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The Asymmetric Relationship Between Oil Price Fluctuation on Exchange Rate Variation: Empirical Evidence from Malaysia and Thailand

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Abstract

The purpose of this study is to investigate the effects of oil price fluctuations on exchange rate variations, particularly for Malaysia and Thailand. The study utilizes monthly observation data from 1994 to 2021 and uses structural breaks, cointegration relationships, and Nonlinear Autoregressive Distributed Lag (NARDL) estimates. Both countries had distinct long- and short-term relationships, but there was also an asymmetric relationship between oil prices and multilateral exchange rates revealed by the study. The asymmetric and non-asymmetric causality relationship for both countries indicate a unidirectional non-asymmetric causality between the oil price and the exchange rate variation. The empirical findings will be of great assistance to policymakers in evaluating global oil price fluctuations as a crucial indicator for monitoring and stabilizing currencies as a long-term monetary policy strategy.

Keywords: asymmetric, exchange rate, NARD estimates, oil price

JEL: C50, E60

1. Introduction

Crude oil is an important energy source in the world, especially in oil producing countries, as the main source of national income and a catalyst for economic growth and development. The unstable variation of the crude oil price can affect society, producers, manufacturing industries, and the economic performance of a country due to changes in the average spending cost (Cavalcanti and Jalles, 2013). In general, crude oil prices are determined by market forces, and the exchange rate plays a crucial role in determining the value of crude oil, whether it is overvalued, undervalued, or vice versa.

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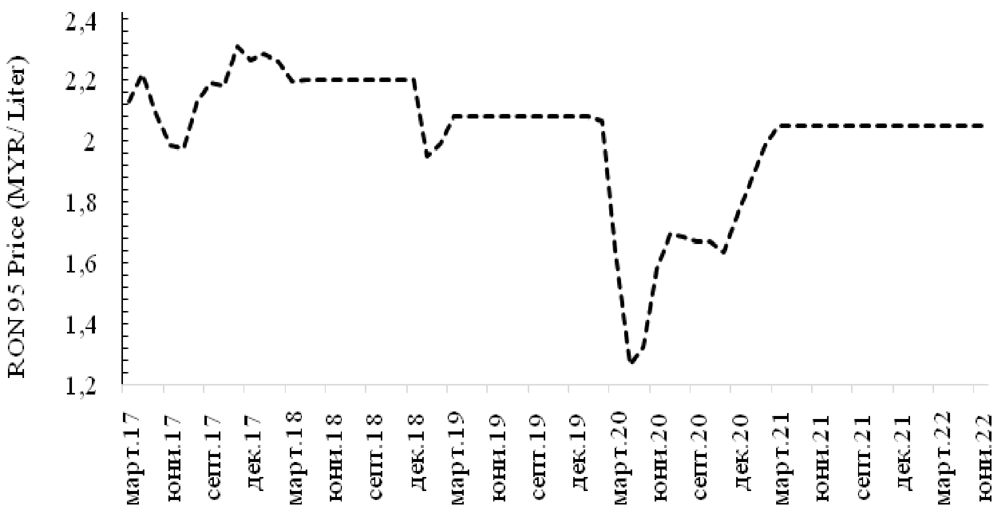
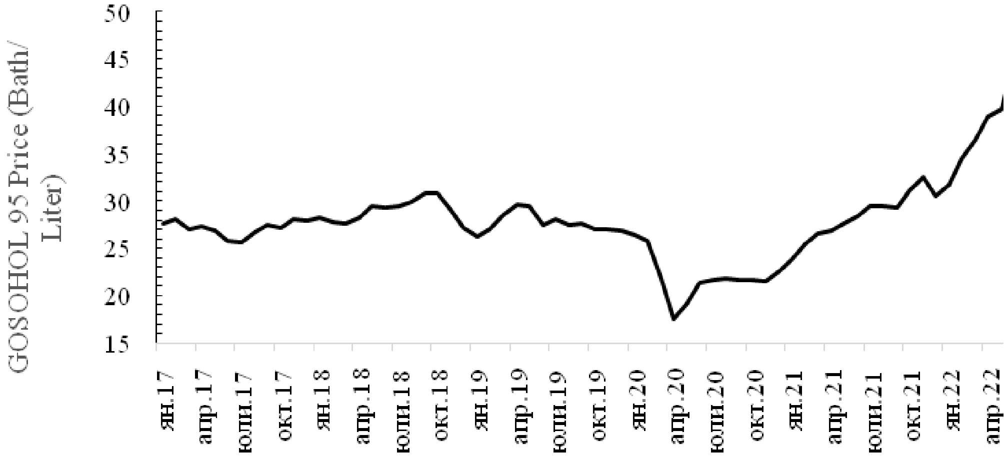
According to Golub (1983), oil prices influence the real exchange rate of those countries by influencing the asymmetries effect between economic performance and the direction of wealth relocating of the country.

Due to this dynamic relationship, several researchers have attempted to analyze the correlation between oil price changes and exchange rate fluctuations since the 1970 oil price shocks (see Haug and Basher, 2019; Bal and Rath, 2015; Nikbakht, 2010; Chen and Chen, 2007). There are few studies that have demonstrated an existing relationship in terms of cointegration relationship, asymmetric effect, and causality direction (Kisswani, 2021; Basher et al., 2016; Fratzscher et al., 2014; Lizardo and Mollick, 2010; Akram, 2004; Amano and Van Norden, 1998). Malaysia and Thailand were identified by O'Neil et al. (2005) and Burkett and Hart-Landsberg (1998) as the countries that recovered fastest from the Asian Financial Crises in 1997. Moreover, both countries are oil-producing countries in the region and have recorded the same decline trend in export value, production quantity, and local fuel prices. Figures 1 and 2 indicate that the fuel prices of these two countries are markedly different. Figures 3 and 4 show that both countries have distinct oil production capacities from 2010 to 2020. It is undoubtedly true that the oil price shocks have damaged the wave of development and undermined the planned strategies for both countries' economic growth performance, as explained by Kisswani, (2021), Chang, and Wong (2003), and Glasure and Lee (2002).



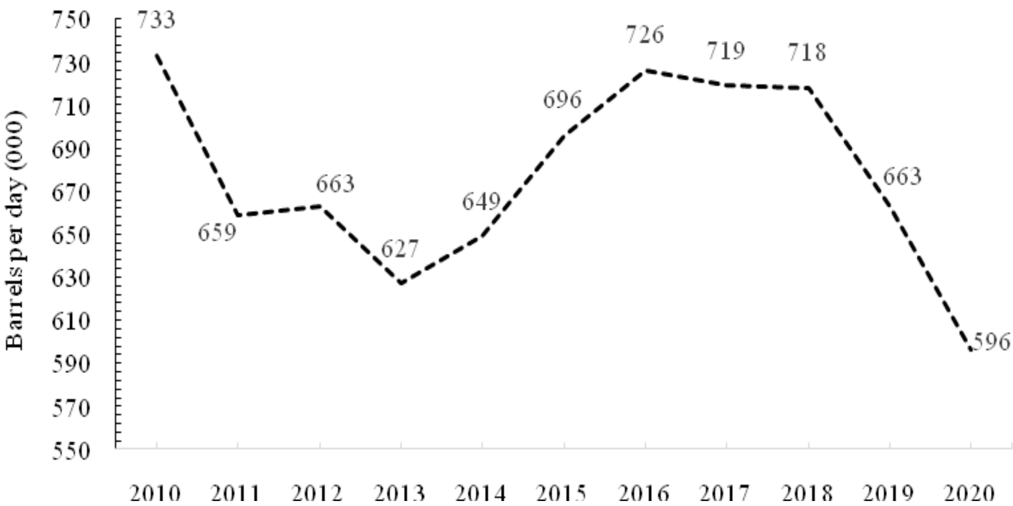
Source: Ministry of Finance Malaysia (2022)

Figure 1. RON 95 fuel prices trends in Malaysia from 2017 to 2022.



Source: Bank of Thailand (2022)

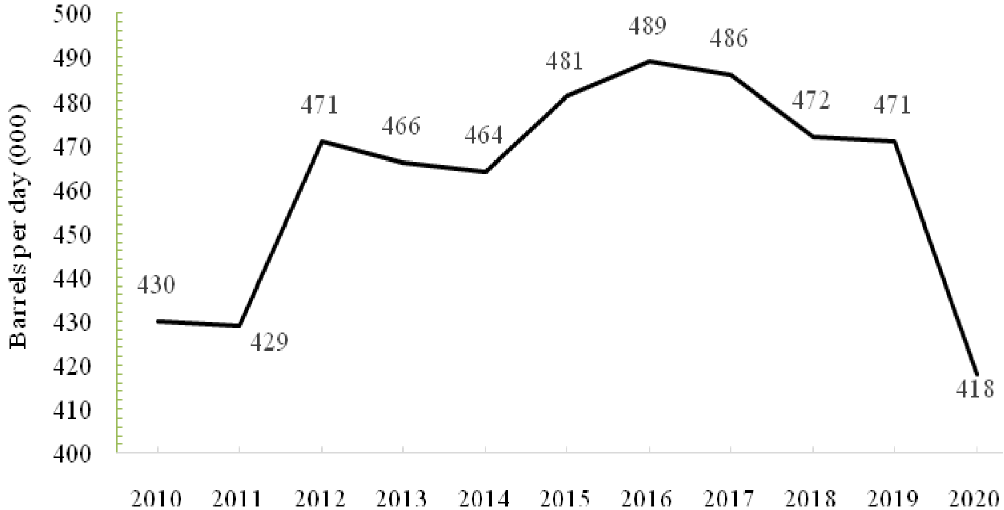
Figure 2. GOSOHOL 95 fuel price trends in Thailand from 2017-2022



Source: International Monetary Fund (2022)

Figure 3. Average oil production of thousands of barrels/per days in Malaysia from 2010-2020

According to Kocaarslan and Soytas (2019), the nonlinearity issue with oil prices may be arising due to data generating issues, regime shifts, and the effect of time-varying coefficients. While Alqaralleh (2020), Brahmasrene et al. (2014), Tiwari et al. (2013), Benhmad (2012), and Akram (2004) postulate that, the nonlinearity of oil price and exchange rate are more likely to stem from the asymmetric properties of their determinants. By adopting asymmetric responses, both positive and negative aspects in the series can be considered and analysed more effectively. Previous studies have hypothesized that the exchange rate has symmetrically reacted to oil price shocks to gain insight into the impact of oil price variations on economic stability. Therefore, an extensive study should consider



Source: International Monetary Fund (2022)

Figure 4. Average oil production of thousands of barrels/per days in Thailand from2010-2020

the asymmetric cointegration and symmetric responses due to the variation of oil prices, which impact exchange rate variation.

The structure of the paper is as follows. Section 2 overviews the literature review of past findings on the relationship between oil prices and exchange rate variations. The data and empirical strategies employed in this study are described in Section 3. Section 4 contains the empirical estimation results and discussions, and Section 5 is where the concluding remarks are presented.

2. Literature Review

The imbalance concentration of surpluses and deficits among the oil exporting countries was significantly influenced by the fluctuation of oil prices, as discussed by Narayan (2013); Lizardo and Mollick (2010). Kisswani et al. (2019) assert that most previous studies that focused on linear analysis have yielded mixed and inconclusive results on the relationship between oil prices and exchange rates. Moreover, Baba and Lee (2022), Bodenstein and Guerrieri (2011), and Kilian (2009) indicate that the fluctuation effect of global oil prices has been possibly driven by different shocks through the international market forces based on demand and supply and trade barrier condition which have resulted from a different impact on the countries macroeconomic variables. The impact of oil price fluctuation on the exchange rate is both positive and negative, depending on the country characteristics and market conditions of Asian countries, as revealed by Nusair and Olson (2019).

During the bullish market for Asian domestic currencies, positive oil prices resulted in an appreciation of the currencies of Indonesia, South Korea, the Philippines, and Thailand. During the bearish market for domestic currencies, positive oil price volatility has resulted in depreciation, which has a constrained effect on Indonesia's currency and an inverse effect on Malaysia's currency. Thus, the currencies responded differently to the oil price fluctuation and had an asymmetrical effect on the bilateral relationship. The relationship between competitiveness exchange rate and oil prices for oil-exporting countries is influenced by the different exchange rate regime, as shown by Lv et al. (2018). Akram (2004) proved that the relationship between the exchange rate and oil prices in Norwegian samples is influenced by monetary policy, specifically the exchange rate regime.

Moreover, Habid et al. (2016) assert that there is no significant evidence indicating that the oil exporter currencies grew in value compared to the oil importer currencies in the event of a shock in oil prices. Iwayemi and Fowowe (2011), and Rautava (2004) also indicate that there is no significant correlation between oil prices and exchange rates. Huang and Guo (2007) demonstrated that genuine oil price disturbances are only capable of increasing China's long-term competitiveness by a small percentage. Reboredo (2012) has discovered that the relationship between oil prices and exchange rates is usually weak, and it can be a complicated causal relationship that is asymmetric according to the frequency and time frame. A complex causal relationship existed between real oil prices in US dollars, as found by Benhmad (2012), and it shifted over time.

Tiwari et al. (2013) found a causal relationship only at the higher time scale when studying the relationship between oil prices and exchange rates in India. The time-varying causality of these variables, particularly during the crisis, was found by Kocoglu et al. (2022) and Albulescu, and Ajmi (2021), as well. In theory, there are only a few major pathways that could potentially transfer the oil price shock to the exchange rate (Buetzer et al., 2012). First, the trade-in goods are the primary focus of the term of trade, while non-traded goods are not. Additionally, changes to portfolio allocations are necessary to rectify the effects of wealth, trade balances, and portfolio allocation related to wealth.

Several studies concluded a theoretical transmission mechanism between oil prices and exchange based on different channels; the term of the trade (Chen and Chen, 2007; Amano and Van Norden, 1998; Corden and Neary 1982), the term of wealth effects (Golub, 1983) and asset pricing theory (Chen et al., 2010; Akram, 2009; Frankel, 2006). Zhang et al. (2016) determined through the transmission mechanism that active financial activities determine oil prices and the exchange rate, and these changes can be brief and swift in the market. Similarly, Beckmann et al. (2020) have concluded that the short-term bidirectional relationship between those variables is bidirectional. Baghestani and Toledo (2019) assume that the changes in oil prices accurately predict the direction of the exchange rate more than 3 months ahead when studying NAFTA countries. Lizardo and Mollick (2010) also found that real oil prices are the most important factor in predicting future exchange rate movements. Habid and Kalamova (2007) and Cashin et al. (2004) discovered that few countries studied have a significant connection between oil prices and competitiveness of exchange rates. Furthermore, Chen et al. (2010) validated the argument by demonstrating that commodity prices are competitive on the global market and have varied impacts on all countries, regardless of whether they are oil exporters or importers.

Gao et al. (2022) have revealed a positive correlation between oil prices and exchange rates, with a mixed causality effect for South Asian countries. In addition, Kisswani et al. (2019) also demonstrated a mixed causality, and Malaysia has experienced an asymmetrical impact. According to Alqaralleh

Table 1. Selected studies on causality relationship between oil prices and exchange rate

Author(s)	Time Span	Country	Estimation technique	Causality direction
Wang et al. (2022)	2008-2021	Belt and Road countries	EMD	OP cause ER
Butt et al. (2020)	1994-2017	Malaysia	TVECM	OP cause ER
Haug and Basher (2019)	1976-2014	Oil exporting countries	ARCH-GARCH	No causality
Singhal et al. (2019)	2006-2018	Mexico	ARDL	OP cause ER
Tran et al. (2019)	2005-2017	ASEAN countries	Markov Switching model	OP cause ER
Bhattacharya et al. (2019)	2000-2016	India	DCC-GARCH	OP cause ER
Ji et al. (2019)	2011-2017	China and US	CO-VAR	OP cause ER
Hussain et al. (2017)	2006-2016	Asian countries	DCCA	Weak relationship
De Vita and Trachanas (2016)	1994-2013	China and India	NARDL	Weak relationship
Bal and Rath (2015)	1994-2013	China and India	VAR-GARCH	Depend on country situation
Nikbakht (2010)	2000-2007	OPEC countries	Panel estimates	ER cause OP
Chen and Chen (2007)	1972-2005	G7 countries	Panel estimates	ER cause OP

Note: ER refer to exchange rate and OP indicate the oil price.

(2020), G-20 countries experience a mixed reaction to exchange rates and oil price fluctuations. The short-period fluctuation effect of oil prices has been validated by Gao et al. (2017), which shows a diverse dynamic characteristic of exchange rates for short-run periods. Thus, the risk associated with oil price fluctuation becomes greater, creating a complicated situation in forecasting future oil price fluctuations and relationships with other indicators. Zhang et al. (2018) provided evidence of the country's unique features and the time-series pattern that created a fluctuation in natural energy prices in Japan, the United States, and Germany. In summary, most previous studies have examined the relationship between exchange rates and oil prices, whether they are bilateral or multilateral exchange rates, by utilizing various econometric estimations. Although the primary finding was that exchange rates and oil prices had a relationship, the relationship results varied depending on the time frame, countries' characteristics, and other external factors. The following Table 1 shows the causal relationship between oil prices and exchange rates from various studies worldwide:

3. Methodology

This study uses monthly data covering 1994 until 2021 based on the available data for both Malaysia and Thailand. The data are composed of the multilateral exchange rate and the global price of Brent crude oil, which is measured as OPEC ($/bbl.) and has a constant price in 2000. The study determines the multilateral exchange rate by combining the weighted average of the real exchange rates of all trading partners in the country and comparing it to the indication of the real effective exchange rate (REER) in the domestic currency. The appreciation of the domestic currency and its purchasing power and competitiveness against trading partners' currencies can be observed through an increased value in the multilateral exchange rate. Data on multilateral exchange rates is available in the JP Morgan Database (2022). While the Bank of Thailand (2022), Ministry of Finance Malaysia (2022), and the International Monetary Fund (2022) provide data on oil prices.

To ensure that the variables used are free of stationary problems, we impose the unit root test as a first step. We carry out the Augmented Dickey-Fuller test (ADF) (1981) and the endogenous structural breaks based on Zivot and Andrew (ZA) (2002) unit root test since there is a multilateral exchange rate effect for Malaysia and Thailand which might have structure breaks consequence of changes in the exchange rate regime from the pegged regime to managed floating regime. The nonlinear stationarity effect with the tested variables in this study is captured using the nonlinear Fourier ADF unit root test.

To measure the long-term relationship between oil prices and the multilateral exchange rate during the sub-period of this study, it is necessary to apply the Gregory and Hansen (1996) cointegration test. The null hypothesis of no cointegration is rejected by this approach when the extension test of the estimation types is dependent on the existence of a cointegration relationship with the sub-sample. The GH cointegration test suggested three model specification alternatives that were able to withstand structural breaks that rejected the business's probability.

First, the level shift model only allows changes in the intercept, as shown in equation (1).

$$y_{1t} = \mu_1 + \mu_2\varphi_{t\tau} + \alpha' y_{2t} + \varepsilon_t \qquad t = 1, \dots, n \tag{1}$$

Secondly, the trend model accompanies the trends in the data and at the same time prevents a change in the level as presented in the equation (2).

$$y_{1t} = \mu_1 + \mu_2\varphi_{t\tau} + \beta_t + \alpha' y_{2t} + \varepsilon_t \qquad t = 1, \dots, n \tag{2}$$

Thirdly, the regime model specification allows for changes in both the intercept and slope of the cointegration vector, as shown below.

$$y_{1t} = \mu_1 + \mu_2\varphi_{t\tau} + \alpha' y_{1t} + \alpha_2' y_{2t}\varphi_{t\tau} + \varepsilon_t \qquad t = 1, \dots, n \tag{3}$$

Additionally, the dummy variable mentioned in the equations, which captures the structural alteration, can be presented as follows:

$$\varphi_{t\tau} = \begin{cases} 0, & t \le [n\tau] \\ 1, & t > [n\tau] \end{cases} \tag{4}$$

The $\varphi_{t\tau}$ and y_{2t}, are variables that are stationary at *I*(1), ε_t is an error term at the *I*(0), μ_n and α' are time-invariant and $\tau\varepsilon(0, 1)$ is the changes point of relative timing, which is normally taken to be (0.15n, 0.85n) interval. This GH cointegration approach computed the usual ADF and PP test statistics, denotes as $\mathrm{ADF}(\tau)$, $\mathrm{Z}_\alpha(\tau)$ and $\mathrm{Z}_t(\tau)$ for the possible existing breakpoints and choosing the smallest value which represents greater evidence in the long-run cointegration condition. Since the variables used in this study tend to have nonlinearities in the long-run relationship, we therefore implement the NARDL estimation proposed by Shin et al. (2014) using the following equations:

$$iv_t^+ = \sum_{j=1}^{t} \Delta iv_j^+ = \sum_{j=1}^{t} max\ (\Delta iv_j, 0) \quad (5)$$

$$iv_t^- = \sum_{j=1}^{t} \Delta iv_j^- = \sum_{j=1}^{t} min\ (\Delta iv_j, 0) \quad (6)$$

A general form for NARDL estimation specification can be written as:

$$\Delta REER_t = \alpha_0 + \beta_0 REER_{t-1} + \beta_1 Oil_t^+ + \\ + \beta_2 Oil_t^- + \sum^{p} \mu_i\ \Delta REER_{t-1} + \\ \sum_{i=1}^{Q} (\gamma_i^+ OIL_{t-i}^+ + \gamma_i^+ Oil_{t-i}^-) + \varepsilon_t \quad (7)$$

where, *REER* is the dependent variable, *Oil* is the independent variable and the parameters p and q are the lag order. The NARDL estimation approach allows a simultaneous cointegration model for a long and short-run relationship with asymmetric relationship which accounted for the different decomposition effects of positive and negative shocks of oil prices on multilateral exchange rates and vice versa. In addition, the NARDL approach can accommodate any order of integration, whether it's $I(0)$, $I(1)$, or a combination of both.

We underscored the significance of asymmetric non-causality in determining the causal direction of oil price shocks, which impact the exchange rate and vice versa (see Nouira et al., 2019; and Hatemi-J et al., 2016). To account for Hatemi-J non-causality, the cumulative sums of positive and negative components of the underlying variables were used, using bootstrap critical values. Hatemi-J (2012) suggested the equation that forms the asymmetric non-causality estimates.

$$y1_t = y1_{t-1} + \varepsilon 1_t = y_{10} + \sum_{i=1}^{t} \varepsilon 1_i \qquad t = 1,2 \ldots T \quad (8)$$

$$y2_t = y2_{t-1} + \varepsilon 2_t = y_{20} + \sum_{i=1}^{t} \varepsilon 2_i \qquad t = 1,2 \ldots T \quad (9)$$

where, the y_{10} and y_{20} are the constant's values; and the $\varepsilon 1_i$ and $\varepsilon 2_i$ are white noise disturbance term, $\varepsilon_{1i}^+ = \max\ (\varepsilon 1_i, 0)$, $\varepsilon_{2i}^+ = \max\ (\varepsilon 2_i, 0)$, $\varepsilon_{1i}^- = \min\ (\varepsilon 1_i, 0)$ and $\varepsilon_{2i}^- = \min\ (\varepsilon 2_i, 0)$ represent the positive and negative parameters (also can be expressed as $\varepsilon 1_i = \varepsilon_{1i}^+ + \varepsilon_{1i}^-$ and $\varepsilon 2_i = \varepsilon_{2i}^+ + \varepsilon_{2i}^-$. This condition can be described as follows:

$$y1_t = y1_{t-1} + \varepsilon 1_t = y_{1,0} + \sum_{i=1}^{t} \varepsilon_{1i}^+ + \sum_{i=1}^{t} \varepsilon_{1i}^- \quad (10)$$

$$y1_t = y2_{t-1} + \varepsilon 2_t = y_{2,0} + \sum_{i=1}^{t} \varepsilon_{2i}^+ + \sum_{i=1}^{t} \varepsilon_{2i}^- \quad (11)$$

where, the positive and negative values for each variable be defined in a cumulative form as $y_{1t}^+ = \sum_{i=1}^{t} \varepsilon_{1i}^+, y_{1t}^- = \sum_{i=1}^{t} \varepsilon_{1i}^-$ and $y_{2t}^+ = \sum_{i=1}^{t} \varepsilon_{2i}^+$, $y_{2t}^- = \sum_{i=1}^{t} \varepsilon_{2i}^-$. Hence, the underlying variables have a permanent impact on positive and negative shocks, respectively. The causal relationship between variables is tested by using the VAR model with order p-value:

$$y_1^+ = v + A_1 y_{t-1}^+ + \cdots + A_p y_{t-1}^+ + \mu_t^+; \\ \text{where, } y_t^+ = (y_{1t}^+, y_{2t}^+) \quad (12)$$

$$y_1^- = v + A_1 y_{t-1}^- + \cdots + A_p y_{t-1}^- + \mu_t^-; \\ \text{where, } y_t^+ = (y_{1t}^-, y_{2t}^-) \quad (13)$$

where, then $y_t^{+/-}$ is the (1x2) vectors of variable, v is the (1x2) vectors of intercepts,

$\mu_t^{+/-}$ is the (1x2) vectors of error terms and A_r is the (2x2) matrix of parameters for lag order r=1, ……, p, and the lag order selection is based on the Hatemi-J criterion (HJC).

4. Empirical Results

To determine their level of stationarity, all variables in the study were subjected to multiple unit root tests. Table 2 presents the unit root test statistics for all variables. The results of the traditional and endogenous structural breaks unit root tests proved the unit root hypothesis as *I*(1) for all variables, as well as the existence of a structural break in the series of variables. Between 1998 and 2008, the structural break showed the effect of variation during the Asian Financial Crisis and the Global Financial Crisis. Most economies in the world have been affected by both financial crises, particularly in emerging markets in East and Southeast Asia countries during the late 1990s and 2000s. The Fourier ADF unit root test reveals that the REER variables in Thailand are experiencing a unit root issue. Utilizing different analysis approaches is necessary due to the integration of unit root test statistics as *I*(1) and mixed, as demonstrated in Table 3.

Table 4 shows the estimates of long-run cointegration relationships for the sub-period of a series based on the GH estimates. The statistical result for Malaysia shows a rejected null hypothesis of no cointegration for the regime and regime trend estimation model,

Table 2. Unit root test results

	At level		At first difference	
	ADF	**ZA**	**ADF**	**ZA**
$REER_{Mal}$	-2.299	-3.197 (2015/M06)	-17.177***	-17.610*** (1998/M02)
Oil_{Mal}	-1.718	-4.423 (2014/M08)	-17.063***	-17.259*** (2008/M08)
$REER_{Thai}$	-2.299	-3.066 (1998/M11)	-17.177***	-17.344*** (1997/M12)
Oil_{Thai}	-2.021	-2.801 (2002/M02)	-13.917***	-8.872*** (1999/M01)

Note: *** denotes rejection of the null of a unit root at the 1% level.

Table 3. Fourier ADF unit root test results

	Min. SSR	$\check{k}$	Lag	FADF-stat	$F(\check{k})$
$REER_{Mal}$	0.023	2	1	-2.443	1.068
Oil_{Mal}	0.609	1	3	-2.797	3.082
$REER_{Thai}$	0.032	1	5	-4.721***	5.778***
Oil_{Thai}	0.609	1	1	-2.797	3.082

Note: The finite sample critical values for FADF and F-test are taken from Table 1 of Enders and Lee (2012). *** Denotes rejection of the null of a unit root at the 1% level.

Table 4. Gregory and Hansen cointegration test results

Estimations	ADF-stat	T_B	Z_t-stat	T_B	Z_a-stat	T_B
Malaysia						
Level shift	-4.20	1998/M06	-4.31	1998/M01	-31.21	1998/M01
Level shift with trend	-3.59	1999/M10	-4.75*	1999/M06	-34.36	1999/M06
Regime change	-6.09***	1998/M03	-5.94**	1997/M07	-61.69**	1997/M01
Thailand						
Level shift	-5.09**	2002/M06	-4.39*	2002/M03	-30.01	2002/M03
Level shift with trend	-4.29	2002/M06	-4.53	2003/M11	-31.77	2003/M11
Regime change	-5.99**	2004/M02	-5.90**	2003/M11	-49.67	2003/M11

Note: ***, ** and *refer to significant value of 1, 5 and 10% based on Gregory and Hansen (1996) critical value statistics. TB represent the break date from the GH cointegration estimation.

with break dates occurring between 1997 and the end of 1999. Thailand's results rejected the null hypothesis that a level and regime trend with a break date in 2002 and 2004 did not have cointegration. The break dates in line with the Asian Financial Crises have worsened both countries' economic progress, highlighted by Nambiar (2003) and Chin and Jomo (2001). Political issues and changing monetary policy caused the loosening of credit extensions and the reduction of interest rates in 2002, leading to the expectation of break-up dates in Thailand (Mutebi, 2003). With the Royal Thai Army coup against the ruling government, Thailand's political issues become more heated, resulting in a short-term currency depreciation shock in 2006 (Reuters, 2008).

According to a study by Bahmani-Oskooee and Baek (2017), a nonlinear model was superior to a linear model in identifying an exchange rate. The asymmetric effect of oil prices on the multilateral exchange rate was investigated by this study using the NARDL approach, and the statistical results are presented in Table 5. By setting out lag orders, this study used the general-specific approach to select actual NARDL estimations. The reason for eliminating insignificant regressors is because they can cause estimation inaccuracies and generate noise in the dynamic multiplier. The critical upper bound has been exceeded in Malaysia, which suggests that oil prices and the multilateral exchange rate have an asymmetric long-run relationship. Thailand, despite being at the 10% significant critical value between bound critical values, recorded an inconclusive result, which is surprising. While the t_{BDM} statistics value proposed by Banerjee et al. (1998) in detecting the asymmetric cointegration is significant in Malaysia and not indicating a significant result for Thailand; and this finding was almost similar to Kisswani et al. (2019) who presented a similar result while studying the impact of oil price on the exchange rate for ASEAN-5.

This study continues to test dynamic asymmetric relationships in both the long and short-run terms as shown in Table 5 to confirm the appropriateness of performing the asymmetric model. There is an existence of asymmetric relationships across both positive and negative sides, and the oil price has recorded a significant level of relationship for both positive and negative long-run relationships with the estimated coefficients at 0.073 and -0.100 respectively for Malaysia's multilateral exchange rate. The multilateral exchange rate indicator shows an almost 7.3% increase in response to a positive 1% increase in world oil prices, as can be assumed analytically. Instead, a negative 1% decrease in the world oil price level leads to an almost 10% depreciation in the multilateral exchange rate indicator. Furthermore, the long-term relationship between oil prices and Malaysia's multilateral exchange rate indicator is asymmetric. The oil price fluctuation in Thailand resulted in an insignificant coefficient value for both positive and negative long-run estimates. In the short run, the oil prices variable has an asymmetrical relationship with Thailand's multilateral exchange rate.

Table 5. The NARDL estimation results

	Malaysia		Thailand	
	Coef.	**Std. error**	**Coef.**	**Std. error**
$REER^{+}_{t}$	-0.078*** (0.000)	0.019	-0.048*** (0.004)	0.016
Oil^{+}_{t}	0.006* (0.052)	0.003		
Oil^{-}_{t}	0.008** (0.027)	0.004		
$\Delta REER^{+}_{t-1}$			0.119** (0.039)	0.057
$\Delta REER^{+}_{t-3}$	0.071** (0.040)	0.058	-0.125** (0.030)	0.057
$\Delta REER^{+}_{t-4}$			0.145** (0.013)	0.058
$\Delta REER^{+}_{t-7}$			-0.111* (0.056)	0.057
ΔOil^{+}_{t-3}			-0.078** (0.011)	0.030
ΔOil^{-}_{t}	0.054*** (0.006)	0.019		
ΔOil^{-}_{t-1}	-0.034* (0.060)	0.018		
ΔOil^{-}_{t-2}			-0.039* (0.076)	0.022
ΔOil^{-}_{t-3}	-0.032* (0.056)			
LR^{+}	0.073** (0.037)		-0.024 (0.734)	0.116

	Malaysia		Thailand	
	Coef.	Std. error	Coef.	Std. error
LR^{-}	-0.100** (0.014)		0.045 (0.591)	0.289
LR-asymmetric	16.14*** (0.000)		2.017 (0.157)	
SR-asymmetric	2.539 (0.112)		4.967** (0.027)	
F_{PSS}	5.396**			
t_{BDM}	-3.989**			
Diagnostic Test				
Serial Correlation	3.690	0.145	5.990	0.245
Breusch-Pagan	0.330	0.567	0.321	0.487
D-W Statistics	1.903		1.807	

Note: Only the significant coefficient reported through the estimation results and values in ( ) indicate the p-value. ***, ** and * denote rejection of the null hypothesis of no cointegration at the 1, 5 and 10% significance levels.

The long-term asymmetric relation with oil price fluctuation revealed by Butt et al. (2020) and Kisswani et al. (2019) in Malaysia is akin to our findings. The study by Bahmani-Oskooee and Kanitpong (2019) and Ibrahim and Chancharoenchai (2013) has demonstrated a short-run asymmetric relationship between oil prices and economic growth in Thailand. Additionally, both Sanusi (2020) and Basnet and Upadhyaya (2015) came to the conclusion that there is no clear relationship between the global oil price fluctuation and exchange rate for ASEAN countries, as well as oil exporting and oil-importing countries. Basnet and Upadhyaya (2015) argue that oil prices do not induce fluctuations in the exchange rate of ASEAN countries, and some ASEAN countries exhibit a unique pattern of response to global oil price fluctuations. The exchange rate's impact on oil prices is different between oil-producing and non-oil-producing countries, as revealed by Wang et al. (2022).

Figure 5 demonstrates the long-term dynamic multiplier effects of positive and negative changes in world oil prices in Malaysia and Thailand. The oil price in Malaysia experienced a fluctuating long-run cumulative pattern in the early period, then dropped and then crossed over to negative changes approximately in the 10-period and remained until the end period. Thailand's outcome fluctuates during the early estimation period, then rises and overshoots the positive, and remains until the end of the study period.

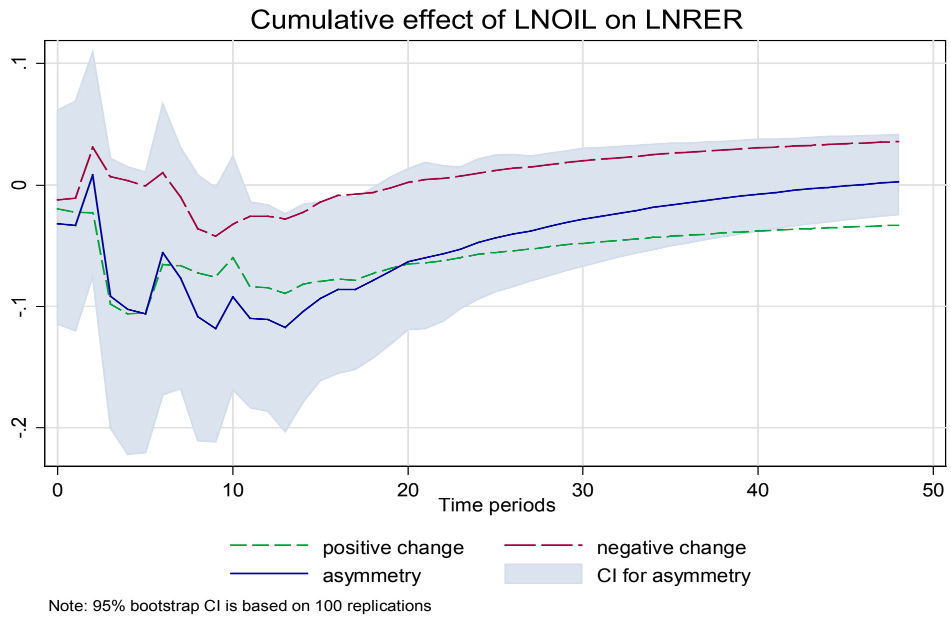


Figure 5(a). The cumulative multiplier effects for Malaysia

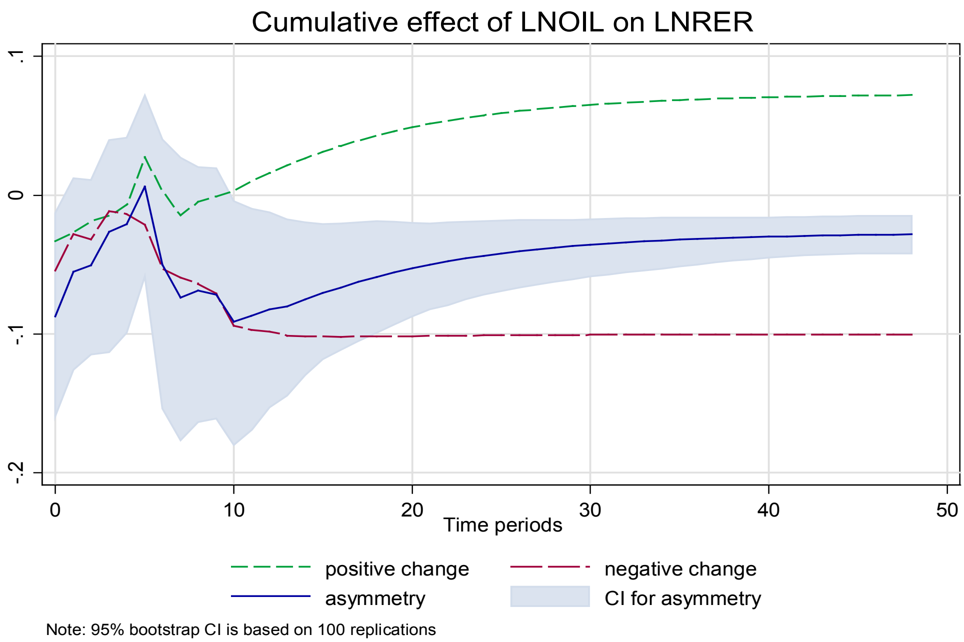


Figure 5(b). The cumulative multiplier effects for Thailand

Table 6. Asymmetric and non-asymmetric causality results.

Null hypothesis	Malaysia		Thailand	
	Test value	Causality	Test value	Causality
Asymmetric causality				
Oil – / ⟶ REER	0.113	No	0.340	No
Oil ⟵ / – REER	0.007	No	0.235	No
Non-asymmetric causality				
Oil^{+} – / ⟶ $REER^{+}$	3.991***	Yes	4.001***	Yes
Oil^{+} ⟵ / – $REER^{+}$	0.211	No	0.131	No
Oil^{-} – / ⟶ $REER^{-}$	0.433	No	0.007	No
Oil^{-} ⟵ / – $REER^{-}$	1.123	No	0.032	No

Note: *** denote rejection of the null hypothesis of causality at the 1% significance level based on the bootstrap critical value.

We tested the possibility of an asymmetric causality relationship between oil prices and multilateral exchange rates using the Hatemi-J (2012) nonlinear approach. The bootstrap critical value was used to determine positive and negative changes in asymmetric non-causality using the Hatemi-J (2012) Gauss code, as shown in Table 6. Based on the results presented, it is unclear whether changes in oil prices, whether rising or falling in the symmetric condition, have any causality direction for both countries. Both countries experience strong positive causal effects from oil price fluctuations to exchange rate variations. This outcome parallels those of Khraief et al. (2021) and Jung et al. (2020) because of the trade balances between these two countries, which are among the biggest oil producing nations in the ASEAN region.

The non-asymmetric causality between oil prices and REER in Malaysia was caused by the fluctuating value of the US dollar, which is the invoice currency for international trade, in comparison to the use of local currency. The value of the local currency will be depreciated and the value of the local multilateral exchange rate will be directly reduced by an appreciation of the US dollar, and vice versa. Wang et al. (2022) in a recent study found that the relationship for long cycle periods was influenced by the exchange rate regime, balance of payment, and economic performance. The oil price shock has had a negative impact on China's exchange rate, as evinced by Ju et al. (2014), despite having a positive impact on China's GDP.

5. Concluding Remarks

The results of this study demonstrated an asymmetric and causal connection between exchange rate variation and oil price fluctuation, especially in light of the dataset used in the study. The non-asymmetric causality exhibits a one-way causality between oil price fluctuation and exchange rate variation, giving a clear picture of both countries' effects on unstable global oil prices. The NARDL estimates revealed that the impact of oil price appreciation on exchange rate variability was distinct from the impact of oil price depreciation on multilateral exchange rates that involved both countries. Policymakers may need to rethink the monetary and fiscal framework to reduce the financial burden due to the uncertainties of global commodity prices, inflationary pressure, currency volatility and instability, and economic growth. The exchange rate for both countries is primarily influenced by the fluctuation of oil prices. By considering the expansion of petrol and export subsidy programs, particularly for local retail consumption, policymakers can mitigate the risk of shocks. Financial instruments that are suitable for absorbing exchange rate transactions and translation risk are required. Future monetary policies can be improved through monitoring currency movements and the social well-being of society in light of the global oil price shock, as indicated by the asymmetric effects.

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References

Akram, Q. F. (2004). Oil prices and exchange rates: Norwegian evidence. *Econometrics Journal,* 7(2): 476-504.

Akram, Q. F. (2009). Commodity prices, interest rates, and the Dollar *Energy Economics,* 31(6): 838-851.

Albulescu, C. T. and Ajmi, A. N. (2021). Oil price and US dollar exchange rate; change detection of bi-directional causal impact. *Energy Economics*, 100: 105385.

Alqaralleh, H. (2020). On the asymmetric response of the exchange rate to shocks in the crude oil market. *International Journal of Energy Sector Management,* 14(4): 839-852.

Amano, R. and van Norden, S. (1998). Oil prices and the rise and fall of the U.S. real exchange rate. *Journal of Review International Economic,* 6(4): 683-694.

Baba, C. and Lee, J. (2022). Second-round effects of oil price shocks- implications for Europe’s inflation outlook. *International Monetary Fund Working Paper,* WP/22/173.

Bahmani-Oskooee, M. and Baek, J. (2017). Do exchange rate changes have symmetric or asymmetric effects on the demand for money in Korea? *Review of Economic Analysis*, 49(46): 155-168.

Bahmani-Oskooee, M. and Kanitpong, T. (2019). Thailand-China commodity trade and exchange rate uncertainty: Asymmetric evidence from 45 industries. *The Journal of Economic Asymmetries,* 20, e00130.

Baghestani, H. and Toledo, H. (2019). Oil prices and real exchange rates in the NAFTA region. *The North American Journal of Economics and Finance,* 48: 253-264.

Bank of Thailand. (2022). Price of Certain Manufacturer Goods. Available at https://app.bot.or.th/BTWS_STAT/statistics/

Bal, P. D. and Rath, N. B. (2015). Nonlinear causality between crude oil price and exchange rate: A comparative study of China and India. *Energy Economics,* 51: 149-156.

Banerjee, A., Dolado, J. and Mestre, R. (1998). Error-correction mechanism tests for cointegration in a single-equation framework. *Journal of Time Series Analysis,* 19(3): 267-283.

Basher, S., Haug, A. and Sadorsky, P. (2016). The impact of oil shocks on exchange rates: A Markov-switching approach. *Journal of Energy Economics,* 54: 11-23.

Basnet, H. C. and Upadhyaya, K. P. (2015). Impact of oil price shocks on output, inflation and the real exchange rate: Evidence from selected ASEAN countries. *Applied Economics,* 47(29): 3078-3091.

Beckmann, J., Czudaj, R. and Arora, V. (2020). The relationship between oil prices and exchange rate: revisiting theory and evidence. *Energy Economics,* 88(6): 104772.

Benhmad, F. (2012). Modeling nonlinear Granger causality between the oil price and U.S. dollar: A wavelet based approach. *Economic Modeling,* 29(4): 1505-1514.

Bhattacharya, N. S., Jha, K. S. and Bhattacharya, M. (2019). Dependence between oil prices and exchange rate volatility: An empirical analysis. *Journal of Applied Economics and Business Research,* 9(1): 15-26.

Bodenstein, M. and Guerrieri, L. (2011). Oil efficiency, demand, and prices: A tale of ups and downs. Board of governors of the federal reserve system. *International Finance Discussion Paper*, 1031: 1-52.

Brahmasrene, T., Huang, J. C. and Sissoko, Y. (2014). Crude oil prices and exchange rates: Causality, variance decomposition and impulse response. *Energy Economics,* 44: 407-412.

Buetzer, S., Habib, M. M. and Stracca, L. (2012). Global exchange rate configurations: Do oil shocks matter? *Working Paper Series 1442, European Central Bank*, 1-42.

Burkett, P. and Hart-Landsberg, M. (1998). East Asia and the crisis of development theory. *Journal of Contemporary Asia, 28(*4): 435-456.

Butt, S., Ramakrishnan, S., Loganathan, N. and Chohan, M. A. (2020). Evaluating the exchange rate and commodity price nexus in Malaysia: Evidence from the threshold cointegration approach. *Financial Innovation,* 6(22). Available at https://doi.org/10.1186/s40854-020-00181-6

Cashin, P., Céspedes, L. F. and Sahay, R. (2004). Commodity currencies and the real exchange rate. *Journal of Development Economics,* 75(1): 239-268.

Cavalcanti, T. and Jalles, J. T. (2013). Macroeconomic effects of oil price shocks in Brazil and in the United States. *Applied Energy,* 104: 475-486.

Chang, Y. and Wong, J. F. (2003). Oil price fluctuations and Singapore economy. *Energy Policy,* 31(11): 1151-1165.

Chen, S. S. and Chen, H. C. (2007). Oil prices and real exchange rates. *Energy Economics,* 29: 309-404.

Chen, Y. C., Rogoff, K. S. and Rossi, B. (2010). Can exchange rates forecast commodity prices? *The Quarterly Journal of Economics*, 125(3): 1145-1194.

Chin, K. F. and Jomo, K. S. (2001). Financial liberalization and system vulnerability. In K.S. Jomo (Eds.). *Malaysian Eclipse: Economic Crisis and Recovery.* (pp. 55-70). London Zed Books.

Corden, W. M. and Neary, J. P. (1982). Booming sector and de-industrialisation in a small open economy. *Economic Journal*, 92(368): 825-848.

De Vita, G. and Trachanas, E. (2016). Nonlinear causality between crude oil price and exchange rate: a comparative study of China and India: A failed replication (negative Type 1 and Type 2). *Energy Economics,* 56: 150-160.

Dickey, D. A. and Fuller, W. A. (1981). Likelihood ratio statistics for autoregressive time series with a unit root. *Econometrica: Journal of the Econometric Society*, 1057-1072.

Frankel, J. A. (2006). On the Yuan: The choice between adjustment under a fixed exchange rate and adjustment under a flexible rate. *CESifo Economic Studies,* 52(2): 246-275.

Fratzscher, M., Schneider, D. and Van Robays, I. (2014). Oil prices, exchange rates and asset prices. *European Central Bank Working Paper,* No. 1689.

Gao, W., Wen, J., Mahmood, H. and Zakaria, M. (2022). Nonlinear and asymmetric impact of oil price on exchange rates: Evidence from South Asia. *Economics-The Open-Access, Open-Assessment Journal, De Gruyter*, 16(1): 243-256.

Gao, X., Fang, W., An, F. and Wang, Y. (2017). Detecting method for crude oil price fluctuation mechanism under different periodic time series. *Applied Energy,* 192: 201-212.

Golub, S. S. (1983). Oil prices and exchange rates. *Economic Journal,* 93(371): 576-593.

Glasure, Y. U. and Lee, A. R. (2002). The impact of oil prices on income and energy. *International Advances in Economic Research*, 8(2): 148-154.

Gregory, A. W. and Hansen, B. E. (1996). Residual-based tests for cointegration in the models with regime shifts. *Journal of Econometrics,* 70(1): 99-126.

Habib, M. M. and Kalamova, M. M. (2007). Are there oil currencies? the real exchange rate of oil exporting countries. *European Central Bank Working Paper Series, No. 839,* 1-38.

Habib, M., Bützer, S. and Stracca, L. (2016). Global exchange rate configurations: Do oil shocks matter? *IMF Economic Review,* 64(3): 443-470.

Hatemi-J, A. (2012). Asymmetric causality tests with an application. *Empirical Economic,* Vol. 43(1): 447-456.

Hatemi-J, A., Al Shayeb, A. and Roca, E. (2016). The effect of oil prices on stock prices: Fresh evidence from asymmetric causality tests. *Applied Economics,* 49(16): 1584-1592.

Haug, A. A. and Basher, S. A. (2019). Exchange rates of oil exporting countries and global oil price shocks: A nonlinear smooth-transition approach. *Applied Economics,* 51(48): 1-15.

Huang, Y. and Guo, F. (2007). The role of oil price shocks on China's real exchange rate. *China Economic Review,* 18(4): 403-416.

Hussain, M., Zebende, G. F., Bashir, U. and Donghong, D. (2017). Oil price and exchange rate co-movements in Asian countries: Detrended cross-correlation approach. *Physica A: Statistical Mechanics and Its Applications,* 465: 338-346.

Ibrahim, M. H. and Chancharoenchai, K. (2013). How inflationary are oil price hikes? A disaggregated look at Thailand using symmetric and asymmetric cointegration models. *Journal of the Asia Pacific Economy,* 19(3): 409-422.

International Monetary Fund. (2022). Primary commodity prices. Available at https://www.imf.org/en/

Iwayemi, A. and Fowowe, B. (2011). Impact of oil price shocks on selected macroeconomic variables in Nigeria. *Energy Policy,* 39(2): 603-612.

Ji, Q., Liu, B.-Y. and Fan, Y. (2019). Risk dependence of CoVaR and structural change between oil prices and exchange rates: A time-varying copula model. *Energy Economics,* 77: 80-92.

Ju, K., Zhaou, D., Zhou, P. and Wu, J. (2014). Macroeconomic effects of oil price shocks in China: An empirical study based on Hilbert-

Huang tranform and event study. *Applied Energy,* 136: 1053-1066.

Jung, Y. C., Das, A. and McFarlane, A. (2020). The asymmetric relationship between the oil prices and the US-Canada Exchange rate. *The Quarterly Review of Economics and Finance*. 76: 198-206.

JP Morgan Database. (2022). Available at https://www.jpmorgan.com.

Khraief, N., Shahbaz, M., Mahalik, M. K. and Bhattacharya, M. (2021). Movement of oil prices and exchange rates in China and India: New evidence from wavelet based, non-linear, autoregressive distributed lag estimation. *Physica A: Statistical Mechanics and its Application,* 563: 125423.

Kilian, L. (2009). Not all oil shocks are alike: disentangling demand and supply shocks in the crude oil market. *American Economic Review,* 99(3): 1053- 1069.

Kisswani, K. M. (2021). The dynamic links between oil prices and economic growth: Recent evidence from nonlinear cointegration analysis for the ASEAN-5 countries. *Emerging Markets Finance and Trade*, 56(11): 3153-3166.

Kisswani, K. M., Harraf, A. and Kisswani, A. M. (2019). Revisiting the effects of oil prices on exchange rate: Asymmetric evidence from the ASEAN-5 countries. *Economic Change and Restructuring,* 52(3): 279-300.

Kocaarslan, B. and Soytas, U. (2019). Asymmetric pass-through between oil prices and the stock prices of clean energy firms: New evidence from a nonlinear analysis. *Energy Reports,* 5: 117-125.

Kocoglu, M., Kyophilavong, P., Awan, A. and Lim, S. Y. (2022). Time-varying causality between oil price and exchange rate in five ASEAN economies. *Economic Change and Restructuring,* 56(2):1007-1031.

Lizardo, R. A. and Mollick, A. V. (2010). Oil price fluctuations and US dollar exchange rates. *Energy Economics,* 32(2): 399-408.

Lv, X., Lien, D., Chen, Q. and Yu, C. (2018). Does exchange rate management affect the causality between exchange rates and oil prices? Evidence from oil-exporting countries. *Energy Economics*, 76: 325-343.

Ministry of Finance Malaysia. (2022). Prices of Petroleum and Diesel. Available at https://data.gov.my/data-catalogue/fuelprice.

Mutebi, A. M. (2003). Thailand in 2002: Political consolidation amid economic uncertainties. *Asian Survey,* 43(1): 101-112.

Nambiar, S. (2003). Malaysia's response to the financial crisis: Reconsidering the viability of unorthodox policy. *Asia-Pacific Development Journal,* 10(1): 1-23.

Narayan, S. (2013). Foreign exchange markets and oil prices in Asia. *Journal of Asian Economics,* 28: 41-50.

Nikbakht, L. (2010). Oil prices and exchange rates: the case of OPEC. *Business Intelligences Journal,* 3: 83-92.

Nouira, R., Amor, T. H. and Rault, C. (2019). Oil price fluctuations and exchange rate dynamics in the MENA region: Evidence from non-causality-in-variance and asymmetric non-causality tests. *The Quarterly Review of Economics and Finance,* 73: 159-171.

Nusair, S. A. and Olson, D. (2019). The effects of oil price shocks on ASIAN exchange rates: Evidence from quantile regression analysis. *Energy Economics,* 78: 44-63.

O'Neil, J., Wilson, D., Purushothaman, R. and Stupnytska, A. (2005). How solid are the BRICs. Global Economics Paper No. 134.

Rautava, J. (2004). The role of oil prices and the real exchange rate in Russia's economy: A cointegration approach. *Journal of Comparative Economics,* 32(2): 315-327.

Reboredo, J. C. (2012). Modelling oil price and exchange rate co-movements. *Journal of Policy Modeling,* 34(3): 419-440.

Reuters. (2008). Timeline: Thailand since 2006 coup ousted Thaksin. Available at https://www.reuters.com/article/us-thailand-coup-idUSBKK5906620080228.

Sanusi, K. A. (2020). Oil prices asymmetric and exchange rate volatility: Case of oil-exporting emerging countries. *Journal of International Studies,* 13(4): 101-109.

Shin, Y., Yu, B. and Greenwood-Nimmo, M. (2014). Modelling asymmetric cointegration and dynamic multipliers in a nonlinear ARDL framework. *The Festschrift in Honor of Peter Schmidt.: Econometric Methods and Applications,* 281-314.

Singhal, S., Sangita, C. and Chandra, P. B. (2019). Return and volatility linkages among international crude oil prices, gold price, exchange rate and stock market: Evidence from maxico. *Resources Policy,* 60: 255-261.

Tiwari, A., Dar, A. and Bhanja, N. (2013). Oil price and exchange rates: a wavelet based analysis for India", *Economic Modelling,* 31: 414-422.

Tran, O. T. K., Le, M. T. H., Hoang, A. T. P. and Tran, D. N. (2019). The impact of oil shocks on exchange rates in southeast Asian countries - A Markov-switching. Approach. In V. Kreinovich, N. Thach, N. Trung and D. Van Thanh (Eds.), *Beyond Traditional Probabilistic Methods in Economics. Studies in Computational Intelligence 2* (pp. 779-794). Springer.

Wang, Y., Geng, X. and Guo, K. (2022). The influence of international oil price fluctuation on the exchange rate of countries along the Belt and Road. *The North American Journal of Economics and Finance,* 59: 101588.

Zivot, E. and Andrews, D. W. K. (2002). Further evidence on the great crash, the oil-price shock, and the unit-root hypothesis. *Journal of Business & Economic Statistics*, 20(1), 25-44.

Zhang, H. J., Dufour, J. M. and Galbraith, J.W. (2016). Exchange rates and commodity prices: Measuring causality at multiple horizons. *Journal of Empirical Finance,* 36,:100-120.

Zhang, D., Shi, M. and Shi, X. (2018). Oil indexation, market fundamentals, and natural gas prices: An investigation of the Asian premium in natural gas trade. *Energy Economics,* 69: 33-41.