
| | LASP- ≠ > LIR+ | 0.514 | 8.522 | 4.024 | 2.306 |
| | LASP+ ≠ > LIR- | 0.200 | 11.562 | 4.437 | 2.412 |
| | LIR+ ≠ > LASP+ | 0.409 | 10.726 | 3.94 | 2.146 |
| | LIR- ≠ > LASP- | 0.374 | 10.032 | 4.102 | 2.395 |
| | LIR- ≠ > LASP+ | 0.346 | 11.095 | 4.003 | 2.361 |
| | LIR+ ≠ > LASP- | 0.421 | 11.647 | 4.162 | 2.412 |
| | | | | | |
| | LASP+ ≠ > LDER+ | 0.022 | 6.899 | 3.973 | 2.763 |
| | LASP- ≠ > LDER- | 1.249 | 6.228 | 3.56 | 2.54 |

| Hatemi-J (2012) Asymmetric Causality Analysis | | | | | |
|---|---|---|---|---|---|
| Airlines | Direction of Causality | Wald Stat. | Critical Bootstrap Value | | |
| | | | 1% | 5% | 10% |
| Southwest | LASP- ≠ > LDER+ | 0.511 | 6.238 | 3.69 | 2.608 |
| | LASP+ ≠ > LDER- | 1.899 | 7.371 | 3.83 | 2.659 |
| | LDER+ ≠ > LASP+ | 0.525 | 6.748 | 3.844 | 2.69 |
| | **LDER- ≠ > LASP-** | **10.894*** ** | **7.265** | **3.892** | **2.66** |
| | **LDER- ≠ > LASP+** | **7.986*** ** | **6.692** | **3.756** | **2.727** |
| | LDER+ ≠ > LASP- | 0.332 | 6.697 | 3.827 | 2.704 |
| | LASP+ ≠ > LBOP+ | 0.241 | 6.826 | 3.714 | 2.623 |
| | LASP- ≠ > LBOP- | 1.159 | 7.188 | 3.756 | 2.657 |
| | **LASP- ≠ > LBOP+** | **4.616** ** | **7.01** | **3.77** | **2.645** |
| | LASP+ ≠ > LBOP- | 0.014 | 6.869 | 3.845 | 2.793 |
| | LBOP+ ≠ > LASP+ | 0.886 | 7.579 | 4.062 | 2.788 |
| | **LBOP- ≠ > LASP-** | **4.335** ** | **7.075** | **4.048** | **2.776** |
| | LBOP- ≠ > LASP+ | 1.843 | 7.557 | 4.073 | 2.74 |
| | LBOP+ ≠ > LASP- | 2.259 | 6.754 | 3.657 | 2.663 |
| | LASP+ ≠ > LIR+ | 1.342 | 7.045 | 3.925 | 2.714 |
| | LASP- ≠ > LIR- | 1.334 | 6.904 | 3.659 | 2.645 |
| | LASP- ≠ > LIR+ | 0.143 | 6.712 | 3.807 | 2.652 |
| | LASP+ ≠ > LIR- | 0.643 | 7.03 | 3.756 | 2.605 |
| | LIR+ ≠ > LASP+ | 0.031 | 7.05 | 3.948 | 2.716 |
| | LIR- ≠ > LASP- | 0.096 | 6.843 | 3.658 | 2.567 |
| | **LIR- ≠ > LASP+** | **47.711*** ** | **15.775** | **11.199** | **9.275** |
| | **LIR+ ≠ > LASP-** | **12.711** ** | **15.78** | **11.492** | **9.384** |
| | | | | | |
| | **LASP+ ≠ > LDER+** | **2.521*** | **7.438** | **3.621** | **2.391** |
| | LASP- ≠ > LDER- | 0.018 | 7.28 | 3.593 | 2.473 |

| Hatemi-J (2012) Asymmetric Causality Analysis | | | | | |
|---|---|---|---|---|---|
| Airlines | Direction of Causality | Wald Stat. | Critical Bootstrap Value | | |
| | | | 1% | 5% | 10% |
| Westjet | LASP- ≠ > LDER+ | 0.050 | 8.213 | 3.671 | 2.525 |
| | LASP+ ≠ > LDER- | 0.017 | 8.411 | 3.61 | 2.552 |
| | LDER+ ≠ > LASP+ | 1.431 | 8.542 | 3.604 | 2.5 |
| | LDER- ≠ > LASP- | 1.829 | 6.908 | 3.604 | 2.488 |
| | LDER- ≠ > LASP+ | 0.374 | 7.537 | 3.761 | 2.513 |
| | LDER+ ≠ > LASP- | 0.067 | 7.946 | 3.606 | 2.457 |
| | LASP+ ≠ > LBOP+ | 0.011 | 6.656 | 4.043 | 2.717 |
| | LASP- ≠ > LBOP- | 0.034 | 7.096 | 4.014 | 2.888 |
| | LASP- ≠ > LBOP+ | 0.311 | 6.566 | 3.736 | 2.62 |
| | LASP+ ≠ > LBOP- | 0.019 | 6.87 | 3.819 | 2.725 |
| | **LBOP+ ≠ > LASP+** | **7.184*** ** | **6.8616** | **3.957** | **2.807** |
| | LBOP- ≠ > LASP- | 0.001 | 6.472 | 3.763 | 2.617 |
| | LBOP- ≠ > LASP+ | 0.052 | 6.86 | 3.894 | 2.727 |
| | LBOP+ ≠ > LASP- | 1.801 | 6.956 | 3.633 | 2.612 |
| | LASP+ ≠ > LIR+ | 0.536 | 7.116 | 3.911 | 2.749 |
| | LASP- ≠ > LIR- | 0.283 | 6.845 | 4.021 | 2.753 |
| | LASP- ≠ > LIR+ | 0.368 | 6.849 | 3.896 | 2.748 |
| | LASP+ ≠ > LIR- | 0.368 | 6.991 | 3.815 | 2.756 |
| | LIR+ ≠ > LASP+ | 2.352 | 6.89 | 3.809 | 2.653 |
| | LIR- ≠ > LASP- | 1.277 | 6.52 | 3.745 | 2.56 |
| | LIR- ≠ > LASP+ | 0.491 | 6.672 | 3.74 | 2.595 |
| | LIR+ ≠ > LASP- | 0.060 | 6.851 | 3.783 | 2.696 |