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Oil Price Pass-Through into Inflation Revisited in Malaysia: The Role of Asymmetry

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ABSTRACT

This paper investigates the asymmetric oil price impact on inflation in Malaysia. The oil price asymmetric effect on inflation is examined using the Nonlinear Autoregressive Distributed Lag (NARDL) approach. The approach simultaneously tests the short run and long run nonlinearities of the oil price through positive and negative partial sum decompositions. The results showed that there is evidence of long-run and short-run asymmetry indicating that inflation reacts differently during an increase and a decrease in oil prices after the fuel subsidy rationalisation. Furthermore, the impact of an increase in oil prices on inflation is greater than the decrease in oil prices. Thus, understanding the asymmetric oil price inflationary effect will help policymakers in implementing appropriate policies to accommodate the asymmetry. Future research needs to investigate other possible factors with the asymmetric effect such as exchange rates.

INTRODUCTION

The use of oil prices as a source of energy have affected a country economy sectors such as transportation, energy and industrial sectors directly or indirectly (Çatik & Önder, 2013; Zhao, Zhang, Wang, & Xu, 2016)the existence of an asymmetric relationship between economic activity and oil prices is investigated by regime-dependent impulse response functions and forecast error variance decompositions based on a multivariate two-regime Threshold VAR (TVAR. Literature has indicated that there is a significant relationship between oil prices and inflation (Salisu, Ndako, Oloko, & Akanni, 2016; Trang, Tho, & Hong, 2017). The reason is that oil price movements have a direct effect on production costs, which in turn will increase inflation (Long & Liang, 2018). Earlier studies have assumed a linear relationship between oil prices and inflation (Istiak & Alam, 2019). This assumption implies that an increase or a decrease in oil prices will cause the same magnitude towards inflation in a different direction. Thus, if oil prices decrease, a firm may reduce its cost of production or pass through the cost to the end-users (Long & Liang, 2018). At the same time, a decrease in oil price will lead to a reduction in production cost and, thus, the price level. However, the assumption of the linear model may be too restrictive in the case of oil price pass-through into inflation, so an extension of this needs to be investigated further. This is because, the oil price reduction will not always reduce inflation in the same magnitude or size during the oil price increment (Davari & Kamalian, 2018). Even though a decrease in oil prices will contribute to a lower cost of production and higher productivity but it will also cause a higher nominal wage, which in turn leads to higher production costs. Therefore, there will be an only small reduction or no change in goods and services product prices. Besides, when the oil prices drop, there is a possibility that domestic firms only reduce the cost of production to a small extent which leads to the decrease of CPI is also smaller (Atil, Lahiani, & Nguyen, 2014; Choi, Furceri, Loungani, Mishra, & Poplawski-Ribeiro, 2018). This consequence implies that there is an asymmetric oil price pass-through effect where the magnitude is different during an increase and a decrease in oil prices. Thus, it is important to study the asymmetric oil price inflationary effect because if there is an asymmetric effect exist, customers will benefit less from the decrease of oil prices.

From the empirical perspective, most studies have indicated the asymmetric relationship between oil prices and inflation (Bala & Chin, 2018; Davari & Kamalian, 2018; Lacheheb & Sirag, 2018; Salisu, Isah, Oyewole, & Akanni, 2017). Therefore, this study revisits the impact of the asymmetric effect of oil price into inflation before and after the fuel subsidy rationalisation which has not been extensively investigated in Malaysia. The Malaysian government has announced the subsidy reductions for oil-based sources such as petrol, diesel, and liquefied petroleum gas (LPG) on 16th July 2010 effectively (Abdul Hakim, Ismail, & Abdul Razak, 2016). This current study applies nonlinear ARDL approach. The asymmetric inflationary effect of oil price towards inflation is captured using the NARDL to determine if inflation reacts towards oil prices during an increase or decrease in oil prices differently. Additionally, if the asymmetric pass through exists, investigating the oil price pass-through into inflation could seriously bias the oil price exposure estimates (Baharumshah, Sirag, & Soon, 2017). Furthermore, NARDL method performs better for a small sample size of data. Besides, the NARDL approach will allow a long run and short-run asymmetric tests simultaneously (Shin, Yu, & Greenwood-Nimmo, 2014). Understanding the oil price asymmetric inflationary effects can assist the monetary authorities in conducting country policy comprehensively.

The rest of this paper proceeds as follows: A selected literature review of theory and empirical evidence on oil prices effect on inflation are discussed in the next section. Section three describes the data and methodology, section four presents the empirical results and discussion whilst section five represents conclusion and recommendations.

LITERATURE REVIEW

Theoretically, there is a positive relationship between oil prices and inflation, thus, an increase in oil prices lead to an increase in inflation (Istiak & Alam, 2019). As a main source of energy in the transportation and manufacturing industries, oil prices will affect the production costs directly. For example, if the oil price increase, then it will also increase more to the transportation cost, and energy for manufacturing firms. Then, the firms will transfer all these costs or a part of them to their consumers, which cause an increase in price levels of inflation. Thus, if the production costs rise, it is also expected that an increase in the prices of final goods and services (Sek, 2017; Zhao et al., 2016).

Since the oil price crisis in the 1970s, studies have been conducted to investigate the oil price pass-through into inflation (Barsky & Kilian, 2004; Globerman & Bruce, 1976). Though there is mixed evidence on the oil price transmission into inflation, previous literature generally has supported the oil price pass-through effect into inflation (Chen, 2009). In Malaysia, Ibrahim and Said (2012) indicated a long relationship between oil prices and aggregate CPI as well as the disaggregated CPI especially the food, rent, fuel and power, and the transportation and communication indices in the short run. Consistent with Ibrahim and Said's (2012) study, Chou and Tseng (2011) also found out that oil prices have a significant long-run pass-through effect on inflation in Taiwan but insignificant in the short run. Meanwhile, Mandal, Bhattacharyya, and Bhoi's (2012) study in India also indicated the impact of oil prices on inflation especially during the deregulation of some petroleum product prices in 2002.

In contrast, some studies have documented a declining impact of oil prices on inflation as compared in the late 1970s (Chen, 2009). In Chen's (2009) study from 19 industrial countries, the study results showed a declining pass-through effect in the majority of the sample countries. The main reasons are due to local currency appreciation, government monetary policy to mitigate the oil price inflationary effect, fewer regulations in the international trade. Meanwhile, a study by Choi, Furceri, Loungani, Mishra and Poplawski-Ribeiro (2018) also showed that the effect of oil prices on inflation has declined over time due to active government monetary policy to mitigate the inflation. Moreover, Gómez-loscos, Montañés and Gadea's (2011) study in Spain also revealed the declining impact of oil price on inflation. Furthermore, Tang, Wu and Zhang (2010) found out that the effect of oil prices on real GDP and real investment lasts much longer than inflation. Meanwhile, Jongwanich and Park (2009) argued that the declining oil price pass though the effect on inflation because of demand full factors are more important than external movements such as oil prices to be main sources of inflation, especially in Asian countries. The study also revealed that external food and oil price movements explain less than 30 per cent of Asia's CPI inflation, whereas excess aggregate demand and inflationary expectations comprise about 60 per cent.

However, most of these studies that indicated the declining oil price pass-through effect into inflation have applied the symmetric model. There is a possible reason for the declining effect that could be due to oil price asymmetric effect towards inflation that has not been extensively investigated (Baharumshah, Sirag, & Mohamed Nor, 2017; Bala & Chin, 2018). The asymmetric effect of oil prices on macroeconomic variables including inflation has been investigated gradually. Some studies have supported that the global oil prices asymmetric effect on CPI. It means that an increase or a decrease in oil prices have a different effect on inflation. Cunado and Perez de Gracia (2005) also found evidence of asymmetries on how oil prices influenced inflation in Japan, Thailand and South Korea. Choi et al.'s (2018) study finding also indicated the asymmetric oil price inflationary effect, with positive oil price movements have a larger impact on inflation than negative movements. Similarly, Istiak and Alam (2019) also confirmed that an increase in oil prices have a greater effect on inflation than and a decrease in oil prices. The same pattern also can be found in Long and Liang's (2018) study finding where an increase in oil prices have a larger magnitude effect on inflation rather than during an oil price reduction. Furthermore, the oil prices pass through effect into inflation also is greater in net-importer oil countries than net-exporter oil countries, but the asymmetric oil price effects seem to be more significant in oil-exporting countries (Salisu et al., 2017). Meanwhile, in Davari and Kamalian's (2018) study, the study results revealed an asymmetric oil price pass-through effect into inflation where significant effect only exists when there is an increase in oil price but insignificant when the oil prices decrease.

In summary, despite intensive tests on oil price pass-through to inflation since the 1970s, the relationship continues to stand upon mixed evidence. Therefore, a continuous study is essential to fill the gap of this mixed evidence to explore the oil price transmission to inflation relationship. Knowledge from this empirical evidence then it will help the policymakers to maintain and control the inflation.

DATA AND METHODOLOGY

Data

Monthly data from January 1996 until March 2019 were used for empirical analysis. This study applied the Consumer Price Index (CPI) as the proxy for domestic inflation. West Texas Intermediate (WTI) crude oil prices are the proxy for oil prices which were obtained from the US Energy Information Administration (US EIA). The current study applied the augmented Phillips Curve, which also included output growth which is proxied by the Industrial Production Index (IPI) in the estimated model. Consistent with some previous studies, we also included exchange rate proxy by the Real Effective Exchange Rate (REER). This study applied REER rather than bilateral exchange rate with USD as indicated in previous studies since Malaysia pegged Malaysian Ringgit towards USD from 1998 to July 2005. The IPI and CPI data were obtained from the International Monetary Fund (IMF) website. Meanwhile, money supply (MS) was obtained from Bank Negara Malaysia monthly statistical report. Both CPI and IPI data were rebased to 2010 = 100. The REER was also obtained from the IMF website. All studied variables such as IPI, CPI, REER MS, and oil prices were expressed in natural logarithms.

Unit Root Tests

The Augmented Dickey-Fuller (ADF) (Dickey & Fuller, 1979) and the Phillips-Perron (PP) (Phillips & Perron, 1988) unit root tests were applied to investigate the stationarity of data as well as to confirm none of the variable series is integrated more than which will cause F-statistic using the NARDL approach will be invalid. This study applied the Schwarz Information Criterion (SIC) criteria to choose the optimal lag length.

Empirical Model

This study applied the augmented Phillips curve framework to investigate the oil price pass-through effect into inflation. Following some previous studies (Davari & Kamalian, 2018; Long & Liang, 2018; Sek, 2017), the general model with oil prices can be written as follows:

$$CPI_t = \beta_0 + \beta_1 OILP_t + \beta_2 REER_t + \beta_3 MS_t + \varepsilon_t \quad (1)$$

where, CPI is a consumer price index, $OILP$ is the oil price, $REER$ is the real exchange rate, MS is money supply (M2), and β_i is a vector of long-run coefficients. However, Equation (1) cannot capture the asymmetric effect of oil price changes on inflation. Thus, equation (1) is modified to incorporate the asymmetric component of oil prices (Ibrahim, 2015; Shin et al., 2014). The asymmetric model can be specified as follows:

$$CPI_t = \alpha_0 + \alpha_1 OILP_t^+ + \alpha_2 OILP_t^- + \alpha_3 REER_t + \alpha_4 MS + \varepsilon_t \quad (2)$$

Where, α_i is a vector of long-run coefficients. The oil price asymmetric effect is estimated by including the positive changes $OILP_t^+$ and negative changes $OILP_t^-$ in oil prices. Where the $OILP_t^+$ and $OILP_t^-$ are partial sums of the positive and negative changes in $OILP_t$ respectively, and $OILP_t = OILP_0 + OILP_t^+ + OILP_t^-$. By replacing the negative (positive) values with zeros, the partial sum of negative (positive) values are calculated as:

$$OILP_t^+ = \sum_{j=1}^{t} \Delta OILP_j^+ = \sum_{j=1}^{t} \max(\Delta OILP_j, 0), \quad OILP_t^- = \sum_{j=1}^{t} \Delta OILP_j^- = \sum_{j=1}^{t} \min(\Delta OILP_j, 0) \quad (3)$$

From Equation (2), α_1 is the coefficient of the long-run relationship between oil price positive movements and inflation, whereas α_2 is the coefficient of the long-run relationship between oil price negative movements and inflation. Both partial sums of the positive and negative changes in oil prices are expected to have a positive sign, but they are not anticipated to have a similar magnitude (Lacheheb & Sirag, 2018). Since partial sums of the positive changes in oil prices are expected to have a higher effect on inflation than negative changes, then $\alpha_1 > \alpha_2$. In other words, oil prices will affect inflation differently.

To determine the long-run relationship in Equation (2), we applied the NARDL model proposed by Shin et al. (2014). This methodology is based on the ARDL model developed by Pesaran, Shin and Smith (2001). Generally, the ARDL method has two major advantages. Firstly, the approach is applicable if no variables are integrated more than . Secondly, the method has better statistical properties in small samples. Furthermore, the asymmetric extension in the ARDL method allows us to investigate asymmetries in the long run, short-run or both in the model.

Contrary to Ibrahim and Said's (2012) and Sek's (2017) oil price pass-through model in Malaysia, this current study oil price pass-through into inflation model also included exchange rate movement and money supply variables to represent both demand-pull and cost-push inflation factors. Equation (2) can be framed in NARDL model (Shin et al., 2014) as follows:

$$\begin{aligned}\Delta CPI_t &= \beta_0 + \beta_1 CPI_{t-1} + \beta_2 OILP_{t-1}^+ + \beta_3 OILP_{t-1}^- + \beta_4 REER_{t-1} + \beta_5 MS_{t-1} \\ &+ \sum_{i=1}^{p} \phi_i \Delta CPI_{t-i} + \sum_{i=0}^{q} \varphi_i \Delta REER_{t-i} + \sum_{i=0}^{r} (\theta_i^+ \Delta OILP_{t-i}^+ + \theta_i^- \Delta OILP_{t-i}^-) + \sum_{i=0}^{s} X_i \Delta MS_{t-i} + \sum_{i=0}^{t} \eta_i \Delta gap + \varepsilon_t\end{aligned} \quad (4)$$

Where, gap refers to the output gap $(y_t^a - y_t^e)$ that represents the effects of variations in GDP which is proxied by the IPI index on inflation (Sek, 2017). Meanwhile, p,q,r,s and t represent the lag orders. Where y_t^a and y_t^e refer to output and potential output respectively so $(y_t^a - y_t^e)$ represents the output gap. y_t^e is the Hodrick-Prescott filtered trend of y_t^a (Chen, 2009; Chou & Tseng, 2011; Ibrahim & Said, 2012). In original Philip curve framework, in the short run, if the actual output is greater than the expected output, inflation will increase; or in other words, if unemployment is less than the natural rate of unemployment, inflation is expected to increase (Long & Liang, 2018). Thus, Equation (4) captures both the long run and short-run oil price asymmetric effect into inflation. The lagged-level terms coefficients indicate a long-run relationship among the variables. Meanwhile, the coefficients of the summation signs represent a short-run relationship among the variables. The errors in Equation (4) must be serially independent, which indicates the optimal lag length selection for the studied variables in the model.

Based on Equation (4), there are two tests were applied to investigate the long-run level relationship among the variables. The first test is the Banerjee, Dolado and Mestre's (1998) *t*-statistic testing to hypothesize if $\beta_1 = 0$. Equation (4) will only consist of the short-run term of the studied variables if $\beta_1 = 0$. The second test is based on Pesaran et al.'s (2001) *F*-statistic testing to hypothesize that the coefficients on the level variables are jointly equal to zero $(H_0 : \beta_1 = \beta_2 = \beta_3 = \beta_4 = \beta_5 = 0)$ against non-zero $(H_a : \beta_1 \neq \beta_2 \neq \beta_3 \neq \beta_4 \neq \beta_5 = 0)$. Comparison of the computed F-statistic value with the critical values provided by Pesaran et al. (2001) is conducted to confirm the long-run relationship among the studied variables. However, if the sample size is smaller (less than 100), then the critical value provided by Narayan (2005) will be applied. The two asymptotic critical value bounds based on Pesaran et al.'s (2001) F-statistic testing are: a lower bound value assuming all regressors are purely , and an upper bound value assuming all regressors are pure . If the computed F-statistic is greater than the upper bound critical value, then, there is a level long-run relationship among the level variables. However, if the computed F-statistic is smaller than the lower bound critical value, then, the long-run relationship among the level variables is insignificant. Meanwhile, if the computed F-statistic falls within the bounds, the result is inconclusive.

After the long-run relationship among the variables is confirmed, then, estimation on the effect of long-run independent variables on inflation can be conducted by normalizing the independent variable coefficients over the lagged dependent variable coefficient (Anno, Halicioglu, & Anno, 2015; Bahmani-Oskooee & Fariditavana, 2015; Ibrahim, 2008). In other words, the long-run effects of all variables are measured by the estimates of β_2 to β_4 normalized on β_1. Thus, from Equation (2) and (4), $\alpha_1 = -\beta_2/\beta_1$ and $\alpha_2 = -\beta_3/\beta_1$ represent the asymmetric long run OILP coefficients, while $\alpha_3 = -\beta_4/\beta_1$ is the long-run coefficient for REER. If both coefficients for the partial sums of positive and negative changes on oil prices are same in terms of sign and size, then the effects oil price on inflation is symmetric, if not, they are asymmetric. Thus, using the Wald test in Equation (4), the long run asymmetry can be performed on the null hypotheses of $H_o:\ \alpha_1 = \alpha_2 \text{ or } -\frac{\beta_2}{\beta_1} = -\frac{\beta_3}{\beta_1}$ against $H_a:\ \alpha_1 \neq \alpha_2 \text{ or } -\frac{\beta_2}{\beta_1} = -\frac{\beta_3}{\beta_1}$. Meanwhile, the test for short-run asymmetry can take one of the following forms; (i) $H_o : \theta_i^+ = \theta_i^-$ for all $i = 1,\ldots,r$ and $H_o : \theta^+ = \theta^-$ for all $i = 1,\ldots,s$ or, (ii) $\sum_{i=0}^{r} \theta_i^+ = \sum_{i=0}^{r} \theta_i^-$. This study applied general-to-specific method, so, the second method $(\sum_{i=0}^{r} \theta_i^+ = \sum_{i=0}^{r} \theta_i^-)$ is more applicable because the lag length for short-run variables will differ among variables (e.g., Delatte & López-Villavicencio, 2012; Fousekis, Katrakilidis, & Trachanas, 2016).

RESULTS AND DISCUSSION

Unit Root Tests

Both the ADF and PP unit root tests indicated that there was no variable series were integrated more than *I*(1) at the 5 per cent significance level, regardless of the constant, and the trend included in the test equations (see Table 1). Therefore, the NARDL model is appropriate to investigate the oil prices pass through to inflation as none of the variables is integrated at $I(2)$.

Results and Discussion

The optimal lag length for the NARDL method is chosen based on general-to-specific by dropping the insignificant lags using a unidirectional 5 per cent decision rule starting with maximum lag 12 (e.g., Delatte & López-Villavicencio, 2012; Fousekis et al., 2016; Shin et al., 2014). Apart from testing for the full sample, we also tested the relationship between the partial sums of the positive and negative changes in and inflation for two different periods. The first period is before the fuel subsidy rationalization (1996:M1 until 2010: M06), while the second period is after the fuel subsidy rationalization (2010:M07 until 2019:M3).

Table 2 shows the NARDL estimation results. The study results showed that there is no evidence of long-run cointegration for a full sample where the t_{BDM} and F_{PSS} tests are not significant statistically at 5% level. This implies that the effect of oil price movements on Malaysia inflation is limited for the whole sample. However, there is evidence of long-run relationship among the variables when we tested for oil price asymmetric effect for different periods of the fuel subsidy rationalisation period. Even the long-run coefficients for both partial sums of the positive and negative changes in $OILP$ are statistically significant for both periods. The results indicate that an increase and a decrease in oil prices will influence to Malaysia's inflation significantly.

The study results revealed an asymmetric effect of oil price on inflation before the fuel subsidy rationalisation period. However, there is evidence of a long and short-run asymmetric effect of oil price pass-through into inflation after the fuel subsidy rationalisation. Consistent with the previous studies, an increase of oil price has higher magnitude than a decrease on oil price (e.g., Apergis & Vouzavalis, 2018; Lacheheb & Sirag, 2018; Long & Liang, 2018) indicating the oil price asymmetric inflationary effect. With the fuel subsidy rationalisation in mid of 2010, the relationship between Malaysia's inflation and oil prices become more closely linked because of petrol price mechanism reforms. Yet, the Malaysian government still have control over domestic oil price. Therefore, when oil prices increase, the related authorities have cost pressures to fine-tune domestic oil prices, so that the firm's production cost, and then the inflation. However, when the oil prices are decreasing, some of the domestic firms have less incentive to lower domestic cost of production in line to oil prices, thus, the declining oil prices effect on inflation is smaller.

Furthermore, as expected, the money supply has a significant positive relationship with inflation for all sample period indicating an increase in money supply leads to an increase in inflation (Bala & Chin, 2018). Meanwhile, exchange rate indicated a negative relationship with inflation indicating a depreciation (appreciation) of home currency lead to an increase (decrease) in inflation in Malaysia for both before and after the fuel subsidy rationalisation period. The effect of exchange rate on inflation is consistent with some previous studies (e.g., Chen, 2009; Cheng & Tan, 2002; Jiang & Kim, 2013; Naz, Mohsin, & Zaman, 2012). For instance, Cheng and Tan (2002) highlighted that that external factors such as exchange rate are relatively more important than domestic factors in determining inflation in Malaysian.

Table 1 ADF and PP unit root tests

Variable	At Level				At First Difference			
	ADF		PP		ADF		PP	
	Constant	Trend	Constant	Trend	Constant	Trend	Constant	Trend
LNCPI	−0.7426	−3.4416	−0.9639	−3.0996**	−12.5479***	−12.5377***	−12.0859***	−12.0664***
LNMS	−2.4323	−0.0015	−2.1207	−0.3256	−14.4372***	−14.6532***	−14.5565***	−14.6517***
LNREER	−2.3996	−2.9775	−2.5306	−2.7956	−14.4042***	−14.4001***	−14.3643***	−14.3512***
LNOILP$^+$	−0.0144	−2.8214	0.1318	−2.5452	−11.2244***	−11.2076***	−11.2274***	−11.2109***
LNOILP$^-$	−1.0077	−1.2231	−0.9275	−1.4751	−15.5574***	−15.555***	−15.6444***	−15.6297***
GAP	−6.2915***	−6.2803***	−12.2198***	−12.203***	−5.0914***	−5.0808***	−39.3232***	−39.277***

Notes: *** and * denote significant at 1% and 10%, respectively. The optimal lag order is selected based on SIC in the ADF test equation. The null hypothesis for both the ADF and PP test are the series have a unit root, if the null hypothesis is rejected, we can conclude that the series is stationary.

Table 2 Asymmetric estimation results for oil prices price-through to inflation

	Full Sample (1996: M1 – 2019: M3)	Before Fuel Subsidy Rationalisation (1996: M1 – 2010: M6)	After Fuel Subsidy Rationalisation (2010: M7 – 2019: M3)
Long Run Cointegration Tests			
F_{PSS}	2.1542	8.7525***	6.3924***
T_{BDM}	−2.5456	−4.7564***	−4.8901**
Long Run Coefficients			
MS	–	0.1500[0.0371]**	0.0679[0.029276]**
REER	–	−0.1194[0.044986]**	−0.2730[0.077198]**
OILP+	–	0.0448[0.014868]**	0.0619[0.012735]**
OILP-	–	0.0459[0.018000]**	0.0216[0.011787]*
Symmetric Test			
$Wald_{LR}$	–	0.0111	38.5209***
$Wald_{SR}$	3.8543	–	8.2605**
Diagnostic Tests			
Serial correlation: LM(2)	0.7331	0.6987	2.1503
Heteroskedasticity: ARCH(2)	0.0546	0.1056	1.4550
Ramsey RESET	0.5622	3.5596**	0.2698
CUSUM	Stable	Stable	Stable

Notes: (1) ***, **and * denote significance at 1%, 5% and 10% level, respectively; (2) The lag order is between (), the standard errors are between []; (3) W_{LR} and W_{SR} refer to the Wald test for the long run and Short-run symmetry respectively. (4) F_{PSS} indicates the Paseran-Shin-Smith F test statistic (2001), and following Shin et al. (2013), the conservative of critical values is adopted, $k = 3$. The Upper bound test statistics of the critical values (Table CI(iii)) are 3.77, 4.35 and 5.61 at 10 per cent, 5 per cent and 1 per cent respectively; (5) T_{BDM} refers to Banerjee-Dolado-Mestre t-test statistic (1998). The critical value for k = 3 is 4.19 at 5% level.

CONCLUSION AND RECOMMENDATION

This study investigates the asymmetric oil price inflationary effect on Malaysia's inflation using the NARDL method in an augmented Phillips curve framework. The findings showed that the money supply and exchange rate have a significant effect on inflation. Furthermore, the findings also indicated that the effects of global oil prices on Malaysia's inflation are asymmetrical and significant, but only after the fuel subsidy rationalisation in Malaysia. The findings implied two main conclusions. Firstly, inflation in Malaysia is due to a combination of both the elements of demand-pull and cost-push inflation as indicated in Jongwanich and Park (2009). An excess of aggregate demand over existing good and services supply caused by an increase in the quantity of money supply increasing price levels. Meanwhile, under cost-push inflation, prices rise because of a rise in the raw material costs due to exchange rate and oil prices movements which are significant in this study. Thus, knowledge of factors from both theories are essential to understand the causes of inflation, especially in Malaysia for mitigation strategies. Secondly, an increase in oil price has a greater impact than a decrease in oil price on inflation, which confirms that the asymmetric oil price pass-through. It implied that an increase in oil prices will bring Malaysia's price level up significantly, while a decrease in oil prices cause smaller effects on Malaysia's inflation.

Therefore, the study findings have two main implications. The study result confirms the long-run relationship between the positive and negative components of the oil prices on inflation. Thus, the element of asymmetric effect oil prices passes through into inflation and other macroeconomic variables should not be ignored by researchers and policymakers. Secondly, even though, inflation in Malaysia is driven by demand-pull factor through rapid economic growth, it is also important to give more consideration towards oil price asymmetric effect when controlling domestic inflation through monetary and fiscal policy. The government should implement diverse monetary policy efforts to deal with the negative effect of the oil price movements after the fuel subsidy rationalisation.

Hence, monetary authorities' knowledge and understanding of the empirical association between oil prices and inflation is crucial, to maintain inflation under control to benefit all users. Besides, the knowledge will also assist the policymakers to adopt appropriate policies to accommodate the asymmetries. Besides, the government should also invest in alternative energy as well as improve energy usage efficiency, to mitigate the negative impact of oil price movements. Moreover, future research needs to investigate other possible factors with an asymmetric effect such as exchange rates is necessary.

REFERENCES

Abdul-Hakim, R., Ismail, R., & Abdul-Razak, N. A. (2014). Fuel Subsidy Rationalisation: The Perils of the Middle Class in Malaysia Roslan Abdul-Hakim* Russayani Ismail** Nor Azam Abdul-Razak**. *Jurnal Ekonomi Malaysia*, *48*(2), 83–97. Retrieved from http://www.ukm.my/fep/jem/pdf/2014-48(2)/jeko_48(2)-8.pdf

Abdul Hakim, R., Ismail, R., & Abdul Razak, N. A. (2016). Fuel Subsidy Reform in Malaysia: An Assessment on the Direct Welfare Impact on Consumers. *International Postgraduate Business Journal*, *8*(1), 26–36. Retrieved from http://oyagsb.uum.edu.my/images/2018/List_of_Issues/Fuel_Subsidy_Reform_in_Malaysia_An_Assessment_on_the_Direct_Welfare_Impact_on_Consumers.pdf

Anno, R. D., Halicioglu, F., & Anno, R. D. (2015). *An ARDL model of unrecorded and recorded economies in Turkey*. https://doi.org/10.1108/01443581011086666

Apergis, N., & Vouzavalis, G. (2018). Asymmetric pass through of oil prices to gasoline prices: Evidence from a new country sample. *Energy Policy*, *114*(November 2017), 519–528. https://doi.org/10.1016/j.enpol.2017.12.046

Atil, A., Lahiani, A., & Nguyen, D. K. (2014). Asymmetric and nonlinear pass-through of crude oil prices to gasoline and natural gas prices. *Energy Policy*, *65*, 567–573. https://doi.org/10.1016/j.enpol.2013.09.064

Baharumshah, A. Z., Sirag, A., & Mohamed Nor, N. (2017). Asymmetric Exchange Rate Pass-through in Sudan: Does Inflation React Differently during Periods of Currency Depreciation? *African Development Review*, *29*(3), 446–457. https://doi.org/10.1111/1467-8268.12280

Baharumshah, A. Z., Sirag, A., & Soon, S. (2017). Asymmetric exchange rate pass-through in an emerging market economy: The case of Mexico. *Research in International Business and Finance*, *41*(April), 247–259. https://doi.org/10.1016/j.ribaf.2017.04.034

Bahmani-Oskooee, M., & Fariditavana, H. (2015). Nonlinear ARDL approach, asymmetric effects and the J-curve. *Journal of Economic Studies*, *42*(3), 519–530. https://doi.org/10.1108/JES-03-2015-0042

Bala, U., & Chin, L. (2018). Asymmetric Impacts of Oil Price on Inflation: An Empirical Study of African OPEC Member Countries. *Energies*, *11*(11), 3017. https://doi.org/10.3390/en11113017

Banerjee, A., Dolado, J., & Mestre, R. (1998). Error-correction Mechanism Tests for Cointegration in a Single-equation Framework. *Journal of Time Series Analysis*, *19*(3), 267–283. https://doi.org/10.1111/1467-9892.00091

Barsky, R. B., & Kilian, L. (2004). Oil and the Macroeconomy Since the 1970s. *Journal of Economic Perspectives*, *18*(4), 115–134. https://doi.org/10.1257/0895330042632708

Çatik, A. N., & Önder, A. Ö. (2013). An asymmetric analysis of the relationship between oil prices and output: The case of Turkey. *Economic Modelling*, *33*, 884–892. https://doi.org/10.1016/j.econmod.2013.06.004

Chen, S.-S. (2009). Oil price pass-through into inflation. *Energy Economics*, *31*(1), 126–133. https://doi.org/10.1016/j.eneco.2008.08.006

Cheng, M. Y., & Tan, H. B. (2002). Inflation in Malaysia. *International Journal of Social Economics*, *29*(5), 411–425. https://doi.org/10.1108/03068290210423532

Choi, S., Furceri, D., Loungani, P., Mishra, S., & Poplawski-Ribeiro, M. (2018). Oil prices and inflation dynamics: Evidence from advanced and developing economies. *Journal of International Money and Finance*, *82*, 71–96. https://doi.org/10.1016/j.jimonfin.2017.12.004

Chou, K., & Tseng, Y.-H. (2011). Pass-Through of Oil Prices to CPI Inflation in Taiwan. *International Research Journal of Finance and Economics*, *69*(69), 73–83. https://doi.org/10.1111/j.1365-3156.2005.01418.x

Cunado, J., & Perez de Gracia, F. (2005). Oil prices, economic activity and inflation: Evidence for some Asian countries. *The Quarterly Review of Economics and Finance*, *45*(1), 65–83. https://doi.org/10.1016/j.qref.2004.02.003

Davari, H., & Kamalian, A. (2018). Oil price and inflation in Iran: Non-linear ARDL approach. *International Journal of Energy Economics and Policy*, *8*(3), 295–300. Retrieved from https://www.scopus.com/inward/record.uri?eid=2-s2.0-85046778854&partnerID=40&md5=779319c855ca2b3dbbeb1a017355ca16

Delatte, A.-L., & López-Villavicencio, A. (2012). Asymmetric exchange rate pass-through: Evidence from major countries. *Journal of Macroeconomics*, *34*(3), 833–844. https://doi.org/10.1016/j.jmacro.2012.03.003

Dickey, D. A., & Fuller, W. A. (1979). Distribution of the Estimators for Autoregressive Time Series With a Unit Root. *Journal of the American Statistical Association*, *74*, 427–431. https://doi.org/10.2307/2286348

Fousekis, P., Katrakilidis, C., & Trachanas, E. (2016). Vertical price transmission in the US beef sector: Evidence from the nonlinear ARDL model. *Economic Modelling*, *52*, 499–506. https://doi.org/10.1016/j.econmod.2015.09.030

Globerman, S., & Bruce, H. (1976). Inflation and the price of oil in Canada. *Energy Policy*, (22), 1975–1977. Retrieved from http://www.sciencedirect.com/science/article/pii/0301421576900446

Gómez-loscos, A., Montañés, A., & Gadea, M. D. (2011). The impact of oil shocks on the Spanish economy. *Energy Economics*, *33*(6), 1070–1081. https://doi.org/10.1016/j.eneco.2011.05.016

Granger, C. W. J., & Yoon, G. (2002). *Hidden Cointegration*. Retrieved from https://escholarship.org/uc/item/9qn5f61j

Ibrahim, M. H. (2008). The Exchange-Rate Exposure of Sectoral Stock Returns: Evidence From Malaysia. *International Journal of Economic Perspectives*, *2*(2), 64–76. Retrieved from http://search.ebscohost.com/login.aspx?direct=true&db=bth&AN=35860136&site=ehost-live

Ibrahim, M. H. (2015). Oil and food prices in Malaysia: a nonlinear ARDL analysis. *Agricultural and Food Economics*, *3*(1), 1–14. https://doi.org/10.1186/s40100-014-0020-3

Ibrahim, M. H., & Said, R. (2012). Disaggregated consumer prices and oil price pass-through: Evidence from Malaysia. *China Agricultural Economic Review*, *4*(4), 514–529. https://doi.org/10.1108/17561371211284858

Istiak, K., & Alam, M. R. (2019). Oil prices, policy uncertainty and asymmetries in inflation expectations. *Journal of Economic Studies*, *46*(2), 324–334. https://doi.org/10.1108/JES-02-2018-0074

Jiang, J., & Kim, D. (2013). Exchange rate pass-through to inflation in China. *Economic Modelling*, *33*, 900–912. https://doi.org/10.1016/j.econmod.2013.05.021

Jongwanich, J., & Park, D. (2009). Inflation in developing Asia. *Journal of Asian Economics*, *20*(5), 507–518. https://doi.org/10.1016/j.asieco.2009.07.004

Lacheheb, M., & Sirag, A. (2018). Oil price and inflation in Algeria: A nonlinear ARDL approach. *Quarterly Review of Economics and Finance*. https://doi.org/10.1016/j.qref.2018.12.003

Long, S., & Liang, J. (2018). Asymmetric and nonlinear pass-through of global crude oil price to China's PPI and CPI inflation. *Economic Research-Ekonomska Istrazivanja* , *31*(1), 240–251. https://doi.org/10.1080/1331677X.2018.1429292

Mandal, K., Bhattacharyya, I., & Bhoi, B. B. (2012). Is the oil price pass-through in India any different? *Journal of Policy Modeling*, *34*(6), 832–848. https://doi.org/10.1016/j.jpolmod.2012.06.001

Narayan, P. K. (2005). The saving and investment nexus for China: Evidence from cointegration tests. *Applied Economics*, *37*(17), 1979–1990. https://doi.org/10.1080/00036840500278103

Naz, F., Mohsin, A., & Zaman, K. (2012). Exchange rate pass-through in to inflation: New insights in to the cointegration relationship from Pakistan. *Economic Modelling*, *29*(6), 2205–2221. https://doi.org/10.1016/j.econmod.2012.07.012

Pesaran, M. H., Shin, Y., & Smith, R. J. (2001). Bounds testing approaches to the analysis of level relationships. *Journal of Applied Econometrics*, *16*, 289–326. https://doi.org/10.1002/jae.616

Phillips, P., & Perron, P. (1988). Testing for a unit root in time series regression. *Biometrika*, *75*, 335–346. https://doi.org/10.1093/biomet/75.2.335

Salisu, A. A., Isah, K. O., Oyewole, O. J., & Akanni, L. O. (2017). Modelling oil price-in fl ation nexus : The role of asymmetries. *Energy*, *125*, 97–106. https://doi.org/10.1016/j.energy.2017.02.128

Salisu, A. A., Ndako, U. B., Oloko, T. F., & Akanni, L. O. (2016). Unit root modeling for trending stock market series. *Borsa Istanbul Review*, *16*(2), 82–91. https://doi.org/10.1016/j.bir.2016.05.001

Sek, S. K. (2017). Impact of oil price changes on domestic price inflation at disaggregated levels: Evidence from linear and nonlinear ARDL modeling. *Energy*, *130*, 204–217. https://doi.org/10.1016/j.energy.2017.03.152

Shin, Y., Yu, B., & Greenwood-Nimmo, M. (2014). Modelling Asymmetric Cointegration and Dynamic Multipliers in a Nonlinear ARDL Framework. In & W. H. R. Sickels (Ed.), *Festschrift in Honor of Peter Schmidt: Econometric Methods and Applications* (pp. 281–314). Springer.

Tang, W., Wu, L., & Zhang, Z. (2010). Oil price shocks and their short- and long-term effects on the Chinese economy. *Energy Economics*, *32*, S3–S14. https://doi.org/10.1016/j.eneco.2010.01.002

Trang, N. T. N., Tho, T. N., & Hong, D. T. T. (2017). The impact of oil price on the growth, inflation, unemployment and budget deficit of Vietnam. *International Journal of Energy Economics and Policy*, *7*(3), 42–49. Retrieved from https://www.scopus.com/inward/record.uri?eid=2-s2.0-85025082475&partnerID=40&md5=0422e36aa5c261e737cbd485ccce73aa

Zhao, L., Zhang, X., Wang, S., & Xu, S. (2016). The effects of oil price shocks on output and inflation in China. *Energy Economics*, *53*, 101–110. https://doi.org/10.1016/j.eneco.2014.11.017