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ABSTRACT

This paper examines the dynamic effects of oil price, aggregate demand and aggregate supply shocks on output and inflation in four small developing economies using a structural VAR model. For all countries, despite finding the expected response of output to oil price shocks, an upward causal effect of oil price innovations on the domestic price level is established which adversely accompanies the growth stimulating effects in oil-exporting countries. This paper also finds asymmetric effects of oil price changes on macroeconomic variables in all sample countries. Finally, our empirical results find two further things: firstly, that for Malaysia, Pakistan and Thailand, nominal demand and supply shocks are the main sources of fluctuations in inflation and output respectively, whereas for Indonesia the converse holds and secondly that whilst the 1998 recession was largely induced by only supply and demand shocks the recession of 2008-09 could potentially be explained by oil price changes.

Key words: Macroeconomic fluctuations, Oil price, Structural VAR models, Asian developing economies

JEL Classification Numbers: C32, E31, E32, F41, O40, O53

1. INTRODUCTION

In the existing literature, the relationship between changes of oil price (OP) and macroeconomic fluctuations has been intensively discussed (e.g., Abeysinghe, 2001; Bjornland, 2000; Hamilton, 1983, 1996, 2003, 2009 and 2011; Kilian, 2008 and 2009; Kilian and Vigfusson, 2013; Mork, 1989). A large amount of empirical evidence supports the existence of a causal relationship from OP changes to output fluctuations (Cunado and Perez de Gracia, 2003; Jimenez-Rodriguez and Sanchez, 2005) and also in the variations of domestic aggregate price level (Barsky and Kilian, 2004; Elder and Serletis, 2010; Rotemberg and Woodford, 1996). The seminal contribution in this area is credited to Hamilton (1983), the empirical work shows that the OP shocks contribute to some recessions in the US before 1972, but not necessarily lead a recession. In alignment with the previous finding, Hamilton (1996) claims a non-linear relationship between OP and output. More precisely, OP increases (whether the OP has exceeded the maximum OP in recent years) are believed to be more important than OP decreases in predicting output growth, as suggested by Hamilton. Elder and Serletis (2010) find that the volatility of the OP has statistically significant negative effects on output: exacerbates the negative impact to a negative OP shock and dampens the impact to a positive OP shock. The recent work of Kilian and Vigfusson (2013) states that the OP is not helpful for out-of-sample forecasting in the asymmetry nonlinear models, but useful in symmetric nonlinear models. It is possible to forecast the 2008-09 recession by using the latter.

Conventional wisdom suggests that the correlation between OP shocks and macroeconomic fluctuations comes from a set of fundamental shocks, which hit all sectors of the economy. A large number of studies has focused on identifying the source of that shocks. The seminal ideas come from Hamilton (1983) and Kilian (2009), who focus on the demand and supply side respectively. Both authors provide extraordinary explanations and rigorous proofs. Hamilton believes that oil supply shocks, usually caused by a shortfall of OPEC oil production due to political events in the Middle East, has a major role in explaining the dynamics of OP and real GDP movements. However, Kilian (2009) believes that oil demand and speculative OP shocks linked with global economic activity have being the major driving force of oil price fluctuations since 1973.

The variations of OP are expected to have very different effects on oil-importing and oil-exporting countries. Brown *et al.* (2004) show that increased OP has a similar effect to a tax, which is collected by oil-exporting countries from oil-importing countries. Most of the empirical studies mainly related to developed economies have confirmed that OP changes have a negative effect on output growth in oil-importing countries (e.g., Jimenez-Rodriguez and Sanchez, 2005; Schneider, 2004; Schubert and Turnovsky, 2011). Increases in OP and the resultant instability affect the economy through higher input costs, reallocation of resources, decreases in income and depreciation of currency. As a result, economic performance is depressed while inflation and unemployment are raised. A sudden increase in the OP causes an exogenous inflationary shock as high OP puts pressure on the general price level, and leads to higher interest rates. The former is very likely lead to a recession. Other studies (e.g., Bjornland, 2000) indicate that an increase in OP is associated with higher growth in net oil-exporting countries through increased state revenue, which leads to higher national income and currency appreciation. Bjornland (2009) states that high OP also affects oil-producing countries through negative trade effects by rising inflation and since oil-importing countries suffer from oil induced recession and therefore demand fewer exports from oil-exporting countries. For those oil-exporting countries with a large export sector, the negative trade effect may indeed off-set the positive wealth effect, which leaves the net effect ambiguous.

The recent experience in Asian countries somehow forms the hypothesis of non-negligible effects of OP shocks on economic fluctuation under some circumstances. Cunado and Perez de Gracia (2005) investigate potential impacts of OP on economic activity and consumer price indexes for six Asian countries and they find that results are sensitive to the choice of the OP (domestic or international). The short-run effects of OP on economic growth and inflation are statistically significant. Spikes in OPs prior to the global crisis led to high inflation rates in most South and South East Asian countries evidenced by double-digit figures. The inflationary pressures also induced large budget deficits and balance of payment concerns. Lescaroux and Mignon (2009) and Tang *et. al.* (2010) both find negative effects of OP on macroeconomic variables in China. However, in the recent work of Schubert and Turnovsky (2011), the evidence shows that recent OP shocks have a tempered effect on economic activity on developing countries compared with those in 1970s and 1980s.[1] One obvious explanation would be the fall in both proportion and influence of oil in the economy due to more credible policy response, more flexible labour market and appearance of oil substitutes.

[1] See Blanchard and Gali (2008) for a detailed review.

Mork (1989), Lee et al. (1995) and Hamilton (1996) introduced asymmetric specifications of the OP to reconstruct the relationship between OP and economic performance. It has been asserted in the literature that the relationship between OP shocks and macroeconomic variables is non-linear and many studies have suggested the possibility of an asymmetric impact of OP shocks on macroeconomic variables (Mork, 1989; Lee and Ni, 2002; Jimenez-Rodriguez and Sanchez, 2005; Hamilton, 2009 and 2011; An et al., 2014, Kilian and Vigfusson, 2011). According to these studies, the negative effects of higher OPs are greater than the positive effects of lower OPs in oil-importing countries. On the other hand, Moshiri (2015) examines the asymmetric effect of OP shocks on macroeconomic performance in the nine major oil-exporting countries using a VAR model. He finds that the negative OP shocks have damaging impacts on output of oil-exporting countries, however positive OP shocks do not stimulate output.

The main contribution of this paper is to extend the existing empirical literature in two directions. Firstly, we investigate the linear effects of OP shocks, in addition to nominal AD and AS shocks, on output and inflation in four Asian developing countries: Indonesia, Malaysia, Pakistan and Thailand. The reason behind our investigation of these countries is that there is little previous evidence on the effects. Secondly, we investigate the asymmetric effects of OP by using a non-linear method, namely the asymmetric specification. The conjecture is that positive oil price shocks could have larger effects on growth and that negative oil price shocks do not substantially affect growth for oil-importing countries (and vice versa for oil-exporters). The study uses a structural VAR approach, which imposes both short-run and long-run restrictions to identify different structural shocks and to carry out both linear and non-linear models.

Indonesia is the largest oil producer in Southeast Asia and is also a major oil-exporter during the period analysed due to its considerable oil reserves. According to the World Bank, Indonesian exports account for about 40% of GDP. Malaysia has the third highest oil reserves of the Southeast Asian countries but its net oil-exports are very small due to the small gap between domestic production and demand. Thailand produces some oil domestically, however it is still a significant oil-importing country due to the large domestic demand of oil. In Thailand, two thirds of oil demand is imported from abroad, which accounts for a large proportion of GDP. Pakistan is also an oil-importing country since it has limited domestic oil reserves and relies heavily on imports. However, Pakistan demands the smallest amount of oil among the four sample economies. Oil-importing developing economies are generally considered highly vulnerable to external shocks, and prominent among these is volatility in the OP because an OP increase transfers income from countries with a higher propensity to consume to countries with lower propensity to consume. Given the above facts about production and demand, this study will consider Indonesia and Malaysia as oil-exporting countries, and Pakistan and Thailand as oil-importing countries.

Although Indonesia and Malaysia are net oil-exporters, due to the exhaustion of oil fields and the lack of investment in exploration of oil, the economy experienced stagnant oil production. Consequently, the oil market is relatively tight due to the small gap between domestic production and oil demand. It is interesting to investigate the impact of the OP on countries which are in the process of transforming themselves from net-exporters to net-importers. For all sample countries, governments provide subsidies on the OP in order to reduce the adverse effect of OP shocks on real economic activities. Consequently, when the international OP rose from 50 dollars per barrel in 2007 to 140 dollars per barrel in 2008 a significant budget deficit was induced. According to the World Bank (2013)[2], the ratios of government budget deficit to GDP increased from -0.08% to -1.6% in Indonesia, -4.6% to -6.7% in Malaysia, -3.9% to -7.2% in Pakistan and -1.3% to -4.8% in Thailand after the 2008 recession. In the past three decades, these countries have experienced an increased demand for energy, particularly for oil following the deepening of economic development. There has recently been a period of negative growth which was dominated by the global financial crisis and also with the adverse effect of an OP shock. Identifying and understanding the effects of various shocks on macroeconomic fluctuations in the sample countries, particularly the effects of OP shocks, could provide some policy recommendations for regional co-operation in the Asian-Pacific area. This could help to minimize negative influences from global economic fluctuations and achieve macroeconomic stability for sustainable growth and development.

The rest of the paper is organised as follows. Section 2 introduces a theoretical model with separated OP shocks in addition to AD and AS shocks. The empirical methodology and estimation results are reported in Section 3. Finally, a few concluding remarks are provided in Section 4.

2. THEORETICAL MODEL

[2] http://siteresources.worldbank.org/DEC/Resources/84797-1154354760266/2807421-1382041458393/9369443-1382041470701/Oil_Price_Volatility.pdf

The theoretical framework in this paper is a modified AD and AS model. The effects of different structural shocks on macroeconomic variables have been modelled explicitly.

The Lucas supply curve (Lucas, 1972 and 1973) with rational expectations can be defined as:

$$y_t^s = \bar{y}_t + \alpha[p_t - E_{t-1}(p_t \mid \Omega_{t-1})] \tag{1}$$

where AS y_t^s, is a function of natural rate of output $\bar{y}_t$ and the difference between actual domestic price level p_t and its expectation given all available past information Ω_{t-1}. Taking the expectation conditional on time *t*-1 and rearranging Eq. (1) gives:

$$y_t^s = E_{t-1}(y_t \mid \Omega_{t-1}) + \alpha[p_t - E_{t-1}(p_t \mid \Omega_{t-1})] + \eta_t \tag{2}$$

where η_t represents productivity shock, which can be further decomposed into a supply (defined as domestic supply) shock and an OP shock (see Bjornland, 2000).

$$y_t^s = E_{t-1}(y_t \mid \Omega_{t-1}) + \alpha[p_t - E_{t-1}(p_t \mid \Omega_{t-1})] + \varepsilon_t^s + \beta\varepsilon_t^{op} \tag{3}$$

Eq. (3) describes the AS curve where output increases as a result of an unpredicted increase in price levels, an OP shock ε_t^{op} and a positive realization of the AS shock ε_t^s. High OPs are considered as technology shocks, which reduce output level through increasing production cost in oil-importing countries. In another words, the oil price affects the supply side of the economy by increasing the cost of inputs and necessitating a rearrangement of resources, thus leading to lower GDP.[3] Oil price hikes may add to inflationary pressures and reduce real incomes and, as a result, consumer expenditure will be compressed. Furthermore, real output may also be affected in the face of weaker domestic demand and reduced company's profitability. Research's finds that OP affects output and price levels, and the lower level of demand can be counteracted through the corresponding monetary policies implemented by the central banks (Hamilton, 1996, Hamilton, 2003 and Hooker, 2002). High OPs affect the economy of oil-importing countries through increased marginal costs and inflation. It is therefore expected that $\beta < 0$ for oil-importing countries. In contrast, oil-exporting countries will respond to the same shock positively ($\beta > 0$) due to an increase in national income

[3] Brown *et al.* (2004) argues that rising OPs decrease purchasing power and consumer demand in oil-importing economies, and that the opposite should be expected for oil-exporting nations.

through greater oil export revenue. This is especially applicable to those oil-exporting countries where the oil sector is large compared with the rest of the economy.

The demand curve can be expressed as:

$$y_t^d = m_t - p_t + \gamma op_t \tag{4}$$

where AD, y_t^d, is a function of literal money m_t, domestic price level p_t and oil price op_t. Similarly as for the supply side, taking expectations conditional on time $t-1$ and rearranging Eq. (4) gives,

$$y_t^{\,d} = E_{t-1}(y_t \mid \Omega_{t-1}) - [p_t - E_{t-1}(p_t \mid \Omega_{t-1})] + \varepsilon_t^d + \gamma \varepsilon_t^{op} \tag{5}$$

Eq. (5) explains that AD equals its expected value given the information available at the end of period *t-1*, plus the effect of an OP shock ε_t^{op} and nominal demand (defined as a price shock) shock ε_t^d. Oil price fluctuations can also affect the economy through the demand side via the income effect. Spikes in the OP will shift income from oil-importing countries to net oil-exporting countries. Therefore, in each category we would expect gamma γ to be less than 0 and greater than 0 respectively.

The economy is in equilibrium when,

$$y_t^s = y_t^d = y_t \tag{6}$$

Hence we have,

$$p_t = E_{t-1}(p_t \mid \Omega_{t-1}) - \left(\frac{1}{1+\alpha}\right)\varepsilon_t^s + \left(\frac{1}{1+\alpha}\right)\varepsilon_t^d + \left(\frac{\gamma-\beta}{1+\alpha}\right)\varepsilon_t^{op} \tag{7}$$

$$y_t = E_{t-1}(y_t \mid \Omega_{t-1}) + \left(\frac{1}{1+\alpha}\right)\varepsilon_t^s + \left(\frac{\alpha}{1+\alpha}\right)\varepsilon_t^d + \left(\frac{\alpha\gamma+\beta}{1+\alpha}\right)\varepsilon_t^{op} \tag{8}$$

Following Bjornland (2000), we assume that world OP can only be affected by shocks to oil demand and oil supply, while other factors (such as political events) are considered as exogenous to the OP.[4] Hence,

[4] In particularly, our sample countries are small economies. Hence, this is a reasonable assumption.

$$op_t^w = op_{t-1}^w + \varepsilon_t^{op} \quad (9)$$

The early studies included Blanchard and Gali, 2010; Bjornland, 2000; Hamilton, 1983, 2003; Jimenez-Rodriguez and Sanchez, 2005; Schmitz el al, 2007; Tang, 2010 who regard OP changes ~~are~~ as exogenous to the contemporaneous value of macroeconomic variables. Furthermore, they prove that oil shocks affect macroeconomic variables whereas changes in these variables cannot affect OP which is exogenously determined by the world's demand and supply shocks. The reason behind this is that OP has been dominated by political events like the OPEC embargo in 1973, the Iranian revaluation in 1978-1979, the Iran-Iraq War in 1980-81, the Gulf War in 1990-1991, and increasing demand confronting declining world production in 2003-2008.

Eqs. (7) - (9) give us the structural form model in the paper. Each structural shock (OP shock, ε_t^{op} , AD shock, ε_t^d and AS shock, ε_t^s) is a white noise and they are assumed to be uncorrelated with each other. In the short run, OP, AS and AD shocks affect the output level due to nominal and real inflexibilities as exhibited in Eq. (8). In alignment with Blanchard and Quah (1989), we assume AS shocks have permanent effect on output level, while AD shocks only affect output level in the short run. The OP shocks are assumed to be exogenous, which is consistent with the recently work of Kilian and Vigfusson (2013).

3. EMPIRICAL METHODOLOGY AND RESULTS

3.1 Data Description

In this section we investigate the response of different types of shocks into four Asian countries. The data used in this study is real OP, real GDP and consumer price index (CPI) for 4 sample economies: Indonesia, Malaysia, Pakistan[5] and Thailand.[6] For all countries,

[5] For Pakistan, quarterly data series for GDP are not publish or are not available for a longer period of time. The industrial production index is used as a proxy of the real GDP. The quarterly series for the industrial production is downloaded from *IMF*, *IFS*, 2015. Although, industrial production data for Pakistan is available before 1990 but in order to be consistent with other countries we consider it from 1990.

[6] Data are downloaded from the International Monetary Fund (IMF), International Financial Statistics (IFS), Edition: July 2015. The real *GDP* series are based on authors' calculation from the GROSS DOMESTIC PRODUCT (GDP) (Units: National Currency; Scale: Billions) and GDP DEFLATOR (2005=100) for two countries except Indonesia, where the consumers' price index, CPI, has been used as the deflator. . The domestic nominal OP series is calculated from PETROLEUM AVERAGE CRUDE PRICE (Units: US Dollars per Barrel) converted to each country's national currency. For Malaysia and Thailand, the real OP is computed from deflated by implicit consumer price index, while for Indonesia and Pakistan, where the CPI has been used as the

quarterly GDP data is not available for an extended period of time and therefore, the sample starts at the earliest available date. The time-spans differ across countries depending on the availability of data: Indonesia (1990q1 to 2015q4), Malaysia (1991q1-2015q4), Pakistan (1990q1-2015q4) and Thailand (1993q1-2015q4). The data are transformed by taking logarithms.

3.2 Empirical Model and Estimation Results

As shown in Appendix A, Table A1, the unit root tests (both Augmented Dickey Fuller and Phillips Perron tests) indicate that none of these three series are stationary, so that all of them are differenced before estimation. Before proceeding further, a few pre-estimation tests are conducted. As exhibited in Appendix A, Table A2, we use the approach introduced by Zivot and Andrews (1992) to test the null of unit root against structural break-stationary alternative hypothesis. Furthermore, we test the OP growth, inflation and GDP growth data with several unit root tests with structural breaks in essentially trend-stationary series, namely, ERS-P_T Elliott-Rothenberg-Stock, NP-MZα Ng-Perron, SKP-MSB Silvestre-Kim-Perron, SKP-MZ_T Silvestre-Kim-Perron and PP- Zα Phillips-Perron[7].The results indicate that all of these three series are stationary at first difference for each country (see Appendix A, Table A2). The results are consistent with the conventional unit root test without structural breaks. For all countries, the break period for each series is reported in table Appendix A, Table A2. The Johansen test of cointegration is performed next to the level series with appropriate assumptions on trends and lags to check whether the variables are cointegrated in each country (see Appendix Table A3). Generally speaking, there is no cointegration evidence among three series in any country.[8]

Notice, then, that we are modelling the rate of growth of GPD and OP as well as inflation. A reduced-form VAR (k) model is fitted to the stationary data where the a priori assumption of weakly exogenous OP is imposed. Therefore, denoting the lower case names of the variables as the log-transformed values of oil prices (op), GDP (y) and CPI (p), the model used for estimation is

deflator. The CPI series are given as follows: CPI:17 CAPITAL CITIES (Indonesia), CPI PENINSULAR MALAYSIA (Malaysia), CPI:12MAJOR CITIES ALL INC. (Pakistan), CPI: URBAN (Thailand).

[7] Ng-Perron (2001) proposed four test statistics that are based upon the GLS-detrended data.

[8] Both the trace and maximum eigenvalues test statistics indicate no cointegration at the 0.05 level for Indonesia, Malaysia and Pakistan, while at the 0.01 level for Thailand.

$$
\begin{aligned}
\Delta op_t &= a'_1 \mathbf{x}_{1t} + \sum_{j=1}^{k} a_{11j} \Delta op_{t-j} + e_t^{op} \\
\Delta y_t &= a'_2 \mathbf{x}_{2t} + \sum_{j=1}^{k} a_{21j} \Delta op_{t-j} + \sum_{j=1}^{k} a_{22j} \Delta y_{t-j} + \sum_{j=1}^{k} a_{23j} \Delta p_{t-j} + e_t^{s} \\
\Delta p_t &= a'_3 \mathbf{x}_{3t} + \sum_{j=1}^{k} a_{31j} \Delta op_{t-j} + \sum_{j=1}^{k} a_{32j} \Delta y_{t-j} + \sum_{j=1}^{k} a_{33j} \Delta p_{t-j} + e_t^{d}
\end{aligned}
\quad (10)
$$

where $\boldsymbol{x}_{jt}$ (j=1,2,3) is a vector containing deterministic variables used to model variable j. This vector contains a constant that accounts for the possibility of the presence of a deterministic time trend in the growth of the variables and a set of intervention variables to account for the structural breaks suggested by the stationarity tests commented above[9]. More detailed information regarding the estimation results can be obtained from the authors on request. The exogeneity property of OP growth is manifested in the first equation of system (10) as GDP growth and inflation do not affect OP, which is driven only by its past dynamic. To validate the exogeneity assumption of the OP, we perform a Granger causality test to examine whether the lagged values of growth and inflation have explanatory power on OP growth and the results are reported in Appendix A4. The results show that OP is not affected by real GDP for all countries. The finding is consistent with previous studies such as Bjornland (2000) and Tang (2010). Furthermore, inflation does not Granger cause OP for Indonesia and Pakistan but for Malaysia and Thailand the exogeneity condition for OP is valid only at 1% level of significance.

The model can be written in compact form as

$$\Delta \boldsymbol{z}_t = \boldsymbol{A_0} \boldsymbol{x}_t + \sum_{j=1}^{k} \boldsymbol{A}_j \Delta \boldsymbol{z}_{t-j} + \boldsymbol{e}_t \ , \quad (11)$$

where $\boldsymbol{z}_t = (op_t,\ y_t,\ p_t)'$ and $\boldsymbol{e}_t = \left(e_t^{op},\ e_t^{s},\ e_t^{d} \right)' \sim N(\mathbf{0}, \boldsymbol{\Omega})$, where $\boldsymbol{\Omega}$ is a positive definite matrix containing the variance and covariances of the errors of the reduced form model. Estimation of this model is performed using the *JMulTi* software[10] and EViews. Summarized estimation results are shown in Table 1[11]. The first two rows indicate the number of effective observations used in estimation and the autoregressive order used in each model. For all countries the optimal lag selected by the Bayesian Information Criteria indicates a large value of 2. The next two rows indicates the value of the multivariate Box-Pierce portmanteau test

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[9] The results are not reported but up to request.
[10] Free software available for download at http://www.jmulti.de/, accompanying Lüktepohl (2006).
[11] Estimation has been performed also using annual data for Pakistan and results seem to be robust.

for autocorrelation along with the corresponding p-values, indicating that there is no significant correlation left in each model.

[TABLE 1]

Table 1: Model Estimation Results

	Indonesia	Malaysia	Pakistan	Thailand
N	104	100	104	92
K	2	2	2	2
Q	152.02	126.09	115.51	151.57
p-val (Q)	0.09	0.58	0.91	0.10
M-JB	216.30	376.01	19.02	20.96
p-val (JB)	0.00	0.00	0.00	0.00
λ_{max}	0.52	0.58	0.59	0.51
$\lvert\widehat{\boldsymbol{\Omega}}\rvert$	2.40e-9	5.65e-11	2.58e-09	1.26e-10
Llik	544.12	693.83	551.82	599.68

Next, the multivariate Jarque-Bera test indicates departure from the assumption of normality of the residuals. However, given the good fit of the model, and that there are not significant outliers left unmodelled, we consider the estimates satisfactory. The maximum eigenvalue of the autoregressive polynomial (λ_{max}) indicates no problem of persistence or cointegration as tested initially using Johansen's cointegration tests (see Appendix B). Finally, the value of the likelihood function, the determinant of the covariance matrix and the Akaike and Bayesian Information Criteria are also reported. Estimates have been checked for robustness indicating stability of the estimates.

The impulse-response analysis is performed using the Wold decomposition as

$$\Delta \boldsymbol{z}_t = \boldsymbol{C_0}\boldsymbol{x}_t + \boldsymbol{e}_t + \sum_{j=1}^{\infty} \boldsymbol{C}_j \boldsymbol{e}_{t-j} , \quad (12)$$

where $(\boldsymbol{I_3} - \boldsymbol{A}_1 L - \cdots - \boldsymbol{A}_k L^k)^{-1} = \boldsymbol{I_3} + \sum_{j=1}^{\infty} \boldsymbol{C}_j L^j$ and L the lag operator. The convergence of the multivariate polynomial is assured in the studied cases by the stability of the estimated VAR models. Notice that the elements of the vector of errors $\boldsymbol{e}_t$ are contemporaneously correlated so that a shock in one variable ($e_{jt} \neq 0$) implies an instantaneous shock in the rest of variables. To avoid this problem and obtain isolated shocks on each variable, an orthogonalization of it is needed in order to obtain the impulse responses. This model is denoted as the Structural VAR(k) model and its (structural) shocks $\boldsymbol{\varepsilon}_t = (\varepsilon_t^{op},\ \varepsilon_t^{s},\ \varepsilon_t^{d})'$ contemporaneously uncorrelated. Here we denote ε_t^{op} the structural shock of OP, ε_t^{s} is interpreted as an AS shock and ε_t^{d} as AD shock. The identification of the structural *VAR* model (or the orthogonalization of the reduced form errors) can be achieved in various ways; here we follow the Blanchard and Quah (1989) method which consists of setting a set of restrictions on the matrix of long run effects as

$$\boldsymbol{e}_t = \boldsymbol{C}(1)\boldsymbol{\varepsilon}_t = \begin{bmatrix} c_{11} & c_{12} & c_{13} \\ c_{21} & c_{22} & c_{23} \\ c_{31} & c_{32} & c_{33} \end{bmatrix} \begin{pmatrix} \varepsilon_t^{op} \\ \varepsilon_t^{s} \\ \varepsilon_t^{d} \end{pmatrix} \quad (13)$$

According to the theoretical model in Eq. (9), real OP are free from domestic demand and supply shocks, i.e., the contemporaneous effects of AS and AD shocks on OP are zero. Therefore, we have 2 more restrictions: zero short-run restrictions on OP, $c_{12} = c_{13} = 0$. Finally, we impose a long-run restriction (Blanchard and Quah, 1989), where AD shocks have no long-run effects on the growth of output, $c_{23} = 0$. For simplicity the structural shocks are normalized to have unit variance so that, denoting $\boldsymbol{C}_0^*$ the restricted matrix, then $cov(\boldsymbol{e}_t) = \boldsymbol{C}_0^*\boldsymbol{C}_0^{*\prime}$.

To account for asymmetric effects, this study separates OP innovations into positive and negative parts following Mork (1989)[12]. Mork (1989) introduces an asymmetric concept of OPs and proposes to separate positive from negative OP changes. He indicated that there is an asymmetry effect of OPs on macroeconomic variables. He confirmed that positive OP shocks have a significantly negative impact on GDP while negative OP shocks have no significant effects for oil-importing countries. He defines positive and negative quarterly OP ($\Delta \mathrm{OP}_t^+$ and $\Delta \mathrm{OP}_t^-$ respectively) changes in the following ways;

$$\Delta \mathrm{OP}_t^+ = \max\left[0, \left(\mathrm{OP}_t - \mathrm{OP}_{t-1}\right)\right] \quad (14)$$

$$\Delta \mathrm{OP}_t^- = \min\left[0, \left(\mathrm{OP}_t - \mathrm{OP}_{t-1}\right)\right] \quad (15)$$

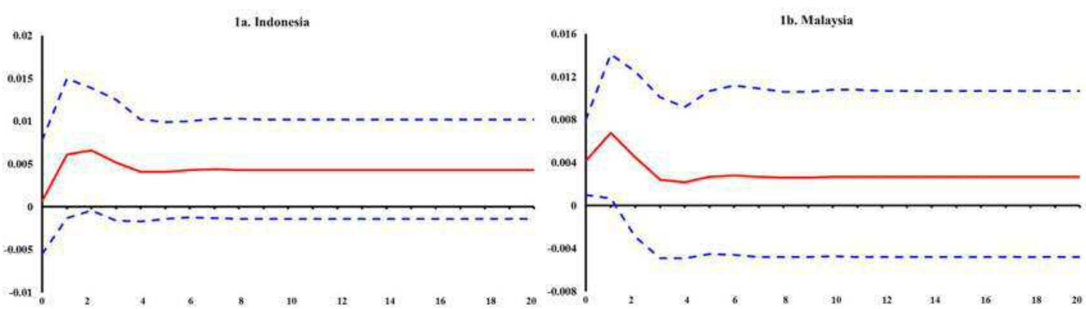
[12] The approaches of Hamilton (1996) and Lee et al. (1995) are not used due to the current size of the paper and also due to the facts that the results used by Mork's approach are more explanatory.

3.3 Impulse Response Analysis: Linear Specification

The accumulated response of each variable to a shock of magnitude equal to two standard deviation confidence interval (dashed line) is plotted in Figures 1 to 6. Generally speaking, OP shocks seem to have some long-run effects on the output growth in the four sample economies, but the magnitudes are not comparable with the AS shocks. The OP shocks have, as expected, a positive effect on the growth of output and inflation in Indonesia and Malaysia, although the effect is insignificant as growth is raised by only 0.5% and 0.8% after the shock for Indonesia and Malaysia respectively ,[13] see figure 1a-1b[14]. This positive output response is consistent with the conventional wisdom that an increase in OPs leads to a rise in the revenue and income of oil-exporting countries (see Ito (2008), Bjornland (2000) and Rautava (2004). However, the confidence interval confirms that after the first quarter OP shocks have a negligible effect on output in the long-run. This may be because Indonesia recently experienced an increase in the production dependency on oil and has a high share of oil in the consumption bundle. In addition, the Indonesian economy has experienced stagnant oil production when compared to demand due to the exhaustion of old oil fields and lack of investment in exploration for oil reserves. Hence, an increasing OP may have a negligible positive effect on its output.

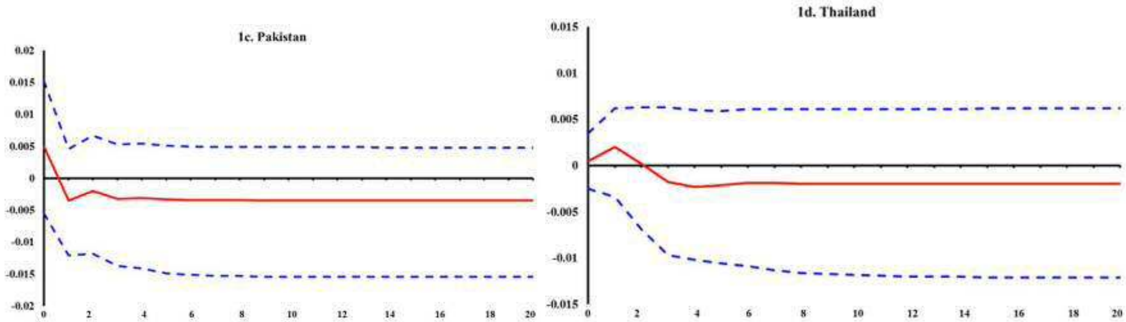
[FIGURE 1]

Figure 1: Accumulated Effects of OP Shocks on GDP Growth



[13] This result contradicts that of Salim and Rafiq (2011) findings where OP shocks tend to lower GDP in Indonesia and Malaysia.

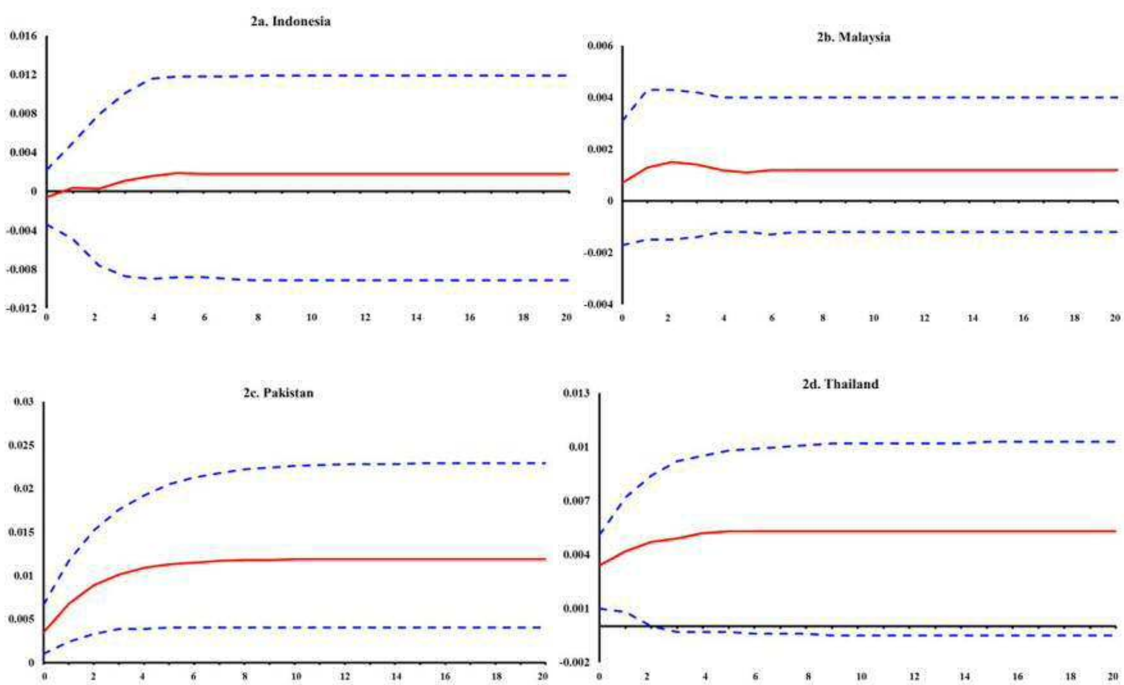
[14] According to Hsing (2012), OP shocks would not damage the output of Indonesia because this country produces most of its oil to meet the domestic consumption.



As an oil-importing country, OP shocks have a negative and permanent effect on the output of Pakistan, where growth decreased by 0.3% after the shock. This may be caused by the recent move towards oil dependent production and the fact that Pakistan imports around 80% of its domestic demand. The confidence intervals (see figure 1c) verify that the effect on output of OP shocks is not significant in Pakistan.

[FIGURE 2]

Figure 2: Accumulated Effects of OP Shocks on inflation

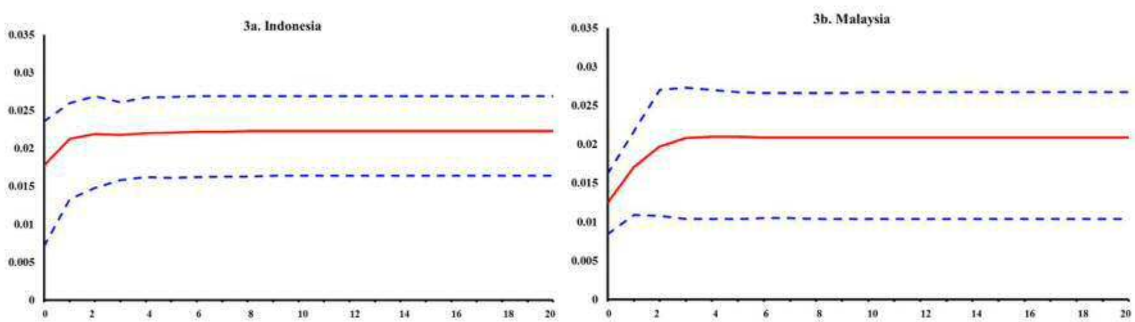


For oil-importing countries like Thailand, OP shocks have a negative but insignificant effect on the growth of output, where the negative response of output to OP shock is about 0. 8% (figure 1d). The reason behind the small damage of OP on GDP may be because Thailand produces a sizeable amount of oil which meets some part of domestic demand even though it is a net oil-importing country. Furthermore, the Thai government not only subsidizes OP but also promotes exports, which brings a massive amount of trade surplus. Furthermore, the negligible response of output to OP shocks (in Thailand) is also affected by the pattern of international trade. Abeysinghe (2001) argues that a higher OP can affect open economies directly and indirectly on which the indirect effect runs through trading partners of the economy. During the bad period, a part of trade surplus can be used to overcome the increased world OP. The crucial domestic demand could be autarkic. It should also be noted that if data from longer periods are available, the long-run output response may well be revealed as negative in alignment with the expectations for oil-importing countries in theory.

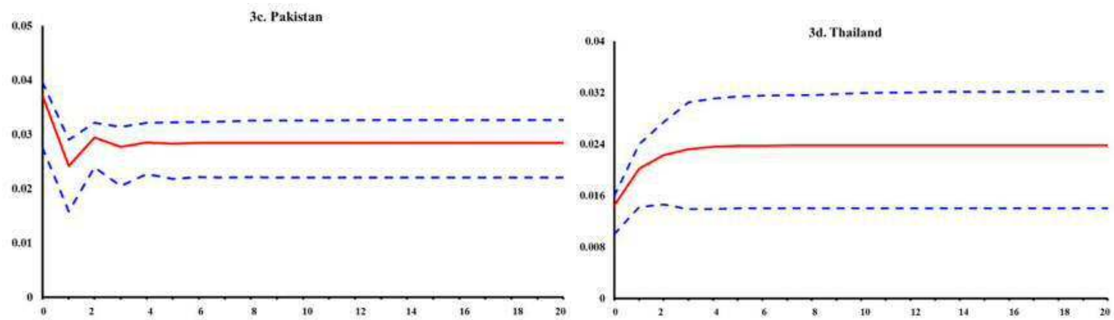
Oil price shocks have positive effects on domestic prices, which cause inflation in all countries. As expected, we find that the oil-importing countries (Pakistan and Thailand) experience a significant boost in inflation after an OP shock as reported in figures 2c-2d, because a higher OP leads to an increase in the cost of production. In contrast, oil-exporting countries are responding to the same shock positively due to an increase in national income through greater oil-export revenue, which implies that high OP increases the growth of demand from oil producers. However, as indicated in figure 2a-2b, the response of domestic price growth to OP shocks is negligible for Indonesia and Malaysia, which can be attributed to the response of exchange rates, which tend to appreciate in oil-exporting countries, exerting a non-significant effect on inflation[15].

[FIGURE 3]

Figure 3: Accumulated Effects of AS Shocks on Output Growth



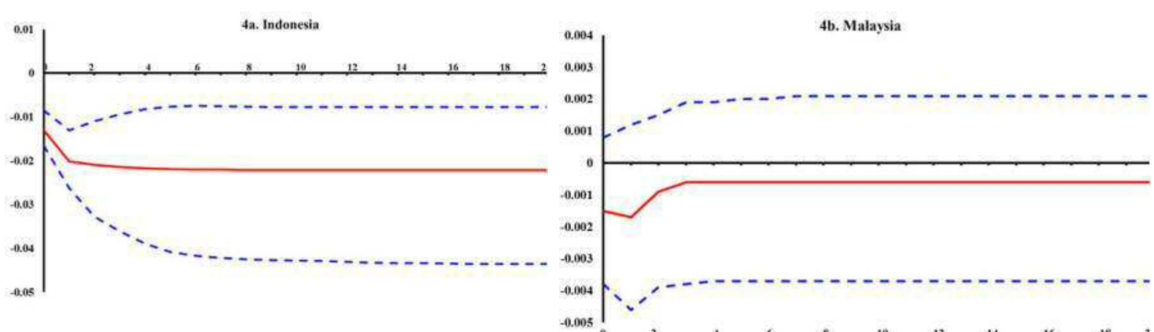
[15] See Baumeister et al. (2010).

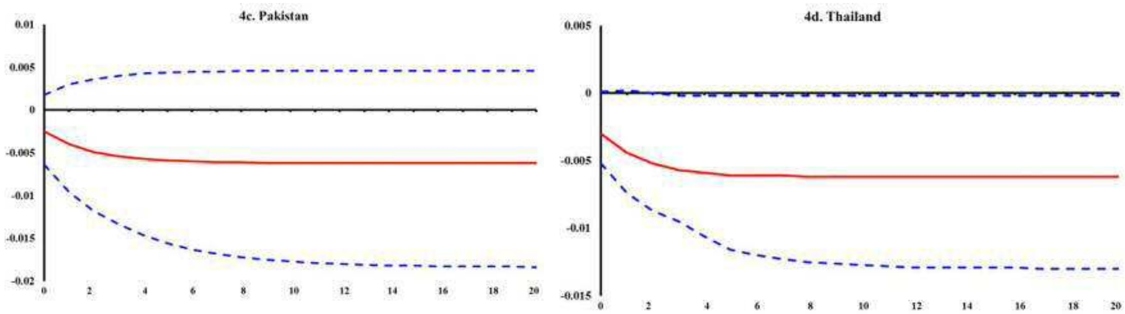


As expected, the reaction of output to AS shocks is positive and permanent in all countries (see figure 3). The impact of a productivity shock vary from 2.2% to 3.8%. However, the immediate reactions to AS shock fluctuate from period to period for each economy. The positive effects become stable after 4 quarters for all countries. On the other hand, the AS shocks have a relatively stable negative impact on price growth in all investigated countries (figure 4). In Indonesia, the cumulative negative response of domestic price growth reaches a trough after 1 quarter (around 2%) and becomes stable after 12 quarters at 4%. In Pakistan, the domestic price growth is reduced by 0.5%. The AS shocks have a significantly negative effect on domestic prices and cause deflation in Thailand. The price response to the AS shock are relatively smaller in Malaysia when compared to the other three countries. This is perhaps due to the fact that productivity growth in the tradable sector causes high domestic AD (higher export) as a result of less deflation. Demand (inflationary) shocks have a significantly positive effect on the output in all countries, but the positive effect gradually decreases and dies out after 10 quarters. In the long-run, the response of GDP to inflationary shocks disappears in all countries, which is consistent with the theoretical expectations and restrictions (e.g. Blanchard and Quah, 1989).

[FIGURE 4]

Figure 4: Accumulated Effects of AS Shocks on Inflation

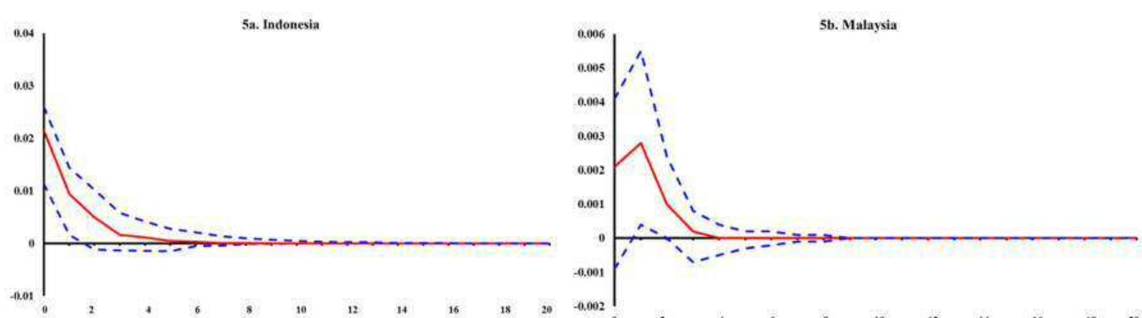




The inflationary shocks have a permanent and positive effect on inflation in all countries, which is consistent with the economic theory. The response is higher in Indonesia and Pakistan, where a single unit shock corresponds to about a 3% and 2.2% rise in price growth respectively. In comparison, the demand shocks caused only a 0.6% increase in price growth in Malaysia. Thailand is in between, with around 1.1%. According to the findings, the impact of OP shocks on selected Asian developing economics is not as high as in industrialized countries highly dependent on oil for instance the US, Japan, Russia, UK, Norway and China etc., which are among the biggest oil users in the world (Abeysinghe, 2001; Hamilton, 1983; Bjornland, 2000). Compared to large and established economies, the countries selected for this study suffer less after OP shocks which may be due to their low dependency on oil for production and small contribution of oil in the consumption bundles. In addition, it can be attributed to direct government subsidies to the OP to protect citizens and domestic industry from international OP shocks. The subsidized OP benefits many economic sectors and therefore effectively controls adverse effect of OP in the sample countries. The evidence suggests that the relationship between OP and GDP is negligible.

[FIGURE 5-6]

Figure 5: Accumulated Effects of AD Shocks on Output Growth



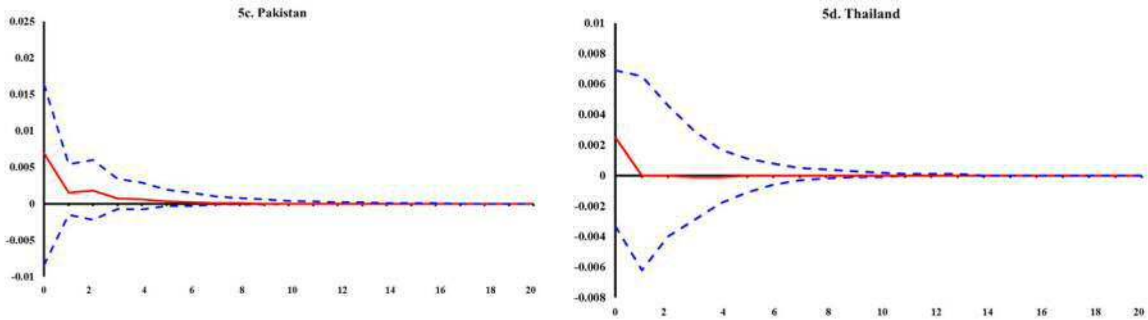
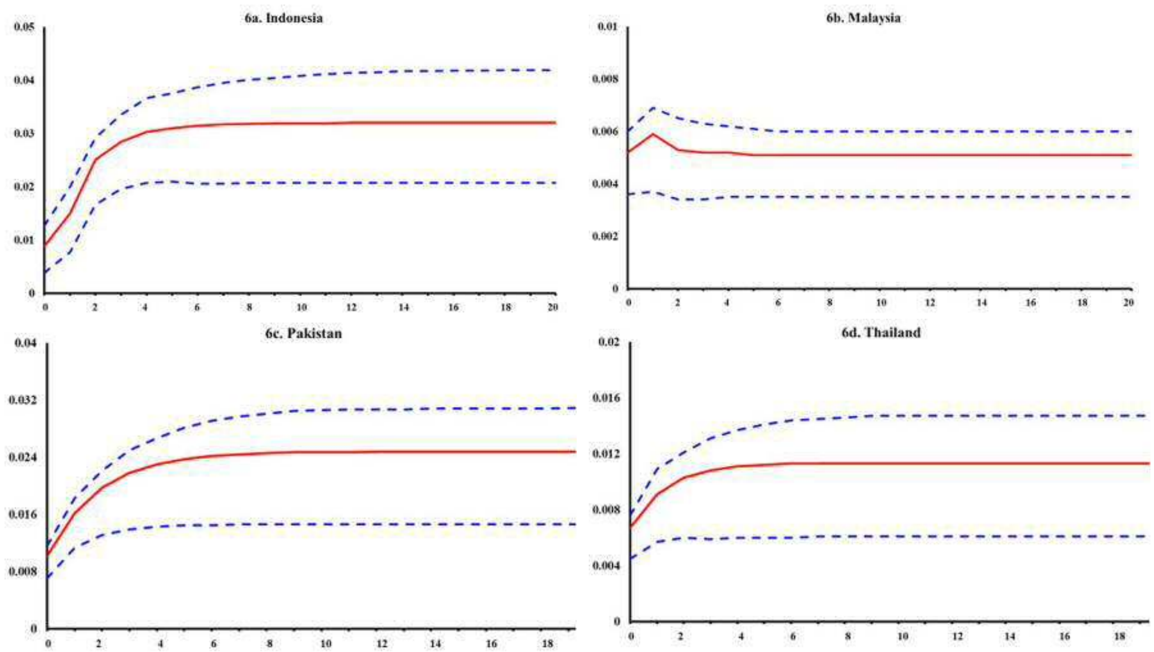


Figure 6: Accumulated Effects of AD Shocks on Inflation



3.4. Impulse Response Analysis: Asymmetric Specification

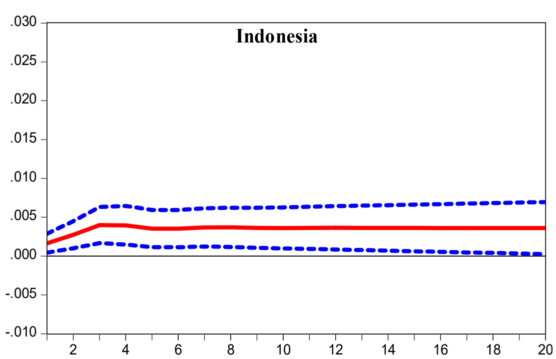
To assess asymmetries with respect to the sign of the OP shock under different starting conditions, cumulative responses of output growth to a positive and to a negative OP shocks are obtained by using a VAR. Figure 7a-7h shows the cumulative response of output growth to OP shocks, where the left panel shows the responses to a positive OP shock and the right panel presents the responses for a negative shock. For oil-exporting countries, positive OP shocks induce positive effects on output growth and inflation in Indonesia and Malaysia however the impact is insignificant in Malaysia. In contrast to the linear model, the response of output growth to an OP shock is highly significant for Indonesia. Output growth falls in response to a negative OP shock in oil-exporting countries and our findings confirm that the magnitude of the response is significantly larger than with the linear model estimation. The fall in output growth resulting from a negative OP shock is greater than the increase in output resulting from a positive OP shock. Overall, as expected, the responses of growth and inflation are asymmetric with respect to the sign of the OP shocks for both oil-exporting countries. Additionally, the asymmetric effects of OP on output growth are larger than the symmetric effects. Therefore, these findings are in line with those in previous studies (An et al., 2014; Kilian and Vigfusson, 2011; Mendoza and Vera, 2010; Moshiri, 2015). For both countries (Indonesia and Malaysia) a non-linear specification yields a more accurate representation than the linear model.

With regards to the oil-importing countries, in Pakistan the reduction in output growth resulting from a positive OP shock is larger than the increase in output growth due a negative OP shock. However, for Thailand the response of output growth to a negative OP shock is larger than the absolute reaction to a positive OP shock and in general, the response of growth to OP shocks is significant in Thailand. The findings are consistent with those in the previous literature on oil-importing countries. (Jiménez-Rodríguez and Sánchez, 2005; Hamilton, 2009, 2011; An et al., 2014). The findings for Thailand are in line with the results of Köse and Baimaganbetov (2015), who find a greater impact of negative OP shocks on output growth. The evidence shows that the non-linear approach produces impulse response functions that are comparably more precise than those generated through the linear model.

Figure 7: Accumulated Effects of Positive and Negative OP Shocks on GDP Growth: Asymmetric Specification

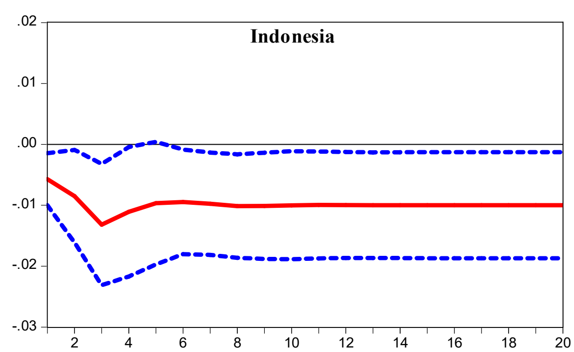
Positive OP Changes

7a.



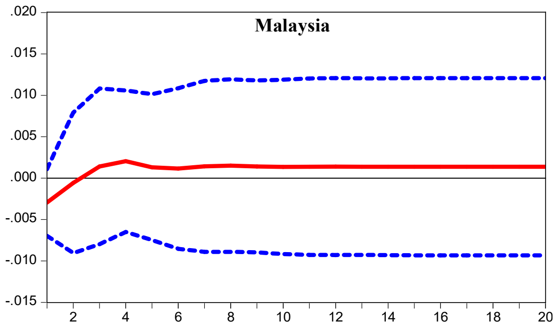
Negative OP Changes

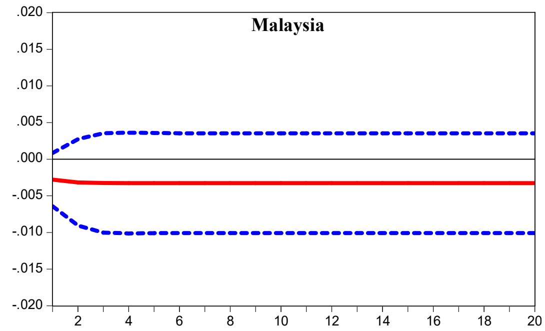
7b.



7c.

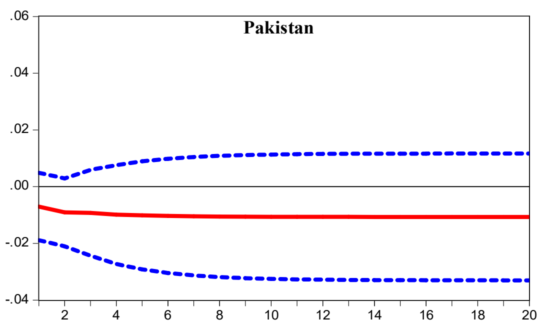
7d.

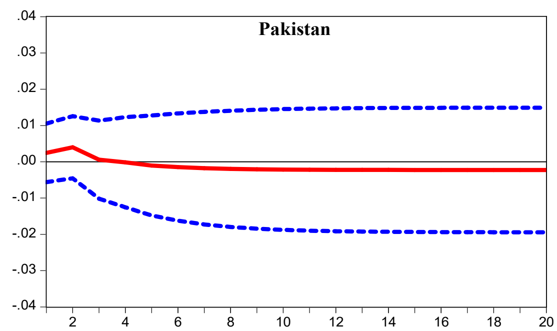




7e.

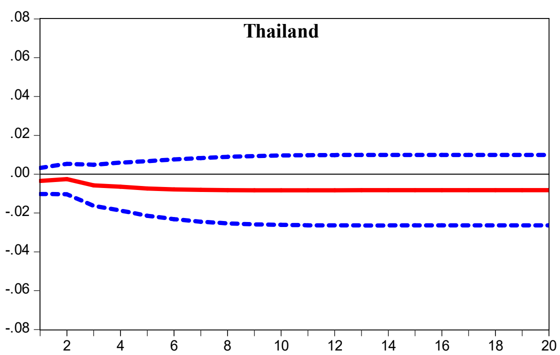
7f.





7g.

7h.



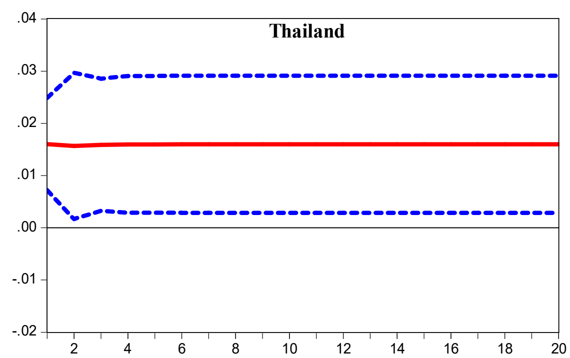
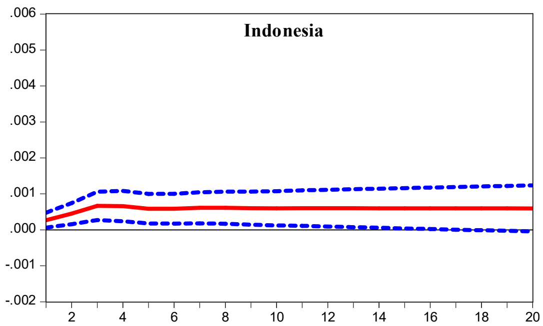


Figure 8a-8h represents the impulse response functions of inflation to an OP shock. In the case of positive OP changes, we observe that despite each country responding somewhat differently to OP shocks, there is a similar pattern in the impulse response functions. For positive OP innovations, the response of inflation is consistent with the sign of the OP shock in all sample countries, but only significant for Indonesia. Furthermore, in oil exporting countries, the reduction in inflation due to a negative oil price shock is greater in magnitude than the increase in inflation resulting from a positive oil price innovation. In addition, the increasing response of inflation due to a positive OP shock in the non-linear specification is consistent with the linear specification in all countries however, the magnitude of the shock is greater in the former case. These findings are consistent with those of Hooker (2002). Surprisingly, we have found that negative OP shocks cause inflation in the oil-importing countries of Pakistan and Thailand. This result can be rationalised in terms of the unusual circumstances experienced by these economies during the period under study. In contrast to the linear specification, inflation responses to negative OP shocks are significant in all of the countries, except Malaysia.

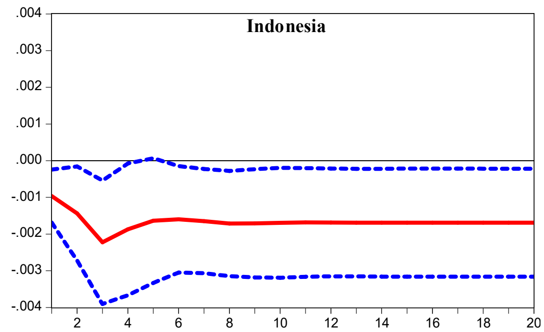
Figure 8: Accumulated Effects of Positive and Negative OP Shocks on Inflation: Asymmetric Specification

Positive OP Changes	Negative OP Changes

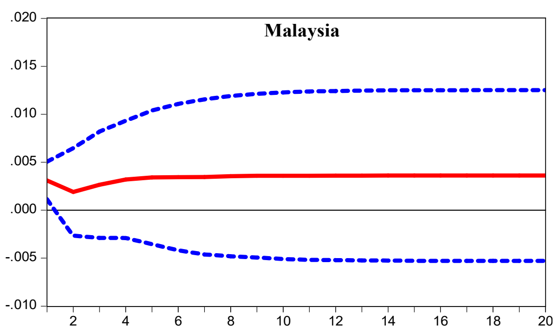
8a.



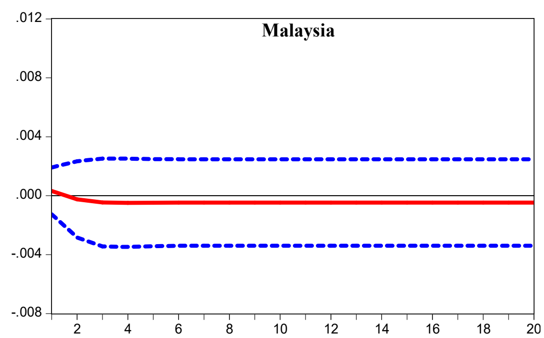
8b.



8c.

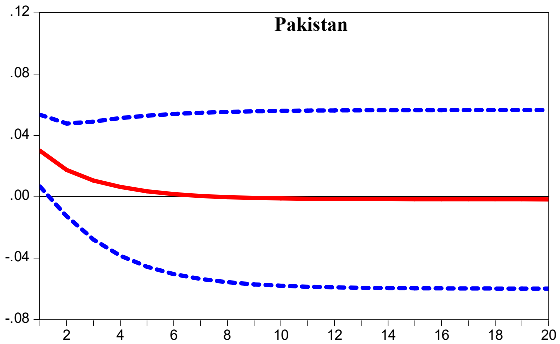


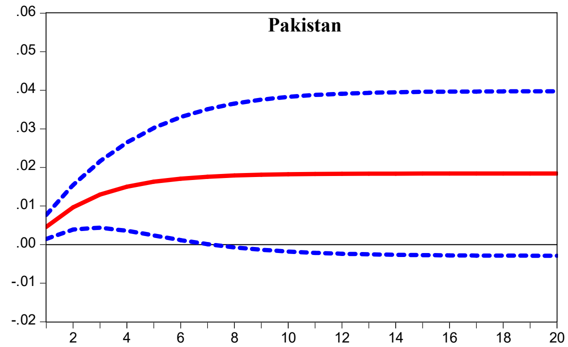
8d.



8e.

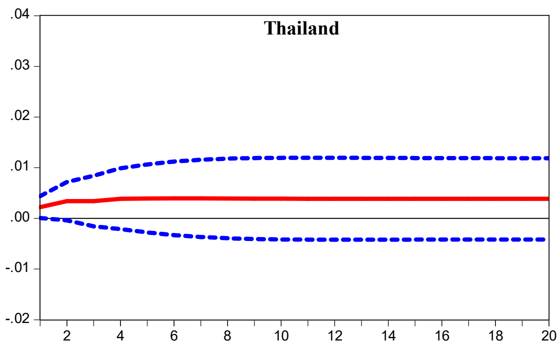
8f.

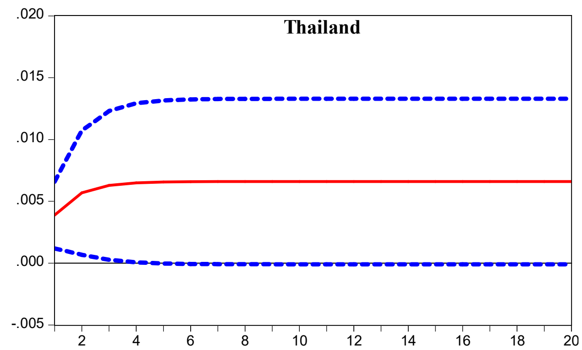




g.

h.





3.4 Forecast Error Variance Decomposition: Linear Specification

In this subsection, we study the forecast error variance decompositions (FEVDs), which allow us to verify how much of the forecast error variance is explained by shocks to each explanatory variable in a system over a time period. Variance decomposition is based on structural decomposition (orthogonalization) estimated in the factorization matrices for the identified VAR model. For each country in this study, variance decomposition is used to measure the proportion of fluctuations in output caused by OP, AS and AD shocks. Tables 2-5 show the variance decompositions of the linear specification.

[TABLE 2]

Table 2: Forecast-Error Variance Decompositions of Output Growth and Inflation Indonesia: Linear Specification

Horizon	Output Growth			Inflation		
(quarters)	OP shock	AS shock	AD shock	OP shock	AS shock	AD shock
1	0.0	41.0	59.0	0.0	69.0	31.0
2	3.0	34.0	63.0	0.0	65.0	34.0
3	3.0	33.0	64.0	0.0	50.0	49.0
4	3.0	33.0	64.0	0.0	49.0	51.0

6	3.0	33.0	64.0	0.0	49.0	51.0
8	3.0	33.0	64.0	0.0	49.0	51.0
12	3.0	33.0	64.0	0.0	49.0	51.0

The FEVDs for Indonesia are reported in Table 2. These results show that real OP shocks cause 2% of the variation in output at all horizons. AS shocks contribute to 41% of the changes in output in Indonesia in the short-run, whilst this decreases to about 33% in the long-run. The interesting finding is that nominal AD (inflationary) shocks is the main source of variation in output and explains about 64% of fluctuations in output growth. The finding is very much consistent with the hyperinflation period during the Asian financial crisis, where the rate of inflation rose sharply and reached about 80% in mid-1997. In response, Indonesian GDP growth quickly decreased witnessing negative economic growth of over 13% in 1998. Oil price disturbances explain close to 0% of the variations of inflation in the long-term, while AS disturbances explain about 49% to 69% of forecast-error variance of inflation in Indonesia. In the short-term, inflationary shocks contribute about 31% to the variation in prices but this percentage gradually increases with time, reaching about 51%. Table 2 clearly shows that in the 12th quarter these AD shocks only explain 51% of long-run variation in prices. Unlike the findings of Cover *et al.* (2006), who find that the major source of long-term inflation variation is AD shocks, the current results indicate that in Indonesia AS shocks cause the greatest changes in inflation.

In Malaysia, OP shocks account for 1% to 15% of the forecast-error variance in output as indicated in Table 3, which also becomes stable in a longer-term. The contribution of supply shocks to output varies within the range of 81%-88%. Regarding long-term inflationary change in Malaysia, about 3% of this is explained by real OP shocks. Demand disturbances are the single most significant source of variation in inflation, accounting for about 88% of the variance. Supply shocks only explain 9% of these fluctuations in the long run.

[TABLE 3]

Table 3: Forecast-Error Variance Decompositions of Output Growth and Inflation Malaysia: Linear Specification

Horizon	Output Growth			Inflation		
(quarters)	OP shock	AS shock	AD shock	OP shock	AS shock	AD shock
1	10.0	88.0	2.0	2.0	8.0	90.0
2	12.0	86.0	2.0	3.0	8.0	89.0
3	13.0	83.0	4.0	3.0	9.0	88.0

4	15.0	81.0	4.0	3.0	9.0	88.0
6	15.0	81.0	4.0	3.0	9.0	88.0
8	15.0	81.0	4.0	3.0	9.0	88.0
12	15.0	81.0	4.0	3.0	9.0	88.0

In Pakistan, OP shocks have a relatively small effect on output as exhibited in Table 4, and contribute to only 6% of the long-run variation in output. AS shocks are the important causal factors of output variation contributing to 90% of the variance over the time period under investigation. Nominal AD shocks explain only 4% of output fluctuations in the long-run. The results show that the real OP shock causes 1% of short-term and about 15% of long-term variations in price growth. In the short-term, demand disturbances explain about 85% of the variations in domestic prices, with this contribution gradually declining as time goes on. Supply disturbances are less important for explaining inflation changes in Pakistan, contributing only 5% in the long-run.

[TABLE 4]

Table 4: Forecast-Error Variance Decompositions of Output Growth and Inflation Pakistan: Linear Specification

Horizon	Output			Inflation		
(quarters)	OP shock	AS shock	AD shock	OP shock	AS shock	AD shock
1	2.0	95.0	3.0	10.0	5.0	85.0
2	2.0	90.0	4.0	14.0	5.0	81.0
3	6.0	90.0	3.0	15.0	5.0	80.0
4	6.0	90.0	3.0	15.0	5.0	80.0
6	6.0	90.0	3.0	15.0	5.0	80.0
8	6.0	90.0	3.0	15.0	5.0	80.0
12	6.0	90.0	3.0	15.0	5.0	80.0

The forecast-error variance decomposition for output and price growth in Thailand is reported in Table 5.

[TABLE 5]

Table 5: Forecast-Error Variance Decompositions of Output Growth and Inflation Thailand: Linear Specification

Horizon	Output			Inflation		
(quarters)	OP shock	AS shock	AD shock	OP shock	AS shock	AD shock
1	0.0	97.0	3.0	17.0	14.0	69.0
2	1.0	94.0	5.0	16.0	15.0	69.0
3	2.0	93.0	5.0	16.0	15.0	68.0
4	4.0	92.0	5.0	16.0	16.0	68.0

6	4.0	92.0	5.0	16.0	16.0	68.0
8	4.0	92.0	5.0	16.0	16.0	68.0
12	4.0	92.0	5.0	16.0	16.0	68.0

In terms of variance decomposition of output, AS shocks contribute the biggest proportion in Thailand. The short run effect is 97% which gradually decreases with the forecast horizon to 92%. In the long-run, OP and AD shocks account for 4% and 5% of the variation of output respectively. Supply shocks in Thailand account for a sizable fluctuation in inflation representing about 16% of the long-term variability. Real OP disturbances explain about 16% of the variation in inflation and demand disturbances describe about 68%.

To summarise the FEVD results, the study concludes that AS disturbances are the most important factor behind output movements in both short-term and long-term in this set of countries except in Indonesia. It seems that the inflationary (AD) shocks are the main source variation in output for Indonesia. It suggests that the recession in the Indonesia during 1997-98 was dominated by inflationary disturbances. For all four countries, output behaviour seems consistent with real business cycle theory. Demand is the main determinant of the variability in domestic prices in Malaysia, Pakistan and Thailand. In Indonesia, supply shocks are more dominant than demand shocks in explaining domestic price fluctuations. In all countries, the demand, and supply shocks are a significant source of business cycles.

3.5. Forecast Error Variance Decomposition: Asymmetric Specification

Tables 6 and 7 show the findings of the FEVD with regards to the non-linear model, which presents how much of the unanticipated changes of the output and inflation are explained by OP shock. The contribution of positive OP shocks to output and inflation variability is 7% and 8% respectively for Indonesia, as reported in Table 6, whilst negative OP innovations explain 9% of the variation in both output and inflation. In the case of Malaysia, negative OP shocks contribute sizably to variations in output (23%) and inflation (20%). We find that shocks to OP variables tend to explain more of output and inflation volatility in asymmetric than in symmetric specifications in both oil-exporting countries.

TABLE 6

Table 6: Forecast-Error Variance Decompositions of Output Growth and Inflation Indonesia and Malaysia: Asymmetric Specification

	Indonesia				Malaysia			
Horizon	Output Growth		Inflation		Output growth		Inflation	
Quarters	OP+	OP-	OP+	OP-	OP+	OP-	OP+	OP-

1	4.0	3.0	5.0	3.0	1.0	26.0	0.0	4.0
2	5.0	4.0	5.0	4.0	2.0	22.0	5.0	9.0
3	7.0	9.0	8.0	9.0	7.0	22.0	5.0	19.0
4	7.0	9.0	8.0	9.0	8.0	22.0	5.0	20.0
6	7.0	9.0	8.0	9.0	8.0	23.0	5.0	20.0
8	7.0	9.0	8.0	9.0	8.0	23.0	5.0	20.0
12	7.0	9.0	8.0	9.0	8.0	23.0	5.0	20.0

For the oil -importing countries Pakistan and Thailand, positive OP shocks explain substantial variations in inflation, 16% and 19% respectively, as presented in Table 7. In the case of Thailand, the contribution of negative OP shocks to variations in output is 19%. Overall, the findings confirm that for models using a non-linear specification of the oil price, OP shocks tend to explain more of output and inflation variability than models using a linear specification in all sample countries under study.

TABLE 7

Table 7: Forecast-Error Variance Decompositions of Output Growth and Inflation Pakistan and Thailand: Asymmetric Specification

	Pakistan				Thailand			
Horizon	Output Growth		inflation		Output growth		inflation	
Quarters	OP+	OP-	OP+	OP-	OP+	OP-	OP+	OP-
1	0.0	1.0	19.0	17.0	1.0	21.0	16.0	0.3
2	3.0	1.0	17.0	27.0	1.0	19.0	14.0	3.0
3	3.0	2.0	16.0	26.0	3.0	19.0	13.0	3.0
4	3.0	3.0	16.0	26.0	4.0	19.0	13.0	3.0
6	3.0	3.0	16.0	26.0	4.0	19.0	13.0	3.0
8	3.0	3.0	16.0	26.0	4.0	19.0	13.0	3.0
12	3.0	3.0	16.0	26.0	4.0	19.0	13.0	3.0

4. CONCLUSIONS

This paper examines the dynamic effect of OP, AD and AS shocks on both output and domestic aggregate price growth in Indonesia, Malaysia, Pakistan and Thailand using a structural VAR model with a mixture of short-run and long-run restrictions following the standard Blanchard-Quah approach. Furthermore, we have compared the results using two different specifications of the OP, namely a standard linear model and a non-linear specification as proposed in the literature. The cumulative impulse responses and forecast error variance decomposition functions are computed for each country.

Our results show that in the linear model the effect of OP shocks on output is positive in Indonesia and Malaysia, but negative in Pakistan and Thailand. However, the effects are insignificant for all countries. These results are consistent with the findings of Ran and Voon (2012), who concluded that OPs do not have a significant effect on economic activity in East Asian countries. When using the nonlinear model, in contrast to the linear model, we find that positive and negative OP shocks separately have significant effects on output and inflation in Indonesia. Additionally, we observe that OP shocks have a significant impact on inflation in Pakistan and Thailand. Overall, the findings confirm that OP changes have larger effects on macroeconomic variables when a non-linear model is used as opposed to the standard linear model in all four economies. The evidence also shows that positive OP innovations have different impacts on output growth and inflation to those of negative innovations. This contrasts with the linear model in which OPs are assumed to have symmetrical impacts on real activity.

The findings of the current study also suggest that OP increases causes inflation in all countries, which corresponds to an earlier conjecture in section 2. This is consistent with the finding of Abeysinghe (2001) and Cunado and Perez de Gracia (2005) that even oil-exporting countries such as Indonesia and Malaysia couldn’t evade the adverse repercussions of high OPs. The inflationary consequences for oil-exporters are negligible, possibly because of the exchange rate appreciation in the aftermath of an OP shock. The results of OP shocks are particularly negative for oil-importers, as they may bear losses because of the high input cost. On the other hand, oil-exporters may experience some benefits and revenue increases but also suffer high inflation. Although our variance decomposition investigation suggests that OPs have a role in explaining output and inflation volatility in all sample economies, our findings suggest that OP shocks are more likely to cause fluctuations in the macroeconomic variables of some countries than in others. The relatively small or negligible effect found for some countries could be attributed to government direct control and subsidised OPs which help to minimize the adverse effect of OP on real activities and to avoid a sharp decline in GDP and high inflation in response to positive OP shocks. In addition, the economic structure of a country plays a crucial role, which may affect the influence of OP shocks on macroeconomic fluctuations. Countries with a low production reliance on oil, a low share of oil in the consumption bundle and relatively low labour intensities in production are expected to suffer less from OP shocks. Shocks of AD demand and AS have played a significant role in explaining recessions, particularly the 1997-98 recession in East Asian countries. For the recession experienced in 2008-09 the OP had little impact and the recession was largely caused by other disturbances in all countries.

In alignment with conventional wisdom, productivity (AS) shocks are the key reason for fluctuations in output and nominal AD shocks are the main factor inducing fluctuations in aggregate price growth in all countries except in Indonesia. In Indonesia, demand disturbances are more important than supply disturbances in explaining output fluctuations and interestingly, productivity shocks are the main reason for fluctuations in aggregate price growth in Indonesia because its economy is highly dependent on exports. These findings may suggest that output growth of the trade sector is higher than that in non-trade sectors in Indonesia. The findings confirmed all the restrictions imposed by the model to identify the different shocks. Most of the dynamic changes of the macroeconomic variables are in line with the economic model, and the shocks fit well with actual events that have occurred in the various countries.

These findings carry significant policy recommendations to governments, suggesting the need for comprehensive reforms of OP and oil subsidy policies. The government policies should pay more attention to emerging new and advanced solutions to achieve OP stability. Many countries increase oil subsidies in order to minimize the damaging effects of OP increases on poor people however the consequences of OP stabilization policies are budget deficit[16] and pollution. The policy should be implemented in such a way so as to reduce OP shocks to the economy and minimize budget deficit. This suggests that the removal of oil subsidies should be gradual because people could recognize policies and become more resilient to OP shocks. Furthermore, in order to control inflation, the monetary policy response to an OP shock could involve raising the interest rate to reduce consumer and investment spending.

Furthermore, such results have other significant implications, in particular that the identification and decomposition of demand and supply shocks are crucial. This enables better analysis of the effects of monetary and fiscal policy on the economy, which is in turn taken as a measure of progress of the growth and improvement of market mechanisms. It could also help these countries walk out of budget deficit and achieve a balanced budget, which will substantially reduce the risk of falling into financial crisis again.

Overall, for a fuller understanding of recent developments in the economies that have been considered, and in order to structure economic policies that aim at stabilizing the macroeconomy, the results of the current study should be carefully taken into account during

[16] Rafiq et al. (2009) examined the impact of OP shocks on economic activity in Thailand by employing a *VAR* model. Using quarterly data from 1993q1 to 2006q4 they found a structural break in the time series data during the Asian financial crisis of 1997-1998. They also found that the budget deficit originated mainly from movements in OPs during the post crisis period, which may have been due to the floating exchange rate policy.

the design and improvement of economic policies. This is particularly relevant for Asian countries, where (productivity) supply and inflationary shocks are the main source of variation in economic activities.

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APPENDIX A

Table A1: Unit Root Test

Variables	*Augmented Dickey-Fuller (ADF) Test*				*Phillips-Perron (PP) Test*			
	Indonesia	Malaysia	Pakistan	Thailand	Indonesia	Malaysia	Pakistan	Thailand
Real oil price (OP_t)	-2.969^{+}	-2.127	-1.944	-1.533	-2.381	-2.347	-1.749	-1.594
Oil price growth (ΔOP_t)	-8.745^{+++}	-8.420^{+++}	-8.839^{+++}	-7.569^{+++}	-8.985^{+++}	-8.786^{+++}	-8.843^{+++}	-7.736^{+++}
Real *GDP* (y_t)*GDP*	-1.973	-3.182	-1.381	-2.480	-1.905	-2.897	-1.701	-2.5787
Growth (Δy_t)	-8.282 $^{+++}$	-4.901 $^{+++}$	-14.487^{+++}	-10.490^{+++}	-8.272^{+++}	-11.584^{+++}	-14.723^{+++}	10.454^{+++}
Consumer prices (p_t)	-2.068	-2.780	-1.839	-2.259	-1.989	-2.774	-1.579	-1.971
Inflation (Δp_t)	-8.295^{+++}	-8.705^{+++}	-3.256^{++}	-6.565^{+++}	-8.295^{+++}	-8.642^{+++}	-5.429^{+++}	-6.101^{+++}

Note: $^{+++}$, $^{++}$ and $^{+}$ indicate the growth of significance at the 1%, 5% and 10% respectively. Constant and time trend are used for the variables at growth, while only constant is included for variables at the first order difference.

Table A2: Summary of the Unit Root Tests for Output and Inflation with and without Structural Breaks

	Indonesia			Malaysia		
Tests	ΔOP_t	Δy_t	Δp_t	ΔOP_t	Δy_t	Δp_t
ZA	-8.564^{***}	-8.690^{***}	-8.695^{***}	-9.043^{***}	-5.925^{***}	-8.449^{***}
MZa	-37.745^{***}	-49.089^{***}	-49.164^{***}	-46.919^{***}	-49.400^{***}	-39.008
MSB	-4.342^{***}	-4.954^{***}	-4.958^{***}	-4.817^{***}	-4.966^{***}	-4.407
MZT	0.115^{***}	0.101^{***}	0.101^{***}	0.103^{***}	0.101^{***}	0.113
RMT	0.656^{***}	0.500^{***}	0.499^{***}	0.593^{***}	0.506^{***}	0.655
	Pakistan			Thailand		
Tests	ΔOP_t	Δy_t	Δp_t	ΔOP_t	Δy_t	Δp_t
ZA	-9.821^{***}	-15.328^{***}	-4.415^{***}	-8.212^{***}	-12.676^{***}	-5.633^{***}
MZa	-9.261^{***}	-45.043^{***}	-12.604^{***}	-43.258^{***}	-44.454^{***}	-34.965^{***}
MSB	-2.152^{***}	-4.745^{***}	-2.426^{***}	-4.640^{***}	-4.714^{***}	-4.135^{***}
MZT	0.232^{***}	0.105^{***}	0.193^{***}	0.107^{***}	0.106^{***}	0.118^{***}
RMT	2.646^{***}	0.547^{***}	2.275^{***}	0.596^{***}	0.551^{***}	0.838^{***}

Note: ***, ** and * indicate the growth of significance at the 1%, 5% and 10% respectively. For M unit root tests the MAIC information criterion is used to select the autoregressive truncation lag, k, as proposed in Ng and Perron (2001). *ZA*is the Zivot-Andrews unit root test. MP_T is the Elliot-Rothemberg-Stock unit root test. ADF-GLS is the Elliot, Rothemberg and Stock unit root test. The critical values are taken from Ng and Perron (2001).

Table A3: Cointegration Test Results with Trace and Maximum Eigenvalues Statistics

(a) Indonesia

	Trace	*Test*	*Maximum Eigenvalues*	
Hypothesised No. of CE(s)	*Statistics*	*Critical Values 5%*	*Statistics*	*Critical Values 5%*
None	29.120	29.797	20.675	21.132
At most 1	8.445	15.495	7.333	14.265
At most 2	1.112	3.841	1.112	3.841

(b) Malaysia

	Trace Test		*Maximum Eigenvalues*	
Hypothesised No. of CE(s)	*Statistics*	*Critical Values 5%*	*Statistics*	*Critical Values 5%*
None	22.064	29.797	15.409	21.132
At most 1	6.654	15.495	5.007	14.265
At most 2	1.647	3.841	1.647	3.841

(c) Pakistan

	Trace Test		*Maximum Eigenvalues*	
Hypothesised No. of CE(s)	*Statistics*	*Critical Values 5%*	*Statistics*	*Critical Values 5%*
None	20.332	29.797	15.313	21.132
At most 1	5.019	15.495	4.288	14.265
At most 2	0.731	3.841	0.731	3.841

(d) Thailand

	Trace Test		*Maximum Eigenvalues*	
Hypothesised No. of CE(s)	*Statistics*	*Critical Values 5%*	*Statistics*	*Critical Values 5%*
None	32.698	29.797	24.707	21.132
At most 1	7.992	15.495	14.265	14.265
At most 2	1.889	3.841	1.889	3.841

Table A4: VAR Granger Causality/Block Exogeneity Wald Tests (p-values)

Country	GDP growth does not Granger cause Oil price growth	Inflation does not Granger cause Oil price growth
Indonesia	0.92	0.94
Malaysia	0.46	0.01
Pakistan	0.22	0.51
Thailand	0.23	0.01