

## Oil price fluctuations and airline profitability: The case of Turkish Airlines

### Petrol fiyatlarındaki dalgalanmalar ve havayolu kârlılığı: Türk Hava Yolları örneği

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#### Abstract

This study examines the potential relationship between oil price fluctuations and airline profitability, focusing on Turkish Airlines (THY) from 2001 to 2022. The study uses wavelet analysis to explore the correlation between oil prices and the airline's profit and loss data, considering geopolitical factors and unexpected events that may affect airline operations. THY's financial performance is significantly impacted by oil price fluctuations in the short and medium term, while its long-term profitability remains stable. Strategic planning and intelligent fuel management, including hedging, are imperative to mitigate the effects of volatile oil prices on airline operations. The results of this study provide valuable insights for the airline industry, assisting in better-informed decision-making and contributing to future research. Wavelet analysis proves effective in uncovering complex relationships and trends, offering a comprehensive understanding of the dynamic interactions between oil price changes and airline profitability.

**Keywords:** Oil Prices, Airline Profitability, Turkish Airlines (THY), Wavelet Analysis

**Jel Codes:** L93, Q41, C32

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#### Öz

Bu çalışma, 2001-2022 yılları arasında Türk Hava Yolları'na (THY) odaklanarak petrol fiyatlarındaki dalgalanmalar ile havayolu kârlılığı arasındaki potansiyel ilişkiyi incelemektedir. Dalgacık analizini kullanan çalışma, jeopolitik faktörleri ve havayolu operasyonlarını etkileyebilecek beklenmedik olayları dikkate alarak petrol fiyatları ile havayolunun kâr ve zarar verileri arasındaki korelasyonu araştırmaktadır. THY'nin finansal performansı kısa ve orta vadede petrol fiyatlarındaki dalgalanmalardan önemli ölçüde etkilenirken, uzun vadede kârlılığı sabit kalmaktadır. Petrol fiyatlarındaki dalgalanmaların havayolu operasyonları üzerindeki etkilerini azaltmak için, riskten korunma da dahil olmak üzere stratejik planlama ve akıllı yakıt yönetimi zorunludur. Bu çalışmanın sonuçları, havayolu endüstrisi için değerli içgörüler sunmakta, daha iyi bilgilendirilmiş karar verme sürecine yardımcı olmakta ve gelecekteki araştırmalara katkıda bulunmaktadır. Dalgacık analizi, karmaşık ilişkileri ve eğilimleri ortaya çıkarmada etkili olduğunu kanıtlayarak petrol fiyatlarındaki değişiklikler ile havayolu kârlılığı arasındaki dinamik etkileşimlerin kapsamlı bir şekilde anlaşılmasını sağlamaktadır.

**Anahtar Kelimeler:** Petrol Fiyatları, Havayolu Kârlılığı, Türk Hava Yolları (THY), Dalgacık Analizi

**JEL Kodları:** L93, Q41, C32

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## Introduction

Civil aviation is a crucial component of contemporary life, providing insights into a country's economic and social development. However, macro-level factors such as wars, economic downturns, high oil prices, and increased competition on a global scale can adversely impact this industry (Ilarslan, 2014). It is also essential to recognize that external elements, such as terrorist attacks, natural calamities, labour strikes, and unexpected public health crises, can disrupt normal operations in the air transport industry, leading to an overall decline in airline performance and long-term development (Xu, McGrory, Wang & Wu, 2021).

Airlines' profitability is heavily influenced by fluctuating oil prices, which account for a significant portion of their operating costs. Airlines must manage these fluctuations to ensure long-term financial stability and sustainability in a highly competitive and cost-sensitive industry. However, macro-level factors in Turkey, such as geopolitical instability, terrorist attacks, natural disasters, labour strikes, economic fluctuations, and unexpected global events, further complicate the impact of oil prices. Understanding the impact of oil price fluctuations on airline profitability can significantly improve strategic planning, risk management, and policy formulation (Özdurak, 2020).

This study aims to explore the relationship between oil price fluctuations and the profitability of Turkish Airlines (THY) from 2001 to 2022 using wavelet analysis. Understanding this relationship is crucial for strategic planning and risk management in the airline industry.

Fuel costs are typically the most significant expense despite the various business models airlines adopt. Although fuel costs account for approximately 20% of total costs for network carriers, it can reach as high as 40% for low-cost airlines. Fuel costs represent around 30-40% of operating expenses in the aviation industry, implying that even minor fluctuations in oil prices can have significant impacts. Consequently, airline companies' fuel costs differ from other expenses since the fuel cost price is externally determined. In contrast, expenses such as personnel, aircraft rentals, and airport taxes can be controlled to some extent. Therefore, the oil price is determined by global political and economic conditions, making it challenging to control costs and plans. In such a scenario, few alternatives are available to airlines to mitigate the adverse impact of increased oil prices.

The aviation industry faces a considerable risk due to the volatile nature of fuel prices. As such, airlines have implemented various measures to mitigate this risk. The first step is to increase fuel efficiency, followed by adjusting ticket prices to reflect the increase in fuel efficiency. Another approach involves stabilizing future fuel prices, which airlines achieve through hedging to ensure that fuel prices remain at a specific level, thereby preventing losses from sudden fuel price increases (Kendirli and Kaya, 2015). Despite these efforts, the increasing cost of jet fuel remains a challenge for airlines in maintaining profitability. Hedging fuel risk offers advantages and disadvantages, where airlines with fuel protection incur higher costs if oil prices fall but can save millions of dollars if prices increase. However, airlines have had mixed results with fuel hedging, and there is no consensus on how best to hedge their exposure to jet fuel (Turner and Lim, 2015). In order to combat the risks posed by fuel price fluctuations, airlines have adopted various strategies to increase their operational efficiency. One such strategy involves using advanced air traffic management technologies, including aviation communication, navigation and surveillance systems (CNS), to select the most efficient altitudes and routes for their flights. This allows airlines to minimize waiting times and departure lanes and optimize fuel consumption. Airlines utilize advanced planning software to calculate the most fuel-efficient routes to aid in this process. The International Air Transport Association (IATA) has suggested that optimizing air traffic control can significantly reduce airline fuel consumption (Pahlevan, Ranjbar & Arumugam, 2009). In addition to these technological solutions, airlines are investing in fleet upgrades and aircraft modifications to improve fuel efficiency, as noted by Turner and Lim (2015).

The 2019 IATA chart portrays the airline industry's profitability through the airline operating margin, and inflation-adjusted oil prices are also presented for each year from 1950 to 2017. Despite a consistent trend of lower profitability associated with higher oil prices, the report suggests that the correlation between these variables is weak. The report reveals that oil prices have contributed only 1,5% to the airline profitability variation in the last 70 years. Furthermore, the pricing strategies of airlines, influenced by factors such as economic strength and market characteristics, significantly influence airline prices. Examining exchange rate fluctuations and hedging methods can amplify or mitigate oil price volatility from one airline to another. Ultimately, it has been argued that oil price variations only account for a small fraction of the long-term profitability of the airline industry, implying that the relationship between these variables is not straightforward.

As a methodology, this study explores the impact of oil price fluctuations on Turkish Airlines' profitability from 2001 through the second quarter of 2022. The financial statements and detailed financial data for Turkish Airlines (THY) have been consistently available since 2001. This availability of comprehensive financial records enables a thorough and accurate analysis of the airline's financial performance over time. By selecting this period, the study can comprehensively examine both short-term and long-term effects of oil price volatility on the airline industry, offering valuable insights into airlines' strategic planning and financial management. This study uses wavelet analysis to uncover hidden patterns and complex relationships between oil prices and airline profitability. This approach makes examining both short-term and long-term effects possible, allowing us to understand the dynamics at work better (Alici & Sevil, 2020).

Following the introduction of its arguments, the study examines the literature regarding the relationship between oil prices and airline profitability. The subsequent sections suggest a case study to analyse how the changes influence THY's profitability in oil prices. In conclusion, the study presents its findings and concludes.

## Literature review

Adrangi and Chatrath (1991) investigated the impact of airline fuel hedging on airlines' financial health. Their study included data from periods with heavy losses and failed consolidations, particularly concerning the use of oil derivatives markets. Their findings indicated limited benefits and the overall impact of fuel hedging on air carriers' financial health was negligible, implying that concerns about the effectiveness of hedging strategies were justified.

Braginskii (2009) investigated the impact of high oil consumption in emerging economies, focusing on BRIC countries (Brazil, Russia, India, and China). Although these countries' economic growth has been impressive in the last two and a half decades, the study's findings suggest that the fluctuations in stock returns of BRIC nations do not have a considerable influence on the volatility of global oil prices. Nonetheless, the growing oil consumption in emerging economies is a cause for concern.

Kristjanpoller and Concha (2016) empirically analysed 56 airline companies using GARCH models to investigate the relationship between fuel prices and airline industry performance. The study found a strong positive correlation between fuel price fluctuations and daily returns in West Texas Intermediate crude oil and Jet Fuel prices. Moreover, given the significant impact of fuel costs on airline expenses, the authors highlighted that both direct and indirect effects of fuel prices exist on the industry's financial performance.

Park et al. (2023) focused on airlines' management, profitability, and riskiness. Their research delved into various aspects of airline operations and the challenges faced in managing profitability amidst fluctuating fuel prices and other operational risks.

Wang and Gao (2020) investigated the influence of oil price dynamics on quarterly earnings and their predictability for a sample of 30 airlines over the period 1994 to 2017. The authors identified that demand-driven oil price shocks have a significant positive effect on airline earnings, leading them to conclude that revenue impacts resulting from changes in air travel demand have a more substantial effect on airline earnings than the cost impacts associated with aviation fuel price changes. Furthermore, they found that supply-driven oil price shocks had a more adverse impact on earnings predictability than demand-driven oil shocks, suggesting that supply-driven oil shocks had a more significant adverse effect on earnings.

Killins (2020) conducted a study investigating the relationship between oil price fluctuations and equity returns of Canadian and US rail and airline companies. The study revealed that airline companies respond distinctly to oil price volatility, with US-based airlines' equity returns adversely impacted by upward movements in West Texas Intermediate (WTI) prices.

When looking at the overall relationship, oil prices have both long-run and short-run asymmetric effects on airline costs: a decrease in oil price stimulates airline profits, whereas its increase does not necessarily have a negative impact and sometimes even causes profitability to improve. However, the asymmetric oil quality affects cements on specific scales. According to the effect of the decline in oil prices, passenger efforts to reduce costs are not strong enough to force sellers to realize all the savings from the lower cost of jet fuel. (Chuang, 2020).

Xu et al. (2021) conducted a study investigating the impact of oil prices and exchange rate fluctuations on the performance of China's major airlines, Air China, China Southern Airlines, and China Eastern Airlines, using the Least Absolute Shrinkage and Selection Operator (LASSO) approach. Their findings

demonstrated that the short-term profit of the airlines was inversely related to increases in oil prices, indicating that Chinese airlines are highly sensitive to oil price movements. Furthermore, the study revealed that exchange rate fluctuations significantly impacted airline performance, suggesting that exchange rate risks should also be considered when analyzing the performance of air transport companies.

Mollick and Amin (2021) found that the impact of oil prices on the stock prices of airline companies is asymmetric, with more significant adverse effects observed during periods of oil price increases compared to decreases. The study employed panel data analysis to investigate the interplay between revenues and costs in the pricing of airline stocks. Specifically, the study examined the stock returns of 33 companies over 30 years to assess the differential effects of occupancy and oil prices on the companies' stock performance in the United States.

Horobet and colleagues (2022) conducted a macroeconomic analysis of the airline industry's exposure to oil price risk in the short and long term. Their study employed a panel ARDL model and PMG estimator using monthly data from 2007 to 2020. The study found that the negative impact of oil price risk on airline stock prices is significant, robust, and pervasive. Furthermore, the article discussed the airline industry's expectations and challenges in dealing with oil price risk post-pandemic. The most noteworthy finding from the study is that airline company stock prices and returns are negatively and significantly exposed to oil prices and price volatility. The industry's performance is further hurt by the combination of exposure to oil price risk with the USD/EUR exchange rate.

### **An overview of significant political and economic events affecting global oil prices between 2000-2022**

The enduring importance of oil as a crucial commodity in various sectors, such as transportation, heating, and manufacturing, has remained consistent despite the increasing prevalence of alternative energy sources. The prices of oil, which are sensitive to shifts in supply and demand, have been volatile, with fluctuations often triggered by disruptions or uncertainties. Geopolitical occurrences can majorly impact the oil supply, resulting in price spikes. Similarly, economic downturns can cause a decrease in demand, leading to lower prices. For airlines, whose main cost component is fuel, the consequences of political and economic changes in oil prices are inevitable and cannot be ignored (Ross, 2022).

Several factors influence the price of crude oil, including:

- Prospects for supply and demand as well as perceived disruptions in the market.
- Crude oil demand tends to increase as the economy grows and decreases as the economy slows.
- OPEC negotiates export quotas for its members to influence global oil supply.
- Crude oil prices are volatile because supply and demand are relatively inelastic, which means they are slow to adjust to price signals, requiring significant price moves to balance the market.

In the spring of 2020, crude oil prices collapsed due to the COVID-19 pandemic and the resulting economic slowdown. Although OPEC and its allies reduced production to stabilize prices, they still fell to 20-year lows (Bajpai, 2022).

**Table 1:** Oil Price Response to Political and Economic Events: A Historical Overview

Quarter-Year	Events	Crude Oil Price (per Barrel)
Q4-2000	Highest price before September 11	\$ 38.73
Q3-2001	September 11 attacks	\$ 31.76
Q4-2001	Bottom price after September 11	\$24.22
Q1-2005	Low spare capacity	\$ 54.71
Q2-2008	Highest price before the worldwide financial crisis	\$ 125.21
Q1-2009	OPEC reduced production objectives by 4.2M barrels per day	\$ 42.89
Q2-2014	Highest price before supply glut price collapse	\$ 95.07
Q1-2015	OPEC production quota unchanged despite low oil price	\$ 44.41
Q4-2019	The price just before the worldwide epidemic	\$ 50.38
Q1-2020	COVID-19 declared a pandemic	\$ 40.34
Q2-2020	The global pandemic reduced oil price	\$ 24.65
Q1-2022	Russia invaded Ukraine	\$ 77.94

Source: Visual Capitalist. (n.d.). Historical oil prices. Retrieved from <https://advisor.visualcapitalist.com/historical-oil-prices/>

### An analysis of Turkish Airlines' losses over the past few years

In 2003, Turkish Airlines (THY) established strategies to expand its product lines and increase its aircraft fleet to achieve strong financial performance. However, the occurrence of subsequent events, such as plane crashes, hijackings, and terrorist attacks in Istanbul, as well as the US air attack and invasion of Iraq, led to a loss in the company's financial performance during the second and fourth quarters of the year.

In the second and fourth quarters of 2003, THY incurred losses of \$70,542,869.47 and \$63,394,762.74, respectively, attributed to plane crashes and hijackings in the first quarter (THY, 2003). In addition, the terrorist attacks in Istanbul led to sudden increases in oil prices in the last quarter, which were compounded by local political events and the US air attack on Iraq on March 19, 2003. These events negatively impacted Turkey's financial markets and economic balances, leading to short-term increases in foreign exchange rates (Yayci, 2019). The sudden rise in oil prices during this period was due to factors such as shrinking supply, rapidly increasing demand, financial speculation, OPEC's manipulation of oil quotas, and the inability of American refineries to meet local demand (Babalı, 2022). The effects of these events continued into 2004, with THY reporting losses of \$70,448,109.01 and \$56,617,676.25 in the first and second quarters, respectively.

Turkish Airlines (THY) expanded its services and improved its operations in 2006. First, THY incorporated its technical maintenance department, THY Technic, which enabled the airline to provide maintenance services to other regional airlines. A 50-50 partnership was also established between THY and Turkish Do&Co to create a catering company. A joint venture between THY and Opet was formed to offer aviation fuel services to its customers.

In 2008, THY joined the global airline alliance Star Alliance and launched regional airline service via Anadolujet. In 2010, THY also established Turkish Ground Services (TGS). As a result of these initiatives, THY's profitability and service quality have increased significantly.

In 2006, Turkish Airlines (THY) was adversely affected by oil prices, exchange rate fluctuations, and global economic developments. Due to these factors, THY declared losses in the first and third quarters of the year. A loss of \$138,965,813.57 was reported in the first quarter, and a loss of \$64,435,475.16 was reported in the third quarter. Oil prices increased during these periods, contributing to the airline's losses (THY, 2006).

From 2006 to 2009, the natural gas crisis between Russia and Ukraine resulted in political instability, significantly impacting oil prices. The third quarter of 2009 saw a sudden increase in oil prices, which caused a loss of \$34,385,234.68 for the company (THY, 2009). The global financial crisis 2008 and the Russia-Georgia war also contributed to the increase in oil prices and caused disruptions in oil shipments. As a result, there was a decline in the number of domestic and international passengers travelling to Turkey (Erdem, Tsiotas and Cubukcu, 2020).

In late 2009, a barrel of oil was \$80, which increased to \$100 by the end of 2010 and rose to \$115 by March 2011. Marginal fluctuations in oil prices can significantly impact airlines' profit margins, particularly in regions such as the Middle East and North Africa, which are home to oil-producing countries. Turkish Airlines was negatively affected by political and social events in the region as well as the earthquake and tsunami in Japan. Consequently, the airline had to suspend some or all of its flights to countries such as Libya, Tunisia, Egypt, and Japan, leading to a loss of income (THY, 2011).

In the first quarter of 2012, high fuel prices increased the airlines' cost base and adversely affected their profitability (THY, 2012).

During the first quarter of 2014, the company experienced a loss due to increased fuel prices. However, from mid-2014 to early 2016, oil barrels experienced one of the most significant historical declines, with prices reaching as high as 108 and 109 dollars in January and February 2014, respectively. This period was marked by one of the three most significant price declines since World War II and one of the most extended-lasting declines since the supply-driven collapse of 1986. Despite the loss incurred in the first quarter of 2014, the airline could report a profit from the second quarter of 2014 to the first quarter of 2016.

In 2016, Turkish Airlines faced numerous challenges due to the unstable political climate in Turkey, which adversely affected the aviation industry. Following the failed coup attempt in July, the Federal Aviation Administration suspended flights between Turkey and the USA, which hurt Turkish Airlines. The airline's strategy of linking the USA to less accessible destinations in Africa and the Middle East was compromised. In addition, Turkish Airlines had to ground 30 aircraft and reported a total loss of \$644.4 million in the year's first half.

2020, the aviation industry faced an unprecedented crisis due to the COVID-19 pandemic. Turkish Airlines, during this period, incurred a core operating loss of US\$ 255 million, as reported by THY (2020). Despite declining passenger revenue, Turkish Airlines managed to increase its cargo revenue. However, the drop in fuel prices did not improve the airline's profitability, as the decrease in passenger demand offset the benefits of lower fuel costs.

The Company employs swap and option-based derivative instruments to mitigate the impact of fuel price fluctuations on jet fuel costs and maintain costs within a specified range or at a fixed rate. In order to decrease the volatility of fuel market fluctuations on profitability and cash flow, it gradually hedges financial risks through crude oil or jet fuel derivative instruments, with contract amounts covering around 50% of the annual jet fuel consumption. It is worth noting that prior to privatization, Turkish Airlines (THY) did not utilize hedging techniques. Following privatization, THY began implementing these methods intermittently, hedging roughly 10% of its annual jet fuel consumption in 2009 using hedging techniques, which limited the effect of fuel price shifts on jet fuel costs, fixed jet fuel prices within a predetermined range, and reduced potential adverse impacts on the fuel market. THY's decision was predicated on the notion that oil prices had hit a low point in 2009 (Battal, Ü., Mühim, S. A., 2016). When oil prices were low, THY employed hedging strategies and realized profitability. Oil barrel prices climbed between 2009 and 2013. By implementing the technique at the right time, THY was able to shield itself from oil price hikes for 10% of its fuel requirements.

## Methodology

This study used Morlet wavelet analysis. The Morlet wavelet is chosen because it balances time and frequency localization, making it particularly suitable for analyzing data with periodic solid components, such as oil price fluctuations. Its ability to capture both short-term and long-term patterns allows for a comprehensive analysis of the dynamic relationships between oil prices and airline profitability, providing deeper insights into the impacts of these fluctuations on financial performance.

The authors apply the wavelet coherence technique to study the relationship between oil prices and the profitability of US airlines over the period since 1986. The wavelet approach directly measures the correlation of any two data series against the frequency of the fluctuations in either series (Polanco-Martínez et al., 2020). The results suggest that the economic linkages of oil prices and airline profitability are time-scale dependent.

In Turkey, a wavelet coherence technique was employed to explore the time-frequency relationship between bank concentrations and non-performing loans. This analytical approach, introduced by Goupillaud, Grossmann and Morlet (1984), allows the decomposition of a one-dimensional time series into two-dimensional time-frequency domains. In light of this, it is imperative to investigate the long-term and short-term causal connections between banking concentration and non-performing loans in Turkey. This multiscale decomposition method provides a natural framework for analyzing frequency-

based behaviour. The results of this study may have important implications for policymakers, financial institutions, and investors in the Turkish banking industry.

The equation for the wavelet function ( $\psi$ ), which belongs to the Morlet wavelet family, is given as:

$$\psi(t) = \pi^{-\frac{1}{4}} e^{-i\omega_0 t} e^{-\frac{1}{2}t^2}$$

Wavelets are characterized by two primary components: time and location, represented by  $k$ , and frequency, represented by  $f$ . The distribution of wavelets across time and location can be manipulated to achieve localization of various frequencies:

$$\psi_{k,f}(t) = \frac{1}{\sqrt{h}} \psi\left(\frac{t-k}{f}\right), k, f \in \mathbb{R}, f \neq 0$$

Continuous wavelets are generated based on the  $p(t)$  time series data, following the approach described below:

$$W_p(k, f) = \int_{-\infty}^{\infty} p(t) \frac{1}{\sqrt{f}} \psi\left(\frac{t-k}{f}\right) dt,$$

The presented equation depicts the coefficient of the degenerate time of origin for the  $p(t)$  time series:

$$p(t) = \frac{1}{C_\psi} \int_0^\infty \left[ \int_{-\infty}^\infty |W_p(a, b)|^2 da \right] \frac{db}{b^2}.$$

The wavelet power spectrum (WPS) provides a means of obtaining more comprehensive information about the magnitude of a given time series:

$$WPS_p(k, f) = |W_p(k, f)|^2$$

Wavelet coherence, utilized in this study, identifies any correlation between two-time series, namely  $p(t)$  and  $q(t)$ . To generate cross wavelet transforms (CWTs), the two-time series are transformed using the following equation, in line with the approach employed in this research:

$$W_{pq}(k, f) = W_p(k, f)W_q(k, f),$$

Torrence and Compo (1998) defined  $W_p(k, f)$  and  $W_q(k, f)$  as the continuous wavelet transform (CWT) of two-time series, denoted by  $p(t)$  and  $q(t)$ , respectively. Additionally, they presented an equation for square wavelets, which is as follows:

$$R^2(k, f) = \frac{|C(f^{-1}W_{pq}(k, f))|^2}{C(f^{-1}|W_p(k, f)|^2) C(f^{-1}|W_q(k, f)|^2)}$$

In wavelet coherence analysis, the parameter  $C$  denotes time, while the range of  $0 \leq R^2(k, f) \leq 1$  represents the data treatment in the time domain. A value of  $R^2(k, f)$  close to 1 indicates that the time series variables are in phase, while a value close to 0 indicates that the variables exhibit poor correlation.

As  $R^2(k, f)$  is a square value, it provides information on the strength of correlation between variables, but not its direction. This is because Torrence and Compo (1998) and Pal and Mitra (2017) developed an



instrument for assessing wavelet coherence that involves deferring signals in the waves of two-time series. The differential phase equation for wavelet coherence is presented below:

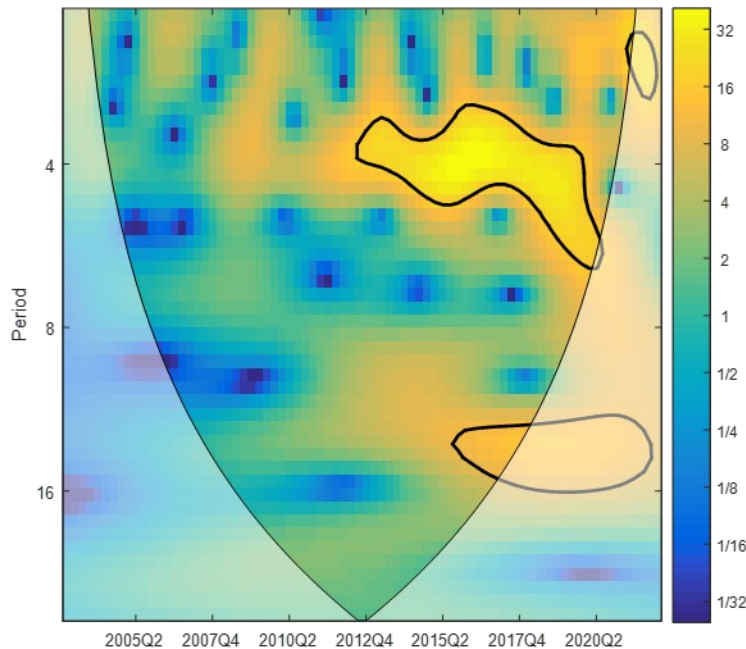
$$\phi_{pq}(k, f) = \tan^{-1} \left( \frac{L \{ C ( f^{-1} W_{pq}(k, f) ) \}}{O \{ C ( f^{-1} W_{pq}(k, f) ) \}} \right),$$

L represents an unrealistic operator, and O shows an actual part operator.

**Empirical findings**

The wavelet coherence analysis (Kirikkaleli & Sowah, 2020) between profit/loss in USD million and oil price revealed high coherence during specific periods, such as the final quarter of 2008, which coincided with a significant escalation in oil prices (Matar et al., 2021). The relationship between oil price fluctuations and airline profitability is crucial for understanding the financial performance of Turkish Airlines. This analysis can provide valuable insights into the impact of oil prices on the airline industry. This could potentially lead to more informed decision-making and strategic planning for airline companies in the future. Fluctuations in oil prices substantially influenced THY's profit/loss fluctuations from 2015 to 2020. The relationship between oil prices and airline profitability is complex and multifaceted. Factors such as fuel hedging, demand for air travel, and competition within the industry also play a significant role in determining the overall impact on an airline's financial performance. The data collection for this study commenced on 12/10/2022. The data were gathered by examining publicly available financial statements online; therefore, approval from an ethics committee was not required.

The data analysis depicted in Figure 1 reveals the presence of short-term fluctuations in profit/loss in 2017. The company experienced losses from 2011 to 2014, particularly affecting the first quarter. This trend persisted from 2016 to 2019. The year 2020 was characterized by a significant adverse impact of the pandemic on the company's financial performance, resulting in losses for the entire year.

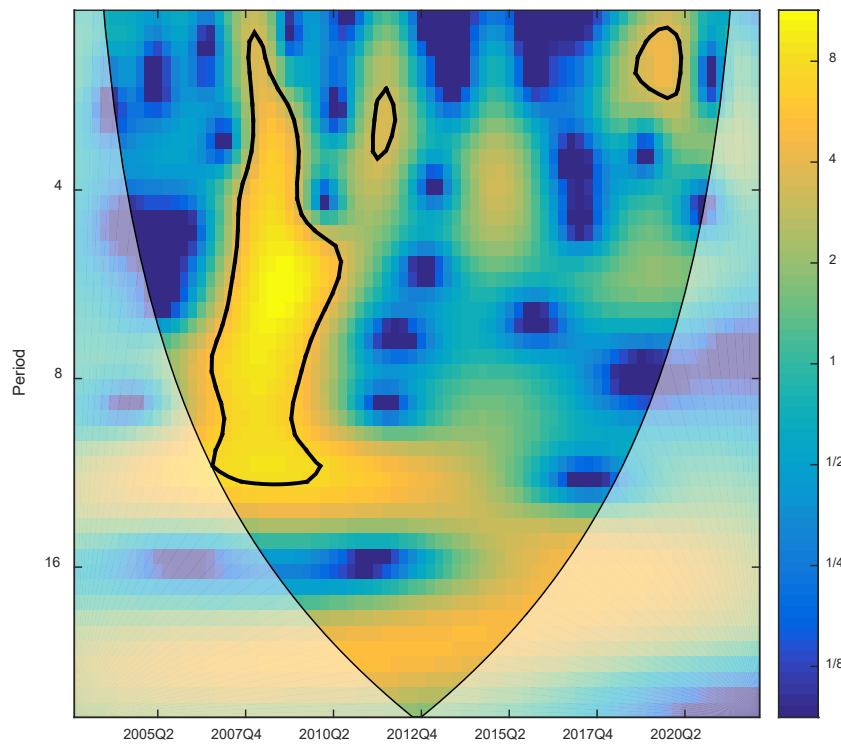


**Figure 1:** Analysis of THY Profit/Loss Fluctuations from 2001 to Q2 2022

The analysis indicates that oil price fluctuations have a notable impact on the financial performance of THY, particularly in the short and medium term. From 2006 to 2009, significant short and medium-term fluctuations in oil prices were observed, with a notable surge in 2008 impacting global markets and THY's profitability (Aydın & Ari, 2020) and the year 2011 also exhibited significant fluctuations in oil prices. In 2018, there was a short-term escalation in oil prices. The year 2020 showed a significant

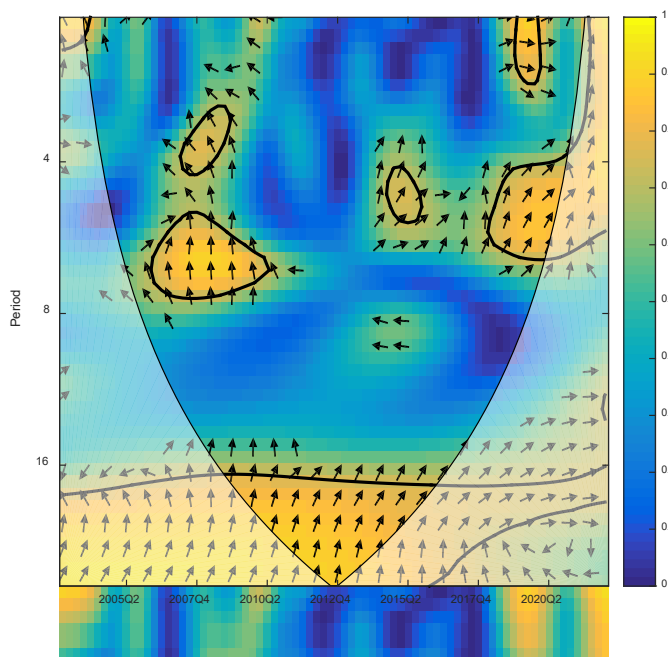


adverse impact on THY's financial performance due to the COVID-19 pandemic, which affected oil prices and airline profitability (Kurşuncu & Seçilmiş, 2023).



**Figure 2:** Wavelet Power Spectrum Analysis of Oil Price Trends from 2001 to Q2 2022

In historical context and geopolitical factors, the analysis indicates that oil price fluctuations have a notable impact on the financial performance of THY, particularly in the short and medium term. From 2006 to 2009, significant short and medium-term fluctuations in oil prices were observed, with a notable surge in 2008 impacting global markets and THY's profitability (Aydın & Ari, 2020). The year 2020 showed a significant adverse impact on THY's financial performance due to the COVID-19 pandemic, which affected oil prices and airline profitability (Kurşuncu & Seçilmiş, 2023).



**Figure 3:** Wavelet Coherence Analysis of the Relationship between Profit/Loss in USD Million and Oil Price

The present study uses wavelet coherence analysis to examine the relationship between profit/loss of USD million and oil price. Our results reveal that the wavelet coherence between profit/loss USD million and oil price attained its zenith during the final quarter of 2008, which coincided with the commencement of oil price escalation in the preceding quarter of 2007. The escalation in oil prices considerably impacted the airline industry's profit/loss statement, with the company registering a loss in the initial two quarters of 2011. Moreover, our findings demonstrate that oil price fluctuations substantially influenced profit/loss fluctuations from 2015 to 2020.

THY has employed various strategies to manage fuel price risks, including hedging and improving fuel efficiency. Hedging has helped mitigate the adverse impacts of sudden fuel price increases, although it comes with challenges and mixed results (Sorokin, 2022). Advanced air traffic management technologies and fleet upgrades have also been part of THY's strategy to improve fuel efficiency and reduce costs. The airline has also focused on implementing innovative fuel-saving measures such as new engine designs and lightweight materials in aircraft construction. These initiatives have contributed to a more sustainable operation and improved profitability for Turkish Airlines (Mızrak et al., 2022). The findings suggest a significant correlation between oil price fluctuations and airline profitability. Furthermore, it is essential to consider the potential impact of geopolitical events on oil prices in the future (Kang et al., 2021).

## Results

This study aimed to assess the effects of oil price fluctuations on airline profitability, with a specific focus on Turkish Airlines (THY). To achieve this goal, we utilized Wavelet Analysis as a powerful tool to investigate the relationship between oil price fluctuations and THY's profitability between 2000 and the first quarter of 2022.

The analysis results indicated that oil price fluctuations significantly affect THY's financial performance, impacting the airline's short- and medium-term profitability. However, THY has maintained its profitability in the long run despite the impact of oil price fluctuations.

### 1. Financial Performance and Oil Price Fluctuations

According to the wavelet coherence analysis, there is high coherence during specific periods, particularly the final quarter of 2008, which coincides with significant increases in oil prices. This suggests that oil price fluctuations significantly impact THY's profitability, particularly in the short and medium term.

**Short-term Fluctuations:** Significant short-term fluctuations were observed in profit/loss data in 2017, with notable losses between 2011-2014 and 2016-2019. Due to the COVID-19 pandemic, 2020 resulted in substantial financial losses.

**Medium-term Fluctuations:** From 2006 to 2009, oil prices experienced significant short and medium-term fluctuations, with a notable surge in 2008 impacting global markets and THY's profitability.

**Figure 1:** An analysis of THY Profit/Loss Fluctuations from 2001 to Q2 2022 demonstrates a significant correlation between profit/loss fluctuations and oil prices.

**Figure 2:** A wavelet coherence analysis of oil price trends from 2001 to Q2 2022 highlights periods of high volatility.

**Figure 3:** The wavelet coherence analysis of the relationship between Profit/Loss in USD Million and Oil Price indicates a significant impact from 2015 to 2020.

### 2. Geopolitical and Economic Factors

The historical context indicates that oil price fluctuations significantly impact THY's financial performance, particularly during geopolitical events such as the 2008 financial crisis and the 2020 COVID-19 pandemic. Strategic planning for the airline industry should consider geopolitical and economic factors.

According to the findings, oil price fluctuations significantly affect the profitability of airlines, specifically Turkish Airlines (THY). This study aims to interpret these findings within the context of strategic fuel management and planning within the airline industry. These figures illustrate the correlation between profit/loss and prices and highlight the chosen scale and period based on oil price trends from 2001 to Q2 2022. Figure 1 and Figure 2 are scaled according to the time-frequency localization of wavelets. In Figure 3, the density outside the cone of influence indicates less reliable data, which should be analyzed cautiously.

The findings of this study have important implications for the airline industry. They highlight the crucial role of strategic planning in mitigating the effects of volatile oil prices on operations. This study also emphasizes the importance of intelligent fuel management strategies, including hedging, to ensure long-term and sustainable business models for airlines.

As a result, we are using Wavelet Analysis as an analysis tool, which allows for a comprehensive understanding of the complex relationships between oil price fluctuations and airline profitability. This approach can be used in future research to investigate the impact of external factors on the performance of companies across a range of industries.

## Discussion

The discussion highlights the critical role of strategic planning and intelligent fuel management in mitigating the effects of volatile oil prices on airline profitability. The study's findings are consistent with previous research, which has shown that:

**Fuel Hedging:** Hedging can mitigate the adverse impacts of sudden fuel price increases. However, it comes with challenges and mixed results.

**Technological Advancements:** Investment in advanced air traffic management technologies and fleet upgrades has improved fuel efficiency.

**Global Context:** The impact of geopolitical events on oil prices is significant—similar patterns in different regions emphasise this issue's global nature.

This study aimed to investigate the impact of oil price fluctuations on airline profitability using Turkish Airlines (THY) as a case study. The findings suggest that changes in oil prices significantly affect THY's financial performance in the short and medium term while the airline's long-term profitability remains stable.

Conducting this study in developing countries such as Turkey, which are not oil-rich nations, is crucial to accurately measure the effect of oil price fluctuations on the airline industry. The dynamics of developed countries differ significantly from those of undeveloped countries in this industry, making it challenging to determine the actual impact of oil prices. Thus, examining a country that falls between the two categories is essential to identify the real effect. Therefore, Turkish Airlines should be selected as a case study.

The Wavelet Analysis method used in this study provides a comprehensive approach to analyzing significant signals that can be applied to future research in various sectors. To the best of our knowledge, this is the first study to apply Wavelet Analysis to investigate the impact of oil price fluctuations on airline profitability, and the results demonstrate the effectiveness of this approach in uncovering hidden relationships and trends.

This study contributes to the growing literature on the effects of external factors on company profitability. Future research may explore the use of different analysis tools to develop effective management strategies and provide a deeper understanding of these complex relationships. In conclusion, the findings of this study emphasize the importance of intelligent fuel management strategies, including hedging, to ensure long-term and sustainable business models for airlines facing the challenge of managing high operational costs cost-effectively.

## Limitations and future research directions

Most of the parameters in the wavelet model are driven empirically, such as Daubechies wavelet and mother wavelet choice. When correlations are higher in the dataset, the estimation may be affected by the choice of the mother wavelet. Therefore, the research is open to scholars to propose wavelet model improvement by attempting different mother wavelet parameter choices and testing on other datasets. What is more, considering the revealed impact of oil price changes as information stimulus on different time intervals in the wavelet domain, the impacts of different oil price uncertainty levels and exchange rate dynamics on airline profitability are also areas that can further enrich wavelet analysis and airline finance fields in the context of the studied limitations. Furthermore, considering a potential greenhouse effect on the aviation sector, further investigations can also identify potential changes in the impact of the association of oil price changes with airline finance and business performance between the pre-and post-Kyoto Protocol periods, as well as the effects of recent environmental concerns together with oil price - airline finance - business performance association.

The current study is performed by employing a rich dataset to investigate the impact of oil price fluctuations on the profitability of airline carriers. However, the profitability investigation can be

broadened, and the determinants of profitability can be analyzed in more detail. Additionally, business performance indicators can be used in ways other than just profitability. Moreover, wavelet techniques can be adapted to investigate the impact of oil prices on airline profitability and business performance in other geographical domains by including different sets of airline company financial databases. Similarly, the impacts of other oil price benchmarks, such as Dubai Crude Oil or Brent Crude Oil, could be explored. Although the wavelet analysis model developed in this study has already been utilized in some recent research, the sample is nevertheless limited, and its application to other airline carrier company datasets is highly critical to supporting conclusions more effectively.

## **Conclusion**

Airlines face the crucial challenge of managing high operational costs cost-effectively. The aviation industry, however, exhibits limited capacity to control fuel costs as opposed to other types of expenses. As a result of the intense competition among airline companies, high and constantly fluctuating fuel costs necessitate cost control measures. Elevated oil prices reduce profits as airlines cannot directly pass on the price increase to customers. Supply and demand, production quotas, and refinery capacity determine oil prices. As aviation is highly dependent on oil, most airlines adopt forward-looking fuel policies to secure fuel requirements and prices. Large fuel volumes are purchased upfront or traded through futures markets or currency trading when oil prices fall. Nevertheless, airlines may mitigate the impact of oil prices through management strategies and tools.

This study examines the relationship between oil price fluctuations and Turkish Airlines (THY) profitability between 2000 and the first quarter 2022. Wavelet Analysis was a powerful tool for achieving this goal, enabling the analysis of signals in small areas, which is particularly useful when dealing with significant signals. The Wavelet Analysis method analyses signals in the time domain, allowing low-frequency information in the extended and high-frequency information in the short time interval to be extracted. This technique provides a comprehensive data analysis, making it possible to uncover hidden relationships and trends.

In light of these advantages, the Wavelet Analysis method was chosen to investigate the effect of oil price fluctuations on THY's profitability. The analysis revealed that oil price fluctuations specifically affect the airline's financial performance. Specifically, the findings show that changes in oil prices tend to affect THY's profitability in the short and medium term, but the airline has been able to maintain its profitability in the long run.

The study's contribution sheds light on the importance of oil price fluctuations on the airline industry's performance, particularly in the case of THY. This finding has important implications for the airline industry as it highlights the importance of strategic planning to mitigate the effects of volatile oil prices on their operations.

Overall, applying the Wavelet Analysis method in this study provides a valuable approach to investigating the impact of external factors on company performance. This approach has broad implications for business management and decision-making, as it allows for a more nuanced understanding of the complex relationships between variables.

To summarize, wavelet analysis was used to analyze the complex relationships between oil price fluctuations and airline profitability. Oil price changes significantly impact THY's financial performance in the short and medium term while its long-term profitability remains stable. Strategic planning and intelligent fuel management strategies, including hedging, are essential to ensure long-term and sustainable business models for airlines.

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### References

- Adrangi, B. & Chatrath, A. (2022). Dynamic Responses of Major Pacific Rim Emerging Equity Markets to the US Crude Oil Fear Index (OVX). *Bulletin of Applied Economics*.
- Alici, A., & Sevil, G. (2020). Analysis of internal financial factors affecting stock price in airline businesses. *The Journal of International Scientific Researches*, 5(Ek), 28-46.
- Aydın, L. & Ari, I. (2020). The impact of COVID-19 on Turkey's non-recoverable economic sectors compensating with falling crude oil prices: A computable general equilibrium analysis. *Energy Exploration & Exploitation*.
- Babalı, T. (2022). Yüksek petrol fiyatları dünya ekonomisi için yeni bir petrol şoku mu? [Are high oil prices a new oil shock for the world economy?]. *Türkiye Cumhuriyeti Dış İşleri Bakanlığı [Ministry of Foreign Affairs of the Republic of Turkey]*. Retrieved from [https://www.mfa.gov.tr/yukse-petrol-fiyatlari-dunya-ekonomisi-icin-yeni-bir-petrol-soku-mu\\_.tr.mfa](https://www.mfa.gov.tr/yukse-petrol-fiyatlari-dunya-ekonomisi-icin-yeni-bir-petrol-soku-mu_.tr.mfa), 18/12/2022
- Bajpai, P. (2022). Top factors that affect the price of oil. *Investopedia*. Retrieved from <https://www.investopedia.com/articles/investing/072515/top-factors-reports-affect-price-oil.asp>, 04/02/2023
- Battal, Ü., & Mühim, S. A. (2016). Havayolu taşımacılığında yakıt anlaşmalarında riskten korunma yöntemleri ve Türkiye uygulaması [Hedging methods in fuel agreements in air transportation and Turkey's implementation]. *Finans Politik ve Ekonomik Yorumlar [Journal of Financial, Political and Economic Comments]*, (611), 39-56.
- Braginskii, O. (2009). Crude oil prices: History, forecast, and impact on economy. *Russian Journal of General Chemistry*, 79, 2486-2498.
- Chuang, S. H. (2020). Cost pass-through in the airline industry: price responses and asymmetries. *Economics Bulletin*.
- Erdem, U., Tsiotas, D., & Cubukcu, K. M. (2019). Population dynamics in network topology: the case of air transport network in Turkey. *Management Research and Practice*, 11(2), 5-20.
- Goupillaud, P. L., Grossmann, A., & Morlet, J. (1984). Cycle-octave and related transforms in seismic signal analysis. *Geoexploration*, 23(1), 85-102. [https://doi.org/10.1016/0016-7142\(84\)90025-5](https://doi.org/10.1016/0016-7142(84)90025-5)
- Horobet, A., Zlatea, M. L. E., Belascu, L., & Dumitrescu, D. G. (2022). Oil price volatility and airlines' stock returns: Evidence from the global aviation industry. *Journal of Business Economics and Management*, 23(2), 284-301. <https://doi.org/10.3846/jbem.2022.16094>
- IATA (International Air Transport Association). (2019). No simple link between oil prices and industry profitability. Retrieved from <https://www.iata.org/en/iata-repository/publications/economic-reports/no-simple-link-between-oil-prices-and-industry-profitability/>, 20/01/2023
- Ilarslan, K., Vurur, S. N., & Biyikli, F. (2014). An empirical study for investigation of the effects of strategic alliances in the civil aviation sector: THY (Turkish Airlines) case. *Mediterranean Journal of Social Sciences*, 5(22), 102.
- Kang, W., de Gracia, F. P., & Ratti, R. A. (2021). Economic uncertainty, oil prices, hedging and US stock returns of the airline industry. *The North American Journal of Economics and Finance*, 57, 101388.
- Kendirli, S., & Kaya, A. (2015). Havayolu şirketlerinde finansal bir araç olarak hedging yönteminin kullanılması [The use of hedging method as a financial tool in airline companies]. *Manas Sosyal Araştırmalar Dergisi [Journal of Manas Social Research]*, 7(4), 124-135.
- Killins, R. N. (2020). The impact of oil on equity returns of Canadian and US railways and airlines. *The North American Journal of Economics and Finance*, 52, 101178.
- Kirikaleli, D. & Sowah, J. K. (2020). A wavelet coherence analysis: nexus between urbanization and environmental sustainability. *Environmental Science and Pollution Research*.

- Kristjanpoller, W. D., & Concha, D. (2016). Impact of fuel price fluctuations on airline stock returns. *Applied Energy*, 178, 496-504. <https://doi.org/10.1016/j.apenergy.2016.06.089>.
- Kurşuncu, O. & Seçilmiş, N. (2023). The Effect of Covid-19 on the Financial Performance of Ground Handling: The Example of Çelebi Aviation Holding. *Journal of Aviation*.
- Matar, A., Al-Rdaydeh, M., Ghazalat, A., & Eneizan, B. (2021). Co-movement between GCC stock markets and the US stock markets: A wavelet coherence analysis. *Cogent Business & Management*, 8(1), 1948658.
- Mızrak, S., Sölük, M., & Özceylan, İ. (2022). The impact of technological advancements on airline fuel efficiency: A case study for Turkish Airlines. *Journal of Air Transport Management*, 102, 102162.
- Mollick, A. V., & Amin, M. R. (2021). Occupancy, oil prices, and stock returns: Evidence from the US airline industry. *Journal of Air Transport Management*, 91, 102015.
- Özdurak, C. (2020). Spillover effect of oil price fluctuations on airlines stock returns in Borsa İstanbul during the COVID-19 pandemic: A VAR-VECH-TARCH Application. *Finans Ekonomi ve Sosyal Araştırmalar Dergisi*.
- Pahlevan Sharif, S., Ranjbar, A., & Arumugam, V. C. (2009). The impact of higher oil prices on airlines share price: the case of Malaysian Airlines. In *The 10th International Conference on "UN Millennium Development Goals: Challenges and Perspectives*.
- Park, K., Kim, H., & Cha, J. (2023). An Exploratory Study on the Development of a Crisis Index: Focusing on South Korea's Petroleum Industry. *Energies*.
- Polanco-Martínez, J. M., Fernández-Macho, J., & Medina-Elizalde, M. (2020). Dynamic wavelet correlation analysis for multivariate climate time series. *Scientific Reports*, 10(1), 21277.
- Ross, J. (2022). Visualizing Historical Oil Prices (1968-2022). *Advisor Newsletter*. Retrieved from <https://advisor.visualcapitalist.com/historical-oil-prices/>, 03/02/2023
- Sorokin, P. (2022). Operational and financial factors for reducing price exposure of Northern European airlines to fluctuations in the fuel market.
- THY (Türk Hava Yolları Anonim Ortaklığı). (2006). Consolidated Financial Statements, pp.24. Retrieved from [https://investor.turkishairlines.com/documents/ThyInvestorRelations/download/finansal/CMB\\_Financials\\_31\\_12\\_2006.pdf](https://investor.turkishairlines.com/documents/ThyInvestorRelations/download/finansal/CMB_Financials_31_12_2006.pdf), 20/12/2022.
- THY (Türk Hava Yolları Anonim Ortaklığı). (2009). Consolidated Financial Statements, pp. 27. Retrieved from [https://investor.turkishairlines.com/documents/ThyInvestorRelations/download/finansal/CMB\\_IFRS\\_Financials\\_31122009.pdf](https://investor.turkishairlines.com/documents/ThyInvestorRelations/download/finansal/CMB_IFRS_Financials_31122009.pdf), 25/12/2022.
- THY (Türk Hava Yolları Anonim Ortaklığı). (2011). Consolidated Financial Statements, p.17. Retrieved from [https://investor.turkishairlines.com/documents/ThyInvestorRelations/download/faaliyet\\_raporu/2011\\_\\_mart\\_Faaliyet\\_Raporu.pdf](https://investor.turkishairlines.com/documents/ThyInvestorRelations/download/faaliyet_raporu/2011__mart_Faaliyet_Raporu.pdf), 24/12/ 2022.
- THY (Türk Hava Yolları Anonim Ortaklığı). (2012). Consolidated Financial Statements, pp.32. Retrieved from [https://investor.turkishairlines.com/documents/ThyInvestorRelations/download/finansal/CMB\\_financials\\_31122012.pdf](https://investor.turkishairlines.com/documents/ThyInvestorRelations/download/finansal/CMB_financials_31122012.pdf), 15/02/ 2023.
- THY (Türk Hava Yolları Anonim Ortaklığı). (2014). Consolidated Financial Statements, pp.3. Retrieved from [https://investor.turkishairlines.com/documents/ThyInvestorRelations/download/finansal/2014\\_12\\_Months\\_Financial\\_Report\\_USD.pdf](https://investor.turkishairlines.com/documents/ThyInvestorRelations/download/finansal/2014_12_Months_Financial_Report_USD.pdf), 10/02/2023.
- THY (Türk Hava Yolları Anonim Ortaklığı). (2016). Consolidated Financial Statements, pp.4. Retrieved from [https://investor.turkishairlines.com/documents/ThyInvestorRelations/download/finansal/2016\\_12\\_Months\\_Financial\\_Report\\_USD\\_v02.pdf](https://investor.turkishairlines.com/documents/ThyInvestorRelations/download/finansal/2016_12_Months_Financial_Report_USD_v02.pdf), 10/02/2023.
- THY 2020 Annual Report. (2020). Retrieved from [https://investor.turkishairlines.com/documents/faaliyet-raporlari/thy\\_annual-report\\_2020.pdf](https://investor.turkishairlines.com/documents/faaliyet-raporlari/thy_annual-report_2020.pdf), 05/02/2023

- Turner, P. A., & Lim, S. H. (2015). Hedging jet fuel price risk: The case of US passenger airlines. *Journal of Air Transport Management*, 44, 54-64.
- Wang, H., & Gao, X. (2020). Oil price dynamics and airline earnings predictability. *Journal of Air Transport Management*, 87, 101854.
- Xu, X., McGrory, C. A., Wang, Y. G., & Wu, J. (2021). Influential factors on Chinese airlines' profitability and forecasting methods. *Journal of Air Transport Management*, 91, 101969.
- Yayci, C. (2019). Irak'ta yaşanan savaşlar ve Türkiye'ye etkileri. *Güvenlik Stratejileri Dergisi*, 15(30), 331-352.