IBN HALDUN UNIVERSITY
SCHOOL OF GRADUATE STUDIES
DEPARTMENT OF ECONOMICS

MASTER THESIS

INVESTIGATING THE EFFICIENCY OF AIRLINE STOCK RETURNS IN TURKEY

MOHAMED HAFIS ZIDA

THESIS SUPERVISOR

ASST. PROF. ASAD UL ISLAM KHAN

ISTANBUL, 2022

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by
MOHAMED HAFIS ZIDA

A thesis submitted to the School of Graduate Studies in partial fulfillment of the requirements for the degree of Master of Arts in Economics

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ISTANBUL, 2022

APPROVAL PAGE

This is to certify that we have read this thesis and that in our opinion it is fully adequate, in scope and quality, as a thesis for the degree of Master of Arts in Economics.

Thesis Jury Members

Title - Name Surname	Opinion	Signature

This is to confirm that this thesis complies with all the standards set by the School of Graduate Studies of Ibn Haldun University.

Date of Submission Seal/Signature

ACADEMIC HONESTY ATTESTATION

I hereby declare that all information in this document has been obtained and presented in accordance with academic rules and ethical conduct. I also declare that, as required by these rules and conduct, I have fully cited and referenced all material and results that are not original to this work.

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Signature

ÖZ

TÜRKİYE'DEKİ HAVA YOLLARININ STOK GETİRİLERİNİN ETKİNLİĞİNİN ARAŞTIRILMASI

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Hisse senedi fiyatları etkin piyasa teorisinin belirlediği gibi piyasadaki tüm bilgileri yansıtıyor mu? Yoksa hisse senet fiyatlarını önemli ölçüde belirleyen bazı ekonomik faktörler var mı? Bu ampirik çalışma, Türkiye'deki havayollarının endüstrisindeki etkin piyasa teorisini incelenmektedir. Türk Hava Yolları ve Pegasus Hava Yolları hisse senet fiyatlarının günlük verilerini ve Yahoo Finance'tan Türk lirası döviz kurlarını kullanarak, döviz kurlarının Türk Hava Yolları ve Pegasus Hava Yolları üzerinde önemli belirleyici etkileri olup olmadığını incelemek için bir dizi cimri GARCH (1;1) modeli kullandık. hisse senedi iadeleri. Ayrıca takvim anormalliklerinin varlığını test etmek için günlük, aylık ve üç aylık süre kukla değişkenler dahil olmak üzere farklı GARCH modelleri tasarladık. Ampirik bulgularımız, döviz kurlarının ortalama hisse senetlerin getirilerini ve oynaklıklarını önemli ölçüde etkilediğini göstermektedir. Takvim anomalisi analizimiz ayrıca, farklı günlerin, ayların ve çeyrek dönemlerin hisse senedi getirilerinin ortalama ve oynaklığı üzerinde önemli ölçüde farklı etkilere sahip olduğunu gösteriyor, bu da Türk Hava Yolları ve Pegasus Hava Yolları'nın hisse senedi getirilerinin etkin olmadığına dair temel bulguyu destekliyor.

Anahtar Kelimeler: Döviz kuru, hisse senet fiyatları, hisse senet iadeleri, piyasa getirileri.

ABSTRACT

INVESTIGATING THE EFFICIENCY OF AIRLINES STOCK RETURNS IN TURKEY

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Do stock prices reflect all information in the market as the efficient market theory states? Or are there some economic factors that significantly determine stock prices? This empirical study examines the efficient market theory in the airline industry in Turkey. Using daily data of Turkish Airlines and Pegasus Airlines stock prices, and Turkish lira exchange rates from Yahoo Finance, we employed a series of parsimonious GARCH (1;1) models to examine whether exchange rates have significant deterministic effects on Turkish Airlines and Pegasus Airlines' stock returns. We also designed distinct GARCH models including daily, monthly and quarterly dummy variables to test for the existence of calendar anomalies. Our empirical findings indicate that exchange rates significantly affect the mean stock returns and their volatilities. Our calendar anomaly analysis also indicates that different days, months and quarters have significantly different impacts on the mean and volatility of stock returns, thereby corroborating the key finding that Turkish Airlines and Pegasus Airlines' stock returns are not efficient.

Keywords: Exchange rate, market returns, stock prices, stock returns.

ACKNOWLEDGEMENTS

I would like to thank Asst. Prof. Asad Ul Islam Khan, who has guided me, corrected me, and supported me indefatigably from the beginning until the end of this research. It is hard to imagine how this project would have become a reality without his invaluable support. I am also indebted to my professors, family members and friends, who have influenced me positively as I strived to complete this work. My older brother, Abdoul Razak ZIDA, has always motivated me to keep up and do great work, I am very grateful for his relentless support. Finally, I am grateful to my lovely parents for their blessings and immeasurable support.

Mohamed Hafis Zida

ISTANBUL, 2022

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LIST OF SYMBOLS AND ABBREVIATIONS

BIST100	Borsa Istanbul stock index
Day	Daily dummy variable
ER	Exchange rates (USD/TRY)
GARCH	Generalized Autoregressive Conditionally Heteroskedastic
GJR	Glosten, Jagannathan and Runkle (1993)
LER	Log of Exchange rates
Month	Monthly dummy variable
PG	Pegasus Airlines
PGSUS	Pegasus Airlines stock index
Quarter	Quarterly dummy variable
RER	Returns of exchange rates
RPG	Pegasus Airlines Stock Returns
RTA	Turkish Airlines Stock Returns
TA	Turkish Airlines
THYAO	Turkish Airlines stock index
c_0	Constant
c_1	Coefficient of the first lag of return
c_2	Coefficient of the second lag of return
d_0	Coefficient of exchange rate returns
d_1	Coefficient of the first lag of exchange rate returns
d_2	Coefficient of the second lag of exchange rate returns
α_0	Constant
α_1	Coefficient of the Arch term
β	Coefficient of the first lag of the conditional variance (previous variance)
λ	Coefficient of exchange rate return in the variance equation
γ	Leverage effect
δ	Risk Premium
δ_1	Coefficient of the dummy variable
δ_2	Coefficient of the product of exchange rate return and the dummy variable

CHAPTER I

INTRODUCTION

1.1. Background

As is commonly understood by those familiar with financial markets, a stock market or stock exchange is a platform where shares of publicly listed companies are bought and sold by investors. Ideally, in such a market, share prices are typically determined by their supply and demand within the market. It follows, then, that a higher demand for a particular share might significantly raise its price, while a sell-off could lead to a dramatic drop of its price. For the sake of clarity, it might be important to note and understand that a stock or share in this context represents ownership of a portion of a company, and a stockholder or shareholder is basically a person or institution that owns a part or parts of a company. For instance, if a legal or ordinary person owns ten shares of a company that consists of one hundred shares in total, then that person owns one tenth of the company, and may consequently be entitled to receive some of the annual proceeds the company makes——also called dividends. Stocks are generally subdivided into two categories: Common stocks and preferred stocks. Whereas the ownership of common stocks of a company gives a person—whether ordinary or legal person—the right to votes that influence decisions pertaining to the operations and management of the company and might render him/her privy to key information concerning the health and direction of the company, preferred stockholders of a company do not have such privileges, but do have the legal advantage of receiving parts of the dividends the company issue prior to other stockholders. However, before delving deeper into further details, it is perhaps useful to point out why stocks and the stock market exist and matter in the first place. Before doing that, let us note that stocks and the stock market are not novel ideas. In fact, they date back to the very beginning of the seventeenth century when the world's first modern stock exchange was established in 1611 in Antwerp (Belgium) with the Dutch East India company as the first publically listed company, which sold stocks (and paid dividends) to investors in the Amsterdam Stock Exchange in order to raise capital (Bebusinessed). Hence at its inception, the primary purpose of issuing and selling shares/stocks was to raise capital that would serve as the lifeblood for the expansion of the issuing company. In other words, issuing shares came into existence as an alternative way for enterprises to get liquidity to finance their businesses. Today, issuing shares to raise capital seems to have become a more glamorous alternative to indebtedness, as it helps companies avoid debt-related liabilities and appears less risky to investors. The lower the debt to equity ratio a company has, the less risky the company is and the more attractive it appears to potential investors, thereby resulting in a feedback loop: A lower debt to equity ratio makes a company less risky, which attracts more investors, which further lowers the debt to equity ratio and makes the company even more attractive to investors and back again. In a nutshell, it can be noted that issuing stocks matters for companies because doing so allows them to raise liquid capital, avoid over-indebtedness and its consequences, appear less risky and attract potential investors. While issuing stocks is quite rewarding for issuing companies as has been noted, what about economic agents on the demand side who purchase stocks? Who are they? Who buys stocks and why? At the end of the day, for a company to issue and sell shares there has to be market players in the economy willing to buy those shares. Who are they and what is in it for them? Several market agents engage in holding stocks among whom the most popular are investors and speculators. Speculators are economic agents that buy stocks only to quickly resell them at a higher price to make a profit. Investors, however, engage in medium and long-term ownership of shares of a company and are usually concerned about how well the company is performing in both the short and long term. In this essay, we will be dealing mostly with investors. Hence, one reason why investors buy stocks is to have a stake in the companies whose stocks they buy. Depending on the types of stocks they acquire, they may benefit from voting rights that allow them to influence the management of the company and might be paid dividends or may reinvest in the company to own an even greater portion of it. Another reason why some agents engage in buying stocks is to diversify their investment portfolio. That is because diversifying one’s portfolio is key to financial risk management and the optimization of overall long term returns. Oftentimes, holding stocks as opposed to holding bonds or other investment instruments may help investors mitigate inflationary risks. Due to these multiple advantages, stocks constitute a substantial share of investors’ investment portfolios worldwide. That is why it is not uncommon for individual and institutional investors to allocate about 25-80% of their investments to stocks. Given this significant importance of stocks in the financial world, it is not surprising that investors and finance researchers are enquiring about the prices and values of stocks and the fundamental factors that determine them. It is from such queries that the efficient market hypothesis was developed and pioneered by Eugene F. Fama, who concluded in 1970 that “the evidence in support of the efficient market model is extensive, and (somewhat uniquely in economics) contradictory evidence is sparse.” (Fama, 1970), the efficient market theory contends that stock prices encompass all available information in the market. In other words, this theory implies that stock prices fully reflect all available information in the market and it is consequently impossible for any investor to predictably outperform the market. This theory is quite significant because if it is verified, then enterprising investors who strive to beat the market may not profit from it because changes in economic variables will be reflected in the stock prices, and arbitrage opportunities will consequently be sparse, if not nonexistent. However, a contrarian theory known as the arbitrage pricing theory, developed by Ross (1976), models asset returns as a function of their expected returns and some macroeconomic variables, thereby implying that stock prices/returns can be predicted. If this theory holds, then enterprising investors can take advantage of arbitrage opportunities to generate higher returns, in other words, buy when the share price is low and sell when it is high. As we proceed with our investigation in the rest of the treatise, we shall see if any of these theories hold in the airlines industry in Turkey and what it means for potential investors interested in this particular sector.

1.2. Brief Information on Turkish Airlines and Pegasus Airlines

Established in 1933, a decade after the proclamation of the Republic of Turkey, Turkish Airlines was initially under the management of the General Directorate of the State Airlines Administration with the soldier and aviator Fesa Evrensev as its first chief executive officer (Turkish Airlines Blog, 2006). As it gradually evolved, the company became a member of the International Air Transport Association (IATA) in 1955, the same year when it became officially known as “Turkish Airlines” – the English translation from its original Turkish “Türk Hava Yolları”, abbreviated as

THY. Since its first international flight in 1947 from Istanbul to Athens, Turkish Airlines has grown significantly. According to THY's publicly-declared data, it operates both locally and internationally, flying to "52 airports in 50 cities in Turkey" and 321 airports in 326 cities around the globe with more than "74 million passengers in 2019" (Turkish Airlines Blog, 2006)

As for its ownership structure, about 49.12% of Turkish Airlines shares are owned by the Turkish Wealth Fund, a $33 billion state-owned investment fund, while nearly 50.88% are owned by the public. Turkish Airlines shares are traded on Borsa Istanbul and its stock index is known as THYAO (Turkish Airlines, n.d.).

Pegasus Airlines (known as Pegasus Hava Tasımacılığı A.S. in the original Turkish), on the other hand, was founded as a joint venture company (a company created by at least two entities) in 1990 by three different business groups: Aer Lingus Group, Silkar Yatirim ve Insaat Organizasyonu A.S., and Net Holding A.S. It was later acquired in 2005 by Esas Holding, which is owned by Sevket Sabanci and his family. Unlike Turkish Airlines, about 34.5% of Pegasus Airlines shares are listed in Borsa Istanbul for the public while 65.5% of the shares are owned by Esas Holding (Pegasus Airlines, n.d.). Initially entering commercial operation with only two aircrafts, Pegasus now carries passengers both domestically and internationally, and is gaining attraction and market share thanks to its relatively low-cost fares. Like Turkish Airlines, Pegasus Airlines stocks are traded on Borsa Istanbul and its stock index is known as PGSUS.

1.3. Motivation

I was reading *The Intelligent Investor* (Graham, 2003) when the idea of exploring on stock valuation came to my mind. I got some rough ideas about it from the book, and I decided to conduct further research on it to deepen my understanding. Hence, my motivation to conduct this study primarily stems from curiosity and an inner desire to have a scientific understanding of the economic elements that determine stock prices. It occurred to me that if we knew the determinants of stock prices, then we could predict them; and accurately doing so could be quite useful to investors. As I went deep into the research, I subsequently narrowed the scope of the study and focused exclusively on the airlines' industry in Turkey mainly because it constitutes a gap that I can fill and make significant contribution to the literature.

A broader element that shaped my motivation for this study has been my profound interest in understanding financial markets, a subject that may indeed sound repugnant to many. Deepening my comprehension of these complex markets provided for me a degree of intellectual fulfillment and paved the way for me towards a better understanding of how the economy works. The more we understand the workings of our economy, the more the likelihood that we can make better decisions to improve our lives and contribute to the progress of humanity. This would seem to be a worthy pursuit.

1.4. Literature Gap

Using different quantitative methodologies, several studies attempted to verify the truthfulness of both abovementioned theories in different industries. John Kraft (1997) came to the conclusion that stock prices are efficient as the efficient market theory states. Other researchers, Gunay (2016) and Mollick and Amin (2021), found that some economic factors have deterministic effects on stock prices, thereby concluding that stock prices are inefficient Although Bari (2020) examined the effect of macroeconomic variables on stock prices/returns in Turkey in general, no study to the best of my knowledge has yet specifically addressed the airlines industry in Turkey. Hence, my study intends to fill this gap by exclusively examining whether airlines stock returns within the airline industry in Turkey are efficient or whether there are any arbitrage opportunities from which enterprising investors may profit. Therefore, this study examines these questions thoroughly by demonstrating whether Turkish Airlines and Pegasus Airlines' (the two main airlines operating in Turkey) stock returns are affected by key macroeconomic variables such as exchange rates.

1.5. Aims & Significance

The primary objective of this research is to question the efficient market theory by investigating whether Turkish Airlines and Pegasus Airlines' stock returns are efficient or not. Stock mean returns or their volatilities being efficient means that there is no macroeconomic variable that has a significant deterministic effect on them. Thus, my aim is to find out whether exchange rate, a key macroeconomic variable, has any significant impact on these airlines' stock returns and their volatilities. I am concerned with exchange rates only and not any other macroeconomic variable because exchange rate has been found in the extended literature to have a significant impact on stock prices in different industries, such as the banking industry. So, is that also the case in the airlines industry in Turkey? Also, exchange rates fluctuations readily affect the competitiveness of domestic goods and services vis-a-vis foreign ones, which ultimately influences the values of domestic companies and, therefore, of their stock values. An increase in exchange rates (a depreciation of the Turkish lira or an appreciation of the U.S. dollar), holding everything else equal, makes domestic goods cheaper and more competitive on international markets, thereby boosting Turkish exports. This, in turn, raises the revenues and profitability of domestic enterprises, which leads to an increase in their stocks values. Conversely, a decrease in exchange rate (an appreciation of the Turkish lira or a depreciation of the U.S. dollar), ceteris paribus, makes domestic goods and services more expensive and less competitive on international markets, thereby resulting in bad business for domestic firms, which eventually translates into lower profitability and lower stock values. That said, does the empirical data support this theoretical link between exchange rates and the airlines' stock returns and their volatilities?

Furthermore, as is often observed in financial markets, specific days of the week or months of the year may have unusual influence on stocks' mean returns and/or their volatilities. These types of irregularities are commonly known as calendar anomalies. Such days or months are anomalies because they are not having the usual effects that typical days or months would. This brings us to the next aim crucial to this study, which is to check for the presence of calendar anomalies in the two airlines' stock returns.

Our study is highly significant in two ways: First, it will fill the literature gap and make useful contributions to the literature on the efficiency of stock returns in Turkey. Second, the empirical findings of this study will help us and potential investors know if there are arbitrage opportunities in this particular industry. Knowing so is instrumental in order to guide us towards better investment decisions.

1.6. Overall Plan of the Rest of the Study

This section briefly summarizes the plan of the rest of the study with the hope of making the presentation of the work more organized and its content more accessible. Following this section is an extensive review of the existing literature on the efficiency of stock prices in Chapter 2. This review will allow the readers to have an overall understanding of many important works and ideas that have been produced and documented concerning the efficiency of stock returns, the efficient market theory, and the airlines industry. In Chapter 3, I present and analyze the data used in the study. Also included in chapter 3 is a detailed analysis of the econometric methodology used in the study and the rationale for adopting it. Chapter 4 presents the empirical findings and englobes a thorough discussion and interpretation of those findings. In Chapter 5, I focus on checking for the presence of calendar anomalies, which includes an in-depth elucidation of the methods used to check those irregularities, the results obtained and their respective implications. The essay ends with Chapter 6 where we draw conclusions and make key recommendations based on the empirical findings of the study. Also mentioned in that last section are some suggestions for future research for readers and/or potential enterprising investors.

CHAPTER II

LITERATURE REVIEW

The quest for answers on the predictability of stock prices is not novel. From enterprising investors to academics, several papers have attempted to gauge the deterministic factors of stock prices in different markets using different methodologies. In the Turkish banking sector, Saldani (2017) found that exchange rates and money supply significantly determine bank's stock prices in Turkey. Using monthly observations of real effective exchange rate, money supply, the industrial production index, and the stock prices of 10 Turkish banks, and adopting a panel causality test, they found that the industrial production index was insignificant in determining the banks' stock prices contrary to the money supply and the exchange rates. This is contrary to the findings of a time series analysis by Kraft (1997) according to which there is no statistically significant relationship between the money supply and stock prices. Their findings, therefore, confirm the efficient market theory that stock prices are efficient and reflect publically available information to the market.

A dynamic panel generalized methods of moments analysis on the determinants of stock prices indicates that stock prices are determined by previous year earnings per share and company size (Mehr-un-Nisa, 2012). According to this model, the efficient market theory does not hold because although key macroeconomic variables such as the money supply and exchange rates have not been found to significantly impact stock prices, some microeconomic variables do. A recent study by Atemsa and Yimga (2021) employed a method of local projections to gauge the dynamic impact of the COVID-19 pandemic on US airline prices. Their findings show a significant negative impact of the pandemic shock on the airlines' stock prices. However, this negative impact is due to the substantial decrease in air travels and revenues following the restrictions. It is, therefore a short-term break and not a permanent structural relationship. So, even if stock prices are efficient, they are not shockproof. A similar study using price simulation found that quality stocks, after the negative COVID-19 shock, recover to their pre-COVID-19 level, but face difficulties when the length of the shock is extended by, say, two months or more (Mahata et al., 2021).

Further studies like the Fourier co-integration analysis by Bari (2020) on the macroeconomic determinants of stock prices in Turkey found the presence of a co-integration between stock prices and the money supply and exchange rates, indicating that the latter has a significant impact on the former. These findings corroborate the study by Saldanli (2017) on bank stock prices, and consequently reject the efficient market theory. A regression analysis on the relationship between corporate eco-innovation and stock price crash risk found that an increase in corporate eco-innovation is associated with a decrease in stock price crash risk (Zaman et al., 2021).

Other studies oriented their analyses towards the impact of political risk: Using the Fully Modified Ordinary Least Squares (FMOLS) co-integration regression, Gunay (2016) analyzed the effect and magnitude of political risk on stock markets in Turkey. Using daily stock prices, his empirical findings confirm the existence of a long-term relationship between the BIST100 and external factors such as the three-month Libor rates and the Euro/U.S. dollar parity. The findings also suggest that the stock market significantly responds to political events, and are consequently in conformity with the arbitrage pricing theory. In another study, using quarterly data and adopting a VAR-type decomposition, Balke and Wohar (2006) found that real dividend growth and market expectations are significant determinants of stock prices. A panel data and panel VAR analysis by Alici and Sevil (2020) found that total assets positively affect stock prices whereas financial leverage has a negative impact on stock prices. As can be inferred, a considerable number of authors have voiced the idea that stock prices are influenced by micro or/and macroeconomic variables. Do stock returns reveal the same pattern or are they different?

Adopting a structural VAR model, Kang et al. (2021) found that economic uncertainty has a significant share in the variations of real airlines stock returns. Besides, other studies tried to measure the effect of non-macroeconomic variables on stock returns. Using the capital asset pricing model (CAPM), Kristjanpoller and Concha (2016) examined the effect of the fluctuations of fuel prices on stock returns. Their findings indicate a positive relationship between fuel prices and airlines stock prices (on a daily basis). Their findings corroborate the idea that asset prices rise when the market is bull, also known as market inertia. A similar study on Chinese and Korean airlines by Yun and Yoon (2018) using a VAR-GARCH-BEKK model shows that oil price returns have a negative impact on airlines’ stock returns. They also found that the volatility of the oil price significantly affects that of the airlines. It has also been found that seat occupancy—number of seats occupied during flights—significantly positively affected stock returns while oil prices had opposite effect (Mollick and Amin, 2021). Sobieralski (2021) used a combination of a simple regression model, a capital asset pricing model, and the Fama French model to determine the effect of monetary policy on airlines asset prices in the US. Their findings revealed that expansionary monetary policy, just like market returns, has a significant positive effect on airlines stock prices while contractionary monetary policy negatively affected stock prices. Assessing the impacts of Covid-19 on the global airline industry considering 52 listed firms, Maneenop and Kotcharin (2020) found that the novel corona virus pandemic had a significant negative effect on the stock prices in the global airline industry, a finding that is in conformity with those of Atemsa and Yimga (2021).

With the exception of a few papers, most findings indicate that macroeconomic and some microeconomic variables significantly affect stock prices and stock returns in different markets in different locations. Does this imply that economic variables also have a deterministic effect on the airlines’ stock returns in Turkey?

CHAPTER III

DATA & METHODOLOGY

3.1. Data

For our empirical analysis, daily data of nominal exchange rate, Turkish Airlines and Pegasus Airlines' stock prices were obtained from Yahoo finance for the period ranging from July 2013 to May 2022. In this study, nominal exchange rate refers to the nominal daily price of the US dollar in terms Turkish liras. For instance, an exchange rate of 14.5 on a given day means that the US dollar was worth 14.5 Turkish liras. The airlines stock prices represent the closing prices on each business day within the period of study. Since stock prices are available only for the working days, we considered a five-day week and removed holiday periods, such as Eid-al-Fitr and New Year's Eve, which fell during the week. Weekends and holidays' exchange rate data were, therefore, eliminated so that our overall sample could be consistent and continuous. As for stock returns, they refer to the percentage increase or decrease in stock value. For instance, if a stock "B" has a return of 10%, then it means that its value has increased by 10% from the previous period to the current. Conversely, if stock "B" has a return of -10% then it lost value by 10% from the previous period to the current. Hence, in this study, daily stock returns of Turkish Airlines and Pegasus Airlines refer to the daily percentage change in the value of those stocks. Mathematically and on EViews, these stock returns are computed as follows: RTA = log (TA/TA (-1)) and RPG = log (PG/PG (-1)), where TA and PG represent the current daily prices of the stocks of Turkish Airlines and Pegasus Airlines, respectively; TA (-1) and PG (-1) represent the one-lagged daily prices of the stocks of Turkish Airlines and Pegasus Airlines, respectively; and RTA, RPG the respective daily stock returns of Turkish Airlines and Pegasus Airlines.

3.2. Methodology

3.2.1. Unit Root tests

Time series data has been one of the most widely used data type in research across different scientific fields. It mainly consists of data of a variable obtained sequentially between equally spaced intervals of time for a given period. The data of airlines' stock prices in our study is an example of time series data because it documents the value of the stock each and every business day for the relevant period. Usually, when making time series analyses, it is not uncommon for researchers to come across data series that are either trended, unstable or explosive. It is, therefore, necessary to check the stationarity of the time series before advancing with the empirical estimations analyses lest we generate spurious regressions. It is important to note that in this exercise as in statistics, a time series is stationary if its mean and variance are constant throughout time. The common statistical test used to gauge stationarity is known as the standard unit root test. It simply reveals whether the time series is stationary, in which case we can continue the analysis with the raw data, or non-stationary (also known as unit-root), in which case the data should first be rendered stationary before making any econometric estimations. In this study, we have conducted different standard unit root testing the results of which are discussed in the following chapter.

3.2.2. GARCH Models

Graphs of the daily stock returns of the two airlines indicate a strong presence of persistent volatility clustering – that is, periods of low volatility tend to be followed by periods of low volatility and periods of high volatility tend to be followed by periods of high volatility – throughout the whole period. In other words, the variance of the error term is changing overtime or technically put, it is heteroskedastic. Also, formally testing for the presence ARCH effects after regressing the stock returns on exchange rate shows that there are significant ARCH effects (details of the ARCH effects test are available in Appendix) – a confirmation that the variance of the residuals is not constant and changes with respect to time. Therefore, an autoregressive conditional heteroskedastic (ARCH) or a generalized autoregressive conditional heteroskedastic (GARCH) model ought to be employed to run our regression while resolving the heteroscedasticity issue. In our analysis, we employed a GARCH model instead of ARCH because it helps us avoid overfitting our model and is more parsimonious. Conceptually, a GARCH model consists of a mean equation where the dependent variable is set as a function of the explanatory variables, and a variance equation in which the conditional variance is modelled as a function of a long term average value (a constant), the square of the previous error term and the previous variance. Mathematically, a simple GARCH (1;1) model may be expressed as follows:

- Mean equation: $Y_t = \mu_0 + \phi_1 Y_{(t-1)} + \mu_t, \ \mu_t \sim \mathrm{N}(0, \sigma_t^2)$
- Variance Equation: $\sigma_t^2 = \alpha_0 + \alpha_1 u_{t-1}^2 + \beta\sigma_{t-1}^2$

Where Y_t is the dependent variable (returns), $Y_{(t-1)}$the explanatory variable, and σ_t^2 is the conditional variance. $(\alpha_0, \alpha_{1,} \beta)$ are non-negative parameters while u_{t-1}^2 and σ_{t-1}^2 are the square of the previous error term and the previous variance, respectively.

In this thesis, we considered different models of a parsimonious GARCH (1;1) to gauge the effect of exchange rate on Turkish Airlines and Pegasus Airlines' stock returns. In the first model, the conditional mean stock returns are set as a function of their previous values, exchange rates and the lags of exchange rate while the conditional variance is set as a function a constant, the square of the previous error term, the variance of the previous period, and exchange rate. In the second model, we removed exchange rate from the conditional variance equation and considered it in the mean equation only while we considered it only in the variance equation in the third model. These three different models allowed us to answer the question as whether exchange rate affected the stock returns or not. And in case it affected stock returns, how and in which direction? Does it affect stock returns directly and positively – meaning that an increase in exchange rate (depreciation of the Turkish lira) is associated with a direct increase in stock returns? Or does it affect stock returns indirectly by influencing its volatility? Or both? The different models can be mathematically expressed as follows:

First model:

- Mean equation: $RTA_t = c_0 + c_1 RTA_{(-1)} + c_2 RTA_{(-2)} + d_0 RER_t + d_1 RER_{(-1)} + d_2 RER_{(-2)} + \mu_t, \ \mu_t \sim \mathrm{N}(0, \sigma_t^2)$
- Variance equation: : $\sigma_t^2 = \alpha_0 + \alpha_1 u_{t-1}^2 + \beta\sigma_{t-1}^2 + \lambda RER_t$

Second model:

- Mean equation: $RTA_t = c_0 + c_1RTA_{(-1)} + c_2RTA_{(-2)} + d_0RER_t + d_1RER_{(-1)} + d_2RER_{(-2)} + \mu_t, \ \mu_t \sim N(0, \sigma_t^2)$
- Variance Equation: $\sigma_t^2 = \alpha_0 + \alpha_1 u_{t-1}^2 + \beta\sigma_{t-1}^2$

Third model:

- Mean equation: $RTA_t = c_0 + c_1RTA_{(-1)} + c_2RTA_{(-2)} + \mu_t, \ \mu_t \sim N(0, \sigma_t^2)$
- Variance Equation: $\sigma_t^2 = \alpha_0 + \alpha_1 u_{t-1}^2 + \beta\sigma_{t-1}^2 + \lambda RER_t$

Where (α_0, α_1, β, λ) are non-negative parameters, and RER is the exchange rate returns. Based on Swartz Information Criteria (SIC), the optimum lags for RTA, RPG, RER were 2, 2, 2, respectively (details are available in Appendix).

In addition to the GARCH models mentioned earlier, we also estimated the GARCH GJR and GARCH-in-Mean models to check for the presence of a leverage effect and risk premium, respectively. These two models can be expressed mathematically as follows:

GARCH GJR:

- Mean equation: $RTA_t = c_0 + c_1RTA_{(-1)} + c_2RTA_{(-2)} + d_0RER_t + d_1RER_{(-1)} + d_2RER_{(-2)} + \mu_t, \ \mu_t \sim N(0, \sigma_t^2)$
- Variance Equation: $\sigma_t^2 = \alpha_0 + \alpha_1 u_{t-1}^2 + \beta\sigma_{t-1}^2 + \lambda RER_t + \gamma u_{t-1}^2 I_{t-1}$

Where $I_{t-1} = 1$ if $\mu_{t-1} < 0$ and $I_{t-1} = 0$ if $\mu_{t-1} > 0$

GARCH-in-Mean:

- Mean equation: $RTA_t = c_0 + c_1RTA_{(-1)} + c_2RTA_{(-2)} + d_0RER + d_1RER_{(-1)} + d_2RER_{(-2)} + \delta\sigma_{t-1} + \mu_t, \ \mu_t \sim N(0, \sigma_t^2)$
- Variance Equation: $\sigma_t^2 = \alpha_0 + \alpha_1 u_{t-1}^2 + \beta\sigma_{t-1}^2 + \lambda RER_t$

  Where δ represents the risk premium.

Theoretically, we expect exchange rate to have a positive effect on stock prices in the short-run, but a negative effect in the long-run. In the short-run, as exchange rate increases (that is, TRY depreciates) domestic goods including stocks become cheaper for investors. As investors buy those cheap and attractive stocks, their demand increase and so does their prices. The empirical findings of the different estimations are discussed in the following chapter.

CHAPTER IV

RESULTS & DISCUSSIONS

This chapter outlines the results of the empirical estimations and provides a comprehensive analysis of the findings. Hence, what follows consists of a brief statistical summary of the data (4.1.), graphical analyses of the exchange rate time series and stock returns (4.2.), an analysis of the results of the unit root testing (4.3.), and a final thorough examination of the results of the GARCH models (4.4.)

4.1. Statistical Summary of the Data

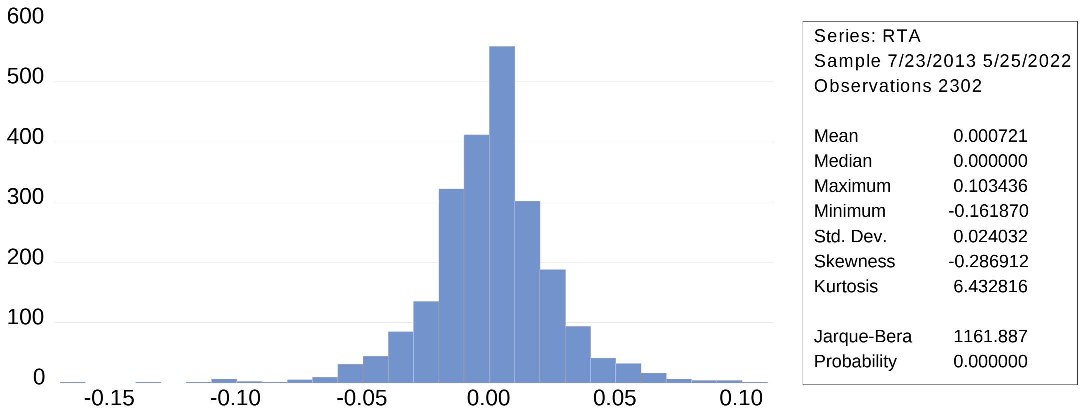

Figure 4.1. RTA Summary Statistics

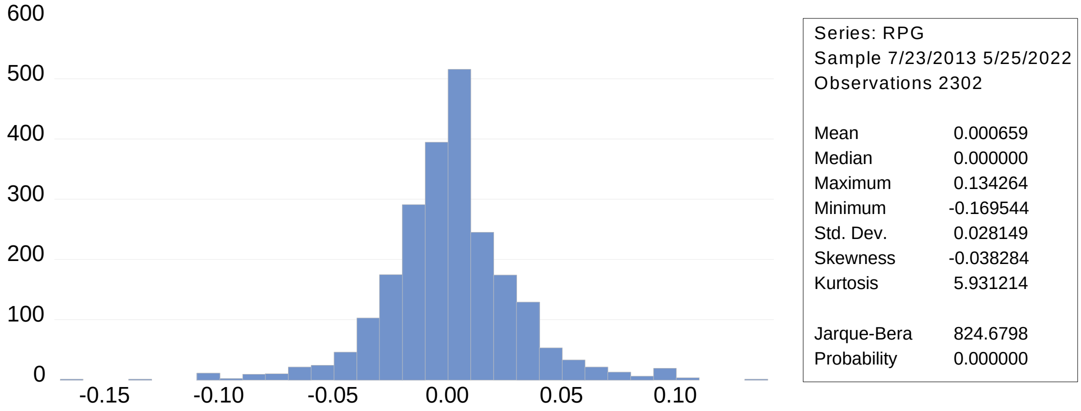

Figure 4.2. RPG Summary Statistics

The two airlines' stock returns (RTA and RPG) have been mathematically computed as follows: $RTA = log(TA/TA_{(-1)})$ and $RPG = log(PG/PG_{(-1)})$, where TA and PG represent the daily prices of the stocks of Turkish Airlines and Pegasus Airlines, respectively. Table 1 displays the descriptive statistics of the returns: the minimum, maximum and mean returns with the standard deviations in parentheses. As can be seen, both stock returns have positive mean returns, but high standard deviations. Also, the two airlines' mean returns are each greater than the market's mean return, suggesting that the two airlines actually outperform the market.

Table 4.1. Summary Statistics of Daily Stock Returns in Turkey 2013-2022

Summary statistics of daily stock returns in Turkey 2013-2022

	Mean (SD)	Min	Max
Turkish Airlines	0.000721 (0.024)	-0.162	0.103
Pegasus Airlines	0.000569 (0.028)	-0.169	0.134
BIST100	-0.001565 (0.0989)	-4.602	0.0623

4.2. Graphs

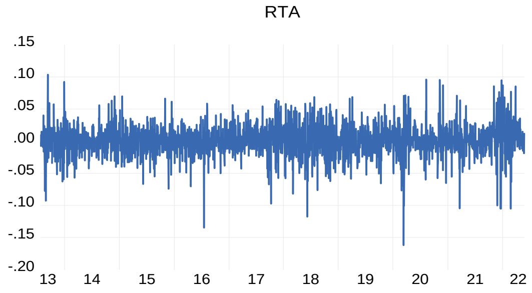

Figure 4.3. Graph of RTA

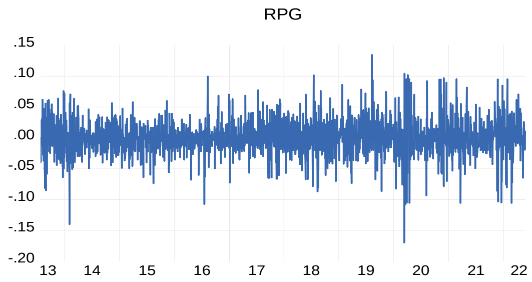

Figure 4.4. Graph of RPG

The graph of the returns of the stock prices of both airlines are stationary. However, they both exhibit volatility clustering as periods of high volatility tend to be followed by periods of high volatlity and those of low volatility seem to be followed by periods of low volatility.

Figure 4.5. Graph of Exchange Rates

Figure 4.6. Graph of the Log of Exchange Rates

The exchange rate, defined as the price of the US dollars in terms of Turkish liras, is upward trended, indicating that the Turkish lira has continuously depreciated against the dollar. The currency appreciated overnight by nearly 35% from around 16.61 per dollar on 14th December 2021 to about 10.81 per dollar on the December 21, 2021 following the Monetary Policy Comity meeting on the December 16, and President Recep Tayyip Erdogan's anouncement to raise market confidence and strengthen the currency. However, that appreciation was short-lived as the currency depreciated right afterwards and remained on its depreciative trend as can be inferred from the graph.

4.3. Results of the Unit Root Tests

Table 2 and Table 3 display the summary of the unit root tests with each relevant test's t-statistic. Using the Augmented Dicky Fuller (ADF) test whose null hypothesis is that the time series are unit root at level, we tested for the stationarity of the time series considering three different specifications: First, with intercept only, then with both intercept and trend, and finally with no intercept nor trend. Our results show that each of our time series are unit root at level at the 5% significance level, but become stationary at first difference. To ensure the reliability of our findings, we also conducted another unit root testing using the Kwiatkowski-Phillips-Schmidt-Shin (KPSS) test—whose null hypothesis is that the series are stationary at level—considering two different specifications: first with intercept only and secondly with both intercept and trend. This test also confirmed that the series are not stationary at levels but become stationary at first difference at the 5% significance level.

Table 4.2. Summary of the Augmented Dickey-Fuller (ADF) Test Results

Time series	At Level			At First Difference			Conclusion
	None	Constant	Trend	None	Constant	Trend	
TA	3.593	3.715	2.307	-31.518***	-31.604***	-31.777***	I(1)
PG	1.475	0.611	-1.032	-43.745***	-43.774***	-43.832***	I(1)
LER	3.435	0.966	-1.725	-43.140***	-43.360***	-43.390***	I(1)
RTA	-32.078***	-48.705***	-48.763***				I(0)
RPG	-30.438***	-30.454***	-30.488***				I(0)
RER	-43.140***	-43.360***	-43.390***				I(0)

As the results show, all the returns are stationary at level at the 5% significance level.

Table 4.3. Summary of the KPSS Test Results

Summary of the Kwiatkowski-Phillips-Schmidt-Shin (KPSS) test results

Time series	At Level		At First Difference		Conclusion
	Constant	Trend	Constant	Trend	
TA	2.816***	0.253	0.692	0.228	I(1)

Table 4.3. (cont.)

PG	3.707***	1.062	0.329	0.035	I(1)
LER	5.540***	0.489	0.259	0.059	I(1)
RTA	0.292	0.095			I(0)
RPG	0.225	0.030			I(0)
RER	0.259	0.059			I(0)

These KPSS test results confirm the ADF test results, so we may conclude that the returns of the stocks are stationary. Hence, we can proceed to use them in our estimations.

Table 4.4. Reference Table

Reference Table	
***	1% significance level
**	5% significance level
*	10% significance level
TA	Turkish airlines stocks
PG	Pegasus stocks
LER	Log of exchange rate (USD/TRY)
RTA	Turkish airlines stock returns
RPG	Pegasus stock returns
RER	Exchange rate (USD/TRY) returns

4.4. GARCH Models Estimation Results

To examine whether exchange rate affects the mean returns of Turkish Airlines and/or the volatility of the returns, we estimated three different GARCH models. The first model is designed so as to have exchange rate in both the mean and variance equations of the GARCH model. The second model considers exchange rate in the mean equation only while the third model considers exchange rate in the variance equation only. We also estimated a GARCH-M and a GARCH GJR model to measure the significance of the risk premium and the presence of asymmetry, respectively.

4.4.1. GARCH Models Results for the Returns of Turkish Airlines

Tables 5, 6 and 7 each displays a succinct summary of the estimation output of the first, second and third model, respectively for Turkish Airlines. In the first model, as Table 5 shows, both the first and second lags of the returns of Turkish Airlines are statistically significant at the 10% significance level, indicating that previous returns have an impact on current returns. While the first lag has a negative impact on the current returns, the effects of the second lag on returns are positive. As can also be seen, both the returns of exchange rate and their lags have insignificant effect on the mean stock returns at the 10% significance level. In the variance equation, all coefficients are positive, suggesting that the non-negativity constraints are not violated. Both the ARCH and GARCH terms are statistically significant at the 1% significance level, indicating that previous volatility and the fitted variance of the previous period have a strong effect on the conditional variance. In addition, the sum of their coefficients [0.9327] is close to one; so, the persistence of volatility will be large. The returns of exchange rate have a positive effect on the conditional variance at the 1% significance level. Hence, it may be said that exchange rate amplifies the volatility of the stock returns, thereby increasing the risk of holding these stocks. In other words, an increase in exchange rates (depreciation of the Turkish lira) is associated with an increase in the volatility and risks of holding Turkish Airlines stocks. In model 2 (see Table 6), after removing exchange rate from the variance equation, the effects of previous stock returns and exchange rate on the current mean returns remain the same, suggesting that our results are consistent. When we remove the exchange rate returns and its lags from the mean equation, as model 3 shows, the results of the variance equation remain similar and consistent with the initial results obtained from the first model. Therefore, exchange rate returns have a significant impact on the volatility of Turkish Airlines stocks returns.

Estimating a GARCH-in-Mean model (see Table 13) – whereby the standard deviation of the conditional variance is included in the mean equation to check its effect on the mean returns—indicates that the risk premium [0.0488] is positive and statistically significant at the 1% significance level. This indicates that higher volatility will lead to higher mean returns for Turkish Airlines stocks; and investors can consequently be compensated for taking extra risk.

Furthermore, as can be noted from the GARCH GJR model estimation (see Table 14), gamma [0.0912] is positive and statistically significant at the 1% significance level, which indicates that there is leverage effect. Hence, bad news has a larger impact on the volatility of the stock returns than good news.

Table 4.5. RTA First Model Estimation Output

Mean Equation			Variance Equation	
Variables	Coefficients		Variables	Coefficients
c0	0.0007* (0.0004)		**α0**	4.05E-05*** (1.06E-05)
RTA(-1)	-0.0392* (0.0208)		**ARCH(-1) α1**	0.0969*** (0.0198)
RTA(-2)	0.0389* (0.0212)		**Leverage Effects (γ)**	
RER	0.0520 (0.0383)		**GARCH (-1) β**	0.8358*** (0.0294)
RER(-1)	-0.0363 (0.0426)		**RER**	0.0033*** (0.0011)

Table 4.6. RTA Second Model Estimation Output

Mean Equation			Variance Equation	
Variables	Coefficients		Variables	Coefficients
c0	0.0008* (0.0004)		**α0**	3.50E-05*** (9.75E-06)
RTA(-1)	-0.0396* (0.0207)		**ARCH(-1) α1**	0.0944*** (0.0187)
RTA(-2)	0.0387* (0.0210)		**Leverage Effects (γ)**	

Table 4.6. (cont.)

Mean Equation			Variance Equation	
Variables	Coefficients		Variables	Coefficients
RER	0.0447 (0.0340)		**GARCH (-1) β**	0.8528*** (0.0270)
RER(-1)	-0.0404 (0.0384)		**RER**	

Table 4.7. RTA Third Model Estimation Output

Mean Equation			Variance Equation	
Variables	Coefficients		Variables	Coefficients
c0	0.0008* (0.0004)		**α0**	3.98E-05*** (1.04E-05)
RTA(-1)	-0.0430** (0.0206)		**ARCH(-1) α1**	0.0969*** (0.0197)
RTA(-2)	0.0350* (0.0209)		**Leverage Effects (γ)**	
RER			**GARCH (-1) β**	0.8370*** (0.0291)
RER(-1)			**RER**	0.0033*** (0.0011)

4.4.2. GARCH Model Results for the Returns of Pegasus Airlines

Tables 8, 9 and 10 each displays the output of the first, second and third model, respectively for Pegasus Airlines. In the first model, as Table 8 shows, the second lag of the returns has a positive significant impact on current returns at the 10% significance level. The returns of exchange rate and its two lags all have insignificant effects on the mean stock returns at the 10% significance level. In the variance equation, all coefficients are positive, suggesting that non-negativity constraints are not violated. Similar to the findings on the Turkish Airlines stock returns estimation, both the ARCH and GARCH terms in the variance equation of Pegasus Airlines' stock returns estimation are statistically significant at the 1% significance level, indicating that previous volatility and the fitted variance of the previous period have a strong effect on the conditional variance. In addition, the sum of their coefficients is close to one; so, the persistence of volatility will be large. The returns of exchange rate have a positive effect on the conditional variance at the 1% significance level. Hence, it may be said that exchange rate amplifies the volatility of the stock returns, thereby increasing the risk of holding these stocks.

In model 2, after removing exchange rate from the variance equation the effects of previous stock returns on the current mean returns remain the same. Also, just like in the Turkish Airlines case both current exchange rate and its previous values are insignificant and consequently have no impact on the mean returns of Pegasus Airlines' stocks. This corroborates the previous findings in the first model and consequently suggests that exchange rates only influence the volatility of Pegasus Airlines' stock returns.

When we remove the exchange rate returns and its lags from the mean equation, as model 3 shows, the results of the variance equation remain similar and consistent with the initial results obtained from the first model. Therefore, exchange rate returns have a significant impact on the volatility of Pegasus Airlines stock returns, but not on its mean returns.

Estimating a GARCH-in-Mean model (see Table 11) shows that the risk premium [0.0733] is positive and statistically significant at the 1% significance level. This indicates that higher volatility is associated with higher mean returns, and that risk-seeking investors are rewarded for taking risk.

Furthermore, as can be noted from GARCH GJR model estimation (see Table 12), gamma [0.0638] is positive and statistically significant at the 10% significance level, which indicates that there is leverage effect. Hence, bad news has a larger impact on the volatility of the stock returns than good news.

In sum, the discussion above has revealed four important findings: First, exchange rate does not have a direct significant effect on the mean returns of any of the two airlines, but do have positive significant impacts on their volatilities. Second, the mean stock returns of both airlines are significantly influenced by their past mean returns, thereby indicating predictability based on past observations. Another key finding is that both Turkish Airlines and Pegasus Airlines' stocks have positive significant risk premiums, which suggests that higher risks will be associated with higher returns. Also, bad news affects both airlines much more profoundly than do good news. While these primary results already suggest that there is inefficiency in the stock returns of these two airlines, further inquiry may be needed in order to substantiate these findings should they be genuinely accurate. Hence, in the following chapter, we will test whether the mean stock returns and their volatilities are free of time-related anomalies or not – anomalies that cause stock returns and/or their volatilities to have unusual values at some specific times.

Table 4.8. RPG First Model Estimation Output

Mean Equation			Variance Equation	
Variables	Coefficients		Variables	Coefficients
c0	9.16E-05 (0.0004)		**α0**	4.17E-05*** (9.83E-06)
RPG(-1)	0.0205 (0.0214)		**ARCH(-1) α1**	0.1466*** (0.0247)
RPG(-2)	0.0404* (0.0212)		**Leverage Effects (γ)**	
RER	0.0149 (0.0399)		**GARCH (-1) β**	0.8114*** (0.0262)
RER(-1)	0.0763 (0.0491)		**RER**	0.0035*** (0.0013)
RER(-2)	-0.0556 (0.0459)			

Table 4.9. RPG Second Model Estimation Output

Mean Equation			Variance Equation	
Variables	Coefficients		Variables	Coefficients
c0	0.0001 (0.0004)		**α0**	3.75E-05*** (9.32E-06)
RPG(-1)	0.0205 (0.0213)		**ARCH(-1) α1**	0.1451*** (0.0243)
RPG(-2)	0.0399* (0.0211)		**Leverage Effects (γ)**	
RER	0.0089 (0.0392)		**GARCH (-1) β**	0.8242*** (0.0247)
RER(-1)	0.0706 (0.0489)		**RER**	
RER(-2)	-0.0560 (0.0447)			

Table 4.10. RPG Third Model Estimation Output

Mean Equation			Variance Equation	
Variables	Coefficients		Variables	Coefficients
c0	0.0001 (0.0004)		**α0**	4.30E-05*** (1.00E-05)
RPG(-1)	0.0189 (0.0213)		**ARCH(-1) α1**	0.1494*** (0.0249)
RPG(-2)	0.0339 (0.0209)		**Leverage Effects (γ)**	
RER			**GARCH (-1) β**	0.8073*** (0.0265)
RER(-1)			**RER**	0.0035*** (0.0213)

Table 4.11. RPG GARCH GJR Estimation Output

Mean Equation			Variance Equation	
Variables	Coefficients		Variables	Coefficients
c0	-5.39E-05 (0.0004)		**α0**	4.26E-05*** (1.01E-05)
RPG(-1)	0.0176 (0.0215)		**ARCH(-1) α1**	0.1149*** (0.0255)
RPG(-2)	0.0404* (0.0212)		**Leverage Effects (γ)**	0.0638* (0.0339)
RER	0.0093 (0.0408)		**GARCH (-1) β**	0.8118*** (0.0266)
RER(-1)	0.0714 (0.0500)		**RER**	0.0033*** (0.0013)
RER(-2)	-0.0560 (0.0468)			

Table 4.12. RPG GARCH-M Estimation Output

Mean Equation			Variance Equation	
Variables	Coefficients		Variables	Coefficients
Risk premium	0.1765** (0.0733)			
c0	-0.0040** (0.0018)		**α0**	4.10E-05*** (9.62E-06)
RPG(-1)	0.0163 (0.0214)		**ARCH(-1) α1**	0.1470*** (0.0243)
RPG(-2)	0.0348 (0.0212)		**Leverage Effects (γ)**	
RER	-0.0064 (0.0397)		**GARCH (-1) β**	0.8112*** (0.0256)
RER(-1)	0.0601 (0.0488)		**RER**	0.0035*** (0.0013)

Table 4.12. (cont.)

Mean Equation			Variance Equation	
Variables	Coefficients		Variables	Coefficients
RER(-2)	-0.0619 (0.0460)			

Table 4.13. RTA GARCH GJR Estimation Output

Mean Equation			Variance Equation	
Variables	Coefficients		Variables	Coefficients
c0	0.0006 (0.0004)		**α0**	3.73E-05*** (8.99E-06)
RTA(-1)	-0.0374* (0.0205)		**ARCH(-1) α1**	0.0442*** (0.0189)
RTA(-2)	0.0414** (0.0210)		**Leverage Effects (γ)**	0.0912*** (0.0276)
RER	0.0488 (0.0376)		**GARCH (-1) β**	0.8480*** (0.0257)
RER(-1)	0.0419 (0.0429)		**RER**	0.0026*** (0.0010)
RER(-2)	-0.0303 (0.0400)			

Table 4.14. RTA GARCH-M Estimation Output

Mean Equation			Variance Equation	
Variables	Coefficients		Variables	Coefficients
Risk premium	0.2900*** (0.1003)			
c0	-0.0056** (0.0022)		**α0**	3.73E-05*** (9.72E-06)

Table 4.14. (cont.)

Mean Equation			Variance Equation	
Variables	Coefficients		Variables	Coefficients
RTA(-1)	-0.0421** (0.0208)		**ARCH(-1) α1**	0.0955*** (0.0187)
RTA(-2)	0.0346 (0.0211)		**Leverage Effects (γ)**	
RER	0.0214 (0.0389)		**GARCH (-1) β**	0.8426*** (0.0269)
RER(-1)	0.0114 (0.0424)		**RER**	0.0033*** (0.0011)
RER(-2)	-0.0295 (0.0412)			

CHAPTER V

CALENDAR ANOMALIES

If one is actively following financial news, one may have often hear of particular days or events or even particular political speeches having had undue unusual effects on stock returns. Some of these irregularities may have led to a significant drop or skyrocketing increase of the market returns. Have there been such irregularities for Turkish Airlines and Pegasus Airlines' stock returns? This section of the thesis details the methodology, estimation results and the key findings concerning the existence of calendar anomalies in our model. That is, by slightly modifying our methodology we will verify whether particular days of the week or particular months or quarters of the year have relatively more significant effects on Turkish Airlines and Pegasus Airlines stock returns than other days, months or quarters. If these airlines' stock returns are efficient, then there should not be a particular day or month or year that has a remarkably higher effect on stock returns and their volatilities than others.

5.1. Day of the Week Effect

To assess the day of the week effect, we have included two key variables in both the mean and the variance equations of our original model: A dummy variable denoted "Day" that assesses the special effect that a specific day may have on the mean and volatility of stock returns; and another variable (RER*Day) denoting the product of the exchange rate and the dummy variable that assesses whether a change (increase or decrease) in exchange rates on a specific day has an unusual significant impact on both the mean and volatility of stock returns. Mathematically, our respective new models for both Turkish Airlines and Pegasus Airlines are as follows:

Turkish Airlines

- Mean equation: $RTA_t = c_0 + c_1 RTA_{(-1)} + c_2 RTA_{(-2)} + d_0 RER_t + d_1 RER_{(-1)} + \delta_1 * Day + \delta_2 (RER_t * Day) + \mu_t, \ \mu_t \sim \mathrm{N}(0, \sigma_t^2)$
- Variance equation: : $\sigma_t^2 = \alpha_0 + \alpha_1 u_{t-1}^2 + \beta\sigma_{t-1}^2 + \lambda RER_t + \delta_1 * Day + \delta_2 RER_t * Day$

Pegasus Airlines

- Mean equation: $RPG_t = c_0 + c_1 RPG_{(-1)} + c_2 RPG_{(-2)} + d_0 RER_t + d_1 RER_{(-1)} + \delta_1 * Day + \delta_2 (RER_t * Day) + \mu_t, \ \mu_t \sim \mathrm{N}(0, \sigma_t^2)$
- Variance equation: : $\sigma_t^2 = \alpha_0 + \alpha_1 u_{t-1}^2 + \beta\sigma_{t-1}^2 + \lambda RER_t + \delta_1 * Day + \delta_2 (RER_t * Day)$

Thus, to test, for instance, whether "Monday" has a special effect on the mean stock returns, the dummy variable "Day" will be set equal to 1 when it is a Monday and 0 if otherwise. Having done so, if δ_1 is statistically significant, then Monday has a special effect on the stocks' mean returns – with the nature of the effect depending on the sign of δ_1. Otherwise, Monday has no special effects on the stocks' mean returns or in other words, there is no anomaly on Mondays. If δ_2 is statistically significant, a change in exchange rate on Monday has a unique impact the mean stock returns than exchange rate changes on other days. After testing for Mondays, the testing continues for the rest of the days following the same procedure and logic.

Given the nature of our raw data, setting the daily dummy variables required following a process that was indeed fruitful, but excruciatingly tedious and cumbersome. Below is a brief summary of the important chronological steps followed to set the daily dummies.

- At first, using Excel and knowing the day of the first date to be Tuesday (I know this by checking the very date on the calendar) and keeping in mind that we working on five-day weeks, I was able to manually match each date with each corresponding for the first 2 weeks in the dataset. Then, I used the "fill in" function that automatically copied down the days, accurately matching each date within the dataset to each corresponding day.
- Then given that some days within the five business days are holidays with no recorded data (because markets are basically closed on such days), I manually removed those days, which were actually quite few.
- Then using the IF function, I generated dummies for each day of the five days. In generating the dummies for Monday for example, I inserted a conditional equation (=IF(B2 = "Monday";1;0)) whose reasoning is as follows: If the day in the cell B2 is "Monday", then set the dummy variable equal to 1, otherwise

set it equal to 0. Then, keeping the cell in relative cell reference we copied our formula down. Then, I did likewise for the rest of the five days.

- A snapshot of the resulting dataset is as follows:

Table 5.1. Daily Dummy Variables Dataset

date	Day name	er	pg	ta	Mon_dum	Tue_dum	Wed_dum	Thur_dum	Fri_dum
2013-07-23	Tuesday	1,91	28,70	8,12	0	1	0	0	0
2013-07-24	Wednesday	1,90	27,60	8,10	0	0	1	0	0
2013-07-25	Thursday	1,92	27,60	8,04	0	0	0	1	0
2013-07-26	Friday	1,92	27,40	8,12	0	0	0	0	1
2013-07-29	Monday	1,92	27,10	8,10	1	0	0	0	0
2013-07-30	Tuesday	1,93	27,90	8,22	0	1	0	0	0

Table 5.1. (cont.)

date	Day name	er	pg	ta	Mon_dum	Tue_dum	Wed_dum	Thur_dum	Fri_dum
2013-07-31	Wednesday	1,92	28,00	8,16	0	0	1	0	0
2013-08-01	Thursday	1,93	28,80	8,10	0	0	0	1	0
2013-08-02	Friday	1,95	29,80	8,20	0	0	0	0	1
2013-08-05	Monday	1,93	31,70	8,24	1	0	0	0	0
2013-08-06	Tuesday	1,93	33,20	8,36	0	1	0	0	0
2013-08-07	Wednesday	1,93	32,30	8,44	0	0	1	0	0
2013-08-08	Thursday	1,93	33,20	8,36	0	0	0	1	0

Table 5.1. (cont.)

date	Day name	er	pg	ta	Mon_dum	Tue_dum	Wed_dum	Thur_dum	Fri_dum
2013-08-09	Friday	1,92	33,20	8,36	0	0	0	0	1
2013-08-12	Monday	1,92	32,00	8,70	1	0	0	0	0

As for the cross-terms denoting the second additional variable, I have generated them on EViews using the following formula : $RLER\_Day = RLER_t * Day$

The following table summarizes our estimation output.

Table 5.2. Day of the Week Estimation Output

DAY OF THE WEEK EFFECT

	TA		PG	
	Mean Equation	Variance Equation	Mean Equation	Variance Equation
RER	0.3060*** (0.0887)	0.0042 (0.0029)	0.1986** (0.0933)	-0.0059*** (0.0019)
RER(-1)	0.0373 (0.0423)	-0.0009 (0.0018)	0.0928 0.0823	
Monday	0.0062*** (0.0014)	0.0003*** (7.12E-05)	0.0045*** (0.0014)	
Tuesday	0.0015 (0.0013)	1.94E-05 (7.58E-05)	-0.0009 (0.0014)	
Thursday	0.0019 (0.0013)	-7.80E-06 (7.28E-05)	-0.0008 (0.0014)	
Friday	0.0005 (0.0012)	-6.27E-06 (5.85E-05)	-.0016 (0.0015)	
	(0.1238)	(0.0036)	(0.1336)	

Table 5.2. (cont.)

DAY OF THE WEEK EFFECT

	TA		PG	
	Mean Equation	Variance Equation	Mean Equation	Variance Equation
RER_Monday	-0.6334*** (0.1228)	0.0027 (0.0034)	-0.5077*** (0.1077)	
RER_Tuesday	0.0371 (0.1337)	-0.0028 (0.0039)	0.2073 (0.1312)	
RER_Thursday	-0.4378 (0.1218)	-9.09E-05 (0.0029)	0.0072 (0.1131)	
RER_Friday	-0.1113 (0.1238)	-0.0027 (0.0036)	0.0536 (0.1336)	

As can be inferred from the table, only Monday has a significant positive effect on the mean stock returns and volatilities of both airlines with the rest of the days having no significant impact on the returns. Put otherwise, Turkish Airlines and Pegasus Airlines' stock returns are consistently positive and more volatile on Mondays as compared to the other days. Also, a *particular* increase in exchange rates (depreciation of the lira) *on Monday* significantly negatively impacts the stock returns of both airlines. Why? How? One possible explanation is the fact that the relatively higher volatilities on Mondays coupled with the local currency depreciation increases uncertainty and fears, thereby leading to a selloff of stocks, which eventually causes their prices to decline. In short, it may be noted from this analysis that of all the weekdays, only Mondays have a *unique particular* effect on the airlines' mean stock returns and their volatilities.

5.2. Month of the Year Effect

To gauge the month of the year effect if any, we have included two key variables in both the mean and the variance equations of our original model: a dummy variable denoted "$Month$" that assesses the special effect that a specific month may have on the mean and volatility of stock returns; and another variable ("$RER_t * Month$") denoting the product of the exchange rate and the dummy variable that assesses whether a change (increase or decrease) in exchange rates in a given month has an unusual significant impact on both the mean returns and the volatility of the stocks. Mathematically, our respective new models for both Turkish Airlines and Pegasus Airlines are as follows:

Turkish Airlines

- Mean equation: $RTA_t = c_0 + c_1 RTA_{(-1)} + c_2 RTA_{(-2)} + d_0 RER_t + d_1 RER_{(-1)} + \delta_1 * Month + \delta_2 RER_t * Month + \mu_t, \ \mu_t \sim N(0, \sigma_t^2)$
- Variance equation: : $\sigma_t^2 = \alpha_0 + \alpha_1 u_{t-1}^2 + \beta\sigma_{t-1}^2 + \lambda RER_t + \delta_1 * Month + \delta_2 RER_t * Month$

Pegasus Airlines

- Mean equation: $RPG_t = c_0 + c_1 RPG_{(-1)} + c_2 RPG_{(-2)} + d_0 RER_t + d_1 RER_{(-1)} + \delta_1 * Month + \delta_2 RER_t * Month + \mu_t, \ \mu_t \sim N(0, \sigma_t^2)$
- Variance equation: : $\sigma_t^2 = \alpha_0 + \alpha_1 u_{t-1}^2 + \beta\sigma_{t-1}^2 + \lambda ER_t + \delta_1 * Month + \delta_2 RER_t * Month$

The estimation output is summarized in the table below:

Table 5.3. Month of the Year Estimation Output

MONTH OF THE YEAR EFFECT

	TA		PG	
	Mean Equation	Variance Equation	Mean Equation	Variance Equation
RER	-0.1713* (0.0952)		0.0853 (0.0916)	
RER(-1)	0.0464 (0.0375)		0.0560 (0.0486)	
January	-0.0025 (0.0021)		-0.0022 (0.0023)	
February	-0.0020 (0.0021)		-0.0028 (0.0023)	
March	-0.0009 (0.0021)		-0.0034 (0.0023)	

Table 5.3. (cont.)

MONTH OF THE YEAR EFFECT

	TA		PG	
	Mean Equation	Variance Equation	Mean Equation	Variance Equation
April	-0.0008 (0.0021)		-0.0008 (0.0023)	
May	-0.0005 (0.0021)		-0.0017 (0.0023)	
June	-.0029 (0.0021)		-0.0013 (0.0023)	
July	-0.0020 (0.0021)		-0.0024 (0.0023)	
August	-0.0033 (0.0021)		-0.0016 (0.0023)	
September	-0.0011 (0.0021)		-0.0012 (0.0022)	
October	-0.0009 (0.0021)		-0.0003 (0.0022)	
November	-0.0002 (0.0022)		-7.62E-05 (0.0023)	
RER_January	0.1091 (0.1712)		-0.2197 (0.1698)	
RER_February	0.4751** (0.2355)		0.0027 (0.2654)	
RER_March	0.2745* (0.1570)		-0.1204 (0.1536)	
RER_April	0.3821 (0.2435)		-0.2234 (0.2720)	

Table 5.3. (cont.)

MONTH OF THE YEAR EFFECT

	TA		PG	
	Mean Equation	Variance Equation	Mean Equation	Variance Equation
RER_May	0.1634 (0.1796)		-0.2941* (0.1746)	
RER_June	0.2226 (0.1941)		0.0564 (0.2046)	
RER_July	-0.0546 (0.2035)		0.0580 (0.2266)	
RER_August	0.0976 (0.1161)		-0.2327** (0.1112)	
RER_September	0.3434* (0.1890)		-0.1633 (0.2054)	
RER_October	0.1802 (0.1890)		-0.1828 (0.1891)	
RER_November	0.3506** (0.1783)		0.4181*** (0.1529)	

Before discussing this table, it is important to remember that including the monthly dummies and the cross-terms in the variance equation led to an estimation failure and resulted in estimates whose P-values were 1.0000, utterly insignificant. Hence, we removed them from the variance equation and considered them within the mean equation only—the output of which is summarized in the table. In conducting our estimation, we first considered the last 11 months starting from February to December and realized that December was insignificant in uniquely affecting the stock returns or the volatilities. Also a change in exchange rates in December proved to have no effect at all; so we dropped December and reconsidered our estimation with the first 11 months starting from January to November. As can be seen in the table above, none of the months has a particular effect on the two airlines stock returns and/or their volatilities. However, an increase in exchange rate in February, March, September or

November has a significant positive impact on Turkish Airlines stock returns. Put differently, holding everything else equal, a depreciation of the Turkish lira in any of these four months is associated with an increase in Turkish Airlines stock returns. As for Pegasus Airlines, an increase in exchange rates in May or August leads to negative returns while an increase in November results in positive returns. Hence, although the months by themselves have negligible effects on the airlines' stock returns, changes in exchange rates in different months affect those mean returns quite differently.

5.3. Seasonal Effect

Every year is marked by distinct seasons that fundamentally affect the airline business in various ways. Summer seasons tend to be marked by high level of tourism, which increases the demand for airlines services, while winter seasons tend to be characterized by relatively lower levels of tourism and travel activities, thereby weakening the demand for airlines' services. Do these seasonal ups and downs significantly influence the airlines stock returns?

Adopting a similar methodology as the one we employed in the previous section, the following model for testing for the presence of seasonal effects may provide some insight:

Turkish Airlines

- Mean equation: $RTA_t = c_0 + c_1 RTA_{(-1)} + c_2 RTA_{(-2)} + d_0 RER_t + d_1 RER_{(-1)} + \delta_1 * Quarter + \delta_2 RER_t * Quarter + \mu_t, \ \mu_t \sim N(0, \sigma_t^2)$
- Variance equation: : $\sigma_t^2 = \alpha_0 + \alpha_1 u_{t-1}^2 + \beta\sigma_{t-1}^2 + \lambda RER_t + \delta_1 * Quarter + \delta_2 RER_t * Quarter$

Pegasus Airlines

- Mean equation: $RPG_t = c_0 + c_1 RPG_{(-1)} + c_2 RPG_{(-2)} + d_0 RER_t + d_1 RER_{(-1)} + \delta_1 * Quarter + \delta_2 RER_t * Quarter + \mu_t, \ \mu_t \sim N(0, \sigma_t^2)$
- Variance equation: : $\sigma_t^2 = \alpha_0 + \alpha_1 u_{t-1}^2 + \beta\sigma_{t-1}^2 + \lambda RER_t + \delta_1 * Quarter + \delta_2 RER_t * Quarter$

Table 5.4. Quarter of the Year Estimation Output

	TA		PG	
	Mean Equation	Variance Equation	Mean Equation	Variance Equation
RER	-0.0384 (0.0468)		-0.0143 (-0.0631)	
RER(-1)	0.0460 (0.0357)		0.0596 (0.0489)	
Quarter 1	6.89E-=5 (0.0009)	**2.13E-05 * 1.15E-05**	-0.0012 (0.0009)	1.98E-05 (1.28E-05)
Quarter 2	0.0008 (0.0008)	-4.40E-06 8.29E-06	-0.0004 (0.0008)	-6.27E-06 (8.79E-06)
Quarter 4	**0.0019** (0.0009)**	1.02E-05 (9.88E-06)	**0.0019* (0.0009)**	2.07E-05 (1.28E-05)
RER_Quarter 1	0.08999 0.1078	**0.0085** (0.0035)**	-0.0232 (0.1167)	0.0058 (0.0041)
RER_Quarter 2	0.1096 (0.1048)	0.0012 (0.0020)	-0.0601 (0.1145)	0.0005 (0.0021)
RER_Quarter 4	0.0758 (0.0794)	**0.0040** (0.0020)**	0.1456 (0.0940)	0.0034 (0.0022)

As the estimation output reveals, Turkish Airlines stock returns are relatively more volatile in the first Quarter. Whereas the second and third quarters have no particular influence in the stock returns and their volatilities, the fourth quarter significantly and positively impacts both Turkish Airlines and Pegasus Airline's stock returns. Also, a rise in exchange rates or a depreciation of the Turkish lira against the dollar in the first or fourth quarter is associated with higher volatilities for Turkish Airlines stock returns. Thus, holding everything else equal, different seasons do have unequal effect on both Turkish Airlines and Pegasus Airlines stock returns and their volatilities.

5.4. Synthesis

The in-depth analysis conducted above has revealed the presence of significant calendar anomalies as far as Turkish Airlines and Pegasus Airlines stock returns are concerned. It has shown that different days of the week, namely Mondays, have unique impact on the mean stock returns and their volatilities. Further investigation on a monthly basis indicated that while months in themselves did not significantly determine the stock returns, changes in exchange rates in some months – February, March, May, August, November – had relatively more significant effect on the performance of the airlines' stocks than the other months. Also, the seasonal analysis has demonstrated that changes in exchanges rates in the fourth quarter of the year (from October to December) have significantly higher effects on the mean stock returns than the other quarters (seasons). In light of these compelling findings and those observed much earlier, it may be retained that Turkish Airlines and Pegasus Airlines stock returns are not efficient—a finding that implies that these stock returns may be predictable and that entrepreneurial investors could potentially take advantage.

CHAPTER VI

CONCLUSION

6.1. Concluding Remarks

This study enquired about the efficient market theory in the airlines industry in Turkey by questioning the efficiency of Turkish Airlines and Pegasus Airlines stock returns. Stock returns are considered efficient if they reflect all information within the market, and are consequently not predictable. Efficient stocks' prices are not affected by changes in macroeconomic variables and are quite free of arbitrage opportunities. That said, the present study sought to investigate whether exchange rate—an important macroeconomic variable found in the literature to have significant effects on banks' stock returns—affects the mean returns and volatilities of Turkish Airlines and Pegasus Airlines stocks, which are fundamentally the main operating airlines in Turkey. Because we sought to obtain lucid and factual answers to our enquiry, daily data of nominal exchange rate, Turkish Airlines and Pegasus Airlines' stock prices were obtained from Yahoo finance for the period ranging from July 2013 to May 2022 to conduct the study. Prior to defining our methodology and running our econometric model, we conducted unit root tests to check for the stationarity of the variables using both the Augmented Dickey Fuller (ADF) test and the Kwiatkowski-Phillips-Schmidt-Shin (KPSS) test. Based on the ADF test—whose null hypothesis is that the series is unit root—it was found that exchange rates, Turkish Airlines and Pegasus Airlines' stock prices were unit root at level but stationary after first difference at the 1% significance level. Similarly, the KPSS test confirmed that the variables are non-stationary at level, but become stationary at first difference. Testing for the stationarity of exchange rates returns, Turkish Airlines and Pegasus Airlines' stock returns using both the ADF and KPSS tests revealed that stock returns and exchange rates returns were all stationary at level at the 1% significance level. Following the unit root test was a formal test for the presence of ARCH effects (after regressing the stock returns on exchange rate), that indicated that there are significant ARCH effects—an indication that the variance of the residuals changes with respect to time. Hence, given the heteroscedasticity of the variance, three distinct GARCH (1;1) models proved suitable to quantify the effects of exchange rates on both the stocks mean returns and their volatilities. A GARCH GJR and GARCH-M were also estimated to assess the leverage effects and the stocks risk premium, respectively. Four main findings emerged from our empirical analysis: First, exchange rates do not have a direct significant effect on the mean returns of any of the two Airlines, but do have positive significant impacts on their volatilities. This is in contrast with the findings of Saldanli (2017) according to which exchange rates have a significant causal effect on banks' (banks in Turkey) stock prices in Turkey. It is also in direct contradiction to a previous finding that exchange rate and money supply have a significant effect on stock prices by Bari (2020). Second, the mean stock returns of both airlines are significantly influenced by their past mean returns, thereby indicating predictability based on past observations. This is in conformity with the findings of Mehr-un-Nisa (2012) according to which increases in previous years stock prices are associated with further increases in current stock prices. Another key finding is that both Turkish Airlines and Pegasus Airlines' stocks have positive significant risk premiums, which suggests that higher risks will be associated with higher returns. Also, the leverage effect was found to be quite significant, thereby indicating that bad news will have more profound impacts on the volatilities of both airlines stock returns than will good news. To corroborate these findings, a further in-depth analysis was carried out to test for the presence of calendar anomalies. Conducting such an analysis required slightly different models whereby daily, monthly, and quarterly dummies were included in the original model as independent variables to inquire on the day of the week, month of the year and season effects on the airlines' stock returns, respectively. A cross-term—the product of the exchange rate return and the daily, monthly or quarterly dummy—was also added in each of the new models to assess the unique effects, if any, that an exchange rate change in a particular day of the week or month/season of the year could have on the two airlines' stocks' mean returns and their variances. The results of these estimations indicated that Mondays, in contrast to other days of the week, have a unique statistically significant impact on the mean stock returns and their volatilities. The monthly-based analysis indicated that no specific month has a distinct significant effect on the stocks' mean returns. However, a change in exchange rates in February, March, May, August or November has unique significant effects on the performance of the airlines' stocks returns. Also, the seasonal analysis has demonstrated that changes in exchanges rates in the fourth quarter of the year (from October to December) have significantly higher effects on Turkish Airlines and Pegasus Airlines' mean stock returns than the other quarters (seasons). By indicating the coincidence of breaks in the Borsa Istanbul stock exchange index (BIST100) and political events in Turkey, Gunay (2016) showed that "some political issues", which happen at different dates and times, "can cause a break in Turkish Stock market" (Gunay, 2016) As a result of all the findings aforementioned, it may be concluded that Turkish Airlines and Pegasus Airlines stock returns are both inefficient—a conclusion that several researchers including Kristjanpoller and Concha (2016) and Mollick and Amin (2021) have reached. This conclusion implies that stock returns are predictable and do not necessarily always encompass all information within the market. Hence, Turkish Airlines and Pegasus Airlines stocks constitute a bundle of glamorous arbitrage opportunities on which astute enterprising investors may explore.

6.2. Recommendations & Directions for Future Research

Considering the findings in this study, I primarily recommend caution to both existing and prospective investors. The business of investing in stocks sounds glamorous and glittering, but may result in apocalyptic outcomes if conducted whimsically. Also, considering the complexity of the issue, investors ought to weigh our findings against other scientific findings on the same topic in order to make more informed investment decisions suited to their goals. Meticulous research combined with a cautious attitude will most likely help investors manage through the constant market swings and evolve successfully.

Our conclusion suggested that both Turkish Airlines and Pegasus Airlines' stock returns are inefficient, thereby opening the door for arbitrage opportunities. Therefore, from a finance point of view I recommend enterprising investors to carefully consider, identify and take advantage of those opportunities. In doing so, it is quite important to note the benefits and drawbacks associated with holding each of these companies' stocks.

Based on our empirical findings, advantages associated with investing in Turkish Airlines stocks include its higher risk premium compared to Pegasus Airlines. At the same level of risk, investing in Turkish Airlines stocks will, on average, generate higher returns than investing in Pegasus Airlines stocks. Also, nearly 50% of Turkish Airlines shares are owned by the Turkish Wealth Fund, a state-owned institution, a factor that could reduce the likelihood of a crash of Turkish Airlines' stock prices. Pegasus Airlines, on the other hand, whose shares are privately owned in majority (approximately 65% owned by Esas Holding) may constitute a riskier asset to hold as it is fully at the mercy of private interests. Nonetheless, Pegasus Airlines has been a growing company whose value is likely to continue to increase in the future. Hence, investing in it today may generate much higher future returns for investors. Also, external shocks have higher asymmetric effects on Turkish Airlines stock volatility than that of Pegasus Airlines. While bad news has a higher impact on both airlines stock volatilities than good news of the same magnitude would, the effect of bad news on the volatility of Turkish Airlines stock returns is higher compared to its effect on Pegasus Airlines. So, Turkish Airlines stock returns is subject to higher volatility when facing an external negative shock. In a nutshell, considering the aforementioned pros and cons of each airline, we recommend potential investors to prioritize on investing in Turkish Airlines while also diversifying their portfolios by having some holdings in Pegasus Airlines' stocks too.

Our analysis on calendar anomalies pointed out that both Turkish Airlines and Pegasus Airlines stock returns were consistently positive on Mondays as compared to the rest of the weekdays. Therefore, it might be profitable for holders of these companies' stocks who want to sell their holdings to do so on Mondays when prices have, on average, risen.

Previously we mentioned that investors could identify arbitrage opportunities in the airlines' industry in Turkey. Doing so correctly may require building a model to accurately predict the stock prices, an interesting subject that is beyond the scope of this present study. However, a future study may focus on building an econometric model to forecast stock prices of Turkish Airlines and Pegasus Airlines. This could prove to be quite instrumental for insatiable profit-seeking investors and intellectually fulfilling for curious learners.

Last but not least, this study focused exclusively on the airlines industry in Turkey. Future studies may address a similar issue in a different specific sector, such as the technology sector. As technology companies have to innovate rapidly and constantly remain competitive, their market values may often rise or drop profoundly depending on whether they remain cutting-edge or lag behind technologically. So, in such a fierce and competitive industry, how would their market values and their stock prices respond to the emergence of disruptive technologies and changes in the overall macro economy?

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APPENDIXES

APPENDIX A

Lag selection

To determine the lag length of our variables, we checked for the optimum lags based on the SIC/BIC following the ARMA criteria tables. Following the model selection method, the model with lowest SIC/BIC is preferable.

Table A.1. Optimum Lags

RTA		**RPG**		**RER**	
Model	**SIC/BIC***	**Model**	**SIC/BIC***	**Model**	**SIC/BIC***
(0,0)	**-4.5926**	**(2,0)**	**-4.2796**	**(0,1)**	**-5.9576**
(1,1)	**-4.5906**	**(0,2)**	**-4.2795**	**(1,0)**	**-5.9567**
(2,0)	**-4.5897**	**(1,1)**	**-4.2790**	**(2,0)**	**-5.9564**

For RTA, the optimum lag based on BIC is 0. However, considering the small (almost insignificant) difference between -4.5926 and -4.5897, we considered workable to use up to the second lag in our estimation. Likewise, we considered up to the second lag of RER because of the small (almost insignificant) difference between -5.9576 and -5.9564

For RPG, the optimum lag is 2 based on BIC with an information criterion of -4.2796.

APPENDIX B

Test for ARCH Effects

The ARCH test is one of the most commonly used tests to check for heteroscedasticity. Its null and alternative hypotheses are as follows:
H0: There are no ARCH effects up to the specified lag
H1: There are ARCH effects up to the specified lag

The decision whether to accept or reject the null hypothesis can be made by analyzing the P-value. If the P-value is less than 5% (< 5%), we may reject the null hypothesis at the 5% significance level, which means that there are ARCH effects up to the specified lag. However, if the P-value is greater than 5% (> 5%), we cannot reject the null hypothesis at the 5% significance level, which means that there are no ARCH effects up to the specified lag.

Table B.1. ARCH Effects Test Statistics for RPG

RPG

F-statistic	129.9600	Prob. F(3,2293)	0.0000
Obs*R-squared	333.8034	Prob. Chi-square(3)	0.0000

Table B.2. ARCH Effects Test Statistics for RTA

RTA

F-statistic	14.6088	Prob. F(6,2283)	0.0000
Obs*R-squared	84.7074	Prob. Chi-square(3)	0.0000

As can be seen on the tables above, the P-values are significantly less than 5% for both RPG and RTA. Hence, we may reject the null hypothesis and conclude that there are ARCH effects up to the third lag for RPG and up to the sixth lag for RTA.

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