Asymmetric Effects of Oil Price Shocks on Economic Growth and Inflation in Asia: What do We Learn from Empirical Studies?

Jiranyakul, Komain

National Institute of Development Administration

February 2025

Asymmetric Effects of Oil Price Shocks on Economic Growth and Inflation in Asia: What do We Learn from Empirical Studies?

Komain Jiranyakul
School of Development Economics
National Institute of Development Administration
Bangkok, Thailand
Email: komain_j@hotmail.com

Abstract

Asymmetric impacts of oil price shocks on key macroeconomic variables are caused by some important effects, such as income effect, uncertainty effect, precautionary saving effect, irreversible investment and reallocation effects. Due to these effects, output and prices respond diferently to oil price increases and decreases. This asymmetry hypothesis has been empirically tested by many economists. This paper surveys recent empirical studies on the asymmetric impacts of oil price shocks on economic activity and inflation in Asia. The empirical findings in Asian economies shows that the responses of output growth to oil price shocks in Japan and South Korea tend to be asymmetric while the responses of inflation seem to be symmetric. For China, the largest oil-importing in Asia, the empirical results show that asymmetry is increasingly discovered. The results of the responses of inflation to oil price shocks in China do not favor the asymmetry hypothesis. The findings in the ASEAN5 economies are likely to support the symmetry hypothesis. In South Asian economies, only few studies favor the asymmetry hypothesis. Because empirical results for other Asian countries are not widely investigated, it is too early to draw some conclusions. One important finding is that Asian oil-exporting countries, Indonesia, Malaysia, and Vietnam, might not escape the adverse impacts of oil price shocks on output growth. Since output and inflation can be unfavorably affected by oil price shocks, some researchers will recommend accommodative monetary policy along with exchange rate policy to stabilize the responses of output and prices when oil price tends to increase in a high oil price regime.

Keywords: Oil price shocks, output growth, inflation, asymmetric and symmetric impacts, Asian economies

JEL Classifications: E31, Q43

1. Introduction

Early empirical studies focus on the impact of oil prices on macroeconomic variables (Darby, 1982, Mork, 1989, Hamilton, 1983,1996 and 2003, Cologni and Manera, 2009, Lahiani, 2019).[1]

[1] Theoretically, an increase in oil price is an adverse supply shock, which causes output to decline and raises the price level in an economy. The brief explanation can be found in Cunado and Perez de Gracia (2005, p. 66).

Empirical evidence shows that oil price increase directly affects inflation and recession. The oil price variable is either nominal world oil price, real world or domestic oil price. However, most studies use real oil price. The relationship between oil price and consumer prices is extensively investigated by later empirical studies. Most of these studies pay attention to the U.S. and other advanced countries. Researchers employ various estimation methods to investigate how macroeconomic variables respond to oil prices. One of the popular methods is vector autoregressive model of order p (VAR(p) model). A VAR model allows for examining interactions among variables. Impulse response functions can explain how shocks affect variables in question. Recent paper by Kilian and Zhou (2023) reveals that energy price shocks are related to consumer prices only in the Euro areas and in the United Kingdom. Furthermore, the response of headline inflation to energy price shocks are more persistent in these countries than in the US and Canada. The less response of inflation to energy price shocks is observed in Japan. Mory (1993) finds evidence of an asymmetric effects of oil price shocks on the U.S. economic activity. In a cross-country study for a set of industrialized economies, Peersman and Van Robays (2012) reveal that the effects of oil price shock on the economy depend on the underlying shifts in the oil price. The transitory decline in output from oil price hike is caused by increased global activity or a rise in oil-specific demand. The role of oil can explain the asymmetric effects of exogenous oil supply shocks. The negative impact of oil shocks on output is permanent for net-oil importing countries. However, the impact is insignificant or even positive for net-oil exporting countries. Besides reviewing theoretical models that motivate the needs to examine the asymmetric responses of output to oil price shocks[2], Bachmeier and Keen (2023) also develop a New Keynesian model with energy and a downward nominal wage rigidity that generates asymmetric responses of output to oil price shocks. Their empirical results show that oil price increase in the high oil price regime reduces output more than in the normal oil price regime. However, a previous study by Herrera at al. (2015) indicate that there is little support for asymmetric response of economic activity to oil price increases and decreases in OECD countries. Also Hooker (2002) argues that to examine the real impact of oil price shocks, structural break specification provides a better fit to the US data than do nonlinear and asymmetric specifications.

For developing countries, research on oil price shocks on output growth and inflation is expanding. Oil price shocks can be defined as fluctuations of world or domestic oil price in nominal or real terms. How output growth and inflation respond to oil price shocks might be different across Asian

---

[2] Oil price shocks can affect macroeconomic aggregates (output and inflation) asymmetrically by some important effects: income effect, uncertainty effect, precautionary saving effect, irreversible investment and reallocation effects (Edelstein and Kilian, 2009).

countries. Therefore, examining the relationship between oil price shocks, output growth and inflation for individual country should be important. The results from empirical studies shed light on how an oil price shock has the impacts on an economy. There is evidence showing that oil demand from Asian countries dominates the world oil demand. Geographical regions respond differently to oil price hike. Countries in Europe and North America are more adversely affected by oil price shocks than those in Asia and South America (Avastveit et al. 2015).

This paper surveys recent empirical studies relating to the asymmetric effects of oil price shocks on output growth and inflation in Asia, which includes Japan, China, South Korea, South Asian countries, the ASEAN5 countries, Hong Kong and Vietnam. Since researchers in the field of energy economics and policy produce research papers for an individual country and a group of countries, the literature on symmetric effects of oil price shocks on output growth and inflation is quite extensive. More recently, the literature on asymmetric effects of oil price shocks has been more widely investigated by many economists. In addition, some studies emphasize the impact of oil price shocks on growth only while other studies focus on the impact of oil price shocks on inflation only. Therefore, a synthesis of empirical findings will include all categories of recent studies. The paper is organized as follows. Section 2 describes different econometric techniques used from the past to the present. Section 3 presents empirical findings from empirical studies in Asia and discusses whether the existing studies is unified or inconclusive. Section 4 concludes with a discussion of some methodological issues as well as some suggestions for future research.

2. The Evolution of Different Analytical Frameworks

Earlier research papers employ a VAR model with different restrictions in the specification. Later on, economists distinguish the results between the long- and the short-run relationships. Therefore, various cointegration tests and Granger causality test become popular. Since linear cointegration tests may fail to capture the relationship between variables in some circumstances, nonlinear cointegration techniques have been used.

2.1 A VAR Model Specification

A simplest form of VAR approach is a stationary VAR(p) model, which can be expressed as:

$$\Delta Y_t = C + A_1\Delta Y_{t-1} + A_2\Delta Y_{t-2} + \ldots\ldots + A_p\Delta Y_{t-p} + e_t \qquad (1)$$

$Y_t^{/} = [y_t p_t op_t]^{/}$

where ΔY is a $p \times 1$ vector changes in output(y), CPI(p), and oil price (op), C is a $p \times 1$ vector of intercepts, $\{A_i, i=1,2,\ldots\}$ is a $p \times p$ matrix of autoregressive coefficients, e is a $p \times 1$ vector of random errors with zero means and positive definitive co-variances. The optimal lag p can be determined by Akaike information criterion (AIC) or Schwarz information criterion (SIC). The specified VAR model treats each endogenous variable in the system as a function of lagged endogenous variables in dynamic simultaneous equations. Eq. (1) is also specified for multivariate framework, e.g., output, CPI, oil price, exchange rate and interest rate. Other forms of the models are recursive and structural VAR models. When the equation is estimated, impulse response functions and variance decompositions can be analyzed. One of the important aspects of the relationship between oil price shocks and output growth or inflation is whether the short-run relationship is either symmetric or asymmetric. The asymmetric Granger causality can be tested using an unrestricted VAR models and VAR Granger/block exogeneity Wald tests (see for example Kumar, 2009).

2.2 Cointegration and Causality Tests

Besides a VAR model, cointegration techniques and Granger causality test are widely used in a bivariate or multivariate framework. Various cointegration techniques can determine whether there exists a long-run relationship between oil price and real GDP or a long-run relationship between oil price and consumer price index (CPI). For a multivariate frame work, there will be a relationship between oil price and output or CPI, which includes other variables into the test equation, such as interest rate, exchange rate and exports. If there is a long-run relationship exists, the short-run dynamics can explain both long-run and short-run causal linkages between oil price changes and other variables. To test for long-run relationship, symmetric cointegration tests proposed by Johansen (1991) can be employed. In addition, the residual-based test for cointegration proposed by Engle and Granger (1987) with or without known structural breaks can be employed to test whether there exists a long-run relationship between oil price and other variables.[3] A similar approach proposed by Gregory and Hansen (1996) is the residual-based test for cointegration with unknown structural breaks. If cointegration does not exist, there should be only a short-run analysis and the use of short-run causality by Granger (1969) is valid. When there exists a linear long-run relationship, short-run dynamics can be analyzed. The results might yield both short-run and long-run causality (Granger, 1988).

[3] Other approaches are proposed by Phillips and Ouliaris (1990) and Pesaran et al. (2001).

2.2.1 Residual-based Tests for Cointegration

Conventional residual-based cointegration test of Engle and Granger (1987) with a known structural break is expressed as:

$$y_{1t} = a + b_1 D_t + b_2 y_{2t} + e_t \tag{2}$$

In Eq. (2), y_1 is either real GDP (output) or CPI and y_2 is oil price. The tests are estimated in a bivariate framework. If oil price and output are cointegrated, it implies that oil price has the long-run impact on output. Similarly, if oil price and CPI are cointegrated, it implies that oil price has the impact on price level, and the coefficient b_1 and b_2 should be statistically significant. The dummy variable, D, captures a known break point. The residual series, *e*, obtained from the estimate of Eq. (2) can be used to test for unit root using the Augmented Dickey-Fuller (ADF) test. The test proposed by Phillips and Ouliaris (1990) is similar to Engle and Granger approach.

Gregory and Hansen (1996) approach also use Eq. (2). The t-statistic obtained from the estimation of Eq. (2) is the ADF* statistic. This statistic is used for comparison with the critical value statistic provided by Vogelsang (1993). If the ADF* statistic is larger than the critical value, the null hypothesis of unit root in the residual series will be rejected. Therefore, there is cointegration or long-run relationship expressed in Eq. (2). On the contrary, the smaller value of the ADF* statistic than that of the critical value leads to an acceptance of the null hypothesis of unit root, and thus there is no cointegration between variables in the model. A dummy variable in Gregory and Hansen test is determined endogenously, i.e., the test assumes that there is an unknown break point.

The existence of cointegration from the estimate of Eq. (2) indicates that the relationship between output or CPI, and oil price can be represented by the symmetric error correction mechanism (ECM) that can be expressed as:

$$\Delta y_{1t} = \phi_0 + \lambda e_{t-1} + \sum_{i=1}^{k} \phi_{2i}\, \Delta y_{t1-i} + \sum_{i=1}^{k} \phi_{3i}\, \Delta y_{2t-i} + u_t \tag{3}$$

where EC_{t-1} is the lagged value of the corresponding error term, which is called the error correction term (ECT), and λ, ϕ_{2i} and ϕ_{3i} are the regression coefficients while u_t is a random variable. The sign of the coefficient of the ECT should be negative and has the absolute value of less than one. If this coefficient is statistically significant, any deviation from the long-run equilibrium will be corrected and thus the long-run relationship is stable. The significance of λ indicates there is long-run causality running from y_2 to y_1 while the significance of ϕ_{3i} indicates short-run causality.

2.2.2 Johansen Cointegration test

The use of Johansen (1991) cointegration test in a multivariate framework is presented in the reduced from in Eq. (4) as the following:

$$\Delta Y_t = C + A_1 \Delta Y_{t-1} + A_2 \Delta Y_{t-2} + \ldots.. + A_p \Delta Y_{t-p} + \alpha\beta^{/} Y_{t-1} + e_t \qquad (4)$$

$$Y_t^{/} = [y_t p_t op_t]^{/}$$

where y_t is output, p_t is CPI, and op_t is oil price. The matrix A_i, i=1,2,….p, is the matrix of short-run parameters, $\alpha\beta^{/}$ is the information on the coefficient matrix between levels of the series, and e_t is the vector of the error terms. The existence of cointegration reveals that there is a long-run equilibrium relationship between the three explanatory variables.[4] In case of the existence of cointegration, the vector error correction mechanism (ECM) is used to examine the short-run dynamics between a change in output, inflation rate and a change in real oil price. The VECM is expressed in Eq. (3) as the following:

$$\Delta Y_t = C + \alpha\beta' Y_{t-i} + \sum_{j=1}^{p-1} \varphi_{2i} \Delta Y_{t-j} + u_t \qquad (5)$$

where $\alpha\beta'$ is the long-run impact matrix, which is the lagged value of the corresponding error terms obtained from the estimate of cointegrating relation expressed in Eq. (4).

The relevant elements of the matrix α are adjusted coefficients and the matrix β contains the cointegrating vector in Eq. (4). Johansen and Juselius (1990) explain that there are two likelihood ratio test statistics to test for the number of cointegrating vectors. The two tests are the trace test and the maximum eigenvalue test. In addition, the two test statistics can be compared with the critical values to determine whether cointegrating vectors exist.[5]

[4] Unit root tests, such as Dicky and Fuller or Phillips and Perron tests, can be used to confirm that all variables are integrated of order 1, or all variables are I(1) series.

[5] If the tract test and maximum eigen values reject the null hypothesis of no cointegration, there will be at least three equations showing the short-run adjustment to the long-run equilibrium. The error correction term in each equation should be significant and negative with the absolute value of less than 1.

2.2.3. Bounds Testing for Cointegration

Pesaran et al. (2001) propose a procedure in testing for cointegration called a conditional autoregressive distributed lag (ARDL) model and error correction mechanism. The ARDL (p, q) model is specified as:

$$\Delta y_{1t} = \mu + \sum_{i=1}^{p} \alpha_i \, \Delta y_{1t-i} + \sum_{j=1}^{q} \beta_j \, \Delta y_{2t-j} + e_t \qquad (6)$$

where Δ denotes first difference and y_1 is output or CPI, and y_2 denotes oil price. The lag orders are *p* and *q*, respectively. They may be the same or different. To determine the optimal numbers of lagged first differences in the specified ARDL model expressed in Eq. (6), the grid search can be used to select a parsimonious model that is free of serial correlation. By adding lagged level of the variables into Eq. (6) as shown in Eq. (7), the computed F-statistic for cointegration test can be obtained.

$$\Delta y_{1t} = \mu + \gamma_1 y_{1t-1} + \gamma_2 y_{2t-1} + \sum_{i=1}^{p} \alpha_i \, \Delta y_{1t-i} + \sum_{j=1}^{q} \beta_i \, \Delta y_{2t-j} + e_t \qquad (7)$$

The computed F-statistic is compared with the critical values. If the computed F-statistic is larger than the upper bound critical F-statistic, cointegration exists. If the computed is smaller than the lower bound F-statistic, cointegration does not exist. In case the computed F-statistic is between the upper and lower bound F-statistic, the result is inconclusive. Unlike other techniques that can be used to test for cointegration, re-parameterization of the model into the equivalent vector error correction is not required. Furthermore, the bounds testing can be applied to the mixed between I(0) and I(1) resulted from unit root tests, but not for I(2) series.[6] If cointegration is found, the lagged residual error series from the long-run equation can be added to Eq. (6) and re-estimates this equation to get ECM term.

2.2.4 Granger Causality Test

When a long-run relationship is not found, the analysis will be limited to the shot run. The standard Granger causality test proposed by Granger (1969) should be employed. The test equations for bivariate framework are expressed as:

$$\Delta y_{1t} = b + \sum_{i=1}^{k} \alpha_i \, \Delta y_{1t-i} + \sum_{j=1}^{k} \beta_i \, \Delta y_{2t-j} + e_t \qquad (8)$$

And

[6] The computed F statistic is obtained by testing Eq. (6) against Eq. (7) by estimating Eq. (6) first. Then coefficient tests are required. By choosing omitted variables which are lagged level variables, the computed F will be obtained.

$$\Delta y_{2t} = c + \sum_{i=1}^{k} \alpha_i \Delta y_{2t-i} + \sum_{j=1}^{k} \beta_i \Delta y_{1t-j} + e_t \tag{9}$$

The lag order *k* can be determined by AIC or SIC. Eqs. (8) and (9) can be estimated by the least-square method. In Granger causality sense, Eq. (8) is important in that it can used to be tested whether oil price shocks Granger cause output growth or inflation.

2.3 Nonlinearity in the Relationship

One can use nonlinear cointegration tests proposed by Enders and Granger (1998) and Enders and Siklos (2001) to test for nonlinear relationship. Also, Shin et al. (2014) propose asymmetric cointegration test using nonlinear autoregressive distributed lags (NARDL) procedure. There is a sound reason to employ nonlinear cointegration techniques when linear cointegration tests cannot detect a long-run relationship between variables. Furthermore, researchers can test for asymmetric effects of oil price shocks on output or inflation, i. e., output or inflation responds differently to positive and negative oil price shocks.

2.3.1 Nonlinear Cointegration Tests

It is important to confirm that the relationship between variables is not linear. In case of the absence of linear cointegration between variables, it is possible that the long-run relationship is nonlinear with asymmetric adjustment towards long-run equilibrium. Therefore, the threshold autoregressive (TAR) and momentum threshold autoregressive (MTAR) models can be used. The two models are residual-based tests developed by Enders and Granger (1998) and Enders and Siklos (2001). The residuals from the estimate of Eq. (2) are decomposed and the test equation is specified as:

$$\Delta e_t = I_t \rho_1 e_{t-1} + (1 - I_t)\rho_2 e_{t-1} + \sum_{i=1}^{k} \beta_i \Delta e_{t-i} + u_t \tag{10}$$

where u_t ~ iid.$(0,\sigma^2)$ and the lagged augmented term ($\Delta\hat{e}_{t-i}$) can be added to yield uncorrelated residuals of the estimates of equation (2). The Heaviside indicator function for TAR is specified in Eq. (11) while this function for MTAR is specified in Eq. (12), which are:

$$I_t = \begin{cases} 1 \; if \; e_{t-1} \geq \tau \\ 0 \; if \; e_{t-1} < \tau \end{cases} \tag{11}$$

and

$$I_t = \begin{cases} 1 \; if \; \Delta e_{t-1} \geq \tau \\ 0 \; if \; \Delta e_{t-1} < \tau \end{cases} \quad (12)$$

where the threshold value τ can be determined endogenously. The necessary and sufficient conditions for the stationarity of $\{e_{t-1}\}$ are $\rho_1 < 0$, $\rho_2 < 0$ and $(1+\rho_1)(1+\rho_2) < 1$ (Pertrucelli and Woolford,1984). The long-run equilibrium value of the error term should be less than zero when these conditions are met. Ender and Siklos (2001) propose two test statistics for the null hypothesis of no cointegration, i.e., t-Max and the F statistic called Φ. If cointegration exists, the t-Max and Φ statistics should be larger than critical values at the 5% level of significance. However, the Φ statistic has substantially more power than the t-Max statistic for testing the null hypothesis of no cointegration ($\rho_1 = \rho_2 = 0$). The main drawback of the Φ statistic is that it can lead to the rejection of the null hypothesis when only one of the rho coefficients is negative. Therefore, Enders and Siklos (2001) suggest that the Φ statistic should be used when rho coefficients are both negative and have the absolute values of less than one.

If the tests indicate that there exist a linear cointegration between output or price level and real oil price, the time series dynamics of the relationship between the two variables can be explored by threshold error correction mechanisms (TECMs). The TECMs can be expressed as:

$$\Delta y_{1t} = \phi_0 + \lambda_1 e_{t-1} + \sum_{i=1}^{k} \phi_{2i} \, \Delta y_{1t-i} + \sum_{i=1}^{k} \phi_{3i} \, \Delta y_{2t-i} + u_{1t} \quad (13)$$

and

$$\Delta y_{1t} = \tilde{\phi}_0 + \lambda_2 e_{t-1} + \sum_{i=1}^{k} \tilde{\phi}_{2i} \, \Delta y_{1t-i} + \sum_{i=1}^{k} \tilde{\phi}_{3i} \, \Delta y_{2t-i} + u_{1t} \quad (14)$$

where k is the lag order, λ_1 and λ_2 are the coefficients showing the speeds of adjustment.[7] The short-run dynamics allow for testing the alternative hypothesis pertaining to the short-run relationship between price level, industrial production and real oil price. The coefficients of the lagged differences of y_2 show the short-run impacts of oil price on the first difference of output or

[7] The speed of adjustment is $\lambda_1 = I_t \rho_1$ in the first regime and $\lambda_2 = (1 - I_t)\rho_2$ in the second regime while I_t in equation (13) is used for the TAR model, and I_t in Eq. (14) is used for the MTAR model.

price level while the coefficients of the asymmetric error correction terms are the speeds of adjustment toward the long-run equilibrium. Eqs. (13) and (14) can also be used to test for short-run causality between oil price and output or price level when asymmetric adjustment is found. The significance of $\lambda_1$and λ_2 indicates there is long-run causality.

Shin et al. (2014) asymmetric cointegration test using nonlinear autoregressive distributed lags (NARDL) procedure is specified as:

$$\Delta y_{1t} = \mu + \sum_{i=1}^{p} \alpha_i \, \Delta y_{1t-i} + \sum_{j=1}^{q} \beta_j^+ \, \Delta {y^+}_{2t-j} + + \sum_{j=1}^{q} \beta_j^- \, \Delta {y^-}_{2t-j} e_t \qquad (15)$$

By adding lagged level of the variables into Eq. (15) as shown in Eq. (16), the computed F-statistic for cointegration testing can be obtained.

$$\Delta y_{1t} = \mu + \emptyset_1 y_{1t-1} + \emptyset_2 y_{2t-1} + \sum_{i=1}^{p} \alpha_i \, \Delta y_{1t-i} + \sum_{j=1}^{q} \beta_j^+ \, \Delta {y^+}_{2t-j} + + \sum_{j=1}^{q} \beta_j^- \, \Delta {y^-}_{2t-j} e_t \qquad (16)$$

The difference of NARDL from ARDL approach is that the oil price shock series is separated to positive and negative shocks.[8]

2.3.2 Asymmetric Impacts of Oil Price Changes on Output Growth and Inflation

One of the important issues concerning short-run relationship between output growth or inflation and oil price shocks is asymmetric effects of oil price increases and decreases on output growth or inflation rate. Following Mork (1989) and Mork et al. (1994) procedure, oil price shock series is separated into positive and negative shocks. By applying Granger causality test, the test equation can be expressed as:

$$\Delta y_{1t} = \alpha + \sum_{i=1}^{k} \alpha_{1i} \, \Delta y_{1t-i} + \sum_{i=1}^{k} \alpha_{2i}^+ \, \Delta y_{2t-i}^+ + + \sum_{i=1}^{k} \alpha_{2i}^- \, \Delta y_{2t-i}^- + \varepsilon_t \qquad (17)$$

where Δy_2^+ is positive oil price changes and $\Delta y_2^-$is negative oil price changes. The lag order, *k*, can be determined by AIC or SIC.[9] With this specification, the t tests can detect the existence of causality. Furthermore, the estimates of Eq. (17) can determine the sizes of the impacts of positive and negative oil price shocks on output growth or inflation rate.

It is necessary to define crucial proxies of oil price changes. The proxies of oil price increases and decreases are:

(1) The first differences of the level of oil price series is positive indicate oil price increases while negative first differences indicate oil price decreases,

[8] A multiple threshold NARDL model is clearly explained by Li and Guo (2022). This model is quite new.
[9] Also, a VAR model can be used for this purpose.

(2) Net oil price increase (NOPI) proposed by Hamilton (1996), which are NOPI4 and NOPI12 defined as the percentage change of oil price series from the past 4 and 12 periods high if that is positive and zero otherwise. Therefore,

$NOPI4_t$ = max [(0, y_{2t} -max (y_{1t-1}, y_{2t-2}, y_{2t-3}, y_{2t-4})]

$NOPI12_t$ = max [(0, y_{2t} -max (y_{1t-1}, y_{2t-2}, ……, y_{2t-12})]

(3) Scaled oil price increase and decrease proposed by Lee et al. (1995) are derived from the estimate of AR(p)-GARCH(1,1) as the following:

Mean equation: $\Delta y_{2t} = a_0 + \sum_{i=1}^{p} a_i \Delta y_{2t-1} + e_t, \quad e_t | I_t \rightarrow N(0, h_t)$ (18)

Variance equation: $h_t = \mu_1 + \alpha e_{t-1}^2 + \beta h_{t-1}$ (19)

Therefore, scaled oil price increase is $SOPI_t$ = max $\{0, e_t/\sqrt{h_t}\}$ and scaled oil price decrease is $SOPD_t$ = min $\{0, e_t/\sqrt{h_t}\}$. The impact of oil price shocks should be larger in a stable environment than in an erratic environment.

2.3.3 Data Availability

The available data in the analysis using the econometric techniques mentioned above are annual, quarterly and monthly. For output series, real GDP series is available in annual and quarterly basis in most countries. The output series in monthly basis should be industrial or manufacturing production index, which contains products produced by energy-intensive industries. However, there will not be any concerns about price level regarding data frequencies. The above estimation techniques are described under a bivariate framework for simplicity. The understanding of the econometric methods can be generalized to a multivariate framework. The availability of the data encourages researchers to add more variables in the model specification. The extended model can capture some transmission channels through which oil price shocks will exert the impacts on output growth and inflation indirectly. This will give intuition for recommending sound economic policies. The data used should not contain unit root in VAR models or cointegration tests, which can be detected by ADF and PP tests. Furthermore, the estimation results should not have multicollinearity problem. When the long-run relationship is found, the estimated ECM in the short-run dynamic will show whether the long-run relationship is stable. The estimated ECM must pass important diagnostic tests, i.e., there are no serial correlation and no further ARCH effect in the residuals.

3. Survey of Recent Empirical Findings in Asia

In a cross-country analysis, Choi et al. (2018) find that on average, oil price shocks have asymmetric impacts on inflation in both advanced and developing economies. Also, they find that transmission channels are important in both advanced and developing economies. The variations of impacts of oil price shocks on inflation can be explained by the share of transport in the basket of CPI and some energy subsidies provided by the government. Guerrero-Escobar et al. (2019) examine the macroeconomic impacts of oil price shocks in countries that are advanced, emerging, oil-importing, oil-exporting, with and without energy price control. They find that the level of development of the country is a crucial factor in explaining the differences in the way oil price shocks affect output and prices. Japan has been the most advanced country in Asia. Killian and Zhou (2023) find that inflation is less responsive to oil price shocks in Japan compared to other advanced countries. Fukunaga et al. (2010) investigate the impacts of oil price shocks on industry-level production in the U.S. and Japan. They find that each shock (oil supply shock, oil aggregate demand shock, and oil-specific demand shock)[10] has different impact on industry-level production due to oil intensiveness in the industry. The types of shocks affect industries in the U.S. and Japan differently. Zhang (2008) finds evidence showing the existence of nonlinear relationship between oil price shock and economic growth in Japan. The asymmetric effects show that oil price increase tends to have larger impact on output growth than oil price decrease. In some studies, Japan, South Korea, and China are included in the group of ASEAN5 countries.[11] Cunado and Perez de Gracia (2005) find that domestic oil price shock Granger causes inflation in South Korea and Japan. Cunado et al. (2015) find that oil demand shock stimulates output growth in Japan and South Korea. Nusair and Olson (2021) find that oil price shocks have asymmetric impacts on output growth in Japan and South Korea while Arahon et al. (2023) find that after the COVID19 pandemic, the asymmetric impacts of oil-specific demand shock on inflation is stronger in Japan, South Korea and China.

China has been the largest oil-importing country in the Asia-Pacific region followed by India, South Korea and Japan (source: World Energy Balances for Regional Ranking 2022 from the website of International Energy Agency). There have been quite a few empirical studies on the impacts of oil price shocks on output and inflation in China. Tang et al. (2010) employ a structural VAR model to investigate the impacts of oil price shocks on China's macroeconomy. Their results show that oil price shocks impose a positive impact on inflation while the impact on output is negative.

[10] The decomposition of these shocks is first proposed by Kilian (2009).
[11] The main reason is that these countries can be affected by the impacts of the 1997 Asian financial crisis and the COVID19 pandemic. Moreover, the combined crude oil imports of these countries are large.

Similar approach is used by Du et al. (2010) who find that there are nonlinear impacts of oil price shocks on output growth and inflation in the Chinese economy. Zhao et al. (2016) find that oil-specific demand shocks is the main cause of fluctuations in output growth and inflation in China. Using quarterly data from 1996Q1 to 2014Q4 to examine the relationship between oil prices and output in China, Wei and Guo (2016) find a positive impact of oil price shocks on output, which is attributed to the influence of oil price shocks on exports. Cross and Nguyen (2017) apply a time-varying VAR model to China's quarterly data between 1992Q1 and 2015Q3 to examine the impact of global oil price shocks on economic growth. They find that there is negative impacts of oil supply and oil-specific demand shocks on output growth while oil demand shocks have the positive impacts. On the contrary, Wen et al. (2019) examine the dynamic effects of crude oil prices and monetary policy in China over the 1996M1-2017M6 period using a time-varying parameter VAR model. They find that oil price shocks stimulate economic growth and inflation in the short run, but reduce growth and inflation in the long run. Furthermore, the long-run negative impact on output growth is greater during the recent global financial crisis. Liu et al. (2020) use a structural VAR model to examine the impacts of oil price shocks on output fluctuations in China over the period 1999M12-2013M7. Their results show that oil price shocks a negative impact on output growth. This impact is stronger after the 2008 global financial crisis. In addition, they find that China's macroeconomic activity seems to be an important source of oil price change. Chen et al. (2020) find that the effects of oil price shocks on China's inflationary process are caused by oil-specific demand shocks. The inflationary effects are weaker since the recent global financial crisis. Li and Guo (2022) find asymmetric impacts of oil price shocks on inflation in China in the short run. However, they do not find asymmetric impacts in India. Oil supply shocks seem to have stronger impacts while other types of shocks have weak impacts.

Kumar (2009) find evidence of asymmetric impact of oil price shocks on industrial growth in India and this impact is negative when oil price increases while a decrease in oil price does not have a significant impact on industrial growth. Cunado et al. (2015) find that oil demand shocks stimulate output in India but have a small impact on inflation. Acharya and Sadath (2018) find that oil price is negatively related to output in India. However, the impact of oil price on inflation is not clear because of energy subsidization by the government. Using annual data from 1970 to 2017, Sultan et al. (2020) applies Johansen cointegration technique to estimate a long-run relationship between CPI, oil price and exchange rate in India. They find that there is a positive long-run relationship between the three variables. In the short run, oil price shocks cause inflation to rise. Zakaria et al. (2021) find that the impact of global oil price on inflation is asymmetric in India, Pakistan, Bangladesh and Sri Lanka.

Cunado and Perez de Gracia (2005) examine the long-run relationship between CPI, economic activity and oil prices in Japan, Singapore, South Korea, Malaysia, Thailand, and the Philippines over the period 1975Q1-2002Q2 by using the residual-based tests for cointegration of Phillips and Ouliaris (1990) and Gregory and Hansen (1996). They find that there is no long-run relationship between CPI, output and oil prices. Moreover, the oil market collapse in 1985 does not impact the relationship. In the short-run, the results of Granger causality reveal that domestic oil price shocks have a significant effect on inflation in all countries. The asymmetric responses of output to oil price shocks is found in South Korea and Thailand. The asymmetric impacts of oil price shocks on inflation are found in all countries, except Singapore. Chang and Wong (2003) find a small impact of oil price shocks on the macroeconomy of Singapore. Shah (2012) employs a structural VAR model to identify oil aggregate supply and demand shocks on macroeconomic fluctuations. The results show that the two types of oil price shocks are the main sources of output fluctuations in Malaysia, Pakistan and Thailand. Only aggregate supply shock matters in Indonesia. Basnet and Upadhyaya (2015) find a long-run relationship between oil price, real GDP and CPI in Thailand, Singapore, the Philippines and Indonesia. However, the impulse response functions show that the effect of oil price shocks on output growth and inflation is absorbed within five to six quarters in all countries. Vu and Nataka (2018) examine the effects of oil price shocks on output and prices in Indonesia, Malaysia, Philippines, Singapore, Thailand and Vietnam. They find stronger effects of oil price shocks in oil-importing countries (Philippines, Singapore and Thailand) than oil-exporting countries (Indonesia, Malaysia and Vietnam).[12] Khan et al. (2019) employ the NARDL approach to investigate the asymmetric impact of oil price shocks on economic activity in Bangladesh, China, Hong Kong, India, Indonesia, Japan, South Korea, Malaysia, Pakistan, the Philippines, Singapore, Sri Lanka and Thailand during 1980Q1 and 2014Q2. They find no evidence of long-run asymmetric impacts of oil price on output in all 13 countries. On the contrary, the symmetric impacts are observed in some countries, namely India, South Korea, the Philippines, Sri Lanka and Thailand. The relatively high impacts of oil price shocks are found in Bangladesh, China, Indonesia, Malaysia and Pakistan. The high impacts indicate that Asian oil-exporters, Malaysia and Indonesia, are adversely affected by oil price shocks. Kisswani (2021) examines the asymmetric relationship between real oil price and real GDP for selected ASEAN5 during 1970 and 2015 using the NARDL model. The long-run asymmetry is found in all countries while the short-run asymmetric impact is found in some

[12] Oil-exporting countries should not bear the negative impact of high oil price. However, Abeysinghe (2001) find that Asian oil-exporters like Indonesia and Malaysia cannot escape the negative impact of oil price shocks. However, there are not many studies that confirm that the macroeconomic impacts of oil price on oil-importing countries are stronger than oil-exporting countries.

countries. The causality test results show mixed findings. However, the long-run asymmetry is not found in Thailand when available quarterly data are used.

Pham and Sala (2020) find that oil price shocks have small effect on inflation in Vietnam. Using a structural VAR model to examine the effect of crude oil price rise on output in Indonesia, Baek (2021) finds that crude oil price rise stimulates economic growth in the era of net oil exporter, but reduces growth in the era of net oil importer. There is little evidence that a surge in crude oil price has detrimental effect on inflation rate.

Nusair and Olson (2021) examine the asymmetric effects of oil price shocks on aggregate output in the ASEAN5 countries, Japan and South Korea using annual data for the period 1973-2018. The results for a linear ARDL model show that oil price shocks do not affect real GDP in Indonesia, Singapore, Thailand and South Korea. However, the results of a nonlinear ARDL model show that oil price shocks exert asymmetric impacts on output in all seven countries. Furthermore, nonlinear causality running from oil price to output is observed.

Aharon et al. (2023) employ monthly data during 1987 and 2020 to examine the interaction between oil price shocks and inflation in the ASEAN5+3 countries. They find that the COVID-19 pandemic is likely the fundamental cause of inflationary impact of oil aggregate demand shocks and oil-specific demand shocks This evidence is found in Malaysia, the Philippines, Singapore, Thailand and Japan. Also, inflation responds asymmetrically to positive and negative oil price shocks in all countries. Sek (2023) examines asymmetric effect of oil price changes on inflation in Malaysia. The asymmetric impacts of oil price shocks on inflation is found. Razmi et al. (2016) analyze the role of monetary transmission channels in transmitting oil price shocks to prices in the ASEAN4 countries during the pre- and post-global financial crisis. They find that during the pre-financial crisis, there is a direct effect of oil price on CPI in Malaysia, the Philippines, and Thailand, except in Indonesia. For the post-financial crisis, there is also an indirect effect in all four economies. The crucial transmission channels are stock prices and exchange rates. Cunado et al. (2015) find that oil price shocks cause output to expand in Indonesia, which is contrary to the finding by Abesinghe (2001).

The empirical findings in Asian economies shows that the responses of output growth to oil price shocks in Japan and South Korea tend to be asymmetric while the responses of inflation seem to be symmetric. For the Chinese economy, the empirical results show that the asymmetry in oil price shocks and output growth is increasingly discovered. The results of the responses of inflation to oil price shocks in China seem to favor the symmetry hypothesis. Also, the findings in the ASEAN5 economies is likely to support the symmetry hypothesis. In South Asian economies, only few studies support the asymmetry hypothesis. Empirical results for other Asian countries are not extensive enough to draw some conclusion. One important finding is that Asian oil-exporting countries, Indonesia, Malaysia, and Vietnam, might not escape the adverse impacts of oil price shocks. Overall, the results from empirical studies in Asia seem to be inconclusive regarding the asymmetry hypothesis.

4. Concluding Remarks

Theoretically, oil price shocks should have a negative impact on output growth and a positive impact on inflation. These impacts can be symmetric or asymmetric. Recently, researchers find that the impacts of oil price shocks on output and inflation tend to be asymmetric. The popular econometric techniques have been VAR models, linear and nonlinear cointegration and Granger causality tests. The methodologies in Section 2 can give basic understanding of econometric methods. New researchers can consult with advanced econometric textbooks for more complicate estimation methods.

This paper reviews the recent existing literature on the responses of economic activity and prices to oil prices in Asian economies. Empirical studies use different econometric methods mentioned above. It appears that different analytical frameworks tend to give inconclusive results. Empirical results show that oil price rises adversely affect output and positively raise consumer prices in most of Asian economies even though cointegration technique results show that evidence of linear and nonlinear long-run relationships between oil price and economic activity or price level is not widely found in the ASEAN5 and some Asian economies. The asymmetric impacts of oil price shocks on output growth are found in Japan, South Korea. The asymmetry hypothesis seems to be supported. Most papers find more symmetric impacts of oil price shocks on output in China and India than asymmetric impacts.

Some issues should be taken into account in future empirical studies on Asian economies:

(1) Oil price variable is available in nominal or real crude oil price, real domestic oil price. The findings show that real domestic oil price is more important to detect the impacts of oil price on output or inflation than global oil price in some studies.
(2) More empirical studies need to be done to confirm whether the impacts of oil price shocks are stronger in oil-importing than oil-exporting countries even though there are few oil-exporting countries in Asia.

(3) Only few studies decompose oil price shocks into different types of shocks, i.e., oil aggregate supply shocks, oil aggregate demand shocks and oil-specific demand shocks. These shocks can have different impact on output and price level.
(4) New research papers should take into account the impacts of structural breaks such as the 1997 Asian financial crisis, the 2008 global financial crisis, the 2009 COVID pandemic and high and low oil price regimes during the period of study. Ignoring regime changes can lead to misleading results and conclusions.
(5) The asymmetric nonlinear autoregressive distributed lags model should be used along with the proxies of positive and negative oil price changes mentioned in Sub-section 2.3.2. New researchers who use first differences of oil price series to separate positive and negative oil price shocks are highly likely to find the results that support the symmetry hypothesis.

If the impacts of oil price shocks are strong, sound monetary can be administered to alleviate the recession and high inflation rate in the future. Monetary policy measures should be accommodative of oil price shocks such that expectations of higher inflation are not triggered. In addition, monetary policy can create a period of less sensitivity of inflation to oil shocks. Oil price subsidies and tax reduction or exemption might be necessary especially in the period of oil price increase.

References

Abeysinghe, T., (2001), "Estimation of direct and indirect impact of oil price on growth," *Economics Letters*, 73(2), 147-153.

Acharya, R. H., and Sadath, A. C., "Revisiting the relationship between oil price and macroeconomy: evidence from India," *Economics and Policy of Energy and the Environment*, 2018(1), 173-190.

Aharon, D. Y., Aziz, M. I. A., and Kallir, I., (2023), "Oil price shocks and inflation: a cross-national examination in the ASEAN5+3 countries," *Resources Policy*, 82(103573).

Avastveit, K. A., Bjornland, H. C., and Thorsrud, L. A., (2015), "What drives oil prices? Emerging versus developed economies," *Journal of Applied Econometrics*, 30(7), 1013-1028.

Bachmeier, L. J., and Keen, D., (2023), "Modeling the asymmetric effects of an oil price shock," *International Journal of Central Banking*, 19(3), 1-47.

Baek, J., (2021), "Crude oil prices and macroeconomic activities: a structural VAR approach to Indonesia," *Applied Economics*, 53(22), 2527-2538.

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

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

Chen, J., Zhu, X., and Li, H., (2020), "The pass-through effects of oil price shocks on China's inflation: a time-varying analysis," *Energy Economics*, 86 (104965).

Choi, S., Furceri, D., Lougani, P., Mishra, S., and Poplauski-Ribeiro, M. (2018), "Oil price and inflation dynamics: Evidence from advanced and developing economies," *Journal of International Money and Finance*, 82(C), 71-96.

Cologni, A., and Manera, M., (2009), "The asymmetric effects of oil shocks on output growth: a Markov-Switching analysis for the G-7 countries," Economic Modelling, 20(1), 1-29.

Cross, J., and Nguyen, B. H., (2017), "The relationship between global oil price shocks and China's output: a time-varying analysis," *Energy Economics*, 62(C), 79-91.

Cunado, J., Jo, S., and Perez de Gracia, F., (2015), "Macroeconomic impacts of oil price shocks in Asian economies," *Energy Policy*, 86(C), 867-879.

Cunado, J., and Perez de Gracia, F., (2005), "Oil prices, economic activity and inflation: evidence for some Asian countries," *Quarterly Review of Economics and Finance*, 45(1), 65-83.

Darby, M. R. (1982), The price of oil and world inflation and recession," *American Economic Review*, 72(4), 738-751.

Du, L., Yanan, H., and Wei, C., (2010), "The relationship between oil price shocks and China's macroeconomy: an empirical analysis," *Energy Policy*, 38(8), 4142-4151.

Edelstein, P., and Kilian, L., (2009), "How sensitive are consumer expenditures to retail energy prices?," *Journal of Monetary Economics*, 56(6), 766-779.

Enders, W., and Granger, C. W. F. (1998), "Unit root tests and asymmetric adjustment with an example using the term structure of interest rates," *Journal of Business and Economic Statistics*, 16(3), 304-311.

Enders, W. and Siklos, P., (2001), "Cointegration and Threshold Adjustment," *Journal of Business and Economic Statistics*, 19(2), 166-176.

Engle, R. F. and Granger, C. W. J., (1987), "Co-integration and error correction: representation, estimation and testing," *Econometrica*, 55(2), 251-276.

Fukunaka, I., Hirakata, N., and Sudo, N., (2010), "The effects of oil price changes on industry-level production and prices in the U.S. and Japan," *NBER Working Paper*.

Granger, C. W. J., (1969), "Investigating causal relations by econometric models and cross spectral methods," *Econometrica*, 37(3), 424-438.

Granger, C. W. J., (1988), "Causality, cointegration, and control." *Journal of Economic Dynamics and Control*, 12(2-3), 551-559.

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

Guerrero-Escoba, S., Hernandez-del-Valle, G., and Hernandez-Vega, M., (2019), "Do heterogenous countries respond differently to oil price shocks," *Journal of Commodity Markets*, 16(C).

Hamilton, J. D., (1983), "Oil and macroeconomy since World War II", *Journal of Political Economy*, 91(2), 228-248.

Hamilton, J. D., (1996), "What happened to the oil price-macroeconomy relationship?" *Journal of Monetary Economics*, 38(2), 195-213.

Hamilton, J. D., (2003), "What is an oil shock?" *Journal of Econometrics*, 113(2), 363-398.

Herrera, A. M., Lagolo, L. G., and Wada, T., (2015), "Asymmetries in the response of economic activity to oil price increases and decreases," Journal of International Money and Finance, 50(C), 108-133.

Hooker, M. A., (2002), "Are oil shocks inflationary? asymmetric and nonlinear specification versus changes in regime," *Journal of Money, Credit, and Banking*, 34(2), 540-561.

Johansen, S., (1991), "Estimation and hypothesis testing for cointegration vectors in Gaussian vector autoregressive models," *Econometrica*, 59(6), 1151-1580.

Johansen, S and Juselius, K., (1990), "Maximum likelihood estimation and inference on cointegration with applications to the demand for money," *Oxford Bulletin of Economics and Statistics*, 52(2), 169-210.

Khan, M. A., Husnain, M. I. U., Abbas, Q., and Shah, S. Z. A., (2019), "Asymmetric effects of oil price shocks on Asian economies," *Empirical Economics*, 57(4), 1319-1350.

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

Kilian, L. and Zhou, X., (2023), "Oil price shock and inflation," *Working Paper 2312*, Research Department, Federal Reserve Bank of Dallas.

Kisswani, K. M., (2021), "The dynamic links between oil prices and economic growth: recent evidence from nonlinear cointegration analysis for the ASEAN-5 countries," *Emerging Market Finance and Trade*, 57(11), 3153-3166.

Kumar, S., (2009), "The macroeconomic effects of oil price shocks: empirical evidence for India," *Economics Bulletin*, 29(1), 15-37.

Lahiani, A., (2019), "Exploring the inflationary effect of oil price in the US: a quantile regression approach over 1876-2014," *Journal of Energy Sector Management*, 13(1), 60-76.

Lee, K. and Ni, S., (2002), "On the dynamic effects of oil price shocks: a study using industry level data," *Journal of Monetary Economics*, 49(4), 823-852.

Lee, K., Ni, S., and Ratti, R. A., (1995), "Oil price shocks and the macroeconomy: the role of oil price variability," *Energy Journal*, 16(4), 39-56.

Li, Y., and Guo, J., (2022), "The asymmetric impacts of oil price and shocks on inflation in BRICS: a multiple threshold nonlinear ARDL model," *Applied Economics*, 54(12), 1327-1395.

Liu, D., Meng, L., and Wang, Y., (2020)," Oil price shocks and Chinese economy revisited: new evidence from SVAR model with sign restrictions," *International Review of Economics and Finance*, 69(C), 20-32.

Mork, K. A., (1989), "Oil and the macroeconomy when prices go up and down: an extension of Hamilton results," *Journal of Political Economy*, 97(3), 740-744.

Mork, K. A., Olsen, O., and Mysen, H. T., (1994), "Macroeconomic responses to oil price increases and decreases in seven OECD countries," *Energy Journal*, 15(4), 19-35.

Mory, J. F., (1993), "Oil prices and economic activity: is the relationship symmetric?," *Energy Journal*, 0(4), 151-162.

Nusair, S. A., and Olson, D., (2021), "Asymmetric oil price and Asian economies: a nonlinear ARDL approach," *Energy*, 219(119594).

Peersman, G., and Van Robays, I., (2012), "Cross-country differences in the effects of oil shocks," *Energy Economics*, 34(5), 1532-1547.

Pesaran, M. H., Shin, Y., and Smith, R. J., (2001), "Bounds testing approaches to the analysis of level relationships," *Journal of Applied Econometrics*, 16(3), 289-326.

Pham, B. T., and Sala, H., (2020), "The macroeconomic effects of oil price on Vietnam: evidence from an over-identifying SVAR analysis," *Journal of International Trade and Economic Development*, 29(3), 907-933.

Phillips, P. C. B, and Ouliaris S., (1990), "Asymptotic properties of residual-based tests for cointegration," *Econometrica*, 58(1), 165-193.

Prettucelli, J., and Wollford, S., (1984), "A threshold AR(1) model." *Journal of Applied Probability*, 21(3), 273-286.

Razmi, F., Azali, M., Chin, L. and Sha Habibulla, M., (2016), "The role of monetary transmission channels in transmitting oil price shocks to prices in ASEAN-4 countries during pre- and post-global financial crisis," *Energy*, 101(C), 581-591.

Sek, S. K., (2023), "A new look at asymmetric effect of oil price changes on inflation: evidence from Malaysia," *Energy and Environment*, 34(5), 1524-1547.

Shah, I., (2012), "Revisiting the dynamic effect of oil price shock on small developing economies," *Bristol Economics Discussion Papers* 12/626, School of Economics, University of Bristol, UK.

Shin, Y., Byungchul, Y., and Greenwood-Nimmo, M., (2014), "Modelling asymmetric cointegration and dynamic multipliers in a nonlinear ARDL framework," in *The Festschrift in Honor of Peter Schmidt: Econometric Methods and Applications*, edited by Sickles, R. C., and Horrace, W. C. New York, Springer, 281-314.

Sultan, Z, Alkhateep, T., and Fawaz, M., (2020), "Empirical investigation of the relationship between oil price and inflation: the case of India," *International Journal of Energy Economics and Policy*, 10(3), 90-94.

Tang, W., Wu, L., and Zhang, Z., (2010), "Oil price shocks and their short- and long-run effects on the Chinese economy," *Energy Economics*, 32(S), 3-14.

Vogelsang, T. J., (1993), “The great crash, the oil price shock, and the unit root hypothesis: erratum,” *Econometrica*, 61(1), 248-249.

Vu, T. K., and Nataka, H., (2018), “Oil price fluctuations and the small economies of Southeast Asia: an analysis using vector autoregression with block exogeneity,” *Journal of Asian Economics*, 54(C), 1-21.

Wei, Y. and Guo, X., (2016), “An empirical analysis of the relationship between oil prices and the Chinese macro-economy,” *Energy Economics*, 56(C), 88-100.

Wen, F., Min, F., Zhang, Y., and Yang, C., (2019), “Crude oil price shocks, monetary policy, and China’s economy,”” *International Journal of Finance and Economics*, 24(2), 812-827.

Zakaria, M., Khiam, S., and Mahmood, H., (2021), “Influence of oil price on inflation in South Asia: some new evidence,” *Resources Policy*, 71 (102014).

Zhang, D., (2008), “Oil shock and economic growth in Japan: a nonlinear approach,” *Energy Economics*, 30(5), 2374-2390.

Zhao, L., Zhang, X., Wang, S., and Xu, S., (2016), “The effects of oil price shocks on output and inflation in China,” *Energy Economics*, 53(C), 101-110.