Applied Energy 178 (2016) 496–504

Contents lists available at ScienceDirect

Applied Energy

journal homepage: www.elsevier.com/locate/apenergy

Impact of fuel price fluctuations on airline stock returns

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HIGHLIGHTS

- Is the first study to analyze 56 stock prices IATA and the fuel price influence.
- There is a puzzle about the effects of the oil to the airline stock price.
- The results show a strong positive influence of fuel price on a daily basis.
- The results support the market inertia and the oil as signal of economic growth.

ARTICLE INFO

Article history:
Received 14 January 2016
Received in revised form 3 June 2016
Accepted 18 June 2016
Available online 25 June 2016

Keywords:
Oil shocks
Airline stocks
CAPM extended

ABSTRACT

This paper analyzes the impact of changes in fuel price on the equity returns of airlines associated with International Air Transport Association (IATA), as listed on the stock market. While it is simple to comprehend that airline price stock returns are related to fuel price variations, it is not as simple to establish whether this relationship is direct or indirect. It could be assumed to be indirect given the high influence of fuel price on airline costs. However, when taking into account the market inertia theory and the paradigm that increases in oil price are indicators of economic growth, these relations could also be assumed to be direct.

In order to solve this puzzle, 56 airlines were studied, relating their price returns to the price variations of West Texas Intermediate crude oil and Jet Fuel by using GARCH models. The main results show a strong positive influence of fuel price fluctuation on a daily basis. These results support the market inertia theory, confirming the paradigm that increases in oil price are signals of improving economic growth.

1. Introduction

The world has witnessed exceptional stages of economic growth and contraction over the last 10 years. Periods of extraordinary economic increase, followed by deep crisis, have set the tone. These cycles of high volatility affect each market in a different manner, especially the fuel market and the financial market. Fuels have reached peaks in production and prices without precedent, which have varied repercussions in different markets and industries. The financial market has undergone many attacks as a result of world events, and at the same time, has been a key player in this maelstrom. Technological evolution also aids the speed and volume of transactions, favoring speculation and capital investment across industries. For these reasons, the oil market as well as oil price and stock have captured the attention of academia, policy makers, and investors, Zhang and Zhang [1] and Zhang [2]. In fact, a rise in oil prices can lead to a depression in some economies, which may result in an economic recession. Given the importance of oil for sustainable economic development and financial markets, various studies have analyzed the oil market, Chang [3] and Sévi [4].

Being able to make clear and understand new relationships and effects of oil on economic aspects is relevant to making better decisions. Multiple studies analyze the impact of fuel prices on various markets and industries, as well as on economies at the global level and by country, for example, Aggarwal et al. [5], Jin and Jorion [6], Mohanty and Nandha [7], Basher et al. [8], and Apergis and Miller [9]. Its effects on the economies of various exporting and importing countries (Berument et al. [10], He et al. [11], Behmiri and Manso [12]), on economic activity (Lardic and Mignon [13]), as well as on financial markets (Sadorsky [14], Filis et al. [15], Basher and Sadorsky [16], Huang et al. [17]) make it one of the most relevant markets due to its influences and effects on different areas. Furthermore, some studies have appeared concerning the impact of the oil market on private sectors of the economy (Nandha and Faff [18], Elyasiani et al. [19], Nandha and Brooks [20], Aggarwal et al.

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http://dx.doi.org/10.1016/j.apenergy.2016.06.089
0306-2619/

[5], Mohanty et al. [21], Arouri and Nguyen [22]). An interesting point made by Narayan and Sharma [23] is that the transportation industry is positively affected by oil price, but it is unclear if this finding is applicable to all of the sectors of transportation, ground transport, sea transport, and air transport. This is the space in which this article comes to fill the gap in knowledge on the impact of the oil market on one of the key sectors in human transportation, the airline industry. In this sense, being able to model and predict the impacts that it will have on airline value as well as changes in oil and oil shocks is the fundamental objective and value of this study.

The airline industry has been in a state of constant change since the Twin Towers attack in 2001. This has caused bankruptcies, mergers, and acquisitions within the industry in search of improving operational and financial efficiency in order to be able to continue developing businesses. In fact, from 2001 to 2016 in the United States, the number of major airlines passed from 10 (American, TWA, American West, U.S. Airways, Delta, Northwest, United, Continental, Southwest, AirTrain) to 4 (American, Delta, United-Continental and Southwest). Some mergers and acquisitions are AirFrance KLM, LATAM (Lan – Tam), and British Airways-Iberia. Other characteristics of the industry are that there are three large alliances among airlines: One World, Star Alliance, and Sky Team.

There is a logical effect of oil price on airline stock, meaning that if oil price increases, then an airline's stock price should decrease. This analysis is based on the percentage that oil price represents within airline costs. Jet fuel accounts for a large portion of passenger airlines' operating costs [24], composing 35% of costs for Southwest Airlines according to Form 10-K (2013–2014), for example. Therefore, the price and the price volatility of jet fuel or oil is constantly affecting this cost structure and also notably affects financial results. This especially occurs when sudden variations exist, although forward contracts, insurance, etc. also exist, which seek to ensure a good buying price. However, some studies show that for some stock markets and industries, the effect is actually positive. Arouri and Nguyen [22] studied the main European stock markets and found evidence of the positive effect of oil price in some industries, supporting these results with a hypothesis based on the fact that increases in oil price are signals of economic growth. Narayan and Sharma [23] analyze the effect of oil price on the stock market, grouping the stocks by industries. They find a negative effect for 12 industries, but a positive effect for two industries: energy and transportation. Thus, it is logical to assume that for the airline industry, which is highly similar to the transportation industry, the effect would be positive. For this reason, there is a dilemma about the relationship between the oil market and airline stock prices, since there are already grounds for this relationship to be positive or negative.

With this objective, we studied the impact of fuel price variation on stock return in airlines associated with the International Air Transport Association (IATA), all publically traded on the stock market. Four different models were applied. The period analyzed is between January 2008 and October 2013 for 56 airlines, characterizing fuel with WTI crude oil barrels and Jet Fuel (JT) for airplanes. This is the first paper to examine the impact of oil on the airline industry. Furthermore, it is also the first to conduct a worldwide analysis of this industry by collecting prices from different stock markets, showing a robustness in the results across stock prices.

The first result obtained shows that the effect of fuel is positive on airline stock prices in the daily frequency analysis. A second result obtained is that by lagging oil price variation, this continues to have a positive effect on airline stock. The third result found is that the oil effect decreases over time, having a higher effect in daily analyses and a lower effect in monthly analyses. Another result is that there are not many cases of asymmetry or extreme shock regarding the effect of oil on airline stock prices.

The results and a greater knowledge of airline stock behavior and its relationship with oil are of interest to investors, fund administrators, economic policy makers, and government administrators. From the point of view of airline administrators, it would be interesting to possess the results of this behavior in order to explain stock return and to be able the separate the contribution of management from the value of the business.

This article is composed of five sections, beginning with this introduction. In the second section, a literature review is carried out on previous works studying the relationship between fuel and stock prices. The applied methodology and variable description are detailed in section three. In the fourth section, the results obtained are analyzed, and finally, conclusions are presented in the last section.

2. Literature review

Various studies have determined how fuel prices and their changes and shocks (sometimes sudden and violent) affect economies, both globally and in certain countries. Hamilton [25] discovered that increases in oil prices were at least partially responsible for all recessions in the U.S. post-World War II, except for the recession of 1960. Later, attention was centered on the role of the asymmetric effects that oil price shocks have on the economy [26,27].

The effect on the stock markets was analyzed by Campbell [28], finding that the reaction of stock prices in the U.S. and Canada to shocks in oil price can be explained by the impact of these perturbations on real cash flows. Nevertheless, results in the cases of Japan and the United Kingdom are not as strong. Subsequently, Jones and Kaul [29] verified that the reaction of the international stock market to oil price shocks can be justified by current and future changes in real cash flows and/or by changes in expected returns. Huang et al. [30] found that returns of oil futures lead over U.S. stock yields of certain individual oil companies, but do not have a relevant impact on market indexes, such as the S&P 500. Meanwhile, Sadorsky [14] concluded that oil prices and their volatility play an important role in the yield of US stocks, showing that changes in oil prices impact economic activity; however, changes in economic activity have little impact on oil prices. Kilian and Park [31] showed that the reaction of real stock returns in the U.S. to oil price shocks varies ostensibly depending on if the oil price change is induced by demand or supply. According to this study, supply and demand shocks that affect the global oil market represent 22% of the long-term variation in U.S. real stock returns.

Strong evidence that oil price volatility affects stock returns in emerging markets was found by Basher and Sadorsky [16] and Basher et al. [8], establishing that positive price shocks in oil prices tend to decrease emerging stock market prices and types of exchange in USD in the short term. Furthermore, it was also found that a positive oil production shock reduces oil price, while a positive shock in real economic activity increases the price of oil. Ji and Fan [32] identified that the crude oil market has significant volatility spillover effects on non-energy commodity markets. Narayan and Narayan [33] found that stock prices, oil prices, and nominal exchange rates are cointegrated in the Vietnam stock market and that oil prices have a positive effect on stock prices. Ghosh [34] revealed that an increase in the oil price return leads to the depreciation of Indian currency vis-à-vis US dollar. Apergis and Miller [9] investigated how explicit structural shocks characterized the endogenous character of oil price changes, affecting stock market returns in eight countries (Australia, Canada, France, Germany, Italy, Japan, the United Kingdom, and the United States), identifying that international stock returns do not respond greatly to oil market perturbations. Finally, Wang et al. [35] grouping the stock

markets as oil-importing and oil-exporting countries, concluded that this characterization is essential when determining magnitude, duration, and direction of the response of a country's stock market to the oil price crisis.

An industrial analysis was performed by Elyasiani et al. [19], examining the impact of changes in oil returns and in the volatility of oil returns on the excess of stock yields and on return volatilities of thirteen U.S. industries. They concluded that oil price fluctuations constitute a systematic risk of asset prices at the industrial level. Nine of the thirteen studied sectors exhibited relationships between return distribution of oil futures and excess of industry yields. Previously, Nandha and Faff [18] determined that an increase in oil prices has a negative effect on stock yields from all sectors, except the gas, oil, and mining industries. Scholtens and Yurtsever [36] investigated the impact of oil price shocks at an industrial level in the Euro Zone during the period of 1983–2007, concluding that the impact of oil price shocks differs substantially throughout the different industries, and that this result is different according to the different oil price specifications. Nandha and Brooks [20] examined the role of oil prices in explaining the stock returns from the "transport sector" in 38 countries, concluding that by allowing an asymmetry according to country group in their model, the oil factor was found to be jointly significant together with the presence of a negative oil risk premium.

Aggarwal et al. [5] performed a complete analysis of the transport sector in the U.S., concluding that while transport stock returns are influenced negatively by improvements in oil price, risks are increased by the decrease in oil price. Mohanty et al. [21] investigated the oil price risk exposure of the U.S. Travel and Leisure Industry, suggesting that oil price sensitivity varies significantly between the six subsectors comprising this industry: airlines, gambling, hotels, recreational services, bars and restaurants, and travel and tourism. The magnitude of exposure is generally negative; nonetheless, it is particularly important for airlines, recreational services, and bars and restaurant subsectors. Narayan and Sharma [23] determined that the U.S. energy and transport sectors have a positive relationship with oil price, while the stocks of the remaining sectors have a negative relationship. In a study conducted in Europe, Arouri and Nguyen [22] concluded that the effect of oil price on stock returns depends largely on the activity sector. Significant studies on the relationship among oil price, the stock market, and industry stock returns are presented by Li et al. [37].

The airline industry is of interest to markets and the world economy; therefore, it has been an object of analysis due to its characteristics of an economy of scale, Johnston and Ozment [38], Assaf [39], its reaction when faced with the subprime crisis, Pearce [40], financial performance, Barros and Peypoch [41], Assaf and Josiassen [42], Barbot et al. [43], and bankruptcies within the industry, Ciliberto and Schenone [44].

From the literature, the relevance of oil price variation can be observed in various aspects of the economy and in particular, the stock market. Although analyses have previously been performed by sector, an analysis has yet to be performed of airline companies at a global level. Thus, the results obtained will improve the knowledge of this important industry's behavior as well as clarify another effect of oil price.

3. Data and methodology

The 56 airlines examined in this study are detailed in Appendix A, considering the 2008–1 to 2013–10 period. The 56 stocks considered represent 98 airlines belonging to the IATA, since the 41 remaining airlines belong to some of the first 56 mostly or in totality. Daily closing prices were obtained in domestic currency, which were later transformed to weekly and monthly prices in the same manner as fuels. In addition to this, each of these series was transformed into USD. Later, all of the price series were transformed into profitability series according to Eq. (1):

$$R_{it} = \log\left(\frac{P_{it}}{P_{it-1}}\right) \tag{1}$$

where P_{it} is the price index i in time t.

Considering the Dow Jones indexes, most of the airlines (passenger airlines) belong to the travel and leisure sector, within the consumer services industry, and a lesser portion (cargo airlines) belong to the industrial transport sector, within the company service industry. According to this, the Dow Jones Global Consumer Services Total Stock Market Index (DWGCS) is considered as a market index.

In terms of fuel, daily crude WTI FOB spot prices in USD per barrel and daily Jet Fuel FOB spot prices in USD per gallon were used, obtained from the U.S. Energy Information Administration databases. In this study, the spot price is used and not the futures prices, according to Aggarwal et al. [5], since most of the fuel price shocks in the literature are measurements constructed using spot prices [6,7]. Secondly, as shown by Ferson and Harvey [45] and Huang et al. [30], fuel futures do not have a significant impact on stock market returns, but stock prices respond mainly to fuel spot price changes. The fuel prices experienced great variations during the analysis period, which can be appreciated in Fig. 1, where a clear upward trend exists in the price of both fuels during the first semester of 2008, followed by a sudden drop until April 2009. After that, prices begin to recover. According to CEPAL [46], the six years between 2003 and 2008 constitute the longest period of sustained growth in oil prices since 1990, with an annual growth average of 25%. The WTI crude price went from 26.18 USD to 99.67 USD per barrel (nominal annual average) between 2002 and 2008, which is the equivalent of nearly a quadruplication since 2002.

The methodology applied in this study is based on the methodology utilized by Nandha and Brooks [20], who examined the role of oil prices in explaining the stock yields of the transport sector in 38 countries. Thus, among the four models applied, all models are derived from the Capital Asset Pricing Model (CAPM), [47–49]. Given Soytas and Oran [50], Aruori (2011), Ghosh [34], and Narayan and Sharma [23], all the models are GARCH (1,1) to incorporate the heteroskedasticity property of the returns time series.

The first model is a classic CAPM in which the variation of oil prices is added as a variable, according to Eq. (2). This model seeks to determine whether the market fluctuations and fuel prices have a significant effect on airline stock yields, as well as the type of relationship existing among these variables. Given that there is a relationship between the stock market and oil (Narayan and Gupta [51], Cunado and de Gracia [52], Soytas and Oran [50], Narayan and Narayan [33], Park and Ratti [53], among others), a market component not explained by the oil price factor is used to determine the market effect.

$$\begin{aligned} R_{it} &= \alpha_i + \beta_i * R^O_{WM,t} + \gamma_i * R_{OIL,t} + e_{it} \\ h^2_{it} &= \varphi_0 + \varphi_1 e^2_{i,t-1} + \varphi_2 h^2_{i,t-1} \\ e_{it} &= h_{it}\vartheta_t; \vartheta_t \sim N(0,1) \end{aligned} \tag{2}$$

where R_{it} is the yield of airline i in the period t; $R_{OIL,t}$ is the fuel price variation (WTI o Jet Fuel); $R^O_{WM,t}$ is the orthogonal yield of the world market measured by $R_{WM,t} - (b_0 + b_1 * R_{OIL,t})$, where b_0 and b_1 are estimators of α and γ in the equation $R_{WM,t} = \alpha + \gamma * R_{OIL,t} + u_t$, meaning that $R^O_{WM,t}$ corresponds to the residual series of this last equation.

The second model (Eq. (3)) seeks to determine whether the negative variations from the market and fuel prices have a significant effect on airline stock yields, and therefore, if asymmetry exists

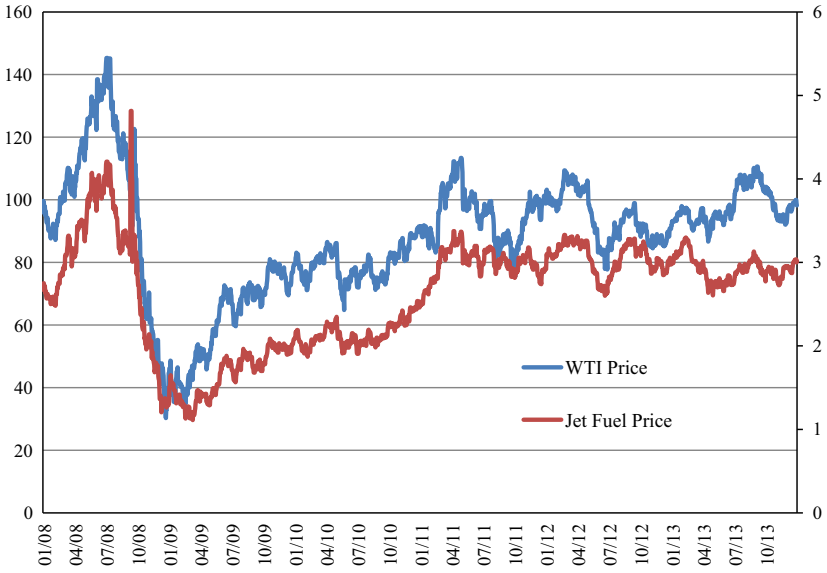

Fig. 1. Oil daily spot price.

with respect to the positive variations. Model 2 is described according to Eq. (3):

$$\begin{aligned} R_{it} &= \alpha_i + \beta_i * R^O_{WM,t} + \beta^D_i * (R^O_{WM,t} * D_M) + \gamma_i * R_{OIL,t} + \gamma^D_i * (R_{OIL,t} * D_O) + e_{it} \\ h^2_{it} &= \varphi_0 + \varphi_1 e^2_{i,t-1} + \varphi_2 h^2_{i,t-1} \\ e_{it} &= h_{it}\vartheta_t; \vartheta_t \sim N(0,1) \end{aligned} \tag{3}$$

where D_M is a dummy variable from the market, and is defined as $D_M = 1$ if $R^O_{WM,t} < 0$, $D_M = 0$ in any other case; D_O is a fuel dummy variable, and is defined as $D_O = 1$ if $R_{OIL,t} < 0$, $D_O = 0$ in any other case.

Model 3 (Eq. (4)) seeks to determine whether the market fluctuations and oil prices with a lag of 1 period have a significant effect on airline stock yields, as well as the type of relationship among these variables. In comparison with Model 1, it can be determined if a lag exists in decision making by the investors about the variations in oil prices.

$$\begin{aligned} R_{it} &= \alpha_i + \beta_i * R^O_{WM,t} + \gamma_i * R_{OIL,t-1} + e_{it} \\ h^2_{it} &= \varphi_0 + \varphi_1 e^2_{i,t-1} + \varphi_2 h^2_{i,t-1} \\ e_{it} &= h_{it}\vartheta_t; \vartheta_t \sim N(0,1) \end{aligned} \tag{4}$$

where $R_{OIL,t-1}$ is the lagged fuel yields, γ_i is the stock sensitivity indicator in the presence of changes in fuel price.

Finally, Model 4 (Eq. (5)) is an extended model that seeks to determine whether fuel price shocks (positive or negative) have a significant effect on airline stock yields. This model is based on the hypothesis that there is an overreaction in the airline price stocks when the oil price variation is abnormal.

$$\begin{aligned} R_{it} &= \alpha_i + \beta_i * R^O_{WM,t} + \gamma_i * R_{OIL,t} + \gamma^D_i * (R_{OIL,t} * D_O) + e_{it} \\ h^2_{it} &= \varphi_0 + \varphi_1 e^2_{i,t-1} + \varphi_2 h^2_{i,t-1} \\ e_{it} &= h_{it}\vartheta_t; \vartheta_t \sim N(0,1) \end{aligned} \tag{5}$$

where D_O is a fuel dummy variable. For daily and weekly analysis, D_O is defined as $D_O = 1$ if $|R_{OIL,t}| > 5\%$, $D_O = 0$ in any other case; for monthly analysis, D_O is defined as $D_O = 1$ if $|R_{OIL,t}| > 10\%$, $D_O = 0$ in any other case. γ^D_i is the sensitivity indicator of stock i before fuel price shocks (daily variations and/or weekly superior, in module, at 5%, superior monthly in module, at 10%).

4. Result analysis

When applying Model 1, results show that the market has a significant and positive influence on most of the airlines, considering all currency combinations, fuels, and possible horizons. In terms of the currency considered, the market generally influences more airlines when the price is considered in USD than when domestic currency is considered, particularly in the weekly and monthly analyses. For the reason of space constraints, only Model 1 is shown for the WTI for the daily analysis in USD. The overall results of Model 1 are presented in Tables 1 and 2. For 64% of the airline

Table 1
Model 1 results for WTI in daily analysis in USD.

Airline ID	β_i	γ_i	Airline ID	β_i	γ_i
A1	0.3603***	0.0826***	A29	0.3203***	0.0768**
A2	0.4310***	0.0607**	A30	0.3338***	0.0825***
A3	0.2400***	0.1225***	A31	0.2395**	0.0342
A4	0.8084***	0.1546***	A32	1.1375***	0.1036***
A5	0.5421***	0.0713*	A33	0.0177	0.1196**
A6	0.0586*	0.0165	A34	1.0769***	−0.0263
A7	0.5655***	0.1183***	A35	0.1691***	−0.0181
A8	0.5999***	−0.0348	A36	1.3005***	0.0068
A9	0.1171***	0.0883***	A37	1.4200***	0.0534
A10	1.3042***	0.1370***	A38	−0.0151	0.0081
A11	0.1427***	0.0160	A39	0.4487***	0.1243***
A12	0.5605***	0.1409***	A40	1.4413***	−0.0283
A13	1.4064***	−0.1182***	A41	0.5984***	0.0064
A14	0.8440***	−0.2261***	A42	0.6459***	0.0231
A15	0.0428***	0.0253	A43	1.0300***	0.1579***
A16	0.3335***	0.0335	A44	0.1350***	0.0260
A17	1.5159***	0.2415***	A45	0.2103**	0.0117
A18	0.3900***	0.1084***	A46	0.4414***	0.0448
A19	0.3350***	0.0733**	A47	0.0581*	−0.0125
A20	0.3156***	0.0187	A48	0.7172***	0.1298***
A21	0.2348***	0.0405	A49	0.0123*	−0.0095***
A22	0.1289***	0.0928***	A50	0.3434***	0.0585***
A23	0.1512***	0.0936***	A51	0.2801***	0.0752***
A24	0.0321	−0.0255	A52	0.7968***	−0.0836***
A25	1.2633***	−0.0114	A53	0.3232***	−0.0532
A26	0.1546*	−0.1796***	A54	1.6070***	−0.2279***
A27	1.5431***	−0.1042***	A55	1.8170***	−0.2708***
A28	0.4459***	0.0774***	A56	0.7423***	−0.0884

* Statistical significance at 10%.
** Statistical significance at 5%.
*** Statistical significance at 1%.

Table 2
Significance and results of market and oil impacts, Model 1.

		Market			Oil		
		Significant (%)	Positive (%)	Negative (%)	Significant (%)	Positive (%)	Negative (%)
Panel A. U.S. Dollar							
WTI	Daily	88	88	0	55	41	14
	Weekly	93	93	0	29	14	14
	Monthly	77	77	0	29	16	13
JF	Daily	88	88	0	50	36	14
	Weekly	91	91	0	39	23	16
	Monthly	70	70	0	20	9	11
Panel B. Domestic Currency							
WTI	Daily	91	89	2	59	46	13
	Weekly	88	88	0	25	9	16
	Monthly	73	73	0	32	13	20
JF	Daily	88	88	0	52	38	14
	Weekly	86	86	0	27	9	18
	Monthly	59	59	0	25	7	18

Significant coefficients reported at the 5% level.

stocks, the β_i is lower than one (and significant at the 5% level), indicating a reduction effect of the market return in the classical CAPM model. 23% of the airlines analyzed have a β_i higher than one, thus indicating an amplifying market effect.

In terms of fuel, the daily price variation has a greater influence on airline prices in the daily for both, WTI and JF. It is noteworthy that the effect of fuel is in its most part positive in the daily frequency, implying that increases in fuel prices boost the value of airlines, which can be explained as a rising movement from both markets. In contrast, at the weekly and monthly level, most of the profit is affected in a negative manner given the increase of one of the main airline costs. In particular, the WTI have more influence than the JF, and the effect is higher in the airline price expressed in domestic currency than in USD dollar, indicating a shock absorber effect of the exchange rate. 46% of the airlines have an inertia effect between the stock price expressed in domestic currency and the WTI price.

For the WTI analysis in USD, 82% have a daily and weekly market effect, indicating a high influence of the market on airline stock prices. In the daily analysis (Table 2), 50% of the airlines have significance at the 5% level for the market and oil coefficients, while a quarter present both effects in the monthly analysis. This result is very intriguing as it shows a contribution of the oil price variation to the stock return in a high percentage of the airlines studied. For 20% of the airline stocks analyzed, the WTI price variation is significant at the 5% level in the daily and monthly analysis, and in 75% of these cases, the sign of the effect is maintained, showing the robustness of the effect.

When incorporating dummy variables associated with the symmetry in Model 2 (Tables 3 and 4), the number of significant market and fuel coefficients decreases in comparison with Model 1. In the case of daily models, the market significance slightly decreases, while fuels decrease even further. In terms of asymmetry, more than 30% of the airlines show this effect when compared to the market, implying that negative variations have a greater impact on airline price variations than positive variations. Meanwhile, the fuel price asymmetry effect on stock prices is not significant in more than 80% of the cases. Again, the majority of the oil effect cases (normal or asymmetric) are positive in the daily analysis, demonstrating the market inertia theory.

30% of the airlines analyzed have a significant positive market effect and one of the WTI variation or WTI asymmetry effects (variation or asymmetry), indicating that almost one-third of the airline stocks are affected by WTI price behavior. It is intriguing to analyze that all cases of asymmetry are positive, implying that when the WTI price decreases, this has a greater impact than when the

Table 3
Significance and results of impact with asymmetry, Model 2.

		Market		Market dummy		Oil		Oil dummy	
		Significant	Positive	Significant	Positive	Significant	Positive	Significant	Positive
Panel A. U.S. Dollar									
WTI	Daily	70%	70%	34%	16%	21%	11%	16%	13%
	Weekly	79%	77%	18%	7%	13%	5%	11%	2%
	Monthly	29%	29%	13%	5%	13%	5%	9%	2%
JF	Daily	70%	68%	36%	20%	18%	11%	9%	7%
	Weekly	77%	77%	14%	7%	16%	9%	9%	2%
	Monthly	27%	27%	21%	16%	13%	2%	20%	11%
Panel B. Domestic Currency									
WTI	Daily	71%	70%	32%	13%	21%	14%	16%	11%
	Weekly	71%	68%	14%	7%	9%	4%	13%	2%
	Monthly	28%	28%	5%	0%	8%	3%	12%	7%
JF	Daily	75%	73%	32%	11%	21%	14%	13%	9%
	Weekly	66%	64%	14%	9%	13%	5%	11%	4%
	Monthly	27%	23%	23%	18%	11%	2%	16%	9%

Significant coefficients reported at the 5% level. The negative coefficients are not presented for the reason of space, but would be the difference between significant minus positive.

Table 4
Model 2 results for WTI daily analysis in USD.

Airline	β_i	β_iD	γ_i	γ_iD
A1	0.3655***	−0.0261	0.0405	0.0861
A2	0.3755***	0.1182***	0.0582	0.0075
A3	0.1335***	0.2502*	0.1591***	−0.0672
A4	0.3662	0.8972**	0.0513	0.1986
A5	0.2890**	0.4884***	0.0862	−0.0341
A6	0.0562	−0.0051	−0.0178	0.0701
A7	0.5686***	−0.0288	0.0327	0.1685**
A8	0.6268	−0.0463	−0.0730	0.0745
A9	−0.0330***	0.3101***	0.0653	0.0463
A10	1.3203***	−0.0182	0.1566***	−0.0406
A11	0.0501	0.1872	0.0204	−0.0076
A12	0.4367***	0.1853**	0.1948***	−0.1058
A13	1.5709***	−0.2811***	−0.1171***	−0.0044
A14	1.0978***	−0.2950*	−0.0958	−0.2471
A15	0.1912***	−0.2333***	−0.0149	0.0737
A16	0.3230***	0.0375	0.0918*	−0.1193
A17	1.9281***	−0.5583***	0.2792***	−0.0629
A18	0.3594***	0.0483	0.0923*	0.0299
A19	0.1765	0.2401	−0.0008	0.1482
A20	0.3293***	−0.0265	0.0163	0.0046
A21	0.3427***	−0.2241***	−0.0111	0.1037
A22	0.0286	0.1905*	0.0284	0.1365*
A23	0.0663	0.1725	0.0841	0.0195
A24	−0.0626	0.1994	−0.0172	−0.0155
A25	1.4212***	−0.2875***	−0.0365	0.0468
A26	0.9692***	−2.0782***	−0.0595***	−0.1564***
A27	1.5126***	0.0529	−0.0908	−0.0254
A28	0.3009***	0.2638**	0.0271	0.0964
A29	0.3724***	−0.1154	0.0107	0.1337
A30	0.2654***	0.1046	0.0355	0.1011
A31	0.2071	0.0483	−0.0103	0.0833
A32	1.1939***	−0.0947	0.0958	0.0148
A33	−0.0813	0.1184	0.0337	0.0914
A34	1.5108***	−0.6083***	−0.0288	−0.0207
A35	0.1201*	0.0762	−0.1102***	0.1735***
A36	1.2217***	0.1550	0.0236	−0.0331
A37	1.4177***	0.0200	0.0883	−0.0690
A38	−0.1102	0.2072*	0.0414	−0.0649
A39	0.2379*	0.3485*	0.0315	0.2023**
A40	1.7374***	−0.4967***	−0.0853*	0.0906
A41	0.6301***	−0.0462	0.0286	−0.0472
A42	0.5900***	0.0943	0.0153	0.0179
A43	1.1899***	−0.2209***	0.1330***	0.0497
A44	0.0992**	0.0736	−0.0119	0.0776
A45	0.1457	0.1503	0.0508	−0.0727
A46	0.2966***	0.2821**	−0.0210	0.1375*
A47	0.0454	0.0193	−0.0574	0.0892
A48	0.8301***	−0.2106*	0.0140	0.2094**
A49	0.0296***	−0.0393***	−0.0183***	0.0182***
A50	0.2916***	0.0941*	0.0636**	−0.0093
A51	0.3235***	−0.1109	−0.0266	0.1997**
A52	0.8431***	−0.1252	−0.2362***	0.3017***
A53	0.0517	0.4692	−0.0599	−0.0095
A54	1.3572***	0.4905***	−0.1159*	−0.2207**
A55	1.8607***	−0.0674	−0.2156**	−0.1096
A56	0.0384	1.4588**	−0.0213	−0.1520

* Statistical significance at 10%.
** Statistical significance at 5%.
*** Statistical significance at 1%.

WTI price increases. This effect is presented for all daily analyses regardless of the currency and the oil.

When performing Model 3, which contains varying market variables and lagged fuel prices, it can be observed (Tables 5 and 6) that the significant percentages from the market maintain similarity with those from the model with variables in the same time period (Model 1). In almost all cases, the market has more impact than Model 1, demonstrating the effect of the market on the airline stock price return in the same day and the next day. The market effect is directly (positive) in all the terms and the two oils. In 66% of the cases of significant market effect, the market coefficient

Table 5
Lag model, significance and results of impact, Model 3.

		Market			Oil		
		Significant (%)	Positive (%)	Negative (%)	Significant (%)	Positive (%)	Negative (%)
Panel A. U.S. Dollar							
WTI	Daily	89	89	0	48	39	9
	Weekly	95	95	0	30	20	11
	Monthly	80	80	0	21	16	5
JF	Daily	91	89	2	54	45	9
	Weekly	96	96	0	23	7	16
	Monthly	82	82	0	20	11	9
Panel B. Domestic Currency							
WTI	Daily	89	88	2	38	14	23
	Weekly	89	89	0	25	9	16
	Monthly	64	64	0	20	11	9
JF	Daily	91	88	4	38	18	20
	Weekly	89	89	0	21	4	18
	Monthly	68	68	0	16	9	7

Significant coefficients reported at the 5% level.

Table 6
Model 3 results for WTI in daily analysis in USD.

Airline ID	β_i	γ_i	Airline ID	β_i	γ_i
A1	0.3882***	0.0857***	A29	0.3193***	0.0141
A2	0.4328***	0.0551*	A30	0.3423***	0.0783***
A3	0.2661***	0.2708***	A31	0.2458***	0.0533
A4	0.8320***	0.2022***	A32	1.1471***	0.0544
A5	0.5663***	0.1543***	A33	0.3277***	0.0625**
A6	0.0644*	0.0021	A34	1.0602***	−0.1025***
A7	0.5950***	0.1343***	A35	0.1577***	0.0388***
A8	0.5853***	0.0352	A36	1.2880***	0.1136***
A9	0.1412***	0.0550*	A37	1.4390***	0.0620
A10	1.3159***	0.0097	A38	−0.0134	−0.0056
A11	0.1286***	0.2258***	A39	0.4641***	−0.0470
A12	0.5722***	0.1167***	A40	1.4532***	−0.0765***
A13	1.3584***	−0.0813***	A41	0.6005***	0.0475
A14	0.8956***	−0.0433	A42	0.6480***	0.0576***
A15	0.0481***	0.0233	A43	1.0933***	0.0196
A16	0.3426***	0.0481*	A44	0.1384***	0.0674*
A17	1.5165***	−0.0167	A45	0.2252***	0.0502
A18	0.4489***	0.0256	A46	0.4264***	0.2810***
A19	0.3625***	0.1321***	A47	0.0562*	0.0146
A20	0.3145***	0.0334*	A48	0.7601***	0.0939***
A21	0.2430***	0.0060	A49	0.0001	0.0002
A22	0.1693***	0.0202	A50	0.3499***	0.0675***
A23	0.1855***	0.0633**	A51	0.3026***	−0.0036
A24	0.0086	0.1633***	A52	0.7976***	0.1796***
A25	1.2669***	−0.0517**	A53	0.2884***	−0.0510
A26	0.0849	0.2473***	A54	1.5164***	−0.0679*
A27	1.5181***	−0.0595*	A55	1.7454***	−0.1032**
A28	0.4739***	0.0694**	A56	0.6328***	0.2790***

* Statistical significance at 10%.
** Statistical significance at 5%.
*** Statistical significance at 1%.

(β_i) is positive and lower than 1, showing lower risk than the market. Nonetheless, when analyzing the significant coefficients from fuel price variations, this value is lower, implying that the effect of fuel variation on airline prices is instantaneous more so than lagged, showing a market efficiency signal when quickly incorporating the fuel market variations in the airline valuations. It should be noted that in models expressed in domestic currency, the decrease is greater. An interesting point of the analysis is that 48% of the airlines show a lag effect in the fuel price variation over the price expressed in USD. Furthermore, this effect is positive in most cases, supporting the market inertia theory instead of the fuel costs theory. The oil effect decreases over time, having a higher effect in daily analyses and a lower effect in monthly analyses. In the daily analyses, the availability of the oil effect is demonstrated to complement the high explanatory power of the market effect.

In this case, the market coefficient (β_i) increases when the term is higher in 57% of the airlines stocks analyzed. 39 (70%) of the airline stocks analyzed have a significant market effect and WTI in the daily analysis, representing 80% of the airlines that have a lagged oil effect. 48% of the airlines analyzed have the two effects (market and lagged oil), and in 85% of these cases, the two effects are positive, confirming the market inertia theory. In the few cases with a positive market effect and a negative WTI effect, the market coefficient (β_i) is greater than 1, thus the WTI effect has a compensatory effect.

Finally, when analyzing Model 4, which incorporates the shock effects from extreme variations in fuel prices, the market influence is generally similar to the original model (Model 1). The significant variations in fuel prices decrease by a greater proportion in weekly and monthly models, but in the daily analyses the oil is relatively the same as Model 1. Regarding the impact of extreme fuel price variations, this is reflected in a greater manner in the daily analyses and for the majority of the coefficients, indicating support for the market inertia theory. In the weekly and monthly analyses, it is not possible to conclude if the effect is positive or negative as there is no clear result. The 93% and 95% positive effect of the market on the airline stock price return in the weekly analysis in USD is particularly interesting, exhibiting a high explanatory power. The results are presented in Tables 7 and 8.

In the WTI daily analysis in USD, almost all cases (6 of 8) have an extreme effect and a price variation effect, explaining more than just the normal oil effect. In almost all cases of extreme effects, the coefficient is contrary to the oil price coefficient, indicating a reverse effect for the cases of extreme variation.

In general, for all models, the airline stocks have a market effect demonstrating a behavior synchronized with the market, and the same effect is found with respect to the oil price variation. This finding is important as the market effect is a common effect to explain stock return. The oil price variation follows to explain what is left unexplained by the market return, showing the importance of oil price variation behavior in airline stock price return. In the majority of cases, the oil effect is positive, supporting the market inertia theory.

5. Conclusions

The main conclusion of this study is that fuel price variation has an impact on airline prices on a daily basis. This effect is fundamentally positive, implying that an increase in fuel price is

Table 7
Significance and results of impact, model with extreme fuel values, Model 4.

		Market			Oil			Oil dummy		
		Significant (%)	Positive (%)	Negative (%)	Significant (%)	Positive (%)	Negative (%)	Significant (%)	Positive (%)	Negative (%)
Panel A. U.S. Dollar										
WTI	Daily	88	88	0	52	36	16	14	9	5
	Weekly	93	93	0	14	13	2	9	0	9
	Monthly	75	75	0	13	2	11	14	11	4
JF	Daily	91	91	0	48	32	16	16	13	4
	Weekly	95	95	0	25	14	11	2	2	0
	Monthly	71	71	0	11	0	11	16	13	4
Panel B. Domestic Currency										
WTI	Daily	91	89	2	54	38	16	14	11	4
	Weekly	86	86	0	11	7	4	13	2	11
	Monthly	70	70	0	9	2	7	9	5	4
JF	Daily	91	91	0	52	36	16	18	11	7
	Weekly	86	86	0	14	5	9	5	2	4
	Monthly	64	64	0	13	4	9	14	11	4

Significant coefficients reported at the 5% level.

Table 8
Model 4 results for WTI daily analysis in USD.

ID	β_i	γ_i	γ_iD	ID	β_i	γ_i	γ_iD
A1	0.3606***	0.0773**	0.0098	A29	0.3174***	0.1017**	−0.0650
A2	0.4316***	0.0684*	−0.0250	A30	0.3356***	0.0728**	0.0229
A3	0.2398***	0.1113***	0.0401	A31	0.2374**	0.0695	−0.1585*
A4	0.8088***	0.1559***	−0.0107	A32	1.1297***	0.1294***	−0.0621
A5	0.5413***	0.0574	0.0623	A33	−0.0187	0.2743***	−0.1518***
A6	0.0593*	0.0096	0.0228	A34	1.1015***	−0.0622*	0.1119*
A7	0.5680***	0.0898**	0.0781*	A35	0.1647***	0.0150	−0.1000***
A8	0.5955***	0.0024	−0.1026*	A36	1.3009***	−0.0169	0.1172
A9	0.1175***	0.0954**	−0.0190	A37	1.4201***	0.0223	0.1473*
A10	1.2914***	0.1750***	−0.0898*	A38	−0.0193	−0.0217	0.0705*
A11	0.1426***	0.0181	−0.0056	A39	0.4331***	0.1703***	−0.1155*
A12	0.5524***	0.1742***	−0.0768	A40	1.5034***	−0.0955***	0.1941***
A13	1.4054***	−0.0983***	−0.0630	A41	0.6002***	−0.0019	0.0182
A14	0.8339***	−0.2169***	−0.0211	A42	0.6459***	0.0231	0.0000
A15	0.0426***	0.0363	−0.0209	A43	1.0290***	0.1658***	−0.0192
A16	0.3345***	0.0275	0.0184	A44	0.1301***	−0.0368	0.1167*
A17	1.5170***	0.2398***	0.0051	A45	0.2093**	0.0170	−0.0163
A18	0.3556***	0.0817**	0.2156***	A46	0.4409***	0.0518	−0.0213
A19	0.3300***	0.0541	0.0860	A47	0.0571*	0.0002	−0.0273
A20	0.3221***	−0.0064	0.0715*	A48	0.7193***	0.1443***	−0.0409
A21	0.2354***	0.0297	0.0304	A49	0.0115*	−0.0089***	0.1295***
A22	0.1294***	0.0998***	−0.0223	A50	0.3452***	0.0538***	0.0142
A23	0.1514***	0.0874**	0.0182	A51	0.2803***	0.0785*	−0.0072
A24	0.0340	−0.0391	0.0292	A52	0.8115***	−0.2015***	0.2873***
A25	1.2524***	0.0116	−0.0790**	A53	0.2426**	−0.0654	0.1000
A26	0.1557*	−0.1720**	−0.0251	A54	1.6075***	−0.2417***	0.0516
A27	1.5515***	−0.1269***	0.0861	A55	1.8624***	−0.3340***	0.2200**
A28	0.4456***	0.0928***	−0.0376	A56	0.7471***	−0.0712	−0.2100

* Statistical significance at 10%.
** Statistical significance at 5%.
*** Statistical significance at 1%.

followed by an increase in airline stock prices. The evidence found supports the idea of market inertia: when the market is bull, the majority of the asset prices (mainly stocks and commodities) increase and also, the market paradigm, that increases in oil price are signals of better economic growth in the future.

We could only verify the existence of asymmetry in a few airlines in the daily analyses, implying that in these cases, a greater reaction exists when fuel prices drop than when fuel prices rise. Lag variation in fuel prices has a minor effect on airline stock prices, showing that a contemporary synchrony exists between prices at a daily level. The results obtained at a daily level are noteworthy, where about 40% of the airlines have a positive effect on the lagged fuel price variations.

In terms of extreme shock variations of fuel prices (basically of Jet Fuel), these have a greater influence at a daily level in around 10% of the airlines analyzed. The impact of market variations on airline stock price variations was observed in both domestic currency and USD, and it was generally found to be positive in all models.

Given these results, an investment policy that should be derived is that a potential diversification between airline stocks and fuel commodities does not exist since the hypothesis based on operating costs was rejected. On the other hand, these findings show that it is important to perform analyses of the oil effect in subsectors, since assuming that they have an inverse relationship due to the importance of oil in their costs is not always valid.

Appendix A. Airlines used for this study

Aegean Airlines (EUR)	Asiana Airlines (KRW)	Garuda Indonesia (IDR)	PAL Holdings (PHP)
Aer Lingus (EUR)	Atlas Air (USD)	GOL (BRL)	Qantas Airways (AUD)
Aeroflot – Germany (EUR)	Avianca – TACA (COP)	Hainan Airlines (CNY)	Royal Jordanian (JOD)
Aeroflot – Russia (RUB)	Cargojet Airways (CAD)	Hawaiian Holdings Inc. (USD)	SAS (SEK)
Aeromexico (MXN)	Cathay Pacific (HKD)	Icelandair Group Holding (ISK)	Shandong Airlines (HKD)
Air Arabia (AED)	China Airlines (TWD)	Intl. Airlines Group – Spain (EUR)	Singapore Airlines (SGD)
Air Berlin (EUR)	China Eastern Airlines (CNY)	Intl. Airlines Group – UK (GBP)	Thai Airways (THB)
Air Canada (CAD)	China Southern Airlines (CNY)	Japan Airlines (JPY)	THY Turkish Airlines (TRY)
Air China Ltd (CNY)	Comair (Zac)	Jazeera Airways (KWD)	Transasia Ariways (TWD)
Air France – KLM (EUR)	Copa Holdings (USD)	Jet Airways (INR)	United Continental Holdings (USD)
Air New Zealand (NZD)	Croatia Airlines (HRK)	Jetblue (USD)	US Airways (USD)
Air Transat (CAD)	Delta Airlines (USD)	Korean Air (KRW)	Virgin Australia Holdings (AUD)
Alaska Air Group (USD)	El Al Israel Airlines (ILS)	LATAM Airlines Group (CLP)	
American Airlines (USD)	Eva Airways (TWD)	Lufthansa (EUR)	
ANA (JPY)	Finnair (EUR)	Malaysia Airlines (MYR)	

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