A Dynamic Analysis of Oil Prices and Inflation Model and Method

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Abstract- The study examines the impact of oil prices on inflation by applying a threshold model for five (5) ASEAN members, namely Malaysia, Indonesia, Singapore, Thailand and the Philippines. Three (3) indicators for oil price shocks are extracted in conjunction with Mork [23], Lee et al. [22] and Hamilton [13] methods. Consequently, these values are used to delineate the effect of price shock differentials. The pass-through effect is integrated into the threshold equation model. Later, the model is calculated to have an impact on inflation of high and low oil prices. The result is that the oil price shock appears to have a major impact on inflation when prices are in the high regime. This extends to all shock measures. The effective exchange rate and industrial price index (IHP) are classified as the primary determinant of inflation in all sample countries. As such, counter-cyclical monetary policy considerations should remain driven by the emerging downside risks of oil price shocks. It requires a more accommodative monetary environment to offset inflationary pressures on the domestic economy.

Keywords- Inflation; Oil Prices; Pass-Through Effect; industrial price index (IHP); Domestic economy.

I. INTRODUCTION

For ASEAN member countries, oil is the key source of energy for sectoral development, such as transport and industrialisation. A series of energy crises that occurred in the 1980s created a great deal of instability in world oil prices. For example, there has been an upward trend in oil prices between 2000 and 2008. The price rose from USD25 per barrel to almost USD150 per barrel. By comparison, at the end of February 2016, there was a decrease below USD35 per barrel in 2014. This is attributed, in particular, to the economic giant, China, as a result of world economic slowdown. A variety of studies have been performed on the transmission process as a result of oil price shocks on macro-economic variables. These studies focused on the effects that could have on multiple channels and sources of shock. Kilian [21] addressed at length the cause and impact of the oil price shock. The research explores both the direct and indirect effects of the shock on the demand and supply side of the economy. On the supply side, rising oil prices contribute to higher cost of production as oil serves as a primary input into the production process (as an energy source and/ or input factor for petroleum products) [3]. In the end, higher manufacturing costs are passed on to higher retail product and service prices.

As for demand, rising and falling oil prices will impact consumer buying pattern. The spike in oil prices is the result of a rise in sales tax [11]. Effect – the consequence of which is a drop in demand for goods and services. In India, a situation where the country faces the challenge of both declining demand for consumption and investment, rising oil prices and passing through them in the form of rising overall prices may further deepen the crisis [32]. As a rise in price increases, there is some aspect of uncertainty about the future prospects of the economy [29], [4] discusses the effects of oil price spikes in the years 2003-2008. This study coincides with the crises of 1973 and 1978-1980. In the midst of both crises as a result of OPEC's supply response, both crises were accompanied by a significant increase in demand. Essentially, the effect of an increase in oil prices on inflation is receding. Crises, however, have led to so much volatility in demand and supply as a result of rising and falling world oil prices. Economists also noticed that unexpected fluctuations in oil prices have a huge effect on economic fundamentals. Increased oil prices have a huge effect on unemployment and inflation [5]. Segal [27] argued that the demand-driven phenomenon is now more important than it was in the 1970s and 1980s. For example, Hooker [15] suggests that the impact of oil prices on inflation declined in the early 1980s and that the strength of power and the abolition of price controls had not delineated the phenomenon. The line of argument is backed by the finding of Nordhaus [24]. The study using data from 2002-2206 shows no evidence of a rise in the price of oil on the general price and the wages. A relatively recent finding offers some evidence either that the impact is diminishing or that there is no association

between the passing of oil prices and inflation [18]. The need for a prudent monetary policy that handles the early signs of the price-wage cycle as a result of oil market fluctuations has helped to explain the situation well.

There are studies that report the opposite [25], [19] and [8]. Just to state a few). Ibrahim [16], for instance, on the relationship between oil prices and food prices for the period 1971 to 2012 using the non-linear ARDL mode, suggests the existence of a long-run relationship between rising oil prices and food price index. Nonetheless, there is not any relationship detected when the oil prices fall. Parallel with previous studies, Sek et al. [28] has compared the effect of oil prices on two set of different countries with respect to oil dependency index. It is reported that there exists an evidence of pass-through effect. The study also adopted the similar method. On the one hand, it indicates that changes in oil prices affect the inflation directly for low oil dependency countries. On the other hand, the indirect effect on inflation as a result of changes in oil prices, is reported for high oil dependency nations. In addition, this effect gets in through production cost for exports. Essentially, these studies suggest that rising and falling oil prices impact inflation differently. Although rising oil prices have a major positive impact on inflation in all situations, falling oil prices are either negligible or negatively affect inflation.

Using wavelet consistency technique for co-movement and causality, on oil exporting economy, Tomiwa [30] suggests a positive co-movement between inflation and oil prices at scale 4-8 between 2014M2 and 2017M1. The causality is from oil prices to inflation. In another occasion, applying the similar technique on Central and Eastern European countries, Dejan Živkov et al. [9] recorded that transmission of oil price increases to inflation is relatively low in Central and Eastern European countries as a 100% rise in oil prices is followed by an increase in inflation of 1–6 percentage points. For most countries, the greatest influence of rising oil prices on inflation is seen for longer time horizons, indicating the indirect spill-over effect is more severe than the direct one. Slovakia and Bulgaria are the countries with the highest and most stable pass-through impact in the observed study, and this could be attributed to countries with the highest oil over GDP ratios.

The great majority of previous studies on the issue centre on either the developed countries or oil exporting nations. Just to state more recent studies, for instance, Adekoya and Adebiyi [1] have confirmed the presence of oil-price-inflation nexus asymmetries in the OECD countries. As such, recommend a proper account of oil price asymmetries for a stronger inflation outlook. Istiak and Alam [17] examined the possible asymmetrical effect of oil prices and economic policy uncertainties on inflation expectations. The study describes asymmetrical effects of oil prices and policy uncertainties on inflation perceptions for positive and negative shocks and pre-and post-financial crisis cycles. A comparable magnitude of the oil price shock has a greater effect on inflation expectations in the post-crisis period than in the pre-crisis period. Moreover, a positive upward oil price shock affects inflation expectations more than a negative downturn in oil prices in the post-crisis era. The results support Fed's increased focus on stabilising demand after the financial crisis. The move has reduced inflation expectations. However, a sudden increase in oil prices can easily trigger inflation through inflation expectations. The study uses the asymmetric-impulse test of Kilian and Vigfusson [21] to investigate asymmetry on the US economy. In addition, Nusair [25] provides strong evidence of long-term asymmetry for the GCC (Gulf Cooperation Council) countries.

On the other hand, there are relatively few studies on ASEAN nations, such as Chang and Wong [7] and Ahmed and Wadud [2]. Although former research on oil price shocks on Singapore's economic performance indicates the existence of asymmetrical oil price shocks on inflation and the output of industries in Malaysia. The study uses the EGARCH conditional volatility model and suggests that oil price volatility is a second significant factor that explains the difference in industrial output.

The influence of oil price shocks on inflation in ASEAN countries is an important problem. The reliance and severity on output as well as on consumption differs in each of the Member States. For example, as oil exporting nations, Malaysia and Indonesia, trade would gain if there is a rise in world oil prices. However, with less oil production, both Malaysia and Indonesia would need to rely on oil imports. For Thailand, Singapore and the Philippines, their yields are either minimal or zero for Singapore. As a result, reliance on oil imports is inevitable. The condition in which they were vulnerable to the adverse effects of oil price shocks. Previous research offers proof of the asymmetrical relationship between oil prices and inflation. There is proof that the relationship is different in a situation of higher and lower oil prices. The question is, given the multitude of differences and similarities between ASEAN member countries, can the impact of asymmetry be sustained? In what price circumstances will the impact of changes in oil prices change the course of the relationship?

Respectively, the analysis may relate in a variety of ways to the existing literature; (i) this review uses three (3) asymmetric indicators for the oil price shocks of Mork's [23], Lee et al. 's [22] and Hamilton's [13]. Three (3) steps were implemented in the approximate threshold model. They help to distinguish the asymmetric reaction of oil price shocks to inflation. Specifically, in the event of a rise and decrease in oil prices; and (ii) estimate the passing-through impact of oil price shocks on inflation using the Hansen [14] threshold model. Such adaptation is of great help in the study of the long-term relationship between oil price fluctuations and inflation. The serious aspect of the model is its ability to establish the nature of the relationship with changes in oil prices.

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As such, this paper is structured as follows; the second section describes the oil sector in ASEAN countries; the third part explains the methodology and the source of the data for the report. The fourth part outlines the results of the study and the fifth section addresses the result and the policy consequences.

II. OIL SECTOR IN ASEAN

ASEAN, as a nation, is home to 641 million people. This is 8.5 per cent of the world's population. Growth in the various industries contributes to an increase in energy demand. ASEAN en bloc is expected to become a net oil importing nation. In this decade alone, their oil production and consumption gap has increased by about 89.8 per cent. Few ASEAN countries remain oil importers. At the same time, some challenges lie ahead. The South East Asia Energy Outlook 2017 reported that the decrease in domestic oil production and the increase in demand have led to an increase in net imports. This increase is expected to exceed USD 300 billion by 2040. This amounts to about 4 per cent of ASEAN's total GDP. Oil is expected to be the single largest energy import with net imports of approximately 6.9 mb/d in 2040. It is equivalent to about USD280 billion by 2040. Respectively, with the continuous increase in demand for oil coupled with a fall in production, ASEAN considers itself to be a net oil importing nation by 2040.

Table 1. Production, consumption and production – oil consumption gap (thousand tonnes), 1990-2015 for five (5) ASEAN countries

Country	Year	1990	1995	2000	2005	2010	2015
Malaysia	Production	30029	33904	29796	34905	31099	31368
	Consumption	889	1518	1890	1969	482	703
	Gap	29140	32386	27906	32936	30617	30665
Indonesia	Production	70778	77961	68938	51452	45707	38054
	Consumption	1231	2412	4097	2500	3156	1437
	Gap	69547	75549	64841	48952	42551	36617
Singapore	Production	0	0	0	0	0	0
	Consumption	50	93	78	56	623	891
	Gap	-50	-93	-78	-56	-623	-891
Thailand	Production	2129	2638	5286	9176	12445	12426
	Consumption	2165	3787	3046	2421	898	603
	Gap	-36	-1149	2240	6755	11547	11823
The Philippines	Production	236	130	57	792	991	768
	Consumption	2340	3450	2628	1858	1308	978
	Gap	-2104	-3320	-2571	-1066	-317	-210

Source: International Energy Agency (2018).

In addition, the 5th ASEAN Energy Outlook Report of the ASEAN Energy Centre (ACE) announced a rise from 68 Mtoe in 2015 to 472 Mtoe by 2040. The rise is primarily due to the transport sector. The contribution of oil to the overall energy supply in 2015 is 409 Mtoe and is projected to remain in the country by 2040. Around the world, ASEAN has had the least of its oil reserves since 2016. In addition, there is none that dominates oil production in the region. Indonesia, the largest oil producer in ASEAN, is showing a downward trend in its production. In January 2018, Indonesia's oil reserve dropped from 4.4 billion barrels in 2006 to 3.6 billion barrels. Its production of crude oil is 881 000 barrels per day, BP Statistical Analysis of World Energy, 2017.

The production-consumption difference for selected five (5) ASEAN countries is shown in Table 1. There is a growing trend for Singapore. The negative gap represents the country's overall reliance on oil imports. Indonesia and Malaysia, on the one hand, are seeing a decline in the divide. This is due to the collective efforts of countries to reduce their level of oil dependence. Thailand, on the other hand, displays an upward trend with an increase in oil consumption. The Philippines, just as it retains its position as a net oil importing country. The difference is negative and the consumption of oil remains high. As a result of the depletion of the oil reserve and the decline in its level of supply, oil production is no longer able to compensate for an increase in its demand. Naturally, ASEAN is expected to be a net importing nation in the near future. Their economy is expected to be impacted by a sustained decline in demand, combined with ups and downs in the price of oil on the international market. On May 22, 2018, the price of crude oil was USD80.49 per barrel. It has been the highest since 2014, ASEAN Energy, 2018. Energy crisis is unavoidable, unless ASEAN reduces its reliance on oil. For its members that have been net oil-importing countries, an increase in oil prices leads to a rise in import expenditure. Such a surge causes an increase in domestic prices.

In this study, the percentage of oil rent in the country's gdp is used as a measure of natural abundance. In essence, it reflects the contribution of the oil sector to an economy. Figure 1 shows the share of oil rents in gdp of four (4) asean countries, except Singapore (no domestic oil production). In 2011 to 2014, oil prices rose by more than usd 100 per barrel. This enables it to contribute to gdp of approximately 4.3 to 6.3 and 2.0 to 2.9 per cent, respectively, for the two oil-exporting countries of Malaysia and Indonesia. However, for the period 2011 to 2016, the share of oil rent shows a decreasing trend for all four (4) countries (see Figure 1). This is commensurate with the steady decline in oil prices (brent oil price sold at USD 111.26 per barrel in 2011 and fell to USD 36.8 per barrel in August 2015) [6] Oil exporting countries are expected to benefit from the rise in oil prices as a result of the contribution of the sector to GDP.

III. DATA AND METHODOLOGY

The research uses quarterly time-series data from 1990:1 to 2018:1. This includes the recent increase in the price of crude oil in 2018 and the sequence of price decline series since 2014:3. The macro-economic data for the model calculation are the Consumer Price Index (CPI), the Actual Effective Exchange Rate (REER), the Producer Price Index (PPI) and the Gross Domestic Product (GDP). All data are taken from International Finance Statistics (IFS). The Brent Crude is used to calculate oil price shocks. All data are recorded in the respective local currencies and in the logarithmic form.
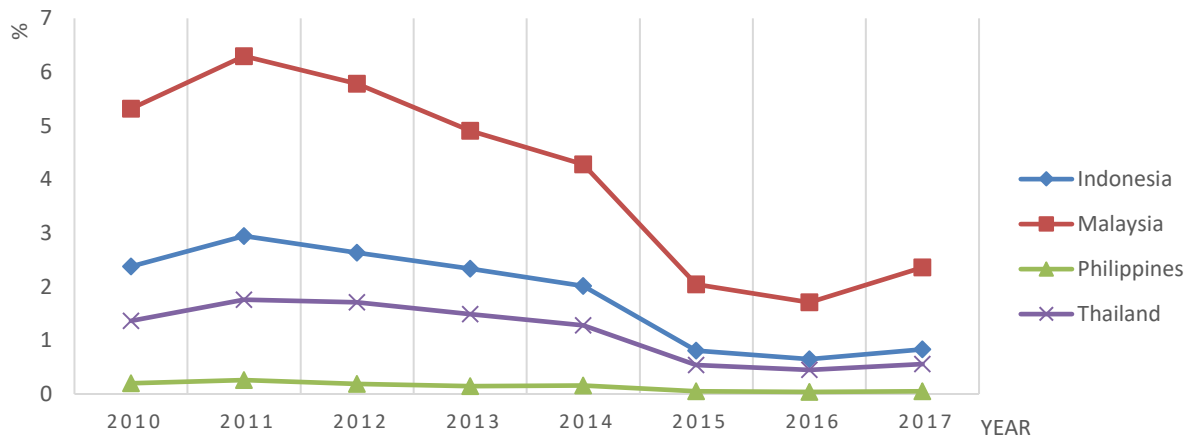

Fig 1. Oil rent (% of GDP)

IV. MEASURE OF OIL PRICE SHOCKS

The study uses three (3) non-linear transformation measures of oil prices for the effect differences in the oil price shocks. These measures have been adopted from the works of Mork ([23], Lee et al. [22], and Hamilton [13]. In the Mork's [23] specification, the non-linear response of oil prices is modelled as a change in real oil prices. Specifically, rise and fall are known to be two (2) distinct variables. In short, Mork has differentiated the positive (+) and the negative (-) change of oil prices as follows:

$$MORK_t^+ = \max\ (\,0, (ROIL -\ \ ROIL_{t-1})) \qquad\qquad [1]$$

$$MORK_t^- = \min\ (\,0, (\ ROIL_t -\ \ ROIL_{t-1})) \qquad\qquad [2]$$

As for Lee et al. [22], the AR (4)-GARCH (1, 1) model was used to represent the conditional variance that serves as a proxy for changes in real oil prices. Their results indicate that the effect of the oil price shocks on real GDP is greater, in contrast to the dysfunctional environment, given the stable oil price environment. The model AR (4)-GARCH (1, 1) used is as follows:

$$\Delta ROIL_t =\ \beta_0\ +\ \beta_1\,\Delta ROIL_{t-1}\ +\ \beta_2\,\Delta ROIL_{t-2}\ +\ \beta_3\,\Delta ROIL_{t-3}\ +\ \beta_4\,\Delta ROIL_{t-4} + \varepsilon_t \qquad [3]$$

$\varepsilon_t|\,I_{t-1}\sim\ N(0, h_t\,)$

$$h_t = \gamma_0 + \gamma_1 e_{t-1}^2 + \gamma_2 h_{t-1} \qquad [4]$$

$$SOPI_t = \max\left(0, \frac{\hat{e}_t}{\sqrt{\hat{h}_t}}\right) \qquad [5]$$

$$SOPD_t = \min(0, \hat{e}_t/\sqrt{\hat{h}_t}) \qquad [6]$$

Hamilton [13] uses the net oil price rise (NOPI) as an explanatory variable to calculate oil price shocks. It is computed as the price of oil in the quarter t, $ROIL_t$, which exceeds the maximum value of the last four quarters. The value is 0 otherwise. Accordingly, by adopting the Hamilton scale, the analysis uses net oil price increase (NOPI) and net oil price decrease (NOPD) as a price shock indicator. Specifically written as follows:

$$NOPI_t = \max\{0, ROIL_t - \max\{ROIL_{t-1}, ROIL_{t-2}, ROIL_{t-3}, ROIL_{t-4}\}\} \qquad [7]$$

$$NOPD_t = \min\{0, ROIL_t - \min\{ROIL_{t-1}, ROIL_{t-2}, ROIL_{t-3}, ROIL_{t-4}\}\} \qquad [8]$$

Pass-through Model and Threshold Model
The effect of the pass-through of oil prices on the consumer price index of a country is based on the exchange rate (EPRT) passing-through effect. The EPRT is one of the key factors that explains the transfer of shocks in an open economy. Lafleche [25] offers a figure illustrating the mechanism for the reaction of domestic prices to exchange rate depreciation. The EPRT equation was used by Sek and Kapsalyamova [28] to calculate the effect of the exchange rate adjustment on inflation in a country based on a single price term. Sek et al. [28] therefore amended the EPRT equation for the study of changes in oil prices on domestic inflation. The pass-through effect of oil prices (OPTE) calculates the percentage change in the consumer price index as a result of a one per cent rise in oil prices. Centred on the ERPT equation used by Sek et al. [28], this study adapts the EPRT equation to the logarithmic transformation form as follows:

$$CPI_{it} = \alpha_1 GDP_{it} + \alpha_2 PPI_{it}^{US} + \alpha_3 REER_{it} \qquad [9]$$

where, CPI is used as a proxy for domestic import rates, GDP as a proxy for the markup price, the US PPI as a cost indicator for foreign producer and the real exchange rate (REER) is used to reflect the exchange rate. The EPRT model is then rewritten as a threshold effect model. The use of the variable oil price shocks is used to examine the effects of the shocks on inflation.

This paper adapts the threshold effect model of Hansen's [14] to analyse the effects of oil price shocks. The threshold effect model, assuming that only one threshold is given as follows;

$$y_t = \begin{cases} x_t\beta + z_t\delta_1 + \varepsilon_t & \text{if} -\infty < w_t < \gamma \\ x_t\beta + z_t\delta_2 + \varepsilon_t & \text{if } \gamma < w_t < -\infty \end{cases} \qquad [10]$$

where y_t denotes the dependent variable, CPI_{it}; x_t represents covariate vector $1 \times k$, β is for a vector of control parameters $k \times 1$. There exist three (3) control variables; namely, GDP_{it}, PPI_{USt} dan $REER_{it}$. z_t stands for vector of exogenous variables with coefficients δ_1 and δ_2. This vector represents three (3) different shocks in oil prices namely, of Mork's [23], Lee et al's [22] and Hamilton's [13]. It measures the positive change (increase in price) and negative change (decrease in price). The w_t symbolizes the threshold variable, that is, value of real crude oil in USD. The value is determined according to changes in the threshold value. The random ε_t is assumed independently and normally distributed with 0 mean and constant variance σ^2; that is, $(\varepsilon_{it} \sim iid(0, \sigma^2))$.

The original model of Hansen [14] is based on the premise that there is only one threshold value. To allow for more than one value for the threshold, the model with model with m+1 regions is used. With the assumption that there exists more than one threshold value; that is, j = 1,...., m+1, the model is rewritten as follows:

$$y_t = x_t\beta + z_t\delta_1 I_1(\gamma_1, \omega_t) + \ ..... + z_t\delta_{m+1}I_m(\gamma_{m+1}, \omega_t) + \epsilon_t \qquad [11]$$

$$y_t = x_t\beta + \sum_{j=1}^{m+1} z_t\delta_j I_j(\gamma_j, \omega_t) + \epsilon_t \qquad [12]$$

where, $\gamma_1 < \gamma_2 < \ldots\ldots < \gamma_m$ is the value of the threshold with $\gamma_0 = -\alpha$ and $\gamma_{m+1} = \alpha$. The $I_j(\gamma_j, \omega_t) = I(\gamma_{j-1} < \omega_t \leq \gamma_j)$ is the indicator for the region j_{th}. In equation (10), $\gamma_1^* \ldots \ldots \gamma_m^*$ denotes the presence of threshold value up to m in the estimated equation. The threshold value (γ_1^*) is estimated with the assumption that the model is divided into two (2) regions as explained in equation [10]. Next, the second threshold value is estimated when the minimum sum of squared residual (SSR) exceeds all observations in ω_t, excluding the first threshold value. Estimated value for the second threshold value γ_2^* is determined through minimizing the least square regression with three (3) existing regions of thresholds. The optimal threshold values are determined according to the BIC. The value of which is derived from the SRR model as follows; $BIC = T\ln(SSR = T) + k\ln(T)$ where k is the number of parameters in the model.

V.   RESULT OF THE ANALYSIS

Table 2 shows the unit-root test for the variables in the study, both at level and first difference. The critical values of 10 per cent, 5 per cent and 1 per cent indicate the significance level for the rejection of a null hypothesis of the presence of unit-root in the model. The panel test of unit-root as illustrated in Table 2 shows all variables in the model are integrated at first difference I(1). In general, most of the variables are found to be non-stationary at level I(0) except for the oil price shocks variable. Largely, the stationarity is achieved at their first difference. For the shock variable, the stationary at level is attributable to the process of generating its values from the original form. Shocks are defined as the difference between the current price and the previous price before the prescribed measure is applied.

Table 2. Unit-root test

Variable	GDP	CPI	REER	PPI
At level				
Im, Pesaran and Shin w-stat	0.81877	-0.44558	-0.92660	-0.25150
ADF - Fisher Chi-square	4.53538	11.0282	11.9567	7.78012
PP - Fisher Chi-square	7.27011	5.25355	13.3875	6.88299
First difference				
Im, Pesaran and Shin w-stat	-5.52048***	-2.95395***	-9.01595***	-15.2189***
ADF - Fisher Chi-square	57.4394***	38.6512***	118.775***	178.502***
PP - Fisher Chi-square	242.494***	46.0700***	234.136***	159.378***

Note: 1. All variables are in logarithmic form and in real term.
      2. *** indicates significance level at 1 per cent.

This paper also tests the asymmetrical relationship based on threshold autoregressive model (TAR) used by Enders and Siklos [10]. For it measures the symmetrical relationship among co-integrated series. The results are summarised in Table 3 which shows a rejection of null hypothesis. A proof of a presence of asymmetric relationship. As the value of F-equal for the TAR model exceeds the critical value at 5 per cent. This is achieved after 10, 000 rounds of simulations. Evidently, the finding of asymmetric relationship between oil prices and inflation is consistent with that of Ghosh dan Kanjilal's [12] which argues that negative oil price shocks affect inflation due to the AD-AS gap.

Table 3. Symmetrical test and co-integration (TAR), Enders dan Siklos [10]

Asymmetric specification	Asymmetric test ($p_1 = p_2$)		Asymmetric co-integration test ($p_1 = p_2 = 0$)	
	F-equal	Critical value	F-joint	Critical value
Mork	5.686	3.836**	7.474	6.561**
Lee et al.	11.741	3.962**	9.796	6.549**
Hamilton	4.004	3.941**	5.972	6.505

Note: Critical value for simulation is 5 per cent
      Number of simulations: 10000
      ** indicates significance at 5 per cent level.

Futhermore, Table 4, shows the threshold effect applied to test the presence of threshold value in the model. Based on the test, the value of F statistic is smaller than its critical value at all 1, 5 and 10 per cent. This situation suggests that there is only one threshold value for both Mork's and Lee's et al. models. Unfortunately, the F value for the Hamilton specification cannot be generated due to lack of information on the model.

The results of the estimation of the threshold models are summarized in Table 5. The findings are that, the rise in price of oil poses a significant negative effect on inflation, provided that the oil price is lower than the threshold value of USD47.7, USD50.5, and USD47.7 per barrel as stated by Mork's, Hamilton's and Lee's et al. specifications (Regime 1). Meanwhile, the rise in oil prices (ROIL+) raises inflation dramatically if the price of oil reaches the threshold value (Regime 2). This relationship is consistent with all three (3) measures of shocks in oil prices used. Besides, the oil price in the reduction specification (ROIL-) for the Regime 2 also positively affects the inflation for the Mork's and Lee's et al. measures. This situation shows that, as oil prices reach the threshold values of USD47.7, USD50.5 and USD47.7 per barrel, it signifies that oil prices are high amid the downward trend.

Table 4. Threshold test

One threshold value	F-stat	Critical value 10%	Critical value 5%	Critical value 1%
Mork	24.02	38.15	48.73	70.10
Hamilton	n./a	n/a	n/a	n/a
Lee et al.	27.17	33.58	42.92	58.06
Model linear	9.61	9.95	13.28	25.41

Table 5. Estimation of threshold effect model

Specification	Mork	Hamilton	Lee	Linear model
Threshold value	Threshold value real oil price (USD)			
Single threshold	47.7	50.5	47.7	81
(Low, High)	(45, 47.8)	(48.8, 50.6)	(46, 48.5)	(71.7, 81.1)
	Regressor Regime Threshold effect			
	Coefficient value	Coefficient value	Coefficient value	Coefficient value
Regime 1				
Price Increase (ROIL+)	-4.842 (0.002)*** (MORK+)	-11.50 (0.000)*** (NOPI)	-1.078 (0.000)*** (SOPI)	-2.398 (0.000)*** [log ROIL]
Price Decrease (ROIL-)	1.396 (0.302) (MORK-)	0.899 (0.591) (NOPD)	-0.158 (0.462) (SOPD)	
Regime 2				
Price Increase (ROIL+)	4.969 (0.001)*** (MORK+)	7.153 (0.002)*** (NOPI)	0.675 (0.011)** (SOPI)	3.419 (0.029)** [log ROIL]
Price Decrease (ROIL-)	4.315 (0.000)*** (MORK-)	2.544 (0.162) (NOPD)	0.495 (0.008)*** (SOPD)	
	Regressor Estimation			
	Coefficient value	Coefficient value	Coefficient value	Coefficient value
REER	-11.92 (0.000)***	-12.01 (0.000)***	-11.51 (0.000)***	-12.56 (0.000)***
PPI	-13.27 (0.000)***	-13.52 (0.000)***	-13.42 (0.000)***	-13.42 (0.000)***
GDP	4.29 (0.000)***	4.61 (0.000)***	4.28 (0.000)***	4.75 (0.000)***
Observation	560	545	540	560
R^2	0.625	0.623	0.629	0.610

Note: ***, **, * indicate significance at 1 per cent, 5 per cent and 10 per cent level.

The results for the estimated regressors show that the key determinants; namely REER, PPI for the US and GDP are significantly influenced the inflation in all the pricing specifications used. The REER and PPI of the US are found to have a negative effect on the inflation. The rise in GDP leads to an increase in domestic price. As indicated in the theory, all regressors display the predicted signs.

VI. CONCLUSION

This research has analysed the non-linear (asymmetric) relationship between oil price shocks and inflation in five (5) selected ASEAN members; namely Malaysia, Indonesia, Thailand, the Philippines and Singapore. With the use of panel data of those countries for 1990:1 to 2018:1, estimation has been conducted using the pass-through effect of oil prices on inflation. Equations for the pass-through effect of oil prices are adapted in the estimation of threshold effect model mooted by Hansen [14] for the identification of the threshold values. The values of which later used to seek answer on the relationship between oil price shocks and inflation. Based on the Mork's, Hamilton's and Lee's et al [22]. specifications that help measuring the shocks, the results of the analysis confirm the presence of one threshold value (and 2 regimes). The value of USD47.7 per barrel is relevant to Mork's and Lee's et al [22]. specification, while, the USD50.5 per barrel shows relevance for the Hamilton's specification. Finding reveals that oil prices asymmetrically impact inflation. Based on the results, inflation rate responds negatively as a result of changes in oil prices provided the oil price increases (ROIL+), when the price below USD47.7 and USD50.5 (Regime 1). Nevertheless, the rise in oil price will have a positive impact on inflation when the price exceeds USD47.7 and USD50.5 (Regime 2). The positive response of inflation as a consequence to a change in oil prices also happens when the oil price falls. In addition, it signals that when the price of oil exceeds the threshold value, then the fall in price may trigger the rise in inflation. These findings are consistent with Sek's et al. [28] which shows that the rise in oil prices leads to higher production cost. Indirectly, it brings about pass-through effect on level of domestic inflation. Futhermore, the findings are also in support of Ghosh dan Kanjilal's [12]. Specifically, it shows an asymmetric relationship between oil prices and inflation in India. In addition, the finding also proves that the negative price shocks on inflation is far obvious than that of the positive shocks. Based on the findings, there are several policy implications worth noting. First, the policy maker needs to seriously weigh the effect of oil prices particularly when the price is high as it will lead to higher production cost and triggers the rise in domestic price. Second, the policy maker should actively control the REER through a continuous exchange rate and monetary policy as it influences the domestic inflation. Olaniyi Evan [26] has provided an evidence on the presence of petro-monetary transmission mechanism in particular in oil-producing Nigeria on domestic inflation. In addition, suggesting not only managing the interest rate but also the exchange rate to cushion the adverse impact of oil prices. In another occasion, Wang et al. [31] suggest that monetary policy should concentrate on core inflation rather than headline inflation. Further, argue that the use of both non-core monetary policy and core monetary policy on inflation, simultaneously bound to fluctuations in oil prices. As it is perceived to be inferior to monetary policy strictly linked to core inflation. Furthermore, the growth in GDP should be monitored as the increase in AD and AS deem to contribute to a rise in price as shown in the previous studies [20], [27] which show that the effect of oil prices is more on demand driven as compared to the effect on the supply side.

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