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Asymmetric Effects of Oil Price Shock on Disaggregated Consumer Prices

(Kesan Asimetrik Kejutan Harga Minyak terhadap Harga Pengguna Tak Agregat)

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ABSTRACT

This paper examines the effects of positive and negative oil price shocks on disaggregated consumer prices. It employs the Structural VAR (SVAR) model on Malaysian data over l991-2020. The findings indicate that positive and negative oil price shocks have different effects on certain sub-groups of the consumer price index, confirming the asymmetric effects of oil prices. Other sub-group indexes, particularly the food index, transport and communication index and recreation, entertainment, education and cultural services index behave symmetrically following positive and negative oil price shocks. The response in food index is the largest following a positive oil price shock, as shown by the forecast error variance decomposition. Meanwhile, the transport and communication index received substantial impacts from a negative oil price shock. Moreover, positive and negative oil price shocks exert inflationary pressure on Malaysia's economy.

Keywords: Asymmetric; price level; oil shocks; structural vector autoregression

ABSTRAK

Makalah ini memeriksa kesan kejutan positif dan negatif harga minyak terhadap harga pengguna tak agregat. Ia menggunakan model vektor autoregresif berstruktur (SVAR) ke atas data Malaysia bagi 1991-2020. Hasil kajian mendapati kejutan positif dan negatif harga minyak mempunyai kesan yang berbeza terhadap beberapa sub-kumpulan indeks harga pengguna, yang mengesahkan kesan asimetrik harga minyak. Bagi sub-kumpulan indeks yang lain, khususnya indeks makanan, indeks pengangkutan dan perhubungan, dan indeks perkhidmatan rekreasi, hiburan, pelajaran dan kebudayaan berlakuan simetrik berikutan kejutan positif dan negatif harga minyak. Tindak balas indeks makanan adalah terbesar berikutan kejutan positif harga minyak seperti yang ditunjukkan oleh ramalan ralat penguraian varians. Sementara itu, indeks pengangkutan dan perhubungan menerima impak yang besar daripada kejutan negatif harga minyak. Selain itu, kejutan positif dan negatif harga minyak memberikan tekanan inflasi terhadap ekonomi Malaysia.

Kata kunci: Asimetrik; paras harga; kejutan minyak; vektor autoregresif berstruktur
JEL: C32, E31, Q43, C50, D60, A10
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INTRODUCTION

Recently, protecting economic welfare is somewhat challenging due to economic uncertainty in the global economy. Oil price fluctuation is typical among the identified sources that inevitably generate uncertainty concerning future oil price movements (Bernanke 1983; Hamilton 1996). Such fluctuations have global implications, particularly for economic welfare. For instance, a sudden rise in oil prices induces higher production costs, which raises consumer prices and thus leads to inflation (Li & Guo 2021)demand and risk shocks and subsequently establish an empirical framework to explore asymmetric pass-through using a novel multiple threshold nonlinear autoregressive distributed lag model (MTNARDL. As a result, high inflation reduces consumer surplus and ultimately threatens economic welfare (Husaini et al. 2019). A reduction in consumer surplus is a loss in economic welfare due to higher living costs (Mankiw 2017).

The mandate of monetary authority is to secure price stability in the economy. Although rising oil prices lead to inflationary pressure, scholars remain divided on how central banks should react to price shocks. Hooker (2002) claimed that monetary policy should refrain from being aggressive in reacting to oil price shocks to ensure lesser impact due to inflation. However, the active role of the central bank in fighting inflation has been proven to reduce oil price pass-through (Chen 2009). Taylor (2000) contends that the inflation regime influences the degree to which oil prices are passed through. An economic environment with low inflation can reduce oil price effects because it eases persistent costs and firm's pricing power.

The central bank's decision on whether to respond is generally influenced by how inflation gradually converges following oil price shock. However, it was discovered that real effects of positive oil prices differed with those from negative oil prices (Mork 1989; Zainal 2021). Understanding the dynamic linkages between oil prices and inflation, considering the asymmetric effects of oil, can thus help central banks in effectively conducting monetary policy. Furthermore, focusing on the asymmetric effects on disaggregated price levels can provide valuable information that lead to more policy-relevant resolutions (Baffes 2007).

This paper investigates asymmetric effects of oil prices on disaggregated price levels from the Malaysian experience and perspective. In 2019, Malaysia ranks as the second largest producer of oil and natural gas in Southeast Asia and the fifth largest exporter of liquefied natural gas (LNG) in the world. Malaysia, as an oil producing country, is debatably susceptible to the oil price fluctuations. The Malaysian economy benefits from the increase in oil prices, particularly in terms of tax revenue. For instance, petroleum income tax (PITA) rebounded significantly by 70.7% to RM20 billion in tandem with higher global crude oil prices averaging USD 71 per barrel in 2018. It has been argued that an oil producing country with high revenue can warrant price stability via both fiscal and monetary policies (Husaini & Lean 2021).

Owing primarily to higher global oil prices, Malaysian inflation is expected to average higher in 2021 (Bank Negara Malaysia 2021). Therefore, the decision of how to react to such an event depends on knowledge on the speed at which inflation converges following an oil price shock. In Malaysia, studies on asymmetric effect of oil prices over disaggregated price levels are still lacking. Therefore, the main motivation for this study is to determine the magnitude of the shock in oil prices on Malaysian consumer prices, specifically at disaggregated levels. By incorporating the asymmetric effects, it can help the central bank to effectively implement the framework of monetary policy (interest rate targeting) and therefore control inflationary pressure.

The study on this topic is important as it will assist policymakers in providing information to help stabilise prices at both aggregated and disaggregated levels. Given that higher living costs are generally attributed to inflation, understanding the reaction of disaggregated price levels provides advantages to policymakers and consumers. If both positive and negative oil price shocks affect disaggregated consumer prices differently, implying the behavioural patterns of asymmetrical oil price effects, Bank Negara Malaysia should modify its implementation on monetary policy. In the perspective of the consumer, a study on this topic can assist in formulating predictions to gauge the oil price effects and thus be able to manage prudent spending. For example, consumers can make better predictions by planning expenses accordingly in the wake of oil price developments. In case where consumer prices tend to rise faster following positive oil prices than negative oil prices, then the consumer can control or minimise the spending that is susceptible to oil price changes. Furthermore, consumers can use products or technologies that are energy efficient.

Following the literature review, the rest of the study is divided into four sections. The methodology is covered in the second section while results and discussion are presented in the third section. The conclusion is given in the fourth section.

LITERATURE REVIEW

Numerous studies on the linkages between oil prices and inflation have been conducted, but the results appear contradictory (Furuoka et al. 2007; Saudi et al. 2018; Saudi & Tsen 2019). Hamilton (1983), for example, examined oil price shocks on the US macroeconomy, including price levels and discovered that positive oil prices impeded output growth. Hamilton (1983) stated that the post-WWII economic recession in the US was due to a surge in oil prices. Rotemberg and Woodford (1996) discovered that higher real oil prices led to higher general prices. Bernanke et al. (1997) established that in the US, oil price shock raised inflation. Hooker (1999) claimed that the macroeconomic impacts of oil prices were indirect due to inflation and interest rates. Several subsequent studies confirmed that oil price shocks induced inflationary pressure. These studies included Chang and Wong (2003) for Singapore, Cologni and Manera (2008) for some G-7 countries, Basnet and Upadhyaya (2015) for ASEAN and Zakaria et al. (2021) for South Asian countries.

However, many scholars have discovered that oil price effects on inflation are lessening or they refused to accept that oil prices cause inflationary pressures (Tsen 2010). For example, Hooker (2002) stated that the oil price pass-through appeared to be largely absent in the United States since 1981. Similarly, Barsky and Kilian (2002) discovered that oil prices did not induce inflation as shown in CPI and GDP deflators. Barsky and Kilian (2004) extended the analysis, claiming that there was no compelling empirical evidence that higher GDP deflator inflation can be linked to oil shocks. Subsequent studies consistently established the effect of declining oil price on inflation. These include van den Noord and Andre (2007) for the US and EU, Chen (2009) for 19 industrialised countries, Jongwanich and Park (2011) for developing

Asia, Conflitti and Luciani (2019) for the US and EU and Jiranyakul (2021) for nine Asian and the Pacific countries.

Past empirical studies have concentrated primarily on the aggregate inflationary effect of oil prices. As postulated by Baffes (2007), focusing on disaggregated price levels provided valuable information which led to more policy-relevant resolutions. Baffes (2007) discovered the different impacts of oil price shocks among commodities. For instance, oil prices increase by about 10% induced food prices to rise by about 1.8%. Chen et al. (2010) stated that agricultural prices, namely corn, soybean and wheat prices can be affected by crude oil prices. Baumeister and Kilian (2014) investigated US food and discovered that corn prices were elevated due to the shock in oil prices. A 1% increase in real oil prices, for example, increased corn prices by 0.5 % over a lapse of one year.

In Malaysia, studies of oil price effects on disaggregated price levels are still lacking. Among past investigations were Ibrahim and Said (2012), Ibrahim (2015) and Husaini and Lean (2021). Ibrahim and Said (2012) who focused on four sub-groups of CPI discovered that oil prices tended to influence significantly most of the CPI sub-groups in the short run. In the extended study, Ibrahim (2015) focused on food prices and oil prices concerning asymmetrical behaviour. The findings showed that oil price increases provided a significant short- and long-term impact on food prices. Recently, Husaini and Lean (2021) studied disaggregated price inflation, in particular CPI and PPI, and discovered that oil price increases affected the PPI more than CPI.

To add new information to existing literature, this study applies an open economy SVAR model to elucidate oil price effects (positive and negative shocks) on aggregate and disaggregated consumer prices. Cushman and Zha (1997) stated that SVAR model can provide reliable and valid results, notably for small open economies. In addition, SVAR assists in analysing the changes in unanticipated (shock) variables towards other variables in the system (Lütkepohl 2005). This study improves on studies by Ibrahim and Said (2012) and Ibrahim (2015) by extending the analysis to nine sub-groups of CPI and taking into account the asymmetrical behaviour of oil prices. Although Ibrahim (2015) disentangled oil prices into positive and negative behaviour, the analysis was limited to food price inflation. Previous studies on the oil price effects on disaggregated prices, for example Ibrahim and Said (2012), Ibrahim (2015) and Husaini and Lean (2021), had neglected fiscal and monetary policy interaction. Thus, this study shall expand on their studies by incorporating fiscal and monetary policy variables using open economy SVAR model given that both policies are important in determining price equilibrium (Sargent & Wallace 1981; Woodford 1995; Leeper 1991; even when inflation is prima facie a strictly monetary phenomenon -- prices are flexible, markets clear and velocity is constant -- inflation is, in the long run, a fiscal phenomenon. This follows from the government budget constraint and the existence of an upper bound on the real per capita stock of interest bearing public debt held by the private sector. Together these ensure that in the long run the growth of the money stock is governed by the fiscal deficit, if we assign to the fiscal authorities the role of Stackelberg leaders and to the monetary authorities that of Stackelberg followers. The discussion of the formal S-W model focuses on the distinct roles of public spending and explicit taxes in their model and on the possibility that optimal policy involves public sector surpluses and a net credit position of the public sector vis-a-vis the private sector. It is also argued that the specification of the demand for and supply of - money is ad hoc, a weakness shared by most existing macro models.. Finally it is shown that if we adjust the published government deficit figures for the effect of inflation on the real value of the stock of nominal government debt (as should be done to obtain a deficit measure appropriate to the S-W modelSims 1994; 2011).

METHODOLOGY

This study used quarterly data from 1991:1 to 2020:3. The period was selected because Malaysia had gone through major transformations, such as the early 1990s shift in monetary policy strategy and had encountered economic and financial crises, such as the 1997/1998 ASEAN crisis, the 2008 global crisis and the 2020 economic crisis due to the COVID-19 pandemic. The data were sourced from the Energy Information Administration (EIA), Federal Reserve Economic Data (FRED), International Financial Statistics (IFS) online database and Bank Negara Malaysia's Statistical Bulletin.

There are two blocks of variables. The foreign block includes two variables; oil prices and foreign national income. Real crude oil imported acquisition costs was used to represent oil prices as proposed by Alquist et al. (2013). In examining the asymmetrical oil price effects, this study adopts Jimenez-Rodriguez and Sanchez (2005) principle:

$$p_t^+ = \sum_{k=1}^{t} \max\,(\Delta p_k, 0) \tag{1}$$

and

$$p_t^- = \sum_{k=1}^{t} \min\,(\Delta p_k, 0) \tag{2}$$

where p_t^+ denotes positive changes oil price and p_t^- represents negative oil price changes. The US real GDP was used to represent foreign national income. The domestic block includes five variables; domestic national income, inflation, government spending, government taxes and interest rates. Real GDP was used to proxy domestic national income. Government expenditure comprised the sum of operating expenditure and development expenditure, whereas government taxes included the sum of tax, non-tax revenues and non-revenue receipts. Inflation was described as a consistent rise in the economy's price level over a given time period. Therefore, the consumer price index was used to measure the inflation level.

The interbank overnight rate (IBOR) was chosen as the interest rate. In April 2004, Bank Negara Malaysia, the country's central bank declared Overnight Policy Rate (OPR) as the primary indicator for representing the direction of monetary policy. Since OPR data only became available in 2004, the overnight interbank rate (IBOR) was used to represent the direction of monetary policy. Previous studies that used IBOR as a monetary policy stance included Domac (1999), Ibrahim (2005), Umezaki (2007)underscoring the increased agency costs of external finance. The decline in lending activity in the first half of 1998 can be attributed to the reduced supply of bank credit relative to demand. Empirical results from vector auto-regression analysis demonstrate that monetary tightening disproportionately affects small and medium-size enterprises. Moreover, monetary shocks contribute substantially more to small and medium-size firms` variance of production (71 percent, Karim and Karim (2014), Karim et al. (2013) and Raghavan and Athanasopoulos (2018).

For the sub-groups of CPI, this study used nine groups, namely food index, beverages and tobacco index, clothing and footwear index, gross rent, fuel and power index, furniture, furnishings and household equipment and operation index, medical care and health index, transport and communication index, recreation, entertainment, education and cultural services index and miscellaneous goods and services index. The nine sub-groups were denoted respectively as LCPI1, LCPI2, LCPI3, LCPI4, LCPI5, LCPI6, LCPI7, LCPI8 and LCPI9. Except for the interest rate, every variable was expressed in logarithms. Additionally, three dummies were added to represent the following events; the 1997-98 Asian Financial Crisis (1997: Q3-1998Q4), the 2008 Global Financial Crisis (2007: Q3-2009: Q1) and the effects of economic recession triggered by the COVID-19 pandemic (2019Q4-2020Q3).

SVAR MODEL

The inflationary effect of oil price shock can be explained using SVAR model as follows:

$$Ay_t = v + C(L)y_{t-p} + \varepsilon_t \tag{3}$$

where A is a rectangular matrix that describes the contemporaneous structural relationship between variables, y_t is (n x 1) vector of variables included in a system, v is (n X 1) a vector of deterministic variables (constants and dummy variables), $C(L)$ is (n X n) square matrix polynomial in the lag operator L and ε_t is (n x 1) vector of structural error that satisfies the conditions $E(\varepsilon_t) = 0$ and is $E(\varepsilon_t\varepsilon_t') = I_n$ is $n \times n$ of the identity matrix.

Equation (3) cannot be estimated using the OLS because there is a lag effect for the dependent variable. This problem, however, can be solved by converting equation (3) to the reduced form representation by multiplying as shown below:

$$y_t = A^{-1}v + A^{-1}(C_1L + C_1L^2 + \cdots + C_kL^k)y_t + A^{-1}\varepsilon_t \tag{4}$$

or

$$y_t = \prod{}_0 + \prod{}_1 y_t + \mu_t \tag{5}$$

where $\prod_0 = A^{-1}v$, $\prod_1 y_t = A^{-1}(C_1L + C_1L^2 + \cdots + C_kL^k)y_t$ and $\mu_t = A^{-1}\varepsilon_t$. The value of μ_t is a residual reduced-form VAR that meets the conditions $E(\mu_t) = 0$ and $E(\mu_t\mu_t') = \sum_\mu$ is a positive and symmetric matrix that can be estimated from the data. Given that the residual reduced-form VAR (μ_t) and the structural error (ε_t) have the relationship $\mu_t = A^{-1}\varepsilon_t$ or $A\mu_t = \varepsilon_t$, the variance-covariance matrix to capture this relationship is as follows:

$$\begin{aligned} E(\mu_t\mu_t') &= A^{-1}\varepsilon_t A^{-1\prime}\varepsilon_t{}' \\ &= A^{-1}E(\varepsilon_t\varepsilon_t{}')A^{-1\prime} \\ &= A^{-1}\textstyle\sum_\varepsilon A^{-1\prime} \\ \textstyle\sum_\mu &= A^{-1}A^{-1\prime} \end{aligned} \tag{6}$$

The variance-covariance matrix $(\sum_\mu)$ has $n(n+1)/2$ different elements. The number of these elements represents the maximum number of identifiable parameters in matrix A, where n represents the number of endogenous variables in the SVAR system. However, matrix A contains $n2$ parameters, which exceeds the maximum number of parameters required by the SVAR system. As a result, the SVAR system faces identification problems.

The order condition introduced by Rothenberg (1971) can be used to solve the identification problems in the SVAR system. Order condition is a standard criterion for resolving SVAR system identification problems (Lutkepohl & Kratzig 2004). This condition states that the zero restrictions in matrix A must be determined subject to $(n^2 - n)/2$. After resolving the identification problems, moximumm likelihood can be used to estimate the SVAR model.

Equation (7), in compact matrix form shows the restriction on matrix A. This study applies short-run zero restrictions as it can generate valid impulse responses (Christiano et al. 2006). In contrast to a recursive approach that relies on variable ordering, this study uses non-recursive identification as it imposes restrictions on contemporaneous causal relationships based on economic theory (Lutkepohl & Kratzig 2004) and is motivated by open economy models, timing information and the imposition of behavioural assumptions (Brischetto & Voss 1999). Hence, their discussion followed in identifying the restrictions on matrix A.

Based on the order condition, the 21 $[(7^2 - 7)/2]$ zero restrictions were required to ensure the model was correctly identified. The system of equations in (7) however, imposed 23 zero restrictions, indicating over-identification in the SVAR model. The validity of over-identification can be checked using the LR test (Enders 2015). The results indicated that the over-identification of the SVAR model was valid.

This study estimated SVAR model separately in investigating asymmetric effects of oil prices on disaggregated consumer price levels. Specifically, this study included one sub-group of CPI in SVAR model to estimate the impact of positive oil price shock. This estimating was also used when examining the negative oil price shock. Since the estimation of oil prices impacts positive and negative shocks on disaggregated consumer price levels separately, over-identification was tested for each disaggregated price model using the LR test. The over-identification was valid for all models[1].

$$A\begin{bmatrix} 1 & 0 & 0 & 0 & 0 & 0 & 0 \\ \alpha_{21} & 1 & 0 & 0 & 0 & 0 & 0 \\ \alpha_{31} & 0 & 1 & 0 & \alpha_{35} & 0 & 0 \\ \alpha_{41} & 0 & \alpha_{43} & 1 & \alpha_{45} & 0 & 0 \\ \alpha_{51} & \alpha_{52} & 0 & \alpha_{54} & 1 & 0 & 0 \\ \alpha_{61} & \alpha_{62} & \alpha_{63} & \alpha_{64} & \alpha_{65} & 1 & 0 \\ \alpha_{71} & 0 & \alpha_{73} & \alpha_{74} & \alpha_{75} & \alpha_{76} & 1 \end{bmatrix}\begin{bmatrix} \mu_{LOP,t} \\ \mu_{LYUS_t} \\ \mu_{LTR_t} \\ \mu_{LGE_t} \\ \mu_{LYM_t} \\ \mu_{LCPI_t} \\ \mu_{R_t} \end{bmatrix} = \begin{bmatrix} \varepsilon_{LOP_t} \\ \varepsilon_{LYUS_t} \\ \varepsilon_{LTR_t} \\ \varepsilon_{LGE_t} \\ \varepsilon_{LYM_t} \\ \varepsilon_{LCPI_t} \\ \varepsilon_{R_t} \end{bmatrix} \quad (7)$$

IDENTIFICATION SCHEME

The study used block exogenous assumptions on foreign and domestic blocks due to the small size of the Malaysian economy (Zaidi & Fisher 2010). Hence, domestic block was not expected to have an effect on oil prices and foreign national income, either contemporaneously or with a lag. Previous empirical studies have made similar assumption, such as Cushman and Zha (1997), Brischetto and Voss (1999), Kim and Roubini (2000) and Zaidi et al. (2016, 2022).

Oil prices were assumed to be exogenous, indicating that they do not respond to domestic variables contemporaneously or with a lag. However, oil prices were expected to be influenced by foreign income with a lag. This assumption was used in previous studies such as Aarle et al. (2003), Raghavan et al. (2012)policy and target variables; (ii, Karim and Karim (2014) and Kaharudin et al. (2017). Foreign income was expected to respond negatively to oil price shocks. The concept of cost-push inflation can be used to explain such phenomena. Previous empirical studies on oil price and US output, including Hamilton (1983), Hamilton (1996), Bernanke et al. (1997), Hamilton and Herrera (2004), Hamilton (2009) and Kilian and Vigfusson (2017), have established that oil price shocks adversely affected output.

Oil prices, government tax revenues and domestic national income are expected to influence government spending contemporaneously. Shock to the oil price was expected to increase government spending. This assumption appears reasonable, as increases in oil prices cause price increases, slowing economic growth. In response to this specific shock, the government pursued expansionary fiscal policy by raising government spending to stimulate economic growth. Past studies of oil price effects in Malaysia, for example, Hong (2010) and Bekhet and Yusoff (2013) discovered that government spending responded positively and significantly following oil price shocks.

Government spending was expected to respond positively to domestic national income. The assumption based on Wagner law states that the expansion of the public sector is primarily determined by economic growth. Hence, growth in the public sector is claimed to be much faster than the national product. As a result, growth in national output induces expansion in the size of the government. Previous studies, for example, Karim and Mokhtar (2005), Abdullah and Maamor (2010) and Govindaraju et al. (2011) have confirmed the validity of Wagner's law in Malaysia.

This study assumed that the Malaysian government formulates budget planning based on government tax revenue. Thus, it was assumed that a shock to government tax revenue will increase government spending. This indicates that a rise in government tax collection can enhance the country's source of income, allowing the government to boost spending. Several studies, including Tang et al. (2013) and Hong (2016), supported this assumption.

Government tax revenue is expected to respond immediately to oil prices and domestic national income. Tax revenue was expected to gain from the oil price shock. The assumption seemed plausible given that Malaysia is considered a net oil producer. In 2019, the share of petroleum-related revenues to total tax revenues accounted for 31% (Ministry of Finance Malaysia 2021). Furthermore, the shock to domestic national income was expected to increase tax revenue. The basic theory of macroeconomics states that raising the tax per unit improves income ($t = \frac{\Delta T}{\Delta Y}$) (Kaharudin et al. 2017). Hence, expansion in national income can induce growth in tax revenue. In addition, other sources of government tax revenue include sales tax and income tax depending on the current economic activity within the same quarter (Kim & Roubini 2008). This assumption was supported by Dungey and Fry (2009) and Kaharudin et al. (2017).

Domestic income is expected to respond simultaneously to oil prices, foreign national income and government spending shocks. Oil price shock is envisaged to increase domestic national income owing to Malaysia's position as an oil exporter. Oil price increases raised export income, enhancing the petroleum income tax and thus promoting the country's output growth. According to Aleksandrova (2016), oil exporting countries' economies benefit from higher oil prices, whereas declining oil prices reduce export income. Given Malaysia's reliance on its main trading partner, the United States, domestic income is expected `to respond positively to foreign income shocks. From 1990 to 2019, Malaysia's overall exports to the US amounted to 43% of total products (WITS 2019).

Fiscal policy shock is expected to accelerate domestic national income. This assumption is based on Keynesian theory, which asserts that fiscal expansion via increasing government spending manages to spur aggregate demand in the short run. Aggregate demand is predicted to rise as a result of fiscal policy's positive effects on disposable income and the wealth effect (Branson 1979; Elmendorf & Mankiw 1998; Romer 2012).

Domestic inflation is expected to respond instantaneously to shocks in oil prices, foreign income, domestic income, government spending and tax revenues. Oil price shock is expected to cause inflationary pressure for domestic inflation. This assumption is based on the cost-push inflation concept. Similarly, domestic income shock is expected to cause inflation in the economy. This expectation is based on the Phillips curve, which posits that output gap and inflation have a positive relationship. Inflation is expected to rise instantaneously following fiscal policy shock. This assumption was earlier discussed by Fatas and Mihov (2001) and Perotti (2002).

In the monetary policy perspective, interest rate is expected to respond immediately following oil prices, fiscal policy, domestic income and inflation shocks. It is projected to rise following oil price shock, as higher oil prices can cause general price levels to increase thus hindering economic growth. To maintain economic and inflationary stability, the monetary authority is supposed to raise interest rates through the adoption of contractionary monetary policy. Furthermore, domestic income and inflation shocks are expected to produce favourable effects on interest rates. This assumption is based on the Taylor rule (Taylor 1993) which posits that effective policy control necessitates interest rate changes in response to price levels and national income.

The assumption that interest rates react immediately following shock in fiscal policy is consistent with past empirical studies (Fatas & Mihov 2001; Perotti 2002; Hong 2016). Perotti (2002), for example, claimed that interest rates can respond to fiscal policy shocks in the same quarter.

RESULTS AND DISCUSSION

This section focuses on the aggregate and disaggregated consumer price responses following oil price shocks with respect to positive and negative impacts. Table 1 shows the descriptive statistics for all variables in their original units of measurement. As shown in Table 1, the mean for oil prices (OP) is USD 51 per barrel. Due to the global financial crisis, oil prices peaked at around USD 126 per barrel in 2008Q2. In 1998Q4, the lowest price ever recorded was USD 13 per barrel. The high standard deviation (29.13) indicates that oil price movements are very uncertain. Furthermore, the oil price has an asymmetric distribution, skewed to the right. The consumer price index (CPI) has a high standard deviation of 18.87 and an asymmetric distribution that is skewed to the right.

TABLE 1. Descriptive statistics

	OP	YUS	RTR	RGE	YM	CPI	R
Mean	51.38	14383060.69	32931.38	38828.07	165958.76	91.10	3.99
Maximum	126.75	19253959.00	58033.38	70251.19	312603.89	122.06	9.97
Minimum	13.09	9269367.00	13989.67	13829.06	54111.64	58.36	1.76
Standard Deviation	29.13	2850060.71	13192.62	17198.54	80059.16	18.87	1.94
Skewness	0.88	-0.18	0.11	-0.00	0.34	0.08	1.34
Kurtosis	2.60	1.95	1.50	1.45	1.77	1.84	3.45
Jarque-Bera	16.37	6.08	11.15	11.88	9.80	6.72	36.45
Probability	0.00	0.04	0.00	0.00	0.00	0.03	0.00

Note: OP is oil prices in USD per barrel, YUS is the US real GDP in USD (million), GE is the government expenditure in RM (million), TR is the government revenue in RM (million), YM is the domestic real GDP in RM (million), CPI is the consumer price index (index) and R is the overnight interbank rate (percent).

To detect stationarity of all variables, this study used the ADF test as shown in Table 2. The test highlighted that, except for the foreign national income and domestic consumer price index, which have been found to be stationary in level, the remaining variables emerge to be differenced-stationary. For disaggregated price levels, some of the disaggregated price levels were stationary in level[2].

As postulated by Sims (1980) and Sims et al. (1990), examining the interrelationships between variables rather than estimating the parameters is in accordance with the VAR model objective. As a result, despite unit root detected in the variables, they advise against differencing and recommend that variables in model VAR be at the same level. Furthermore, even if the variables contain unit roots, a VAR model at the level can be estimated, thereby neglecting potential cointegration restrictions. This is commonly used in SVAR modelling to avoid imposing too many restrictions (Lutkepohl & Kratzig 2004). However, the standard impulse responses are inconsistent in unrestricted VARs with some unit roots because they do not eventually converge to their true values (Phillips 1998).

According to Gospodinov et al. (2013), computed impulse responses for the restricted (based on pre-tests for unit roots and cointegration) and unrestricted VAR specifications do not differ significantly. Gospodinov et al. (2013) further stressed that estimating VAR models at the level and identifying structural impulse responses via short-run restrictions is the most reliable strategy for applied work. Based on their recommendations, as this study used a short run restriction for the identification scheme, the SVAR model is specified in levels. Previous empirical studies have estimated a VAR in levels, despite the variables having a unit root (Sims 1992; Kim & Roubini 2000; Zaidi et al. 2016; Nguyen et al. 2019).

TABLE 2. The result of ADF test

Variables	Level		First difference	
	Constant	Constant & Trend	Constant	Constant & Trend
LOP	-1.7857(0)	-1.8516(0)	-10.8778(0)*	-10.8706(0)*
LYUS	-2.8006(1)***	-0.8362(1)	-11.9072(0)*	-12.4796(0)*
LGE	-1.5579(8)	-0.9802(8)	-3.3371(7)**	-3.5251(7)**
LTR	-1.6375(1)	-1.8353(1)	-15.1752(0)*	-15.2276(0)*
LYM	-1.4958(0)	-2.5415(0)	-7.2251(3)*	-7.4165(3)*
LCPI	-3.0582(0)**	-1.8006(0)	-9.0245(0)*	-9.4593(0)*
R	-2.2417(1)	-2.9449(1)	-7.4421(0)*	-7.4118(0)*

Notes: LOP is the logarithm of the oil prices, LYUS is the logarithm of the US real GDP, LGE is the logarithm of the government expenditure, LTR is the logarithm of the government revenue, LYM is the logarithm of the domestic real GDP, LCPI is the logarithm of the consumer price index and R is the overnight interbank rate. (*) indicates significance at the 1% level, (**) at the 5% level and (***)at the 10% level. For the constants, the τ (tau) -statistic values were -3.47, -2.87 and -2.57 for the 1%, 5% and 10% significance levels, respectively. The τ (tau) -statistic values for constants with time trends were 4.01, 3.43 and 3.14 for significance levels of 1%, 5% and 10%, respectively. Figures in parentheses () represent the optimal lag as determined by the Schwarz Info Criterion (SIC).

In determining the optimal lag length, this study used several model selection criteria. When a maximum lag order of $P_{max} = 4$, LR, FPE, AIC and HQ suggest $p = 2$, whereas SBC chooses $p = 1$ for the aggregate price model and some disaggregated price model estimations. However, lag order of 1 suffers from autocorrelation, except lag order of 2 for aggregate price model. Therefore, this study used 2 lags for our VAR estimation. Meanwhile, estimates from the VAR companion matrix revealed that the eigenvalues were less than one. If the eigenvalue is less than one, the VAR (p) process is said to be stable (Lütkepohl 2005). Similarly, for disaggregated price models, the lag length was chosen when the lag orders up to h did not suffer from autocorrelation problem[3].

Figure 1 displays the aggregate and disaggregated consumer price responses following positive oil price shock. Solid and dotted lines show the estimated responses and confidence intervals, respectively[4]. Over the last 20 quarters, the aggregate consumer price (LCPI) response has been positive and significant, implying that oil price shock with respect to positive impacts induces inflationary pressure in the Malaysian economy. The result is consistent as predicted by the cost-push theory of inflation (Parkin 2019). Our finding corresponds with Khan and Ahmed (2011) where inflation remains positive till the end of period following positive oil price shock in developing countries.

For disaggregated price levels, it seems that positive oil price shocks vary across CPI sub-groups. In particular, positive oil price shock initially induces disaggregated price levels leading to increase in food index (LCPI1), clothing and footwear index (LCPI3), furniture, furnishings and household equipment and operation index (LCPI5), medical care and health index (LCPI6), transport and communication index (LCPI7), recreation, entertainment, education and cultural services index (LCPI8) and miscellaneous goods and services index (LCPI9). Food index rises immediately and remains positive for the remaining period. As the Malaysian economy has shifted to an industrial-based economy, thus becoming a net importer of food, the economy has become vulnerable to fluctuations in global food prices (Ibrahim & Said 2012). As postulated by Tyner (2010), oil prices and food prices have become inextricably associated with food prices rising in tandem with the price of oil.

Oil prices influence food prices through increased transportation costs. This is consistent with the finding that the transport and communication index shot up immediately and reached its peak level in the first quarter. The reliance of transportation on oil prices has caused positive oil prices to directly influence this price index. In addition, positive oil price shocks affect the remaining sub-groups of CPI through production costs (Baffes 2007). In contrast, the CPI sub-groups for beverages and tobacco index (LCPI2) and gross rent, fuel and power index (LCPI4) immediately decline following positive oil price shocks. For instance, beverages and tobacco index declined and remained negative for the remaining period. It appears that the Malaysian consumers redistribute the income by spending less on lower-energy-intensive products such as beverages and tobacco (Saari et al. 2016). Kilian & Vigfusson (2011) claimed that raises in oil prices induced income redistribution instead of a decrease in domestic income. The negative response of gross rent, fuel and power index is potentially the outcome of price control implemented by the Malaysian government to ease the burden during the stage of price increases. However, the outcome seemed to be short-lived as the index increased after 4-quarter.

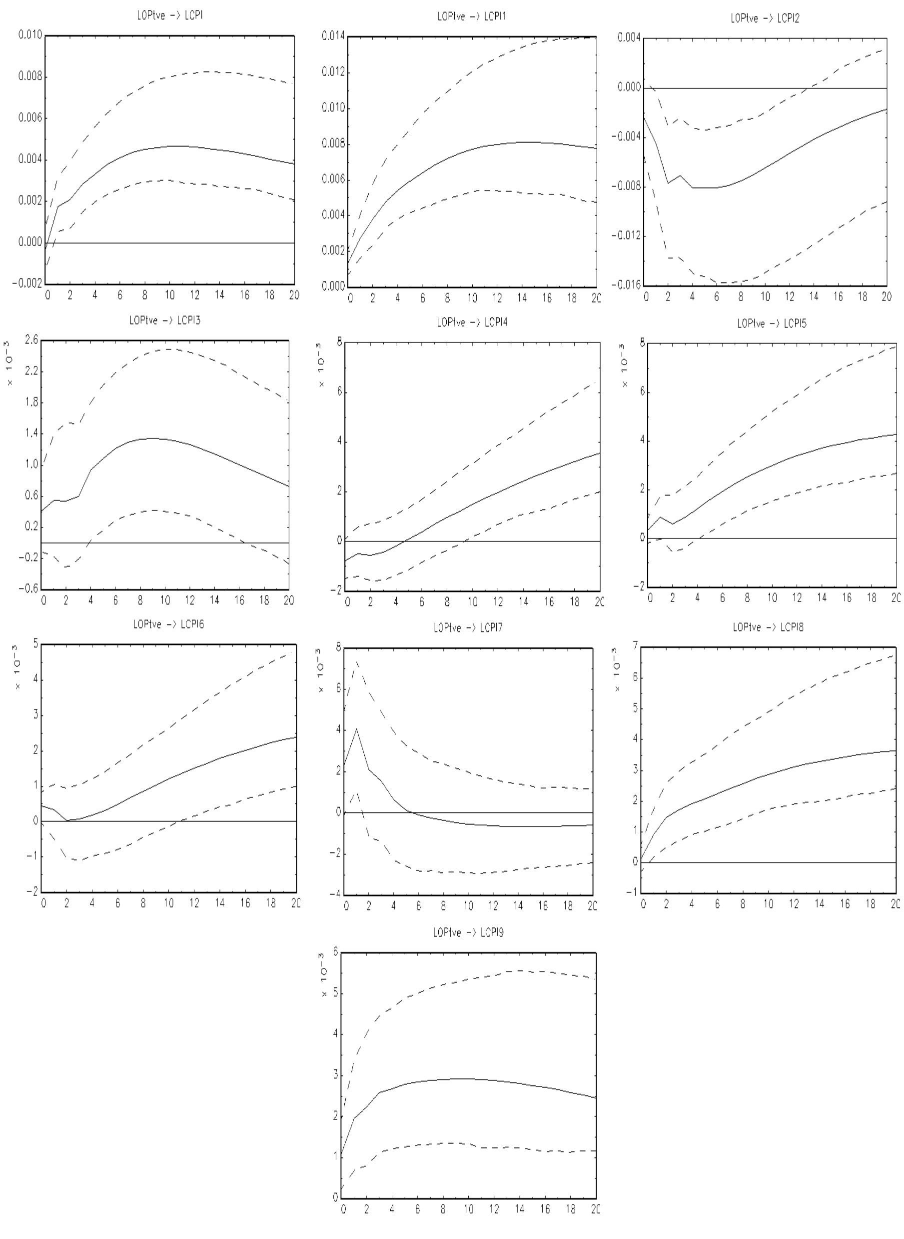

FIGURE 1. Aggregate and disaggregated price responses to positive oil prices

Figure 2 depicts the aggregate and disaggregated consumer price responses following a negative oil price shock. The aggregate price (LCPI) increased and continued to level off for the remaining period, indicating a negative oil price shock that induced inflationary pressure. Aggregate prices (CPI) respond positively as several CPI sub-groups respond in the same pattern following a negative oil price shock. Food index (LCPI1), transport and communication index (LCPI7) and recreation, entertainment, education and cultural services index (LCPI8), which account for more than half of the aggregate CPI initially increase following negative oil price shocks.

Food index rises immediately and remains positive for the remainder of the period. Past studies such as Ibrahim (2015), discovered positive response to the food index following a decline in oil prices. Recreation, entertainment, education and cultural services index also increased immediately and continued to rise until the end of the period. Although transport and communication index shot up immediately, the effect seems to be declining after the second quarter. The presence of the firm's pricing power is the reason for the reactions of these indices following negative oil price shock. The reluctance of firms to lower prices during periods of oil prices decreases indicates that suppliers use their market power, demonstrating that markets for goods in these index groups are imperfectly competitive (Taylor 2000). For the remaining CPI sub-groups, the indices declined immediately. It seems that negative oil price shocks induce certain sub-groups of CPI to fall. For instance, clothing and footwear index (LCPI3) decreased for the remaining period. Negative oil price shocks reduce most of the CPI sub-groups due to lower production costs. As the cost of production reduces, it translates into a reduction in certain CPI sub-groups (Baffes 2007).

The findings above conclude that aggregate CPI and certain CPI sub-groups, namely, food index, transport and communication index and recreation, entertainment, education and cultural services index, respond positively to oil price shocks, regardless of whether the shock is positive or negative. Earlier studies, such as Khan and Ahmed (2011), have discovered that inflation reacts symmetrically to changes in oil price. Other CPI sub-groups reacted differently to oil price shocks, both positive and negative, confirming asymmetrical behaviour of oil price effects at disaggregated price levels. Our findings are consistent with the asymmetric effect found in Husaini and Lean (2021), although this study focuses on disaggregated price inflation in Malaysia, namely, CPI and PPI.

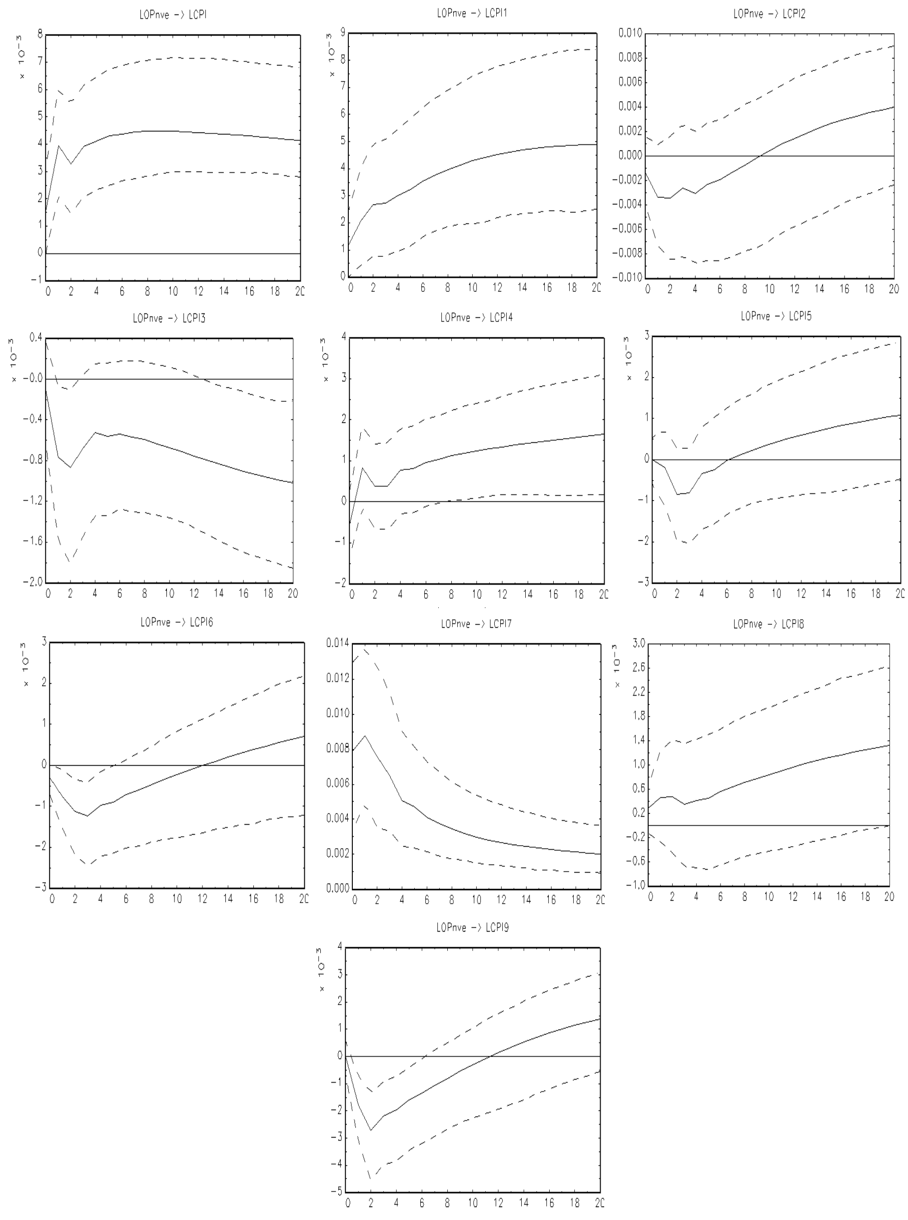

FIGURE 2. Aggregate and disaggregated price responses to negative oil prices

Results of forecast error variance decomposition (FEVD) in Table 3 shows the movement generated by oil price shocks (positive and negative) on aggregate and disaggregated consumer prices. Panel A indicates positive oil price shock. Among the CPI sub-groups, food index (CPI1) was the largest and most persistent. For example, from the first to the 20-quarter, oil price shocks contributed 7% which then increased to 37%. This result confirms the earlier IRF finding. Positive oil price effects on other CPI sub-groups have also increased over time, indicating that the impact is sustained in the longer term. These results suggest positive oil price shocks exert inflationary pressure on aggregate and disaggregated price levels in Malaysia.

Panel B focuses on negative oil price shock. The transport and communication index (CPI7) was the larger and more persistent among the CPI sub-groups. For example, in the first quarter, oil price shock contributed 23 % and climbed to 36 % over a 20-quarter horizon. Furthermore, as the time horizon lengthens, the negative oil price effects on other CPI sub-groups tend to increase.

TABLE 3. Variance decomposition of disaggregated consumer prices due to oil price shocks

	CPI	CPI 1	CPI 2	CPI 3	CPI 4	CPI 5	CPI 6	CPI 7	CPI 8	CPI 9
Quarter										
Panel A: Positive Oil Price Shocks										
1	0	7	1	1	4	1	2	2	0	4
4	13	26	8	3	2	2	1	5	9	13
8	24	37	12	9	2	9	1	4	17	20
12	28	39	13	13	5	16	4	3	23	22
16	29	39	12	14	11	22	8	3	27	22
20	28	37	11	13	17	25	12	3	29	22
Panel B: Negative Oil Price Shocks										
1	9	5	0	0	3	0	1	23	1	0
4	36	13	2	5	3	2	7	35	1	12
8	43	18	2	5	5	1	6	35	1	11
12	45	21	1	6	7	1	5	35	2	9
16	46	22	1	7	8	1	3	36	3	7
20	45	23	2	9	9	2	3	36	4	7

For a robustness check, this study considers different oil price variables. Instead of using Real crude oil imported acquisition costs, the West Texas Intermediate (WTI) was considered as an alternative to the oil price variable. Alquist et al. (2013) discussed alternative oil price measures. The results of the impulse response function of aggregate and disaggregated prices to shocks in the price of oil are nearly similar. The findings show that SVAR model is robust to different oil price variables.

CONCLUSION

This study investigates oil price shocks with respect to asymmetrical effects on disaggregated consumer price levels using an open-economy SVAR model for the Malaysian economy. The empirical finding produced several outcomes. First, the asymmetrical behaviour of oil price shocks applies to certain subgroups of CPI, whereas others, namely food index, transport and communication index and recreation, entertainment, education and cultural services index, show symmetric behaviour. Second, the response in food index is the largest and more persistent among CPI sub-groups following positive oil price shock, as shown by the forecast error variance decomposition. Meanwhile, transport and communication index receive substantial impacts from negative oil price shock. Furthermore, oil price shocks both positive and negative, exert inflationary pressure on disaggregated consumer price levels in Malaysia.

The results have several important implications for government policy and consumer spending management. First, the evidence that a positive oil price shock induced the food index to respond more substantially and persistently than other disaggregated price levels justify government intervention in food price control. The continued control and administration of the prices of several essential food items appear warranted considering the rapid pace of oil price increases. A similar approach should be adopted with regard to transport and communication items as the index receives substantial impact from negative oil price shocks. Second, since oil price shocks, whether on the increase or decrease, exert inflationary pressure on disaggregated consumer price levels, sound policy measures are warranted. For example, monetary authorities have to ensure a low inflation environment in economy, as lower inflation regimes can reduce persistent costs and firm's pricing power, reducing the degree of pass-through of oil price shocks (Taylor 2000). To achieve low inflation, having an independent central bank is becoming important and a necessity (Romer 2011). However, central bank independence will not be sufficient to ensure low inflation unless fiscal policy meets several conditions, such as commitment to government debt sustainability by responding to intertemporal budget constraints (Favero & Monacelli 2003). Therefore, cooperation between monetary and fiscal policy is crucial to ensuring a low inflation environment in the economy.

Third, fostering more service-oriented economies and a wider range of energy consumption are crucial given that oil prices, particularly positive shocks induce most CPI sub-groups to rise at the initial stage. Finally, to reduce the cost of living caused by changes in oil prices, consumers should manage their spending prudently and utilise more energy-efficient technologies. Although the SVAR model is used to estimate asymmetric oil price shock on disaggregated price levels, the source of asymmetric responses at certain disaggregated price levels cannot be determined since it is beyond the scope the study. However, this can be estimated using Coleman (2010) approaches.

NOTES

1 The results are available upon request.

2 The ADF tests for disaggregated price levels are available on request.

3 Since we estimate the impact of oil prices concerning positive and negative shocks on disaggregated consumer price levels separately, the optimal lag-lengths are chosen if the model does not suffer from autocorrelation. Using a positive oil price, we find that lags of 2 for all CPI sub-groups are free from autocorrelation. Similarly, using a negative oil price, we find that lags of 2 for all CPI sub-groups do not suffer from autocorrelation. The results are available upon request.

4 The confidence interval constructed using Hall bootstrap method with a confidence level of 90% and bootstrap repetitions of 1000 times from the original sample data.

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