Hedging the Oil Price Risk Factor on Airline Stock Returns in the Asia-Pacific: A Test of Effective Hedging Instruments

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Abstract

Focusing on the hedging-stock pricing research landscape, this research investigates the role of different futures hedging instruments, namely oil futures, gold futures, and VIX futures and the effect of net hedging benefits by employing them on oil price risk exposure to Asia- Pacific airline firms' stock returns using the hedging-stock pricing model. This research examines 22 Asia-Pacific airline firms' stock returns behaviour with monthly frequency data from 2010 to 2019. A complementary analysis approach using the fixed effect panel and quantile regressions are used to analyse the research model. The findings confirm the negative effects of oil price risk and the benefits of hedging oil price risk on airline stock returns, and the superiority of gold futures over oil futures and VIX futures as effective hedging instruments. The findings provide hedging insights to investors to manage equity investment against oil price risk. In the academic context, little is known about the benefits of cross-commodity hedging to reduce risk in equity investment and this work advances the hedging- stock pricing research. This research confirmed pairing of gold futures-airline stock produces an effective hedge. The equity investors could use cross-hedging strategy to enhance airline stock investment portfolio returns.[5]

Keywords: Airlines firms, Cross-hedging, Equity investment, Market model, Oil price risk, Investor perspective.

JEL: G1, G11, G12, G13

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Introduction

Equity investment in the airline industry is very challenging in today's chaotic environmental conditions due to multifaceted risks (economic fundamental, natural, social, and geopolitical risks) that disrupt business operations and profitability (IATA, 2022; KPMG, 2022; Oliver Wyman, 2022). Focusing on economic risk, uncertainties in oil prices has been acknowledged by industry experts as a significant challenge for airline firms (KPMG, 2022). Practically, oil price fluctuation is a key risk factor to airline firms, which represents, on average, 30-50% of the total firm cost (Merkert and Swidan, 2019). Asia-Pacific is an important market for airlines' stock investments that represents the largest market segment in the global airline industry, with 37% of global passengers' traffic. This market segment provides 46.37 million jobs and contributes $944 billion to GDP (ATAG, 2020). Hence, scoping this region is strategically important. Recapping the issue of concern, fuel is an essential operational cost to the airline firm (IATA, 2022) that will be significantly material to profitability and stock prices behaviour. Since oil prices are a permanent cost component in the airline business, continuous uncertainties in the international oil markets cause volatility in earnings and stock returns. In historical observation (2010:01 – 2022:06), as illustrated in Figure 1, crude oil spot price dropped to a 20-year low below $20 a barrel in April 2020 due to decreased demand during the COVID-19 pandemic. However, crude oil prices increased steadily in February 2022 because of the tight supply surrounding the Russian-Ukraine conflict reaching $106.59 per barrel in May 2022. This caused jet fuel spot prices to increase from $0.61 cents per gallon to $4.12 during the same period. With constant volatility in global oil markets, industry experts acknowledged that without hedging, airlines' operations and profitability are vulnerable to this inflated market pricing (Oliver Wyman, 2022).

Theoretically, oil price changes affect the economic structure, firms' fundamental and financial markets behaviour. In economic sense, increases in the oil price are unfavorable to economic growth prospects that will increase inflations. At the firm level, changes in oil price directly affect profits, investment, revenues and cash flow. This will dampen firms' earning expectations, directly influencing investors' expectations of asset prices in the financial markets (Hamilton, 1983; 1996; Boyer and Filion, 2007; Wan and Kao, 2015; Haykir et al., 2022). In investment context, oil influences the stock price behaviour through a rational asset pricing framework in reference to Jones and Kaul (1996). This model informs that oil price shocks affect companies' production costs, profit margin, and earning expectations at the firm level. On the investor side, lower future earnings expectations due to higher oil prices will be negatively influencing expectations on future stock prices. In addition, this situation will push investors to use higher equity risk premiums, causing additional pressure on firm value. In practice (refer to Table 1 and Figure 1), following the theoretical logic, oil prices have been intense volatile in recent years, weakening the economic and firm prospects due to the multifaceted risk mentioned before. Further, the empirical research confirmed that the general expectation is that increasing oil prices negatively affects the stock returns for oil-dependent sectors or firms (Haykir et al., 2022). The negative oil-stock prices relationships have been confirmed in the oil-dependent sector with greater attention to the transportation sector (Faff and Brailsford, 1999; Aggarwal, Akhigbe, and Mohanty, 2012), particularly in the airlines' sector (see evidence in Table 1). In this regards, the oil-stocks hedging research pointed out a need to manage this risk to protect airline stock returns from excessive oil price risk (see evidence in Table 2).

In the context of hedging-stock pricing research, there are still theoretical and practical gaps in the following aspects. First, the impact of oil price changes on transportation firms' stock returns has not been adequately examined (Aggarwal, Akhigbe, and Mohanty, 2012), particularly in the airlines industry. Second, evidence on oil hedging-stock price relationships is still weak (Morrell and Swan, 2006). Third, recent research highlighted the benefits of cross-commodity hedging instruments like gold futures and VIX futures (Arouri, Lahiani, and Nguyen, 2015) but little is available to confirm their practical validity.

Table 1: Asia-Pacific airlines industry profitability and cost summary

Item/Year	2019	2020	2021[e]	2022[f]
Profitability (Asia/Pacific region)				
Net post-tax profit ($bn)	4.9	-45	-15.2	-8.9
Revenues (%)	1.90	-40.00	-11.90	-4.40
Load factor (%)	72.3	63.8	63.2	68.2
Fuel cost (worldwide average)				
Fuel spend ($bn)	190	80	103	192
Change over year (%)	6.8	-58	29.2	86.2
Opex (%)	23.9	16.2	18.7	24.1
Fuel price ($/barrel)	79.7	46.6	77.8	125.5
Change over year (%)	-7.4	-41.5	67	61.3

Source: IATA (2022).

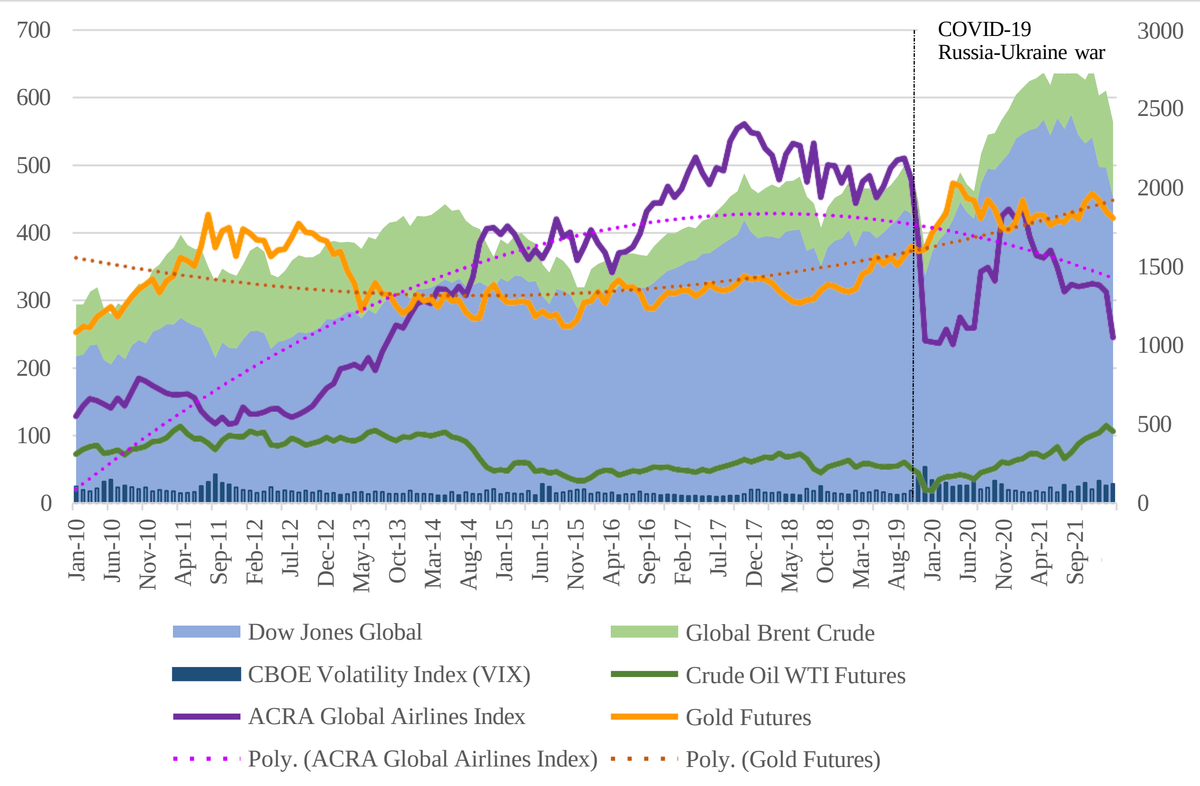

Figure 1: Historical behaviour of airline stocks with variables of interest.
Notes: Right scale represents Global Airline Index and Gold Futures. Left scale represents other variables. Data is manually collected from investing.com and tradingeconomics.com.

This research extends the hedging-stock pricing model that aim to sheds new insights from the following analysis. The first analysis performed to uncover the homogeneous impacts of oil price on stock returns in average, negative (lower quantiles), and positive (upper quantiles) oil price changes. The second analysis examine alternative futures hedging instruments considering own-commodity hedging (oil futures) and cross-commodity hedging (gold futures and VIX futures) instruments. The third analysis, examine the net hedging benefits of employing these futures instruments in an attempt to identify effective hedging instrument against oil price risk negative effects on airline stock investment. The findings suggest that gold futures can improve airlines stock portfolio risk adjusted performance and that it permits to hedge the oil price risk. The findings stand in average, lower and upper quantiles of the model analysis justifying gold futures as an affective hedging instruments for oil price risk. The findings provide new insights for oil price-stock returns-hedging relationships that are practically valuable in investment industry application.

Literature Review

The research landscape

The hedging-stock pricing research attempts to incorporate hedging risk factor in asset pricing model (Herskovic, Moreira, and Muir, 2019). Closely related to the present research focus is application of gold as a hedging factor in the two factor model of asset pricing by Abdullah (2018). Theoretically, it is expected that oil prices will be negatively affecting the stock prices fluctuations (Hamilton, 1983; Kling, 1985). In practice, there is no consensus on the effects of oil price risk due to mix evidences (Smyth and Narayan, 2018). On-going research aims to identify suitable futures hedging instruments (Pennings and Meulenberg, 1997) highlighting the benefits of cross-commodity hedging (Börger *et al.*, 2009; Chen and Tongurai, 2021). Furthermore, quantile relationship between oil and stock returns provides valuable hedging insights (Balcilar, Demirer, and Hammoudeh, 2019) but less investigated. The futures hedging black box in Figure 2 is summarised in reference to Lien *et al.* (2014) which covers hedging instruments, hedging estimations and evaluation of hedging effectiveness. The research uses the basic OLS hedging estimated from OLS regression model and OLS hedge ratio following Lien (2005). In practice, hedging strategy can be undertaken using long (long in futures and short in spot) or short (short in futures and long in spot) hedgers (Lien and Tse, 2002) with a choice of own or cross-commodity instruments.

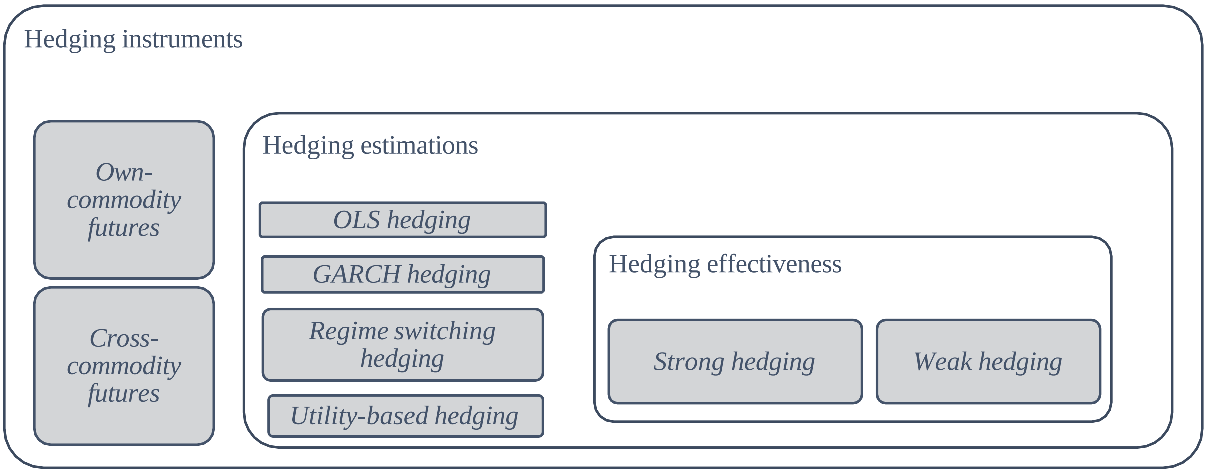

Figure 2: The futures hedging black box

Pricing the oil factor in the cross-section of stock returns

The basic stock pricing theoretical foundation are referred from these models. First, the dividend valuation model has been used by Jones and Kaul (1996) to explain the rational relationship of oil to stock markets; $R_t = E_{t-1}(R_t) + (E_t - E_{t-1})\sum_{j=0}^{\infty} \rho^j \Delta C_{t+j} - (E_t - E_{t-1})\sum_{j=1}^{\infty} R_{t+j} + \sum_{j=0}^{\infty} \beta OIL_{t-j} + \varepsilon_t$. The model assume oil price is relevant to the stock prices only to the extent of rational expectation (E) of oil price (OIL) affect changes affect to future cash flows (C) and expected returns (*E(R)*). Second is using the two-factor market model that inform a linear relationship between market systematic risk (beta) and expected return developed by Stapleton and Subrahmanyam (1983); $R_{it} = \alpha_0 + \beta_1 RM_t + \beta_2 OIL_t + \varepsilon_t$. Where R_{it} is return to stock *i* in period *t*, α_0 is the stock's alpha or abnormal return, RM_t is the return of the stock market in period *t*, *OIL* is the oil price at time *t*, and ε_t are the random residual. This model has been examined by previous research (see, Al- Mudhaf and Goodwin, 1993; Faff and Brailsford, 1999; Sadorsky 2001; Nandha and Brooks, 2009; Aggarwal, Akhigbe and Mohanty, 2012; Treanor, Rogers, Carter, and Simkins, 2014).

Pricing the hedging factor in the cross-section of stock returns

The hedging theory introduced in Ederington (1979) inform the benefits of futures instruments to reduce the investment risk in the cash markets. This theory provides the hedge ratio estimation based on regression model $\Delta S_t = \alpha + \beta \Delta F_{t1} + \varepsilon$ and $\beta = \frac{Cov\ (\Delta S_t,\ \Delta F_t)}{Var\ (\Delta F_t)}$.

Where $(\Delta S_t,\ \Delta F_t)$ is the return for spot and futures instruments respectively, ε_t is the error term, and β coefficient represents the minimum variance hedge ratio (Fan, Akimov, and Roca, 2013). Practically, hedging instruments that are negatively correlated (uncorrelated) with other assets will provide hedging benefits that can be weak (strong) depending on the magnitude of correlations (Batten *et al.*, 2021; Hood and Malik, 2013). Past hedging-stock pricing models are referred from these scholars. First, Robichek and Eaker (1978) which incorporated the foreign exchange hedging benefits in the capital asset pricing framework where the hedging benefit is calculated as calculated as spot price/futures price. Second, Dunbar (2021) which incorporated the net-hedging factor predictor (long minus the short futures contracts) in the 5 factor asset pricing model.

The effect of oil price factor on airline firms' stock returns

Transport sector in particular is an oil consumption sector and expect higher oil prices will be negatively affecting the transport sector stock returns (Nandha and Brooks, 2009). In the specific context of airlines industry, oil price being a cost inputs is expected to be negatively related to profitability and the same negative effect to the stock prices behaviour. Closely related evidence are self-explanatorily summarised in Table 2a. In brief, majority of oil price risk exposure on airlines stock returns evidence confirming negative significant effect despite presence of some inconsistence results. Recent research has been analysing the influence of oil price risk on stock markets in gerenal and quantile perspectives (Das and Kannadhasan, 2020; Khan, Ahmed, and Mughal, 2022). Generally these new evidence pointing to the possibilioty that oil price risk impacts on stock returns are not homogeneous across quantiles for non-oil consumption industry. However, for oil-dependent industry, the negative effects seems to pronounce in all quantiles. The present research extends the oil price risk - airline stock returns relationships in quantile perspectives. Examining the impacts of oil price risk on stock returns in various quantiles data distributions is an alternative way of assessing the possibility of time varying relationships that could impacting the hedging effectiveness.

H1a: On aggregate data (COP average), oil price risk impact to airline stock returns is expected to be negative.

H1b: On quantiles (lower and upper quantiles), oil price risk impact to airline stock returns is expected to be homogeneously negative.

The effect of hedging factor on airline firms' stock returns

One research area in asset pricing research is pricing the hedging factor in the cross-section of stock returns (Dunbar, 2021). Hedging is a risk management approach using futures instruments. In particular, cash positions are hedged by taking an equal but opposite position in the futures market to reduce risk in cash positions (Pennings and Meulenberg, 1997). Hedging stock portfolio with futures is possible through long only investment in commodity futures (Erb and Harvey, 2006). Hedge aims to reduce the impact of oil price risk on airline stocks. Hedging instruments can be own commodity or cross-commodity hedging (Basu and Miffre, 2013). In the hedging-stock pricing research, popularly investigated hedging instrument for oil stock is oil futures (own-commodity hedging) (see evidence in Table 2) and little evidence is available on cross-commodity hedging.

Own commodity hedging – Oil futures is popularly used hedging instrument by airlines firms to hedge jet fuel price risk (Morrell and Swan, 2006) to reduce risk exposure in the cash market investment position (Figlewski, 1985). Generally, hedging effectiveness will be affected by instrument characteristics. By product, study shows that that WTI market has higher hedging effectiveness compared to Brent market (Zhao, Meng, Zhang, and Li, 2018). Based on tenure, hedging effectiveness is highly dependent on the time regime (Horsnell, Brindle, and Greaves, 1995). One side is suggesting oil future hedging is more effective using a near-month contract (Ripple and Moosa, 2005) and other suggests distant maturity for a better diversification benefits (Geman and Kharoubi, 2008). Considering liquidity, WTI crude oil futures contracts is most liquid commodity futures that will leads to diversification both in upward and downward trending in equity markets (Geman and Kharoubi, 2008). Still, careful consideration is needed since some of futures instruments offer little hedging benefits. One study shows that crude palm oil futures in Malaysia shows a low level of hedging effectiveness with nearly steady price behaviour over the years (Ong, Tan, and Teh, 2012).

Cross-commodity hedging – This research concentrated on two non-oil instruments i.e. gold futures and VIX futures that could serves as suitable hedging instruments. Pairing of oil-stock and gold-stock in hedging portfolio could offer an effective hedge (Morema and Bonga-Bonga, 2020). However, the hedge effectiveness (protecting values across times) of gold-oil-stock is not clear given inconclusive evidence. Generally gold regarded as a weak hedging instrument given the present of both positive and negative correlations between the gold and the stock markets (Reboredo, 2013; Hood and Malik, 2013), gold offers a safe haven only (protecting values during crisis) instead of hedging, gold hedging benefits is time (maturity) dependent (Baur and Lucey, 2010; Narayan, Narayan, and Zheng, 2010), market state dependent (in periods of extremely and low and high volatility) (Hood and Malik, 2013), and oil price state (negative oil market shocks) (Reboredo, 2013), gold-stocks relationships change over time (normal to crisis) (Kumar, 2014; Basher and Sadorsky, 2016; Chkili, 2016). Recently, VIX futures has been recognised as a potential hedging instruments which demonstrates an inverse relationship with the stock markets. Earlier evidence found that gold serves as a weak safe-haven instrument and VIX demonstrated a strong safe-haven instrument during down stock markets condition (Hood and Malik, 2013). More recent study, recorded that VIX futures can reduce the oil price risk on stock returns (Batten *et al.*, 2021).

H2a: On average, futures hedging instruments (OF, GF and VIX) are expected to be positively related to airline stock returns.

H2b: On quantiles (lower and upper quantiles), futures hedging instruments (OF, GF and VIX) are expected to be homogeneously positive related to airline stock returns.

H3a: On average, net futures hedging benefits (OF-COP, GF-COP and VIX-COP) are expected to be positively related to airline stock returns.

H3b: On quantiles (lower and upper quantiles), net futures hedging benefits (OF-COP, GF-COP and VIX-COP) are expected to be homogeneously positive related to airline stock returns.

Table 2a: Evidence - Oil price risk exposure on airlines stock returns

No	Author/Year	Industry	Dependent Variables	Independent Variable	Sample Year	Sample /Countries	Method	Findings: Oil price-stock returns relationship
1	Nandha and Brooks (2009)	Transport sector	Transport sector equity returns	Market returns, Oil price	1983 - 2006	Developed countries, Europe, G7 countries	Standard market model	Generally, oil price risk negative impacting transport sector equity returns globally.
2	Lu and Chen (2010)	Transportation Sector	Stock returns	Crude oil price (WTI, Brent, Dubai)	2000 - 2007	China Japan Taiwan France USA UK Hong Kong Singapore	Market model with time varying beta	The results show that effect of oil price risk on transportation firms vary over time with different average impacts on sub-industry. Airline (-ve), marine (+ve/-ve), and land (+ve/-ve).
3	Aggarwal, Akhigbe and Mohanty (2012)	Transportation sector (including Airlines)	Stock return	WTI oil price,	1986 - 2008	United States	Two-factor model	Oil prices is found to be positive and significant related to stock returns during rising oil prices.
4	Mohanty, Nandha, Habis, and Juhabi (2014)	Travel and leisure Industry	Stock returns of US. Travel and Leisure	Oil price	1983 - 2011	United States	Four-factor Asset Pricing Model	Oil price exposures are negatively significant towards subsectors (airlines, recreational services and restaurant & bars)
5	Gaudenzi and Bucciol (2016)	Airline firms	Stock return	Jet fuel price, bond yields; S&P500 market return, total costs, the fuel cost/ total cost	2008 - 2014	United States	General regression model	Jet fuel return is negatively associated with airlines' stock returns. The impact is higher for regular compared to low-cost firms.
6	Kristjanpoller, and Concha (2016)	Airline firms	Stock returns	WTI oil, World stock returns	2008 - 2013	IATA airlines	CAPM model	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
7	Shaeri, Adaoglu, and Katircioglu, (2016)	U.S. multi industries (including Airlines)	Excess Stock returns	WTI oil, Fama-French factors	1983 - 2015	United States	Fama-French 5 factor model	The degree of oil price sensitivity differs across subsectors and over time. Airlines have the largest negative oil price risk exposures,
8	Killins (2020)	Railways and airlines firms	Stock returns	WTI oil prices, WCS oil price, Fama-French factors	2000 - 2018	Canada and U.S.	Fama-French 5 factor model	Equity returns of railways in Canada and airlines in the U.S. tend to be negatively impacted by rising movements in WTI. Additional estimations suggest that equity returns of airlines react asymmetrically and that information regarding oil price movements may diffuse over time.
9	Mollick, and Amin (2021)	U.S. airline industry	Stock return	WTI oil prices, occupancy, yield spread, Fama-French factors	1990 - 2019	25 Emerging countries	Fama-French 5 factor model	The role of oil becomes larger with asymmetries: the effects of oil prices are negative and higher when moving up than down.

Table 2b: Evidence - Hedging on oil price risk exposure

No	Author/Year	Industry	Dependent Variables	Independent Variable	Sample Year	Sample Countries	Method	Findings: Hedging benefits
1	Carter, Rogers, and Simkins (2006)	US airline industry	Fuel hedging behaviour	Capex, firm leverage, credit rating, cash flow to sales ratio, cash holdings, firm size	1993 - 2003	United States	Equally-weighted return, Three standard deviation price change	Oil price hedging in firm perspective. Findings indicates (i) Jet fuel hedging is positively related to airline firm value, (ii) Airline industry stock prices are negatively related to jet fuel prices. The jet fuel exposure coefficient is –0.11, and it is statistically significant.
2	Morrell, and Swan (2006)	Airline Jet Fuel Hedging: Theory and	Hedging of jet fuel	World Gross Domestic Product, Volatility of oil prices, Oil demand	1989 - 2003	United States	CAPM	Hedge shows significant role in protecting profits against sudden rise in crude oil price. Hedging may increase volatility when oil price going up due to strong economic growth and oil supply constraints.
3	Adams, and Gerner, (2012)	Cross hedging jet-fuel price exposure	DV - Jet fuel spot prices	Brent forward oil, WTI forward oil, Heating oil, Gasoil forward oil	1995 - 2010	Europe	GARCH (1,1)	Gas oil outperformed the other possible hedging products in terms of cross hedging effectiveness. Crude oil is not optimal for cross hedging. The performance of cross hedging becomes worst when time of maturity increased.
4	Berghöfer, and Lucey (2014)	Airline industry?	Risk Exposure	Financial and operational hedging,	2002 - 2012	Asia, Europe, North America	Risk exposure, yearly risk exposure coefficients	Fuel financial and operational hedging shows insignificantly capable in reducing the risk exposure.
5	Lim, and Hong, (2014)	Airline industry	DV - Operational cost	Hedge fuel price, Unhedged fuel price	2000 - 2012	United States	Fuel hedging to reduce cost	Hedging shows a negative and insignificant impact on operating cost. Fuel hedging and non-fuel hedging firm remained vulnerable towards fuel cost volatility even with hedging programs.
6	Treanor, Rogers, Carter, and Simkins (2014)	US airline industry	Exposure on hedging	Hedging premium, Capex to sales, standard deviation of fuel returns, change in fuel price	1994 - 2008	United States	Two-factor Market Model	Airlines hedge more of their jet fuel requirements when fuel prices are high (experience higher degrees of exposure to fuel prices). Further finding indicates that the hedging premium does not increase with airline exposure to fuel prices.
7	Turner, and Lim (2015)	U.S. passenger airlines	Jet fuel risk	Hedge ratios, Hedge effectiveness	1993 - 2013	United States	GARCH (1,1)	Heating oil price follows jet fuel closer. Airlines hedging with futures would create the most effective hedge by using 3-month maturity contracts of heating oil.
8	Jalkh, Bouri, Vo, and Dutta (2021)	US travel and leisure (T&L) stocks	(FTSE) US T&L stock index	CBOE VIX, and CBOE OVX	2007 - 2019	United States	Corrected dynamic conditional correlation (cDCC)	The implied volatilities of US stock and crude oil markets are more suitable and effective hedge for the downside risk of US travel and leisure (T&L) stocks
9	Kang, de Gracia, and Ratti (2021)	US airline industry	Stock returns	Real oil prices, jet fuel volatility, economic policy uncertainty, Fama and French factors	1990 - 2017	United States	GARCH (1,1)	Oil price increase and jet fuel price volatility have significantly adverse effect on stock returns of airlines both at industry and at firm level. Further, hedging future fuel purchase has statistically positive impact on the smaller airlines.

Research Methodology

Data Descriptions

The sample covers 22 Asia Pacific airline firms as listed in Table 3, Panel A. The data is unbalanced with monthly frequency spanning from 2010:09 to 2019:09. The variables of interest in this research are listed in Table 3, Panel B. The monthly data of stock prices and stock market indexes are obtained from Refinitiv Eikon. The UK Brent crude oil price (in USD) is chosen as a representative of world real oil price and the monthly data is obtained from Refinitiv Eikon. The exchange rate data is obtained from investing.com. The oil futures and gold future prices are obtained from Refinitiv Eikon. While VIX futures is sourced from investing.com.

Table 3: Data description

Panel A: Panel data of Asia-Pacific airline firms sample (unbalanced panel data)

Country	Airline Stocks	Equity Market	Timeframe
Australia	Qantas Airways	Australia Stock Exchange (ASX200)	2010:09 – 2019:09
China	Air China	Shanghai Stock Exchange (SSE)	2010:09 – 2019:09
China	China Eastern Airlines	Shanghai Stock Exchange (SSE)	2010:09 – 2019:09
China	China Southern Airlines	Shanghai Stock Exchange (SSE)	2010:09 – 2019:09
China	Hainan Airways	Shanghai Stock Exchange (SSE)	2010:09 – 2019:09
China	Shandong Airlines	Shanghai Stock Exchange (SSE)	2010:09 – 2019:09
Hong Kong	Cathay Pacific Airlines	Hang Seng Index (HIS)	2010:09 – 2019:09
India	Jet Airways	National Stock Exchange (NSE)	2010:09 – 2019:09
Indonesia	Garuda Indonesia	Indonesia Stock Exchange	2011:02 – 2019:09
Japan	All Nippon Airways	Nikkei 225 (N225)	2010:09 – 2019:09
Japan	Japan Airlines	Nikkei 225 (N225)	2012:09 – 2019:09
Malaysia	Air Asia	FTSE Bursa Malaysia	2010:09 – 2019:09
New Zealand	Air New Zealand	NZX50	2010:09 – 2019:09
Pakistan	Pakistan International Airlines	Pakistan Stock Exchange (KSE)	2010:09 – 2019:09
Philippine	Philippine Airlines	Philippine Stock Market	2010:09 – 2019:09
Singapore	Singapore Airlines	Singapore Exchange Limited (STI)	2010:09 – 2019:09
South Korea	Asiana Airlines	KOSPI	2010:09 – 2019:09
South Korea	Korean Air	KOSPI	2010:09 – 2019:09
Thailand	Thai Airways	Stock Exchange of Thailand (SET)	2010:09 – 2019:09
Taiwan	China Airlines	Taiwan Stock Exchange (TWSE)	2010:09 – 2019:09
Taiwan	EVA Airways	Taiwan Stock Exchange (TWSE)	2010:09 – 2019:09
Vietnam	Vietnam Airlines	Ho Chi Minh Stock Exchange	2019:05 – 2019:09

Panel B: Variables and measurement

Variables	Acronym	Measurement	Data Source
Stock returns	SR	$SP_t – SP_{t-1}/SP_{t-1}$	Refinitiv Eikon
Market returns	MR	$MP_t – MP_{t-1}/MP_{t-1}$	Refinitiv Eikon
Exchange rate	ER	$ER_t – ER_{t-1}/ER_{t-1}$	Investing.com
Crude oil price	COP	$COP_t – COP_{t-1}/COP_{t-1}$	Refinitiv Eikon
Oil futures	OF	$OF_t – OF_{t-1}/OF_t$-1; *OF-COP*	Refinitiv Eikon
Gold futures	GF	$GF_t – GF_{t-1}/GF_t$-1; *GF-COP*	Refinitiv Eikon
VIX futures	VIX	$VIX_t – VIX_{t-1}/VIX_t$-1; *VIX-COP*	Investing.com

Oil hedging-stock pricing model and hypothesis testing

Standard market model is employed to examine oil price risk-stock price relationships that is used in the prior literature (e.g. Jorion, 1990; Faff and Brailsford, 1999; Sadorsky, 2001; Basher and Sadorsky, 2006). Model 1 represents the basic model in average regression perspectives (overall condition of oil price fluctuations). Where SR_{it} is the monthly excess equity return on the airline companies, MR_{it} is the monthly excess return on the market index, and COP_{it} is the monthly return on the Brent crude oil price. The parameters $\beta_{i's}$ are the sensitivity or slope coefficient of the respective variables. Considering the possibility of heterogeneous effect of oil price risk on stock returns as documented in the previous research (Hamdan and Hamdan, 2020), the research analyses separate impacts of average, lower and upper quantiles oil conditions in the estimations. The alternate hypothesis to confirm *COP is a* priced risk factors; $\beta_{1c} \neq 0$. This analysis is related to hypothesis 1a, b.

$$SR_{it} = \alpha_{it} + \beta_{1a}MR_{it} + B_{1b}ER_{it} + \beta_{1c}COP_{it} + \epsilon_{it} \quad (1)$$

Model 2 examines the roles of futures hedging instruments in addition to the baseline model. In particular, the alternative hedging instruments considered are oil futures (*OF*), gold futures (*GF*) and VIX futures (*VIX*). The positive and negative coefficients indicate the respective futures instruments relationship with the stock returns. Positive indicated a hedging instrument that could enhance the stock returns. While negative mean that the instrument cannot hedge the value of the stock. The alternate hypothesis to confirm are whether *OF*, *GF*, and *VIX* are priced risk factors; $\beta_{2d,2e,2f} \neq 0$. This analysis is related to hypothesis 2a, b.

$$SR_{it} = \alpha_{it} + \beta_{2a}MR_{it} + \beta_{2b}ER_{it} + \beta_{2c}COP_{it} + \beta_{2d}OF_{it} + \beta_{2e}GF_{it} + \beta_{2f}VIX_{it} + \epsilon_{it} \quad (2)$$

Model 3 incorporated the net hedging benefits (i.e. futures returns – CPO returns) for the respective alternative futures hedging instruments (*GF*, *OF*, and *VIX*) in average condition. The net hedging benefit represents the hedge ratio of the respective futures instrument on oil price risk. The alternate hypothesis to confirm the net hedging benefits; $\beta_{3c,3d,3e} \neq 0$. This analysis is related to hypothesis 2a, b.

$$SR_{it} = \alpha_{it} + \beta_{3a}MR_{it} + \beta_{3b}ER_{it} + \beta_{3c}OFCOP_{it} + \beta_{3d}GFCOP_{it} + \beta_{3e}VIXCOP_{it} + \epsilon_{it} \quad (3)$$

In line with the hypothesis testing perspectives (i.e. average and quantiles perspectives), all of the above empirical models are comparatively estimated using FE panel regression and quantile regression. Asset pricing test using panel regression model is used as an alternative in recently in the literature (Tuyon and Ahmad, 2021). In basic form of FE panel regression model is represented as; $y_{it} = (\alpha + \mu_i) + x_{it}\beta + v_{it}$. The FE examines individual differences in intercepts, assuming the same slopes and constant variance across individual (group and entity). Since an individual specific effect is time invariant and considered a part of the intercept, *ui* is allowed to be correlated with other regressors (Park, 2011). In general form, quantile regression is represented as $q_t(y_i|x_i) = x_i\beta_t$. Where subscript t, $0 < t < 1$, denotes a quantile (q_t) of y. This model the regression function for q_t of y conditional on x (Wenz, 2018). Quantile regression enable examination of net hedging benefits in lower and upper quantiles. Practically, lower quantiles reflect low oil price, low economic and stock market prospects. While upper quantiles are associated with high oil price, high economic and stock market prospects. In this model, the interest is to identify hedging instruments that can effectively hedge oil price risk for airline firm stock returns across all market conditions.

Data Analysis and Result

Preliminary data analysis

Descriptive statistics - Descriptive statistics is provided in Table 4 for level and change data properties. Key variable of interests are the oil price behaviour (COP) and the hedging instruments behaviour (OF, GF, VIX). As reported in Panel A, the COP behaviour is recording a low price of $27.08/b, with mean of $79.71/b, and peak price of $124.93/b for the 10 years' period under study. In fact, comparing to the historical performance in Figure 3, the period under investigation recorded a higher COP regime and likely the CPO price to go higher in the near future. To note, the almost similar standard deviation behaviour of COP positive and COP negative changes indicate that there was almost equal performance of CPO price rises and declines. During the same period, the futures instruments have also been trending upwards (as indicated by recent price performance climbing above the historical moving average line). Looking at their standard deviation of futures instruments changes data, VIX is relatively high in volatility followed by OF, and GF recorded a lower volatility. This provides earlier clues on hedging stability behaviour.

Figure 3: Average monthly U.S. refiner acquisition cost of crude oil ($/b), 1975-2021
Data source: U.S. Energy Information Administration; https://www.eia.gov/energyexplained/oil-and-petroleum-products/prices-and-outlook.php

Diagnostic check – Variables stationarity are assessed using panel unit root test (i.e. Levin-Lin-Chu test, Beritung test, Im-Pesaran-Shin test, Augmented Dickey Fuller test and Phillips-Perron test) as reported in Table 5, all indicating that the variables are stationary. Correlation analysis - The correlation matrix is presented in Table 6. Here, the focus is on correlations between COP and SR (oil price risk) as well as the relations of COP with OF, GF, and VIX (hedging instrument properties). The correlation matrix captured that COP is negatively correlates (-0.0204) to SR as theoretically expected. As for the futures hedging instruments, all are positively correlated (OF=0.9884; GF=0.6991; VIX=0.2179) to COP. This behaviour giving some indicators that OF is highly correlated with COP, GF is moderately correlated with COP, and VIX is weakly correlated with COP. In hedging practice, lower asset correlations are preferred for hedging effectiveness.

Table 4. Descriptive statistics

Variable	Mean	Median	Max	Min	Std. Dev.	Skewness	Kurtosis	Obs.
Panel A: Level Data								
SR	5.76	1.14	45.67	0.01	9.83	2.03	6.06	2239
MR	884.27	330.11	6884.52	0.04	1420.47	1.97	5.83	2239
ER	731.44	29.54	23415.50	0.91	2729.73	4.59	24.48	2239
COP	79.71	74.44	124.93	30.80	27.08	0.06	1.48	2239
COPpos	46.38	48.48	124.93	0.00	44.34	0.28	1.60	2239
COPneg	33.25	0.00	120.46	0.00	43.10	0.79	2.00	2239
OF	80.47	74.65	126.10	35.85	26.52	0.08	1.48	2239
GF	1350.14	1298.60	1825.80	1063.40	179.24	0.92	2.87	2239
VIX	16.56	15.63	42.96	9.51	4.99	1.99	9.46	2239
Panel B: Change Data								
SR	0.0060	-0.0029	1.3196	-0.4185	0.1256	2.2802	18.3626	2235
MR	0.0037	0.0045	0.5732	-0.2251	0.0521	0.9132	14.8992	2235
ER	0.0016	0.0002	0.1181	-0.0830	0.0204	0.4267	6.7769	2235
COP	0.0007	0.0109	0.2051	-0.2288	0.0770	-0.5015	3.7758	2235
COPpos	0.0295	0.0109	0.2051	0.0000	0.0409	1.7965	6.6683	2235
COPneg	-0.0288	0.0000	0.0000	-0.2288	0.0505	-2.0869	6.8929	2235
OF	0.0001	0.0062	0.2102	-0.1969	0.0793	-0.1951	3.1206	2235
GF	0.0036	-0.0006	0.1250	-0.1112	0.0466	0.1055	3.0324	2235
VIX	0.0216	-0.0213	1.3457	-0.3849	0.2467	1.8160	9.7123	2235
OF_COP	-0.0006	0.0070	0.2234	-0.2972	0.0737	-0.6896	5.0712	2235
GF_COP	0.0028	-0.0083	0.2495	-0.2476	0.0829	0.3792	3.5210	2235
VIX_COP	0.0209	-0.0225	1.5047	-0.5690	0.2782	1.7304	9.4340	2235

Notes: Panel A present the descriptive statistics for raw (level data) and Panel B present the descriptive statistics for changes (analysed data)

Table 5. Panel unit root test: Individual intercept and trend

Variable/Test	Levin, Lin & Chu	Breitung	Im, Pesaran and Shin	ADF - Fisher	PP - Fisher
SR	-32.6587***	-12.9665***	-30.5209***	725.742***	1145.71***
MR	-36.8754***	-16.7998***	-30.6343***	732.507***	1050.34***
ER	-30.3132***	-5.61982***	-29.5408***	701.399***	1136.75***
COP	-33.7625***	-25.8562***	-26.8882***	618.948***	743.865***
COPpos	-27.6444***	-23.2783***	-21.9825***	473.583***	909.984***
COPneg	-33.2377***	-23.2652***	-24.4776***	546.7***	591.58***
OF	-28.2172***	-13.2356***	-24.4501***	546.553***	962.108***
GF	-36.242***	-11.5296***	-31.9486***	773.212***	1325.56***
VIX	-39.5788***	-32.4256***	-36.6928***	915.321***	1479.75***

Notes: The panel unit root test is performed on changes data. Asterisk *** denotes 1% significant level.

Table 6. Correlation analysis (level data)

	SR	MR	ER	COP	COPpos	COPneg	OF	GF	VIX
SR	1								
MR	-0.1926	1							
ER	-0.0646	-0.1650	1						
COP	-0.0204	-0.0195	-0.0396	1					
COPpos	0.0031	-0.0044	-0.0222	0.34978	1				
COPneg	-0.0150	-0.0067	-0.0016	0.26742	-0.8072	1			
OF	-0.0219	-0.0198	-0.0388	0.98835	0.2520	0.3609	1		
GF	-0.0111	-0.0215	-0.0188	0.69907	0.2030	0.2299	0.6830	1	
VIX	0.0064	-0.0248	-0.0190	0.21788	0.0195	0.1152	0.2398	0.3483	1

Notes: The correlation analysis is performed for raw data (level data).

Empirical Analysis

The impact of oil prices on airline stock returns

The panel regression follows standard estimation procedures. First, the model diagnostic tests to fulfil basic regression assumptions (i.e. multicollinearity, heteroscedasticity, and autocorrelation) are performed. Second, panel model selection tests (BPLM and Hausman) are run to identify the suitable methods. The tests are reported in the regression table. Although the BPLM test favours POLS being an unbiased estimator (Breusch and Pagan, 1980), the estimation proceeds with considering panel-wise effect and hausman test suggest FE model is suitable. In reality, it is common to observe firm-specific effects present in cross- sectional data that OLS cannot control for unobserved individual effects. In such a case, RE and FE models are more effective (Le and Phan 2017; Abdullah and Tursoy, 2019). In addition, to mitigate the presence of heteroscedasticity and autocorrelation, the FE model is run with robust standard errors (Hoechle, 2007). Table 7 presents the results of the panel regression analysis for model 1a,1b to test the hypothesis 1a, b concerning the oil price risk, in addition to control variables effects on airline stock returns. The results of model 1a regression indicated the three predictors explained 15.9% of the variance (R^2= 15.86, F(3, 2188)=139.34, p<.01). In specific, MR found to be the strong positive price factor with (β = .9381, p<.01), ER is confirmed to be a negative price factor with (β = -.3224, p<.01), and average COP is also confirmed to be negative coefficient with (β = -.1028, p<.01). Hence, the prediction of hypothesis 1a and 1b are confirms that COP is negative and significant effecting airlines' stock returns in average, lower and upper quantiles perspectives.

Table 7. Oil price risk

Model	Model 1a (FE, xtregar)	Model 1b(i) (QR)	Model 1b(ii) (QR)	Model 1b(iii) (QR)	Model 1b(iv) (QR)
Conditions	COP average	Lower Quantile (.10)	Lower Quantile (.20)	Upper Quantile (.80)	Upper Quantile (.90)
C	0.0033***	-0.1047***	0.0581***	0.0554***	0.1083***
	(1.37)	(-25.81)	(22.91)	(19.31)	(23.43)
MR	0.9381***	0.8304***	0.9443***	1.0712***	1.1781***
	(19.49)	(7.72)	(27.44)	(17.38)	(11.95)
ER	-0.3224***	-0.5512***	-0.3585***	-0.0841	-0.0092
	(-2.68)	(-2.70)	(-2.48)	(-0.84)	(-0.03)
COP	-0.1028***	-0.1453***	-0.0566	-0.1768***	-0.2237***
	(-3.17)	(-3.06)	(-1.27)	(-3.96)	(-3.38)
R-Squared	0.1586	0.1318	0.1296	0.1043	0.0933
F-Statistic	(3, 2188) 139.34***				
Observation	2235	2235	2235	2235	2235
Model Diagnostics					
Multicollinearity test	1.05				
Heteroskedasticity test	23.4.42***				
Autocorrelation test	3.124*				
Model Selection					
Breusch Pagan Lagrange test (POLS or RE)	0.00 (p>0.05 = POLS)				
Hausman test (RE or FE)	13.65*** (p<0.05 = FE)				

Notes: VIF values are mean VIF, Wald Test (X^2), BP test (X^2). Values in the paranthesis is the *t*-statistics and asterisk *** denotes 1% significant level.

The role of alternative hedging instruments on airline stock returns

Table 8 presents the results of the panel regression analysis for model 2a, b, c to test the aggregate role of alternative futures hedging instruments (OF, GF, and VIX) in addition to the previous three variables as the baseline model (MR, ER, and COP) in influencing airline stock return. The objective of testing this hypothesis is to verify whether these alternative hedging instruments will be able positively related to airline stock returns to confirm that they are suitable hedging instruments in hedging oil price risk on airline stock returns. The results of Model 2 (overall) regression indicated the three predictors explained 16.27% of the variance (R^2=.1627, F(6, 2185)=71.76, p<.01). The average COP is generally confirmed to be significant with negative coefficient. The first three asset pricing variables coefficients signs generally remain the same as in all regression models (2a, 2b, and 2c) despite differences in significant level. In this model 2 (overall), the assessment focus is on the futures hedging instruments coefficients. In case of OF, the coefficient found to be negative significant price factor with (β = -.1155, p<.01). Test for GF coefficient indicates positive but not statistically significant (β = .0094, p>.01, 0.5, 0.10). Test for VIX coefficient indicates positive but not statistically significant (β = .0130, p>.01, 0.5, 0.10). Hence, the hypothesis 2a is failed to be supported. Still, the results giving clues that GF and VIX possibly weak hedging instruments.

Table 8. Role of hedging instruments

Model	Model 2a FE (xtregar)	Model 2b FE (xtregar)	Model 2c FE (xtregar)	Model 2 (overall) FE (xtregar)
Variable of interest	OF	GF	VIX	Overall
Constant	0.0034 (1.38)	0.0034 (1.37)	0.0031 (1.24)	0.0029 (1.21)
MR	0.9517*** (19.72)	0.9381*** (19.48)	0.9403*** (19.52)	0.9550*** (19.76)
ER	-0.3785*** (-3.12)	-0.3237** (-2.59)	-0.3053** (-2.52)	-0.3539*** (-2.79)
COP	-0.0516 (-1.41)	-0.1027*** (-3.13)	-0.0937*** (-2.80)	-0.0393 (-3.13)
OF	-0.1072*** (-3.03)			-0.1155*** (-1.74)
GF		-0.0021 (-0.04)		0.0094 (0.18)
VIX			0.0107 (1.11)	0.0130 (1.34)
R-Squared	0.1622	0.1586	0.1588	0.1627
F-Statistic	(4,2187) 107.19***	(4,2187) 104.46***	(4,2187) 104.82***	(6,2185) 71.76***
Observation	2213	2235	2213	2213
Model Diagnostics				
Multicollinearity test	1.28	1.09	1.09	1.27
Heteroskedasticity test	2704.44***	2293.11***	2259.25***	2600.25***
Autocorrelation test	3.066*	3.116*	3.436*	3.354*
Model Selection				
Breusch Pagan Lagrange test (OLS or RE)	0.00 (p>0.05 = POLS)	0.00 (p>0.05 = POLS)	0.00 (p>0.05 = POLS)	0.00 (p>0.05 = POLS)
Hausman test (RE or FE)	15.16*** (p<0.05 = FE)	14.56*** (p<0.05 = FE)	14.40*** (p<0.05 = FE)	12.71*** (p<0.05 = FE)

Notes: VIF values are mean VIF, Wald Test (X^2), BP test (X^2). Values in the paranthesis is the *t*-statistics and asterisk *** denotes 1% significant level.

The role of alternative hedging instruments on airline stock returns

Table 9 presents the results of the panel regression analysis for model 3a, b, c to test the impacts of alternative futures net hedging benefits (OF-COP, GF-COP, and VIX-COP) in addition to the controlled asset pricing variables (MR and ER) in influencing airline stock return. The test of net hedging benefits is assessing whether by pairing the respective futures instruments with COP, the pairing will generate a positive coefficients which means a net hedging benefits (i.e. futures offset the oil price risk) in airline stock portfolio context. The results of model 3 (overall) regression indicated the model predictors explained 16.16% of the variance (R^2=.01616, F(5,2186)= 85.17, p<.01). The controlled variables remain remains with the correct signs and statistically significant. Variable of interest in the model are the net heading benefits impacts. Based on model 3 (overall) results, net oil futures minus crude oil price investments (OF-COP) turns to be negative coefficients despite being statistically significant with (β = -.0956, p<.05). Second variable, net gold futures minus crude oil price investments (GF-COP) is confirmed to be a positive and significant price factor with (β = .0933, p<.01). Third variable, net VIX futures minus crude oil price investments (VIX-COP) is also confirmed to be a positive and significant price factor with (β = .0182, p<.10). Hence, the prediction of hypothesis 2a is confirms only for GF-COP and VIX-COP but not OF-COP.

Table 9. Impact of net hedging

Model	Model 3a FE (xtregar)	Model 3b FE (xtregar)	Model 3c FE (xtregar)	Model 3 (Overall) FE (xtregar)
Variable of interest	OF hedge	GF hedge	VIX hedge	Overall
C	0.0033 (1.35)	0.0030 (1.24)	0.0028 (1.12)	0.0025 (1.02)
MR	0.9268*** (19.27)	0.9341*** (19.41)	0.9344*** (19.41)	0.9499*** (19.67)
ER	-0.3055** (-2.53)	-0.2638** (-1.66)	-0.2707** (-2.25)	-0.2746** (-2.28)
OF-COP	-0.0322 (-1.04)			-0.0956*** (-2.75)
GF-COP		0.0781*** (2.63)		0.0933*** (2.66)
VIX-COP			0.0213*** (2.50)	0.0182* (1.94)
R-Squared	0.1555	0.1579	0.1596	0.1616
F-Statistic	(3,2188) 135.78***	(3,2188) 138.10***	(3,2188) 137.83***	(5,2186) 85.17***
Observation	2213	2213	2213	2213
Model Diagnostics				
Multicollinearity test	1.19	1.04	1.05	1.22
Heteroskedasticity test	2329.11***	2220.31***	2145.29***	2394.57***
Autocorrelation test	3.509*	3.448*	3.790*	3.647*
Model Selection				
Breusch Pagan Lagrange test (OLS or RE)	0.00 (p>0.05 = POLS)	0.00 (p>0.05 = POLS)	0.00 (p>0.05 = POLS)	0.00 (p>0.05 = POLS)
Hausman test (RE or FE)	11.88*** (p<0.05 = FE)	11.94*** (p<0.05 = FE)	13.30*** (p<0.05 = FE)	14.18*** (p<0.05 = FE)

Notes: VIF values are mean VIF, Wald Test (X^2), BP test (X^2). Values in the paranthesis is the t-statistics and asterisk *** denotes 1% significant level.

Table 10 presents the results of the quantile regression analysis for model 2a(i), a(ii), a(iii), a(iv) re-test the role of alternative futures hedging instruments (OF, GF, and VIX) and the net hedging benefits (OF-COP, GF-COP, and VIX-COP) in lower quantiles (lower COP price conditions) and upper quantiles (higher COP price conditions). Focusing on the variable of interest (the role of alternative hedging variables) in Panel A, the results are qualitatively similar with those earlier analysed in model 2 (as reported in Table 8 and provide validation test for hypothesis 2b) where OF is negatively significant and GF and VIX is positive with weak significant. Turning on the variable of interest (the net hedging benefits) in Panel B, the OF-COP coefficients remains negative across quantiles. The GF-COP and VIX-COP confirmed to be positives across lower and upper quantiles but consistent significant performance is recorded only for GF-COP. The results for hypothesis 3b shows that only GF-COP that could acts as an effective hedging instrument for oil price risk across conditions.

Table 10. Quantile regression estimations

Panel A: Role of hedging instruments

Model	Model 4a(i) (qreg)	Model 4a(ii) (qreg)	Model 4a(iii) (qreg, .40)	Model 4a(iv) (qreg, .80)	Percentile differences
Variable of interest/ Quantiles	Lower Quantile (.10)	Lower Quantile (.20)	Upper Quantile (.80)	Upper Quantile (.90)	Q(10-90): (Wald Test)
C	-0.1039*** (-28.58)	-0.0655*** (31.33)	0.0554*** (19.31)	0.1063*** (24.56)	740.64***
MR	0.8532*** (6.90)	0.9633*** (13.45)	1.0926*** (15.23)	1.2298*** (15.93)	6.34***
ER	-0.6489*** (-3.27)	-0.4779*** (-3.74)	0.1165 (-0.65)	-0.0003 (-0.00)	1.32
COP	-0.8491 (-1.46)	0.0292 (0.75)	-0.0396 (-0.64)	-0.0730 (-0.64)	3.49**
OF	-0.1044* (-1.69)	-0.1447*** (3.25)	-0.1788*** (5.24)	-0.2010*** (-2.93)	0.62
GF	0.0059 (0.09)	0.0157 (0.24)	0.0265 (0.32)	0.0434 (0.33)	0.03
VIX	0.0009 (0.06)	0.0151 (1.84)	0.0436*** (2.62)	0.0422** (1.93)	1.51
Pseudo R-Squared	0.1338	0.1327	0.1126	0.0993	
Observation	2235	2235	2235	2235	

Panel B: Impact of net hedging

Model	Model 4b(i) (qreg)	Model 4b(ii) (qreg)	Model 4b(iii) (qreg)	Model 4b(iv) (qreg)	Percentile differences
Variable of interest/ Quantiles	Lower Quantile (.10)	Lower Quantile (.20)	Upper Quantile (.80)	Upper Quantile (.90)	Q(10-90): (Wald Test)
C	-0.1048*** (-19.35)	-0.0663*** (21.93)	0.0549*** (24.05)	0.1038*** (24.93)	868.24***
MR	0.8009*** (8.14)	0.9577*** (14.34)	1.0910*** (19.41)	1.2448*** (13.62)	6.11***
ER	-5.613*** (-2.95)	-3.5660** (-2.72)	-0.1011 (-2.72)	0.1512** (0.64)	3.68**
OF-COP	-0.0932 (-1.25)	0.0781*** (2.63)	-0.1668*** (-3.96)	-0.1462** (-2.07)	0.75
GF-COP	0.1064* (1.94)	0.0719** (2.21)	0.1269*** (3.00)	0.1444* (1.73)	0.74
VIX-COP	0.0014 (0.08)	0.0186 (1.56)	0.0515*** (3.87)	0.0465** (2.11)	2.84**
Pseudo R-Squared	0.1304	0.1321	0.1112	0.0984	
Observation	2235	2235	2235	2235	

Notes: Values in the paranthesis is the *t*-statistics and asterisk *** denotes 1% significant level. Percentilew differences is calculated in STATA as test [q10]var = [q20]var = [q80]var = [q90]var.

Discussion

In an attempt to advance the hedging-stock pricing research, the present research analyses the own-hedging and cross-hedging commodity strategy's hedging effectiveness. The tested hypotheses with the respective findings are summarized in Table 11.

Table 11. Summary of hypothesis testing

Variables / Methods	Hypothesis/ (Expectation)/ Model	FE Average	QR Lower (10-20%)	QR Upper (80-90%)	Hypothesis decision
Oil risk factor					
COP	H1a /(-ve)/FE H1b/(-ve)/OR	-0.1028***	-0.1453*** -0.0566	-0.1768*** -0.2237***	Accepted H1a Accepted H1b
Hedging instruments					
OF	H2a/(+ve)/FE H2b/(+ve)/QR	-0.1155***	-0.1044* -0.1447***	-0.1788*** -0.2010***	Rejected H2a, H2b
GF		0.0094	0.0059 0.0157	0.0265 0.0434	Rejected H2a, H2b
VIX		0.0130	0.0009 0.0151	0.0436*** 0.0422*	Rejected H2a Rejected H2b
Net heading benefits					
OF-COP	H3a/(+ve)/FE H3b/(+ve)/QR	-0.0956***	-0.0932 -0.1447***	-0.1788*** -0.2010***	Rejected H3a, H3b
GF-COP		0.0933***	0.1064* 0.0719**	0.1269*** 0.1444*	Accepted H3a, H3b
VIX-COP		0.0182*	0.0014 0.0186	0.0515*** 0.0465**	Accepted H3a, H3b

Hedging-stock pricing model for airline stocks investment

The present findings are closely related to the existing evidence specifically in the context of hedging-stock pricing model (Robichek and Eaker, 1978; Dunbar, 2021) concerning the relationships between oil price-hedging-stock returns for airline stocks investments. The research is particularly advancing the discussion of existing research concerning oil price risk exposure on airlines stock returns (key evidence presented in Table 2a) and hedging oil price risk exposure on airlines stock returns (key evidence presented in Table 2b). Presently, there are still observed theoretical-practical traps in the industry practice making this an intriguing issue to discuss. In the context of oil risk-stock returns relations for airlines firms, the present research findings in confirmation with the general expectations of negative effects and disconfirms some inconsistency in existing evidences (see Table 2a). In the context of hedging, popular hedging instrument employed by corporate and portfolio managers to manage oil price risk is using own commodity hedging that is investing in oil futures instruments. Existing evidence have been supporting the benefits of oil futures as a hedging instruments (see Table 2b). Based on these evidences, research in the context of hedging- stock pricing model is only few (Morrell and Swan, 2006; Treanor, Rogers, Carter and Skimkins, 2014). Further, one point to argue is that in case of oil related stocks, oil futures are not the best hedging instrument because they will be positively not negatively correlated as required for effective hedging. The present research findings indicate negative role of oil futures in average as well across quantiles perspectives that invalidate the expected positive roles of oil futures as a hedging instruments. These facts could misinform investors/fund managers that would leads to wrong hedging strategies and eroding airline stock portfolio values. Presently, in response to the needs in the investment industry, researchers is examining alternative hedging instruments using cross-commodity hedging that could could provide an effective hedging instruments for stock returns in general (Börger, Cartea, Kiesel, and Schindlmayr, 2009; Chen and Tongurai, 2021). The promise benefits of cross-commodity hedging lies with identification of negatively correlated assets prices movements between cross-commodity assets. In the context of hedging for oil price risk, some research has documented the possibility of gold futures as a safe haven hedging instruments for oil price risk (Junttila, Pesonen, and Raatikainen, 2018). The present research extends this research in the specific context of airlines stock returns and confirms that gold futures could act as an effective hedging instrument for oil price risk negative impacts on airline stock investment.

Investment strategy implications

Oil prices negative influence on airline stocks is well acknowledged by the industry players. The industry issues motivate the research to examine alternative futures hedging instruments that could offer an effective hedging benefits to offset (at best) or reduce (at least) the negative effect of oil price risk on airline stock returns. The hedging effectiveness refers to the extent to which a futures contract offers a reduction in overall risk cash/spot markets investments (Pennings and Meulenberg, 1997). Practically, hedging the impact of oil price risk on airline stock investments in cash market can be undertaken by single short position (contract to sell in the future) in futures hedging instruments (Erb and Harvey, 2006). The research identified that among alternatives considered, only gold futures best possess an effective hedging behaviour that could protect oil price risk in all market directions. This is consistent with earlier evidence (Junttila, Pesonen, and Raatikainen, 2018). That confirm cross-commodity hedging posses a safe haven propery supporting earlier establish idea by Börger *et al.* (2009) and Chen and Tongurai (2021) among others. The role of gold has been identified as a safe haven instruments for stocks in the literature (Hood and Malik, 2013; Ghazali, Lean, and Bahari, 2013) to name a few. At the same time, the findings challenge the validity of own commodity hedging benefits to offset oil price risk as documented among others in Basher and Sadorsky (2016). Also the recently mentioned VIX futures as a potential safe haven against oil price risk (Hood and Malik, 2013) and for equity portfolios (Zghal and Ghorbel, 2020) needed further scrutiny to confirm its validity. Ideally the findings suggest that gold futures permit to hedge the oil price risk that can improves airlines stock portfolio returns.

Conclusion

The present research is undertaken to advance the hedging-stock pricing research in the following perspectives. The present analysis provide confirmation to negative impacts of oil price movements on airline stock return in all oil prices behaviour states (i.e. average, lower and upper quantiles perspectives). In examining alternatives hedging instruments, the results indicate that oil futures do not provide an effective hedging benefits, VIX futures offers a weak effective hedging, and gold futures possess a strong effective hedging characteristics in reducing oil price risk on airlines stock returns. Research limitations are as follows. First, basic asset pricing model is used. Second, the model ignoring transaction cost and portfolio weighting that are more practical in industry practice (Erb and Harvey, 2006). Future research may employ other asset pricing models. Researcher may also investigate other cross- derivative hedging instruments including but not limited to credit derivatives (Ratner and Chiu, 2013; Zghal and Ghorbel, 2020), and options instruments (Lien and Tse, 2002) which have been identified as a potential effective hedging instruments for oil price risk.

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