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Impact of Crude Oil Price Volatility on Southeast Asian Stock Returns

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Abstract

The study investigates the connection between international oil indices and Southeast Asian stock markets. The outcomes confirm the significant oil-stock linkage in the Southeast Asian region. While the oil price fluctuations have positive effects on stock returns, the impacts of the implied crude oil volatility index are negative. The study further reports the existence of GARCH effects in investigated markets, with a greater effect of negative innovations compared to that of positive. Furthermore, the jump effects are found in most markets, as evidenced by the estimates for GARCH-jump models. Generally, the volatility driven by abnormal information positively affects the volatility of returns while the jump behavior has negative impacts on Southeast Asian market returns.

Keywords: Southeast Asia, oil-stock, volatility transmission, OVX, GARCH-jump.

1. Introduction

Crude oil has been considered as one of the most important inputs of the economy. Consequently, the changes in price of crude oil have a significant impact on the economy in general and the stock market particularly. There are numerous researches performed with the aim of finding the linkage between the crude oil price and stock market returns (Jones & Kaul, 1996; Kilian & Park, 2009; Lee & Chiou, 2011; Ciner, 2013). The association between oil and stock markets is significant in most studies but the connection seems to depend on the types of oil shock and possesses time-varying characteristics. Beside the relationship between the oil price and the market return, many researchers also found the transmission between oil price uncertainty and stock return volatility (Malik & Ewing, 2009 and Diaz, Molero, & Perez de Gracia, 2016). The oil price volatility has continuously attracted attention with many recent contributions (Dutta, Nikkinen, & Rothovius, 2017; Luo & Qin, 2017). These findings show the importance of the crude oil price volatility which has a notable impact on other financial indices and could be considered as an indicator for risk in the stock markets. However, the findings on oil-stock linkages are not consistent across the empirical results. For example, the oil price shocks proved to have a negative impact on the US stock market (Sadorsky, 1999), but in the earlier study of Huang, Masulis, & Stoll (1996) there is no clear connection between oil futures price and US stock returns. Additionally, the sign of reactions to the fluctuations on oil markets are not similar among the countries examined, according to the research of Park & Ratti (2008) for US and 13 European nations.

Departing from most recent studies, this research investigates the impact of the global oil market on stock returns and volatilities in the Southeast Asian region. The paper makes contributions to the existing literature in several aspects. Firstly, while the emerging economies tend to be more sensitive to oil price shocks and the fluctuations in the oil market have a much larger impact on less developed countries generally (Basher & Sadorsky, 2006), there are only a small number of research papers concentrating on these economies (Arouri, Lahiani, & Nguyen, 2011; Fowowe, 2013; Dutta et al., 2017; and Dutta, Noor, & Dutta, 2017). The aim of the current study is to provide a further exploration on the relationship between energy price

volatility and the newly emerging and frontier stock markets. The analysed countries in the research, including Indonesia, Malaysia, Philippines, Singapore, Thailand, and Vietnam range from developed and emerging economies to frontier markets. Therefore, the outcomes provide a comparison between the response of different markets with unequal levels of development in the same geographical area. Secondly, the previous empirical researches mainly focus on the connection between oil price change and stock returns, while there is a limitation of the literature on volatility transmission (Noor & Dutta, 2017). Besides using the traditional oil price index, the research utilizes the CBOE Crude Oil Volatility Index (OVX) in finding the impact of oil volatility on stock returns as well as the volatility spillover among these markets. Additionally, the outcomes of the current study could be a guideline for risk management activities when the Southeast Asian stock markets have gained considerable attention from investors seeking international diversification benefits.

At the empirical stage, the exponential generalized autoregressive conditional heteroskedastic (EGARCH) model, proposed by Nelson (1991), is employed to capture the effects of international oil indices on stock markets investigated. By adding the OVX into the volatility equation, the analysis examines not only the relationship between oil and stock returns, but also the volatility transmission between international oil price and stock market returns. Moreover, the study is advanced by applying the GARCH-jump model, proposed by Chan & Maheu (2002) to further explore the movements of Southeast Asian stock returns. The conditional jump models are proved to attain ability in capturing the effect of abnormal information on market through the researches of Fowowe (2013), Dutta et al. (2017), and Dutta (2018). In this research, both GARCH-jump model with constant jump intensity and time-varying jump intensity are employed to exploring the movement of stock markets.

2. Literature review

Many empirical researches have analysed and confirmed the association between oil and stock markets. An early study of Jones & Kaul (1996) documents the adverse impact of oil price on stock return by applying the cash

flow valuation model for the sample from 1947 to 1991. In line with the finding of Jones & Kaul (1996), Ciner (2001) also finds the linkage between oil futures price and S&P 500 index return. However, the research highlights non-linear causality and further discusses the feedback relation from stock price movements to oil market. In another literature of Driesprong, Jacobsen, & Maat (2008), the negative impacts of six global oil indices on stock returns of eighteen developed countries are illustrated for the period from 1973 to 2004. Besides, Park & Ratti (2008) analyse on the US and thirteen European countries for the period from 1986 to 2005, confirming the effect of world real oil price on all examined market stock returns. Chiang & Hughen (2017) reports the negative impact of oil futures prices on non-oil stock returns. Both negative and positive casual effect of WTI crude oil index return on the change of S&P 500 index are found in analysed subsamples and vice versa (Lu, Qiao, Wang, Lai, & Li, 2017). It means that not only the oil price impacts the stock return, but the stock markets also have some effects on the oil market, which is similar with the findings of Ciner (2001).

Besides focusing on developed countries, many emerging and developing markets have been addressed in the variety of studies. In the research of Driesprong et al. (2008), thirty emerging markets are examined to find the relationship between oil price and stock market. However, the reaction of stock returns in the investigated countries is not clear and significant to all six global oil indices for the period from 1988 to 2004. For the South Asian markets, using VAR(1)-GARCH(1,1) model, Noor & Dutta (2017) find the evidence, that is, the stock markets of India, Pakistan, and Sri Lanka receive the impacts from both global oil price and oil volatility. Fowowe (2013) uses GARCH-jump model developed by Chan & Maheu (2002) in examining the relationship between oil price and Nigerian Stock index. The research exploits the advantages of the GARCH-ARJI model in capturing the effect of extreme shocks in modelling the stock return movements. However, the result shows the insignificant impact of both Brent and WTI oil prices on Nigerian Stock Exchange. Integrating the exponential generalized autoregressive conditional heteroskedastic (EGARCH) with a time-varying conditional jump intensity, Zhang & Chen (2011) modify the model proposed by Chan & Maheu (2002) to explore the impact of international oil price on Chinese stock

returns. By employing the jump component in the model, the researches could extensively investigate the fluctuations of stock markets and solidify the tests for oil-stock relationship.

Turning attention to the volatility of oil price, many other researches concentrate on the volatility transmission between oil and stock markets with the application of GARCH-family models in analysing financial volatility. Malik & Ewing (2009) find the evidence of volatility spillover between oil price and five sectoral markets in the US for the sample from 1992 to 2008 by the mean of bivariate GARCH models. Employing VAR-GARCH approach, Arouri, Jouini, & Nguyen (2011) analyse the oil-stock volatility interaction in the US and Europe. According to the paper, the volatility transmission from oil price to stock markets is stronger than from stocks to oil for European markets. In the US, both directs of volatility transmission are clear and significant. Concentrating on oil-producing countries, the research of Arouri, Lahiani, & Nguyen (2011) confirms the volatility spillover between oil and stock markets in the Gulf Cooperation Council (GCC) countries, including Bahrain, Kuwait, Oman, Saudi Arabia, and the United Arab Emirates. The evidences of volatility transmission of the GCC nations are stronger for the crisis subsample from 2007 to 2010. Also researching on an oil-exporting economy, Lebanon, Bouri (2015), however, finds only weak evidences supporting for volatility transmission between oil and stock markets. The effect of oil price volatility on stock market is also found for China over the period from 1997 to 2014 in the study of Caporale, Menla Ali, & Spagnolo (2014). Most of sectional stock returns positively response to the oil return volatility during the period of oil demand-side shock, but the returns are not significantly related to the oil price change in the same period. A recent study on the US market (Alsalman, 2016), in contrast, finds no statistically significant relationship between oil price volatility and the US stock return for the sample data from 1973 to 2014. The explanation of author is that the companies widely apply hedging technique to reduce to risk from the change of oil price on the market. By mean of VAR model, Maghyereh, Awartani, & Bouri (2016) find the oil-stock relationship through examining the connectedness of newly implied volatility indices. The volatility transmission is confirmed in their research, but the linkage is mostly established in the period from 2009 to 2012 and varies over the sample period.

Dutta, Noor, & Dutta (2017) highlight the informative characteristic of the Crude Oil Volatility Index (OVX) in predicting emerging stock market returns which are highly sensitive to both negative and positive oil volatility shocks. Adding OVX in GARCH variance equation, the negative effects of OVX fluctuation on most Middle East and African stock market returns are indicated in the study of Dutta, Nikkinen, & Rothovius (2017). All twelve investigated markets excepted Qatar exhibit the sensitive reactions of stock volatility to the change of OVX. The finding supports for the volatility transmission between oil and stock markets and strengthens the importance of implied volatility indices in explaining the stock price fluctuations. The OVX also has negative effect on Chinese stock market index while the oil price change positively impacts on Chinese stock market and five sectoral indices examined (Luo & Qin, 2017). Analysing three implied volatility indices, Dutta (2017) presents the association among OVX, VIX, and the US energy sector equity VIX (VXXLE), further confirming the connection between oil and stock markets. Researching on both OVX and WTI oil price, the study of Dutta et al. (2017) shows negative impact of OVX but positive influence of WTI oil index on global emerging stock market index return. The authors also highlight the greater magnitude of OVX impact compared to the effect of WTI oil price change.

3. Data

The data consists of daily continuously compounded index returns, computed as difference in the logarithms of daily value of oil index and stock market indices for six Southeast Asian nations, namely Indonesia, Malaysia, Philippines, Singapore, Thailand, and Vietnam. Daily data on stock market is collected from Morgan Stanley Capital International (MSCI) indices including MSCI Indonesia, MSCI Malaysia, MSCI Philippines, MSCI Singapore, MSCI Thailand, and MSCI Vietnam. While most oil-stock research use WTI and Brent oil price, the current study utilizes Dubai Fateh crude oil index to calculate oil returns due to the considerable proportion of Persian Gulf crude oils in total oil importation among Asian nations. Additionally, the crude oil volatility index (OVX), published by Chicago Board of Options Exchange (CBOE), is used in the research to measure the oil market volatility. The sample data

covers a period of 10 years from May 2007 to December 2017. This sample period is to satisfy the availability of all indices. All the data is downloaded from the DataStream database. Returns of stock and oil markets are calculated as follows: $R_{i,t} = 100 \times [\log(P_{i,t}) - \log(P_{i,t-1})]$; where $R_{i,t}$ is the log return of market index i between time t–1 and t, $P_{i,t}$ is the index price of market i at time t.

Table 1. Descriptive statistics and unit root tests

	Mean	Std. error	Skewness	Kurtosis	ADF	PP
MSCI Indonesia	0.009455	0.791172	-0.241701	7.714645	-47.2575**	-47.2491**
MSCI Malaysia	0.000339	0.440375	-0.383373	8.429915	-47.8484**	-47.8748**
MSCI Philippines	0.010785	0.636541	-0.608473	7.327920	-47.4126**	-47.3201**
MSCI Singapore	0.000494	0.579901	-0.173159	6.289586	-51.6816**	-51.7150**
MSCI Thailand	0.013139	0.668183	-0.414979	7.482530	-51.3368**	-51.3971**
MSCI Vietnam	-0.009487	0.674576	-0.159209	1.507027	-42.6015**	-42.6525**
Dubai Crude Oil	0.000002	0.010124	-0.030461	4.094093	-58.7213**	-58.5775**
OVX	-0.003744	2.057395	0.674917	13.19253	-58.2659**	-58.4820**

Notes: ** indicates the significant level of 5%.

The descriptive statistics for the variables employed the research are shown in table 1. Generally, the index returns have positive means except the return of MSCI Vietnam. MSCI Thailand and MSCI Philippines exhibit the better performance among six markets during the investigated period with the higher mean of daily returns. Generally, the stock index returns present greater volatility than the crude oil return series which has smaller value in standard error. Negative skewness in most return series illustrates that negative return accounts for the large proportion among whole sample while the positive daily increase is more common for the OVX during examined period.

Empirical analysis models employed in the research are based on stationary process. Therefore, it is crucial to know whether the return series investigated are integrated of order zero. Before finding the relationship between oil and stock markets, unit root tests are used to test the hypothesis of presentation of unit root in time series. In this research, the Augmented Dicke-Fuller (ADF) test and Phillips-Perron (PP) test are utilized for checking the sample. The results of unit root tests are shown in some last columns of

tabel1. The null hypotheses of unit root in the ADF and PP tests are both rejected at significant level of 5%. In overall, we could conclude that all return series in the research are significantly stationary and proceed with the time series model analysis.

4. Methodology

The Exponential GARCH model, proposed by Nelson (1991), is employed in this research to investigate the impact of oil price and its volatility on Southeast Asian stock markets. The mean equation for each stock return series can be expressed as follows:

$$R_{i,t} = \mu_i + \varphi_{1,i} R_{i,t\text{-}1} + \varphi_{2,i} RO_{t\text{-}1} + \varphi_{3,i} D_t RO_{t\text{-}1} + \varepsilon_{i,t} \quad (1)$$

where $R_{i,t}$ is the log return of stock market index i between time t and t -1, μ_i is a long-term drift coefficient, RO_t is the log return of oil price index between time t and t–1, D is dummy variable (D = 1 if $RO_t > 0$, D = 0 otherwise), and εi,t is error term for the return of series i at time t, which is assumed to be:

$$\varepsilon_{i,t} = \sqrt{h_{i,t}}\, zi,t \qquad zi,\ t \sim i.i.d.\ (0,1) \quad (2)$$

$$\log(h_{i,t}) = \omega_i + \frac{\alpha_i \left|\varepsilon_{i,t\text{-}1}\right| + \delta_i \varepsilon_{i,t\text{-}1}}{\sqrt{h_{i,t\text{-}1}}} + \beta_i \log(h_{i,t\text{-}1}) + \gamma_i OVX_{t\text{-}1} \quad (3)$$

The equation (3) is a modified EGARCH (1,1) variance function, in which the OVX, as the proxy for oil volatility, is added into the model for investigating the impact of oil uncertainty on stock price return and volatility.

The research is further consolidated by applying GARCH-jump model to analyse the relationship between oil and stock markets. While most GARCH-family models only take into account the effect of smooth changes in volatility, the mixed GARCH-jump model with autoregressive conditional jump intensity (ARJI) developed by Chan & Maheu (2002b) is proved to have considerable improvement in volatility forecast, especially during the extreme fluctuation period of stock return. The GARCH-jump model utilized in the research assumes the following form:

$$R_{i,t} = \tau_i + \psi_{1,i} R_{i,t\text{-}1} + \psi_{2,i} RO_{t\text{-}1} + \psi_{3,i} \Delta OVX_{t\text{-}1} + \varepsilon_{i,t} \quad (4)$$

where $R_{i,t}$ is the log return of stock market index i between time t–1 and t, ROt is the log return of oil price index between time t and t–1, $\Delta OVXt = 100 \times [\log(OVXt) - \log(OVX_{t-1})]$, the error term $\varepsilon_{i,t}$ at time t comprises two components $\varepsilon_{i,t} = \varepsilon_{1i,t} + \varepsilon_{2i,t}$.

The first component $\varepsilon_{1i,t}$ is the normal innovation which has mean of zero and follows normal stochastic process,

$$\varepsilon 1i,\ t = \sigma i,tzi,t \qquad zi,t \sim i.i.d.\ (0,\ 1) \tag{5}$$

$$\sigma_{i,t}^2 = \omega_i' + \alpha_i'\varepsilon_{1i,t\text{-}1}^2 + \beta_i'\sigma_{i,t\text{-}1}^2 \tag{6}$$

where $\omega' > 0$, $\alpha' \geq 0$, $\beta' \geq 0$ to guarantee the positivity of $\sigma_{i,t}^2$.

The second component $\varepsilon_{2i,t}$ is the jump innovation describing abnormal price movement with a mean of zero. The jump innovation is defined as the difference between the jump component and the expected total jump size between t–1 and t:

$$\varepsilon_{2i,t} = \sum_{k=1}^{n_t} Y_{it,k} - \theta\lambda_{i,t} \qquad Y_{it,k} \sim N(\theta,\ d^2) \tag{7}$$

where $Y_{it,k}$ denotes the jump size, $\sum_{k=1}^{n_t} Y_{it,k}$ refers the jump component, n_t is the number of jumps. The distribution of n_t is assumed to be Poisson with an a utoregressive conditional jump intensity parameter λ_t given by:

$$\lambda_{i,t} = \lambda_{0i} + \rho_i\lambda_{i,t\text{-}1} + \nu_i\xi_{i,t\text{-}1} \tag{8}$$

where λ_t is the time-varying expected number of jumps at time t on a given information set, $\lambda_{i,t} > 0$, $\lambda_{0i} > 0$, $\rho_i > 0$, $\nu_i > 0$.

5. Empirical analysis

5.1 Findings of modified EGARCH (1,1) model

As can be seen from the table 2 and table 3, the oil index return significantly and positively impacts the stock returns in all six nations considered from 2007 to 2017. The estimated coefficient for the effect of Dubai crude oil price movement on stock return seems to be higher for Singapore and Thailand, and lower for Vietnam. Across six countries, the estimates for dummy variable are all negative, implying that the negative shocks on oil market has more considerable impact on stock returns in Southeast Asia.

However, the significant evidences are found only in Malaysia, Philippines, and Vietnam. In terms of Indonesia and Singapore, the asymmetric effects are found but not consolidated. For Thailand market, there is no significant difference between the impact of positive and negative oil price shocks to stock return.

Table 2. Effects of crude oil return and OVX Southeast Asian stock markets

	Indonesia		Malaysia		Philippines	
μ	-0.0009	0.0167	0.0006	0.0179**	0.0110	0.0300**
	(0.93)	(0.19)	(0.93)	(0.03)	(0.25)	(0.02)
φ_1	0.0684***	0.0662***	0.1015***	0.0990***	0.0642***	0.0659***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
φ_2	0.0694***	0.0988***	0.0678***	0.1010***	0.0529***	0.0847***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
φ_3		-0.0558***		-0.0598***		-0.0628**
		(0.00)		(0.00)		(0.01)
ω	-0.1149***	-0.1179***	-0.1916***	-0.2011***	-0.1423***	-0.1457***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
α	0.1336***	0.1342***	0.1660***	0.1698***	0.1468***	0.1464***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
β	0.9863***	0.9863***	0.9744***	0.9736***	0.9776***	0.9790***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
δ	-0.0721***	-0.0726***	-0.0675***	-0.0668***	-0.0822***	-0.0831***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
γ	0.0002	0.0002	0.0005*	0.0006*	0.0001	0.0002
	(0.32)	(0.21)	(0.10)	(0.06)	(0.47)	(0.15)

Note: ***, **, and * indicate the significant level of 1%, 5%, and 10% respectively.

Regarding oil volatility, the results reveal that the influence of OVX on stock return volatility is relatively small with the significant level of only 10% for almost half of all markets investigated. The magnitude of transmission is relatively small in the comparison with other estimated coefficients. While the fluctuation on oil market might initiate the volatility in stock returns in Malaysia, Singapore, and Vietnam; there is no significant evidence that the OVX predicts the level of uncertainty on Indonesian, Philippian, and Thai

markets. It seems that Singapore, Malaysia, and Vietnam are more sensitive to the movements of international oil price with the higher magnitude of oil-related coefficients in mean and variance equations.

Table 3. Effects of crude oil return and OVX on Southeast Asian stock markets

	Singapore		Thailand		Vietnam	
μ	-0.0007	0.0102	0.0249***	0.0394***	-0.0076	0.0414***
	(0.92)	(0.19)	(0.00)	(0.00)	(0.21)	(0.00)
φ_1	0.0360*	0.0335***	0.0462**	0.0478**	0.1546***	0.1512***
	(0.08)	(0.00)	(0.01)	(0.01)	(0.00)	(0.00)
φ_2	0.0927***	0.1118***	0.0885***	0.1132***	0.0179*	0.0641***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.09)	(0.00)
φ_3		-0.0399**		-0.0483		-0.0995***
		(0.01)		(0.50)		(0.00)
ω	-0.1354***	-0.1375***	-0.1468***	-0.1500***	-0.2510***	-0.2662***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
α	0.1253***	0.1253***	0.1676***	0.1673***	0.2340***	0.2425***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
β	0.9854***	0.9855***	0.9859***	0.9856***	0.9528***	0.9495***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
δ	-0.0780***	-0.0780***	-0.0630***	-0.0639***	-0.0265**	-0.0232*
	(0.00)	(0.00)	(0.00)	(0.00)	(0.01)	(0.06)
γ	0.0004*	0.0005**	0.0001	0.0001	0.0006*	0.0007*
	(0.06)	(0.04)	(0.80)	(0.50)	(0.09)	(0.08)

Note: ***, **, and * indicate the significant level of 1%, 5%, and 10% respectively.

Additionally, the estimation results indicate the considerable dependence of current equity return on lagged value, as evidenced by the significant estimates of coefficient $R_{i,t-1}$ in all six markets. Moreover, the negative values of coefficient δ imply that the previously negative shocks seem to have greater impact on volatility than the positive one. The positive and significant values of estimation for coefficient $|\varepsilon_{i,t-1}|$ and $\log(h_{i,t-1})$ generally suggest that the volatility on Southeast Asian markets is affected by its own shock and volatility.

5.2 Findings of GARCH-Jump model

Table 4. Estimated results of GARCH-jump models for Indonesia, Malaysia, and Philippines

	Indonesia		Malaysia		Philippines	
	constant	ARJI	constant	ARJI	constant	ARJI
μ	0.0359***	0.0329***	0.0105*	0.0123**	0.0378***	0.0388***
	(0.00)	(0.00)	(0.08)	(0.04)	(0.00)	(0.00)
ψ_1	0.0390**	0.0415**	0.0967***	0.0976***	0.0779***	0.0647***
	(0.04)	(0.03)	(0.00)	(0.00)	(0.00)	(0.00)
ψ_2	0.0520***	0.0481***	0.0529***	0.0546***	0.0380***	0.0393***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
ψ_3	-0.0208***	-0.0195***	-0.0103***	-0.0092***	-0.0127***	-0.0107**
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.03)
ω'	0.0042**	0.0004*	0.0009**	0.0003**	0.0054***	0.0037***
	(0.01)	(0.05)	(0.03)	(0.01)	(0.00)	(0.00)
α'	0.0800***	0.0034***	0.0585***	0.0082***	0.0901***	0.0338***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
β'	0.8747***	0.9901***	0.9238***	0.9828***	0.8749***	0.9366***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
θ	-0.1941**	-0.1008***	-0.1129	-0.0550*	-0.3687*	-0.2509**
	(0.02)	(0.00)	(0.29)	(0.07)	(0.05)	(0.01)
d^2	0.9872***	0.9678***	0.7556***	0.5676***	0.8178***	0.8228***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
λ_0	0.1482***	0.0184***	0.0514*	0.0139***	0.0724	0.0135**
	(0.00)	(0.00)	(0.08)	(0.00)	(0.15)	(0.02)
ρ		0.9443***		0.9389***		0.9132***
		(0.00)		(0.00)		(0.00)
ν		0.5114***		0.5364***		0.5352***
		(0.00)		(0.00)		(0.00)
Log Likelihood	-2682.80	-2651.29	-1156.29	-1128.60	-2223.22	-2205.91

Note: ***, **, and * indicate the significant level of 1%, 5%, and 10% respectively.

In line with the findings in previous section, the oil price movement positively affects stock market returns in Southeast Asian region. The estimates of oil return coefficient are significant at the 1% level in all models and for most markets analysed, except for Vietnam. An increase in oil price might lead to push up economic cost but this is also a sign of the growth in total demand, resulting the positive fluctuation on stock markets. In contrast, the effect of OVX on stock return is negative, as evidenced by the significant and negative estimated coefficient for Indonesia, Malaysia, Philippines, Singapore, and Thailand. This results are similar to the study on 23 emerging markets of Dutta et al. (2017) which also finds negative impact of OVX on stock returns. Possible explanations could be that the higher oil price volatility implies the increase of uncertainty and risk level in economic activities, leading to the change of expected returns on stock markets. For Vietnam, after controlling OVX return, the movements of Dubai crude oil price have no significant impact on stock market. The estimated coefficients for oil index return in GARCH-jump models for Vietnam are only significant at the 10% level. Among six countries investigated, the stock market of Vietnam is smallest in terms of capitalization and is the most recently established. Therefore, Vietnamese stock market seems to be less integrated into global financial system and less sensitive to global shocks. As a developed financial market, Singapore, by contrast, exhibits more sensitive to fluctuation of oil price index, with the highest magnitude of estimated value for oil return parameter.

Table 5. Estimated results of GARCH-jump models for Singapore, Thailand, and Vietnam

	Singapore		Thailand		Vietnam	
	constant	ARJI	constant	ARJI	constant	ARJI
μ	0.0314***	0.0320***	0.0371***	0.0355***	0.0241**	0.0277**
	(0.00)	(0.00)	(0.00)	(0.00)	(0.02)	(0.01)
ψ_1	0.0246	0.0217	0.0387**	0.0144	0.1397***	0.1323***
	(0.19)	(0.27)	(0.04)	(0.40)	(0.00)	(0.00)
ψ_2	0.0755***	0.0752***	0.0609***	0.0498***	0.0179*	0.0190*
	(0.00)	(0.00)	(0.00)	(0.00)	(0.08)	(0.07)
ψ_3	-0.0197***	-0.0194***	-0.0173***	-0.0200***	-0.0022	-0.0013
	(0.00)	(0.00)	(0.00)	(0.00)	(0.64)	(0.78)
ω'	-0.0006	-0.0006	0.0007	0.0005**	0.0030	0.0028**
	(0.17)	(0.14)	(0.19)	(0.03)	(0.10)	(0.04)
α'	0.0741***	0.0720***	0.0769***	0.0156**	0.1444***	0.1098***
	(0.00)	(0.00)	(0.00)	(0.01)	(0.00)	(0.00)
β'	0.9141***	0.9164***	0.9066***	0.9674***	0.8160***	0.8484***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
θ	-0.0978**	-0.1001**	-0.1363*	-0.0439**	-0.1140**	-0.1115**
	(0.02)	(0.01)	(0.05)	(0.01)	(0.02)	(0.01)
d^2	0.3393***	0.3382***	0.6921***	0.5208***	0.5236***	0.4950***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
λ_0	0.2997**	0.3690*	0.1298***	0.0280***	0.2522**	0.1295**
	(0.02)	(0.07)	(0.00)	(0.00)	(0.01)	(0.03)
ρ		-0.2126		0.9591***		0.6369***
		(0.65)		(0.00)		(0.00)
ν		0.2222		0.6335***		0.6865**
		(0.22)		(0.00)		(0.04)
Log Likelihood	-1626.37	-1625.51	-2230.89	-2225.80	-2368.73	-2365.91

Note: ***, **, and * indicate the significant level of 1%, 5%, and 10% respectively.

As shown in the table 4 and table 5, the GARCH parameters are all significant at the 1% level and satisfied with the requirement of non-negativity. The results confirm the GARCH effect in all Southeast Asian stock market returns with high degree of persistence in conditional volatility. Additionally, the impact of previous return on current movement is found in five out of six markets analysed, as evidenced by the significant estimated coefficient for $R_{i,t-1}$. In terms of jump parameters, the existence of jumps is found in most markets and the jump is time-varying. The mean parameter θ of jump is significant at the 5% level for Indonesia, Philippines, Singapore, Thailand, and Vietnam; at the 10% level for Malaysia. The variance parameter d^2 of jump is all significant at the 1% level. It is observed that coefficient of jump variance is positive in all markets, implying that volatility driven by abnormal information has a positive impact on the volatility of stock returns (Fowowe, 2013). Furthermore, the jump intensity parameters (λ_0, ρ, ν) are significant in most of investigated markets at the 1% level, suggesting that the jumps exist in Southeast Asian market returns with the time-varying characteristic. For Singapore, the parameter λ_0 is only significant at the level of 10% while parameters ρ and ν are insignificant. This result indicates the jump does exist in Singapore market but is not time-varying, leading a conclusion that Singapore stock market seems to be more stable compared to others in the research. Moreover, the high and positive estimates of ρ and ν show that the most recent intensity ($\lambda_{i,t-1}$) and intensity residual ($\xi_{i,t-1}$) strongly influence the current jump intensity ($\lambda_{i,t}$), which has a high degree of persistence (Dutta et al., 2017).

6. Conclusion

The main purpose of the research is to explore the connection between international oil indices and Southeast Asian stock markets. In the study, besides using EGARCH model, the GARCH-jump models are employed to capture the movement of stock returns. The findings confirm the significant impacts of oil price fluctuations on stock markets, especially for six markets investigated. In five emerging and frontier markets, namely Indonesia, Malaysia, Philippines, Thailand, and Vietnam, the magnitude of the impact of oil price return on stock markets is as high as in the developed market in the region, Singapore.

The outcomes consolidate the value of the implied crude oil volatility index in explaining the fluctuations on stock markets. While the changes of oil price have positive effect on Southeast Asian stock returns, those of OVX are negative, implying that the increase in level of uncertainty future oil prices leads to negative fluctuation on stock markets. By adding OVX in variance functions of EGARCH model, the research also analyses whether the volatility is transmitted from oil market to stock returns, but the transmission is relatively weak.

The study further reports the existence of GARCH effects in Southeast Asian stock markets, suggesting the current conditional volatility of return is affected by the previous shock and its past volatility. Besides, the results from EGARCH models illustrate the previously negative shocks seem to have greater effects on the current volatility of stock returns in Southeast Asian countries than the positive one. Moreover, the jump effects are found in most markets, as evidenced by the estimates for GARCH-jump models. Generally, the volatility driven by abnormal information positively affects the volatility of returns while the jump behaviour has negative impact on returns in the Southeast Asian markets.

In overall, the outcomes of research suggest the significant interaction between the Southeast Asian stock markets and the global oil indices. Besides confirming the oil-stock markets relationship, the study indicated the negative influences of oil volatility shocks on stock market returns in Southeast Asian countries. The results of empirical analysis could be utilized in improving the prediction of stock price movements, forming a proper investment decision. Furthermore, the stock return volatility investigations in this study also support developing a diversified portfolio and enhancing risk management activities when the linkages between some new markets in Southeast Asian region and the global markets are deeply comprehended.

References

Alsalman, Z. (2016). Oil price uncertainty and the U.S. stock market analysis based on a GARCH-in-mean VAR model. *Energy Economics*, *59*, 251-260. https://doi.org/10.1016/j.eneco.2016.08.015

Arouri, M. E. H., Lahiani, A., & Nguyen, D. K. (2011). Return and volatility transmission between world oil prices and stock markets of the GCC countries. *Economic Modelling*, *28*(4), 1815-1825. https://doi.org/10.1016/j.econmod.2011.03.012

Basher, S. A., & Sadorsky, P. (2006). Oil price risk and emerging stock markets. *Global Finance Journal*, *17*(2), 224-251. https://doi.org/10.1016/j.gfj.2006.04.001

Bouri, E. (2015). Return and volatility linkages between oil prices and the Lebanese stock market in crisis periods. *Energy*, *89*, 365-371. https://doi.org/10.1016/j.energy.2015.05.121

Caporale, G. M., Menla Ali, F., & Spagnolo, N. (2014). Oil price uncertainty and sectoral stock returns in China: A time-varying approach. *China Economic Review*, *34*, 311-321. https://doi.org/10.1016/j.chieco.2014.09.008

Chan, W. H., & Maheu, J. M. (2002). Conditional Jump Dynamics in Stock Market Returns. *Journal of Business & Economic Statistics*, *20*(3), 377-389. https://doi.org/10.1198/073500102288618513

Chiang, I. H. E., & Hughen, W. K. (2017). Do oil futures prices predict stock returns? *Journal of Banking and Finance*, *79*, 129-141. https://doi.org/10.1016/j.jbankfin.2017.02.012

Ciner, C. (2001). Energy Shocks and Financial Markets: Nonlinear Linkages. *Studies in Nonlinear Dynamics and Econometrics*, *5*(3), 203-212. https://doi.org/10.2202/1558-3708.1079

Ciner, C. (2013). Oil and stock returns: Frequency domain evidence. *Journal of International Financial Markets, Institutions and Money*, *23*(1), 1-11. https://doi.org/10.1016/j.intfin.2012.09.002

Diaz, E. M., Molero, J. C., & Perez de Gracia, F. (2016). Oil price volatility and stock returns in the G7 economies. *Energy Economics*, *54*, 417-430. https://doi.org/10.1016/j.eneco.2016.01.002

Driesprong, G., Jacobsen, B., & Maat, B. (2008). Striking oil: Another puzzle? *Journal of Financial Economics*, *89*(2), 307-327. https://doi.org/10.1016/j.jfineco.2007.07.008

Dutta, A. (2018). Oil and energy sector stock markets: An analysis of implied volatility indexes. *Journal of Multinational Financial Management*, *44*, 61-68. https://doi.org/10.1016/j.mulfin.2017.12.002

Dutta, A. (2018). Modeling and forecasting the volatility of carbon emission market: The role of outliers, time-varying jumps and oil price risk. *Journal of Cleaner Production*, *172*, 2773-2781. https://doi.org/10.1016/j.jclepro.2017.11.135

Dutta, A., Nikkinen, J., & Rothovius, T. (2017). Impact of oil price uncertainty on Middle East and African stock markets. *Energy*, *123*, 189-197. https://doi.org/10.1016/j.energy.2017.01.126

Dutta, P., Noor, M. H., & Dutta, A. (2017). Impact of oil volatility shocks on global emerging market stock returns. *International Journal of Managerial Finance*, *13*(5), 578-591. https://doi.org/10.1108/IJMF-03-2017-0039

Arouri, M. E. H., Jouini, J., & Nguyen, D. K. (2011). Volatility spillovers between oil prices and stock sector returns: Implications for portfolio management. *Journal of International Money and Finance, 30*(7), 1387-1405. https://doi.org/10.1016/j.jimonfin.2011.07.008

Fowowe, B. (2013). Jump dynamics in the relationship between oil prices and the stock market: Evidence from Nigeria. *Energy, 56*, 31-38. https://doi.org/10.1016/j.energy.2013.04.062

Huang, R. D., Masulis, R. W., & Stoll, H. R. (1996). Energy shocks and financial markets. *Journal of Futures Markets, 16*(1), 1-27. https://doi.org/10.1002/(SICI)1096-9934(199602)16:1<1::AID-FUT1>3.0.CO;2-Q

Jones, C. M., & Kaul, G. (1996). Oil and the Stock Markets. *The Journal of Finance, 51*(2), 463. https://doi.org/10.2307/2329368

Kilian, L., & Park, C. (2009). The Impact of Oil Price Shocks on the U.S. Stock Market. *International Economic Review, 50*(4), 1267-1287. https://doi.org/10.1111/j.1468-2354.2009.00568.x

Lee, Y.-H., & Chiou, J.-S. (2011). Oil sensitivity and its asymmetric impact on the stock market. *Energy, 36*(1), 168-174. https://doi.org/10.1016/j.energy.2010.10.057

Lu, F., Qiao, H., Wang, S., Lai, K. K., & Li, Y. (2017). Time-varying coefficient vector autoregressions model based on dynamic correlation with an application to crude oil and stock markets. *Environmental Research, 152*, 351-359. https://doi.org/10.1016/j.envres.2016.07.015

Luo, X., & Qin, S. (2017). Oil price uncertainty and Chinese stock returns: New evidence from the oil volatility index. *Finance Research Letters, 20*, 29-34. https://doi.org/10.1016/j.frl.2016.08.005

Maghyereh, A. I., Awartani, B., & Bouri, E. (2016). The directional volatility connectedness between crude oil and equity markets: New evidence from implied volatility indexes. *Energy Economics, 57*, 78-93. https://doi.org/10.1016/j.eneco.2016.04.010

Malik, F., & Ewing, B. T. (2009). Volatility transmission between oil prices and equity sector returns. *International Review of Financial Analysis, 18*(3), 95-100. https://doi.org/10.1016/j.irfa.2009.03.003

Nelson, D. B. (1991). Conditional Heteroskedasticity in Asset Returns: A New Approach. *Econometrica, 59*(2), 347. https://doi.org/10.2307/2938260

Noor, M. H., & Dutta, A. (2017). On the relationship between oil and equity markets: evidence from South Asia. *International Journal of Managerial Finance*, *13*(3), 287-303. https://doi.org/10.1108/IJMF-04-2016-0064

Park, J., & Ratti, R. A. (2008). Oil price shocks and stock markets in the U.S. and 13 European countries. *Energy Economics, 30*(5), 2587-2608. https://doi.org/10.1016/j.eneco.2008.04.003

Sadorsky, P. (1999). Oil price shocks and stock market activity. *Energy Economics, 21*(5), 449-469. https://doi.org/10.1016/S0140-9883(99)00020-1

Zhang, C., & Chen, X. (2011). The impact of global oil price shocks on China's stock returns: Evidence from the ARJI(-ht)-EGARCH model. *Energy, 36*(11), 6627-6633. https://doi.org/10.1016/j.energy.2011.08.052