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The Macroeconomic Effects of Oil Price Fluctuations in ASEAN Countries: Analysis Using a VAR with Block Exogeneity

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Abstract: We use a VAR with block exogeneity to study the effects of oil price fluctuations on the economies of six ASEAN countries. Our method has an advantage over those used in the literature in that it allows us to focus on the effects of oil shocks while avoiding making unnecessary, and often ad hoc and unrealistic, assumptions about the structure of the economies under question. We decompose the factors that drive oil prices into oil supply shocks, oil demand shocks coming from the global real economic activity and oil-market specific demand shocks. We find that, in terms of output and price variabilities, the oil importing countries such as Singapore, Thailand and the Philippines are more sensitive to the situation in the world oil market than the oil exporting countries such as Indonesia, Malaysia. We find evidence that the monetary authorities of ASEAN countries have responded to changes in oil prices due to oil-market specific demand shocks. We also find that much of the surge in world market oil prices in 2007-2008 was mainly due to global aggregate demand shocks and oil-market specific shocks, and by working through oil prices these shocks were important factors that caused the high inflation in ASEAN countries in the first half of 2008.

Keywords: oil price fluctuations, VAR, block exogeneity, ASEAN economies.

JEL codes: F41, Q43, F33.

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1. Introduction

In most ASEAN countries, trade in oil accounts for an important part of total trade. The share of oil in total trade volume in many of these countries is high, and higher than many other countries in the world. For instance, in 2005 the numbers for the three ASEAN countries Indonesia, Singapore and Vietnam are 15.7%, 16.3%, and 17.5%, respectively, while those for the US, Japan, China, and OECD countries are 10.4%, 8.9%, 4.9%, and 8.1%, respectively.[1] This fact and the fact that ASEAN countries are highly open economies[2] suggest that the fluctuations of oil prices in the world market might potentially have important effects on the economies of these countries.[3] In fact, there have been historical episodes in which macroeconomic instabilities in ASEAN countries are associated with international oil price fluctuations. A recent example of this is the surge in inflation in the period 2007-2008 in many ASEAN countries, in which oil price shocks have been widely thought of as one of the primary sources. Fluctuations of oil prices are also one of the main concerns of ASEAN's economic policy makers who wish to maintain a stable macroeconomic environment for their countries. Understanding the effects of oil price fluctuations on these economies thus is a task of great interest and importance. In addition, these countries with both similarity and diversity in economic structure and policy regime provide us interesting examples of small open economies that are vulnerable to external shocks.

The purpose of this paper is to analyze the macroeconomic effects of oil price fluctuations in six ASEAN countries, namely, Indonesia, Malaysia, the Philippines, Singapore, Thailand and Vietnam.[4] We wish to provide some stylized facts on the issue. In the literature, few studies have tackled this issue using the structural vector autoregression (VAR) approach, in which world market oil price is included in the VAR as one endogenous variable, together with other macroeconomic variables of an ASEAN country.[5] There are, however, two problems with these studies. First, they consider only one type of oil price shock, but as pointed out in Kilian (2009), oil prices are driven by different structural supply and demand factors in the international oil market. These factors affect oil prices and at the same time also affect macroeconomic variables of a small open economy like those in ASEAN countries, and these effects might be very different depending on the nature of the factors. For example, an exogenous increase in world aggregate demand and an exogenous reduction in the production of oil by the OPEC both push up the prices of oil in the world market but should have

[1] Calculated by the authors based on data from the IMF's World Economic Outlook (WEO) database 2013.

[2] According to the data of the Penn World Table 8.0, the degree of trade openness (defined as the ratio of the sum of exports and imports to GDP) of Indonesia, Malaysia, Philippines, Singapore, Thailand and Vietnam is 0.58, 1.98, 0.89, 4.02, 1.35, 1.44, respectively, which is much higher than that of United States (0.26), Japan (0.26), OECD member countries (0.47), China (0.57) and Low & middle income countries (0.57).

[3] The importance of oil could be even much greater than would be suggested by these trade numbers because oil and related products are used as inputs for a wide range of goods and services.

[4] These are the major ASEAN countries in terms of economic size. Other ASEAN countries are not included here because their data are not available.

[5] See e.g. Jongwanich and Park (2009) who use a structural VAR to study the sources of inflation in East Asia in the 2000s. Although their main interest is not in oil shocks but they do include oil price in their VAR model.

different effects on a small open economy: while the latter is likely to have no effects other than those through the increase in oil prices, the former may have direct effects on the small open economy through other channels such as trade in goods and services. This insight indicates that without knowing the sources that drive oil prices, the ceteris paribus interpretation about the effects of oil prices on a small open economy in the VAR approach used in the existing studies is not well defined and might potentially be misleading.

A second problem with the existing studies in the literature is a technical one regarding the VAR approach they use: they treat oil price as an endogenous variable, equally with other variables of the small open economy in their VAR model, and therefore often need to estimate a large number of parameters. However, if we take into account the small open economy feature of ASEAN countries, it is reasonable to ignore the feedback from these economies to oil prices and other variables regarding the global economy. As shown by Zha (1999), this can be done using a VAR with block exogeneity in which the oil market block is treated as exogenous, not being affected by shocks coming from the small open economy or its macroeconomic variables at all lags, and by doing so we can reduce the number of parameters needed to be estimated and increase the quality of estimation given the limited sample size.

In this paper we wish to make a contribution to the literature by developing a new method which we believe is suitable to study the effects of external shocks, such as an oil price surge, on a small open economy. First, we use the framework proposed by Kilian (2009) to model the world oil market. Specifically, we decompose the factors that drive oil prices in the world oil market into oil supply shocks, oil demand shocks coming from the global real economic activity, and oil-market specific demand shocks. We identify these factors and then analyze their effects on macroeconomic variables of ASEAN countries using a VAR model. With this we hope to overcome the first problem discussed above. Second, considering the aforementioned second problem, we utilize the framework of a VAR with block exogeneity developed by Zha (1999) in which variables regarding the world oil market are treated as the exogenous block and it is assumed that there is no feedback from the small open economy to this block. There are few papers on ASEAN or Asian countries which use a VAR with block exogeneity, but they either do not include oil prices or do not consider the factors driving oil prices in detail (see for example, Gosse and Guillaumin 2013, Jean-Pierre et al. 2012, Mackowiak 2007, and Sato et al. 2011). We extend the VAR with block exogeneity used in the literature such that our method allows us to identify only oil shocks *without* having to identify other uninterested structural shocks to the small open economy. Thus, with our method we are able to focus on the effects of oil shocks while avoiding making unnecessary, and often ad hoc and unrealistic, assumptions about the structure of the small open economy. This point is crucial for our VAR model has the number of variables to be as large as nine.

For the purpose of the paper, we include into the small open economy block of the VAR model five main macroeconomic variables, namely, the growth rate of output, the inflation rate, exports, imports, the nominal interest rate and the nominal exchange rate. In doing so, we are motivated by the following consideration. Theoretically, the effects of oil price fluctuations on a small open economy can be divided into several channels. A change in oil prices will directly affect the export and import prices and volume (call this the trade channel), and through this channel it will affect GDP and the price level. By changing the trade balance and thus changing the supply of and the demand for foreign currencies in the foreign exchange market, it may also affect the nominal exchange rate, and this in turn would affect the nominal interest rate through the uncovered interest rate parity condition (the financial channel). Moreover, the policy authorities in the small open economy may respond to these changes in the macroeconomic situations using monetary policy or exchange rate policy (the policy response channel), and this would certainly have some effects on the nominal interest rate and the nominal exchange rate as well as other macroeconomic variables.

In our VAR model, we qualitatively and quantitatively analyze effects of oil shocks on these variables by means of impulse response functions and variance decomposition. We also perform historical decomposition to see the role played by oil prices and other external shocks in the high inflation in the first half of 2008 in ASEAN countries.

The rest of the paper is structured as follows. Section 2 describes our empirical methodology of a VAR with block exogeneity. Section 3 gives detailed information on the data and estimation. Results and analysis are provided in Section 4. Section 5 concludes the paper.

2. Empirical methodology

We use a structural VAR with block exogeneity for our study. The most important difference between our VAR method here and the methods using a conventional VAR or a VAR with block exogeneity used in previous studies is that our VAR method requires only identifying the exogenous block, and thus needs to impose much less restrictions. Below are details of our method.

Consider a VAR model which consists of variables from two blocks, namely the world oil market (block 1) and a small open economy (block 2). Because the scale of the small open economy is relatively very small compared to the world oil market, it is reasonable to assume that variables and structural shocks in block 2 do not affect variables in block 1. In other words, variables and shocks belonging to block 1 are given exogenous to block 2, thus the VAR model is called a block-exogenous VAR. With this assumption, we could write the structural form of the block-exogenous VAR model as follows.

$$\begin{pmatrix} C_{11} & 0 \\ C_{21} & C_{22} \end{pmatrix}\begin{pmatrix} y_{1t} \\ y_{2t} \end{pmatrix} = \begin{pmatrix} B_{11}(L) & 0 \\ B_{21}(L) & B_{22}(L) \end{pmatrix}\begin{pmatrix} y_{1t-1} \\ y_{2t-1} \end{pmatrix} + \begin{pmatrix} \varepsilon_{1t} \\ \varepsilon_{2t} \end{pmatrix} \tag{1}$$

Here t denotes time, y_{1t} and y_{2t} are column vectors of variables in blocks 1 and 2, respectively.

C_{ij} are coefficient matrices and $B_{ij}(L)$ are polynomials made up from matrices of coefficients in the lag operator. ε_{1t} and ε_{2t} are column vectors of shocks of blocks 1 and 2, respectively, satisfying $(\varepsilon_{1t}, \varepsilon_{2t})' \sim (0, I)$ with *I* being an identity matrix.

From (1), we can write the structural VAR model for each block as follows.

$$C_{11} y_{1t} = B_{11}(L) y_{1t-1} + \varepsilon_{1t} \quad (1a)$$

$$C_{21} y_{1t} + C_{22} y_{2t} = B_{21}(L) y_{1t-1} + B_{22}(L) y_{2t-1} + \varepsilon_{2t} \quad (1b)$$

The structural VAR model in (1a) can be transformed to a reduced form

$$y_{1t} = C_{11}^{-1} \cdot B_{11}(L) y_{1t-1} + C_{11}^{-1} \varepsilon_{1t} \quad (2)$$

which can be estimated using data of y_1 in block 1 to obtain the polynomial of coefficient matrices $D_{11}(L) \equiv C_{11}^{-1} \cdot B_{11}(L)$ and the residual vector $u_{1t} \equiv C_{11}^{-1} \varepsilon_{1t}$. Given the above assumption on the structural shocks ε_{1t} and some further assumptions on the matrix C_{11}^{-1}, we can identify C_{11}^{-1}. For example, if C_{11}^{-1} is a triangular matrix, which we will assume in the next section, C_{11}^{-1} is the Cholesky decomposition of the covariance matrix of the residual vector u_{1t}. Once C_{11}^{-1} is identified, we can recover the structural shocks ε_{1t}, and together with $D_{11}(L)$ we can obtain the impulse response functions (IRFs) of variables in block 1 to these shocks.

Now let us see how to obtain the IRFs of variables in block 2 to the structural shocks ε_{1t} in block 1 identified as above. From (1b) and (2), we can derive a reduced form of the VAR model for block 2 as follows.

$$y_{2t} = [C_{22}^{-1} B_{21}(L) - C_{22}^{-1} C_{21} C_{11}^{-1} \cdot B_{11}(L)] y_{1t-1} + C_{22}^{-1} B_{22}(L) y_{2t-1} - C_{22}^{-1} C_{21} C_{11}^{-1} \varepsilon_{1t} + C_{22}^{-1} \varepsilon_{2t} \quad (3)$$

Using data of y_1 and y_2, we can estimate the VAR model in (3) to obtain the polynomials of coefficient matrices $D_{12}(L) \equiv C_{22}^{-1} B_{21}(L) - C_{22}^{-1} C_{21} C_{11}^{-1} \cdot B_{11}(L)$ and $D_{22}(L) \equiv C_{22}^{-1} B_{22}(L)$, and the residual vector $u_{2t} \equiv -C_{22}^{-1} C_{21} C_{11}^{-1} \varepsilon_{1t} + C_{22}^{-1} \varepsilon_{2t}$. Since we are only interested in the effects of structural shocks in the world oil market on the small open economy, we need only to know the matrix $A_{21} \equiv -C_{22}^{-1} C_{21} C_{11}^{-1}$. We identify A_{21} by regressing u_{2t} on ε_{1t} whose data is already identified as explained above. With $D_{12}(L)$, $D_{22}(L)$ and A_{21}, we are able to obtain the IRFs of variables of the small open economy to the structural shocks in the world oil market and perform variance decomposition and historical decomposition for these shocks.

It is worth emphasizing that for our purpose in this paper we do not need to know the structure of the small open economy which is captured by the matrix C_{22}^{-1}. Indeed, as done in some previous studies such as Kim and Yang (2012), identifying C_{22}^{-1} requires more assumptions many of which are ad hoc and unrealistic. This problem is especially severe when the number of variables in block 2 is large. The same problem is faced by studies that use a conventional VAR model. Thus we believe that our method here has an advantage over that used in previous studies.

Variables, shocks and identifying shocks in the world oil market block

We follow Kilian (2009) in modelling the world oil market block. We assume a trivariate VAR for the world oil market block so that $y_{1t} = (oprodg_t,\ rea_t,\ nop_t)'$, where *oprodg* is the growth rate of the world oil production, *rea* is an index of global real economic activity and *nop* is the world market nominal oil price.[6] These variables are driven by three types of structural shocks, namely, oil supply shock (*oilsup* shock), shock to aggregate demand for oil (*aggdem* shock) and oil market specific demand shock (*ospec* shock). Thus the shock vector in the world oil market block is $\varepsilon_{1t} = (\varepsilon_{oilsup,t}, \varepsilon_{aggdem,t}, \varepsilon_{ospec,t})'$. As noted by Kilian (2009), distinguishing these three types of oil shocks is important because their effects on an economy as well as the policy implications we could draw from them are very different.

As we mentioned briefly above, a recursive structure is imposed to identify the matrix C_{11}^{-1} as the Cholesky decomposition of the covariance matrix of the residual vector. The oil supply shock ordered first in the shock vector ε_{1t} is defined as a shock that reduces the world oil production at impact. Notice here that we define a negative oil supply shock, rather than a positive one, in terms of oil production. This is for the ease of interpreting the results later since, as suggested by the demand-supply model for the world oil market, a negative oil supply shock will raise the oil price which is the same as the other shocks to oil demand. The oil aggregate demand shock ordered second is defined as a shock that increases the global real economic activity but does not affect the world oil production at impact. Thus this shock reflects the exogenous changes in oil demand that come from the global real economic activity. The last shock, which is the oil market specific demand shock, is defined as a shock that increases the world market oil price at impact but does not affect both the world oil production and global real economic activity at impact. As its name suggests, this shock captures the exogenous changes in oil demand other than those coming, contemporaneously, from the global real economic activity. The contemporaneous zero restrictions on the effects of the oil aggregate demand shock and the oil market specific demand shock on the world oil production are justified by the well-known fact in the literature that the price elasticity of oil supply in the short run is close to zero (see e.g. Hamilton 2009, and Kilian and Murphy 2014).[7]

3. Data and estimation

A monthly dataset is used in our study. For the world oil market block, world oil production data is taken from the website of the U.S. Energy Information Administration. The index of global real economic activity is constructed by Kilian (2009), updated and made available on his website. Data for the nominal oil price is the West Texas Intermediate spot oil price (USD per Barrel) and is taken

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[6] There is one difference with Kilian (2009) here in that we use the nominal oil price (*nop*) data rather the real oil price data defined as *nop* divided by the price level of the small open economy. This is because we believe that from the viewpoint of the small open economy the former should be more appropriate as an exogenous variable than the latter. Fukunaga et al. (2009) also make the same argument.

[7] This is intuitive as well because it takes time for oil firms to change oil production in response to changes in oil prices. Theoretically, this implies a very flat short run oil supply curve.

from the Federal Reserve Economic Database.

As for the small open economy block, we include six major macroeconomic variables: the growth rate of output, the inflation rate, the growth rates of real exports and imports, the nominal interest rate and nominal exchange rate. The reasoning for choosing these variables is explained in the introduction section. For real output, since the data of real GDP is not available at the monthly frequency, we use the index of industrial production (*iip*) as a proxy. For the price level we use the consumer price index (*cpi*). Real exports (*exp*) and real imports (*imp*) are defined as the nominal exports and imports divided by the CPI of the small open economy. For the exchange rate, instead of using other alternatives such as the nominal or real effective exchange rate, we use the data of the nominal exchange rate vis-à-vis the US dollar (the home currency price of one USD) for we believe that, considering the case of ASEAN countries, this variable is more suitable to capture the policy response of the monetary authorities. Nominal interest rate data is the three-month money market rate series. Data of *iip*, *cpi*, *exp* and *imp* are seasonally adjusted, and their growth rates are calculated as the first-differences of their logarithms multiplied by 100. Nominal exchange rate data is also transformed to logarithms and multiplied by 100.

The data of the above macroeconomic variables for the six ASEAN countries in our research are collected from the IMF's International Financial Statistics (IFS) database and the CEIC database. An exception is the *iip* of Vietnam whose data is taken from the General Statistics Office (GSO) of Vietnam. The sample period is 1999m1-2013m7 for all countries except for Singapore whose *iip* data is only available from 2003m1. Although for many countries data for earlier period are available, we decided to set the beginning of the sample period to be 1999m1 because many ASEAN countries changed their monetary policy rules and exchange rate regimes after the Asian currency crisis in 1997-98. This point is important because, as explained in the introduction section, the monetary policy rule and exchange rate regime would affect the channels through which oil price fluctuations affect the small open economy.

In estimating the VAR model described the previous section, we tried both OLS and seemingly unrelated regressions (SUR) methods for one country which was Indonesia. The latter method is thought to be more efficient (Zellner 1962). It turned out, however, that results of the two methods are almost the same, so we decided to use OLS for all countries because it requires much less time for computing. In addition, since the lag selection criteria such as AIC and SBC suggest different lag lengths for each country (often 2, 3 or 4 lags, depending on the country and the criterion), and considering the sample size, we decided to set the same lag length of six for all countries. We also include a constant term when estimating the VAR model.

4. Results and analysis

Figures 1 through 6 show the IRFs to world oil market structural shocks obtained after estimating and identifying the structural VAR model. These IRFs are provided with both point estimates and error bands. For the variables entering the VAR in growth rate, the IRFs are cumulative and thus reflect the responses of the variable in levels. Below let us look at the results for each block in detail.

Responses of world oil market variables to world oil market shocks

Figure 1 shows how world oil market variables respond to world oil market shocks. In response to a negative oil supply shock, the world oil production decreases by about 0.7%, while the (nominal) oil price rises by about 0.5% at impact (for the point estimate), although the change in the oil price is not statistically significant. It takes about four months for this shock to decrease global real economic activity, which exerts probably through the rise in the price of oil, which is used as an input for production of many other goods and services.

A global aggregate demand shock increases global real economic activity, and as a result, raises the oil price. The rise of the oil price due to this shock is 1.5% at impact and is quite persistent over time. This shock also increases oil production at the horizons of three to ten months after its occurrence.

An oil-market specific demand shock raises the oil price by 7.5% at impact and is also very persistent over time. Global real economic activity increases after this shock occurs. In the literature, this fact has been interpreted to suggest that oil-market specific demand shocks identified here might be a kind of news shocks reflecting the change in expectations, and thus resulting in speculative behavior, of traders in the world oil market about the future growth of the world economy and the demand for oil. We think of another possibility: oil-market specific demand shocks could be demand shocks that occur first in the oil industry or a small number of related industries but then overtime spread to other industries, and finally raise the level of global real economic activity as well. The two interpretations suggest two different types of oil-market specific demand shocks both of which could be present in reality. Indeed, recently Kilian and Murphy (2014) and Kilian and Lee (2014) find that there is evidence of speculative demand for oil in the mid-2008 but there is no evidence of that demand in the period from early 2003 through early 2008.

Responses of ASEAN economies to world oil market shocks

Figures 2 through 7 display the responses of macroeconomic variables of ASEAN countries to world oil market shocks. The following facts can be observed. First, overall the effects of an oil supply shock are not statistically significant in most countries for most variables. This result is different from those of an oil aggregate demand shock and an oil market specific demand shock noted below, and therefore it is suggested that distinguishing the types of oil shocks is important in understanding their effects. We could, however, see some exceptions, for example an oil supply shock significantly increases exports in Indonesia, but decreases exports in the Philippines and Thailand. This result is intuitive because an oil supply shock raises the oil price and thus increases export volume for an oil exporting country like Indonesia, meanwhile this shock decreases global aggregate demand and thus reduces imports from non-oil exporting countries like Thailand and the Philippines.

Second, the qualitative effects of a global aggregate demand shock and an oil market specific demand shock are somewhat similar. In most countries we observe that, these shocks increase output, CPI, exports and imports, and as inflation rises, the monetary authorities raise the interest rate, which results in an appreciation of the home currency against the USD. In addition, the pass-through of an increase in the oil price to the CPI may take as short as three months as in Indonesia and the Philippines or as long as ten months as in Malaysia.

Third, many results are consistent with our conventional knowledge about the monetary policy rules and exchange rate regimes of ASEAN countries. The most typical case is Thailand, in which the monetary authority has adopted an inflation targeting policy after the 1997-98 Asian currency crisis. For example, in Thailand when the CPI rises in response to an oil aggregate demand shock or an oil-market specific shock, the monetary authorities raise the nominal interest rate in order to reduce inflation.

Fourth, we also find that some results appear puzzling. For example, in response to an aggregate demand shock, output in Thailand decreases at the horizon of about three months after the shock although the interest rate and the exchange rate almost do not change at the same horizon. In addition, the CPI in Vietnam to goes down in response to a global aggregate demand shock and an oil-market specific demand shock.

Variance decomposition

Table 1 shows the variance decomposition due to each type of shocks in the world market for macroeconomic variables of ASEAN countries. Overall, the results are different across countries and across different types of shocks. For real output, oil supply shocks explain about 10% of its variance in Singapore, but in the Philippines oil-market specific shocks and global aggregate demand shocks are more important, explaining about 9% to 16% of the variance. Interestingly, in Malaysia, the Philippines, Singapore and Thailand oil-market specific demand shocks explain a large fraction of the variance of the nominal interest rate at horizons from 12 to 36 months. This seems to reflect the fact that the monetary authorities in these countries have paid much attention to and have responded to changes in oil prices caused by oil-market specific demand shocks by using the nominal interest rate as the policy instrument or by letting it respond endogenously.

Results in Table 1 are also suggestive about the monetary policy rules and exchange rate regimes in ASEAN countries. According to the IMF's classification of exchange arrangements and monetary policy regime, during the period we are studying here Thailand and the Philippines adopted a combination of a float (or a managed float) and inflation targeting, while Singapore and Malaysia adopted more rigid exchange rate regimes as a nominal anchor to the domestic price level. Table 1 shows that oil-market specific shocks explain a large fraction (29.7% and 50.8%, respectively) of the variance of the nominal exchange rate in Thailand and the Philippines at the long horizon (i.e. that of 36 months). On the other hand, in Singapore and Malaysia these shocks explain a considerable fraction of the middle-to-long-horizon variance of the nominal interest rate (43.8% and 39.5%, respectively, at the 36-month horizon), but they explain only a small fraction of the variance of the nominal exchange rate (9.7% and 3.2%, respectively). These patterns are clearly consistent with the policy regimes that these countries adopted during the sample period.

A comparison between the group of oil exporting countries (Indonesia and Malaysia) and the group of oil importing countries (the Philippines, Singapore and Thailand) reveals that oil-market specific shocks are more important in latter than in the former in causing the variation of output and the price level, two of the most important macroeconomic variables. For example, at the horizon of 36 months, oil-market specific shocks explain 13.6%, 8.2% and 7.0% in the Philippines, Singapore and Thailand, respectively, while those numbers for Indonesia and Malaysia are only 3.3% and 4.5%, respectively. This fact indicates that, at least for the countries in our sample, oil importing countries are more sensitive to oil-market specific shocks than are oil exporting countries in terms of output and price variabilities.

What caused the high inflation in ASEAN countries in 2007-2008?

Figure 8 depicts the year-on-year inflation rate of ASEAN countries in the period 2003-2013, calculated as the rate of change in the price level in one month compared to the one in the same month of the previous year. There was a surge in inflation in the period 2007-2008 in all of the six ASEAN countries. A question of great importance that has been analyzed in the literature is that what caused this high inflation. The fact, as observed in Figure 9, that there was a surge in the world market oil prices suggests that oil prices might have been an important factor. However, some previous studies such as Jongwanich and Park (2009) find that shocks to oil prices (and food prices) are not the main source of the aforementioned high inflation in Asia. We could analyze this issue using our framework here.

Figure 9 shows cumulative effects of the three oil-market structural shocks on the nominal oil price in the world market in each month of the period 2003-2013. By construction, only these three types of shocks affect the nominal oil price. We can see that much of the surge in the nominal oil price in the period 2007-2008 was attributed to global aggregate demand shocks, and some oil-market specific demand shocks in the first half of 2008 were also important.

Figure 10 shows cumulative effects of the structural shocks on inflation of ASEAN countries in each month of the period 2007-2009. The shocks here include the three types of shocks noted above and other unidentified shocks such as those coming from the inside of the economy of an ASEAN country. We observe that in all countries except Malaysia global aggregate demand shocks and oil-market specific shocks played a considerable role in causing inflation to surge in the first half of 2008. In the Philippines, Thailand and Vietnam the effects of these shocks were comparable to those of other unidentified shocks. In the case of Singapore oil supply shocks were also important in some months of 2008. Thus, our finding here is consistent with the conventional wisdom and is different with that of some previous studies mentioned above, indicating that high inflation of ASEAN countries in the first half of 2008 might have been related to the surge in world market oil prices in the same period.

5. Concluding remarks

In this paper we use a VAR with block exogeneity to study the effects of oil price fluctuations on the economies of six ASEAN countries, namely, Indonesia, Malaysia, the Philippines, Singapore, Thailand and Vietnam. Our method has some advantage over those used in the literature in that it allows us to focus on the effects of oil shocks while avoiding making unnecessary, and often ad hoc and unrealistic, assumptions about the structure of the economies under question. We decompose the factors that drive oil prices into oil supply shocks, oil demand shocks coming from the global real economic activity, and oil-market specific demand shocks and study their effects in detail.

Our findings are as follows. First, the effects of shocks are quite different depending on their types, on the policy regimes of each country, and also on whether the country is an oil exporting one or an oil importing one. Specifically, oil-market specific shocks are more important to the variabilities of output and the price level in the oil importing countries Singapore, Thailand and the Philippines than in the oil exporting countries Indonesia, Malaysia. Second, among the three shocks noted above, the monetary authorities of ASEAN countries have responded quickly to changes in oil prices due to oil-market specific shocks. Third, many results are consistent with our conventional knowledge about the monetary policy rules and exchange rate regimes of ASEAN countries. For example, oil-market specific shocks that affect inflation of the home country explain the a large fraction of the variances of both the nominal interest rate and the nominal exchange rate in Thailand and the Philippines, the two countries which have adopted a float exchange rate regime and/or an inflation targeting. On the other hand, these shocks explain a large fraction of the variance of the nominal interest rate but not that of the nominal exchange rate in Singapore and Malaysia, the two countries that have adopted more rigid exchange rate regimes. Fourth, much of the surge in world market oil prices in 2007-2008 was mainly due to global aggregate demand shocks, and some oil-market specific shocks in the first half of 2008. By increasing oil prices these shocks were important factors that caused the high inflation in the same period in the ASEAN countries.

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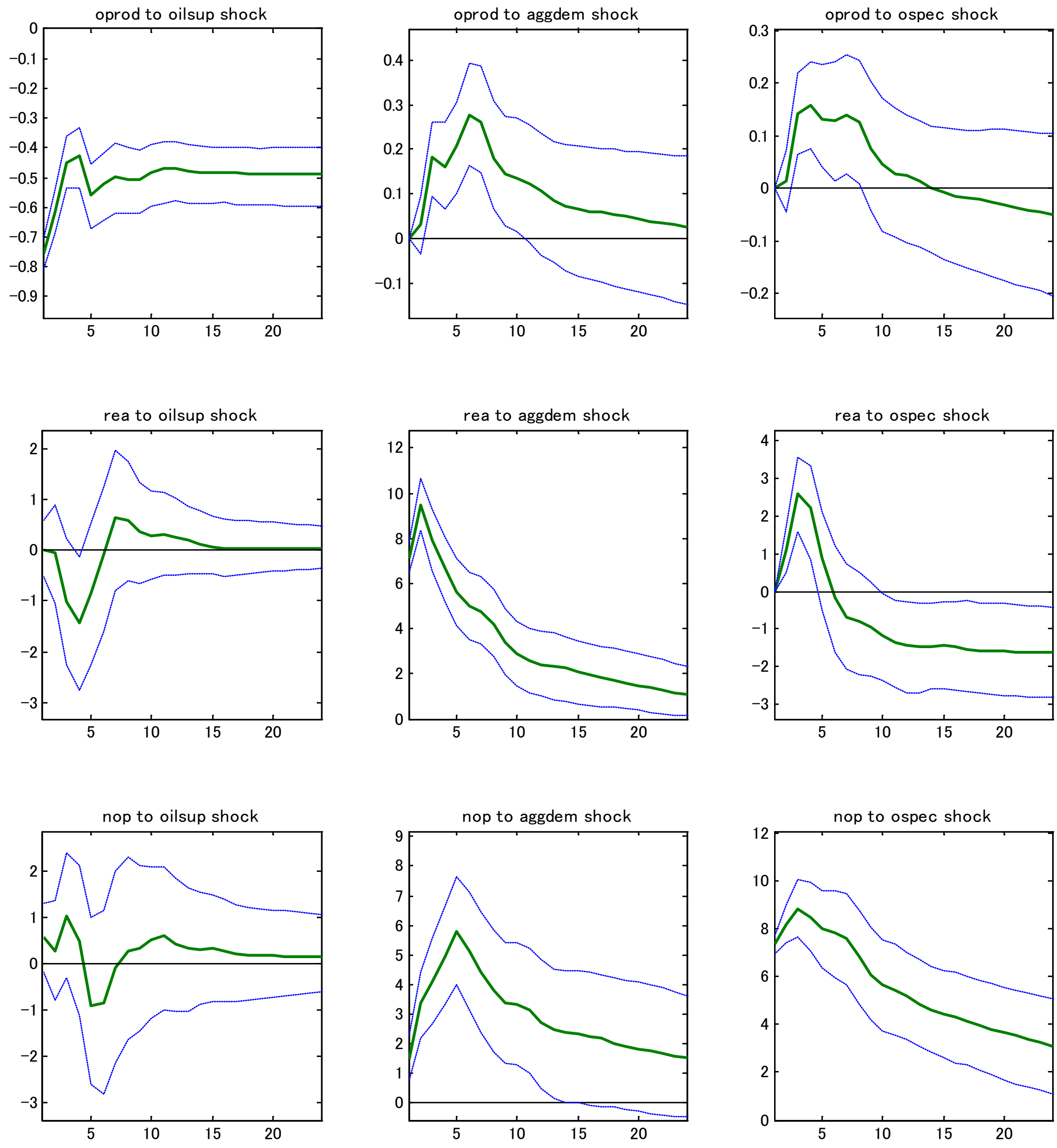
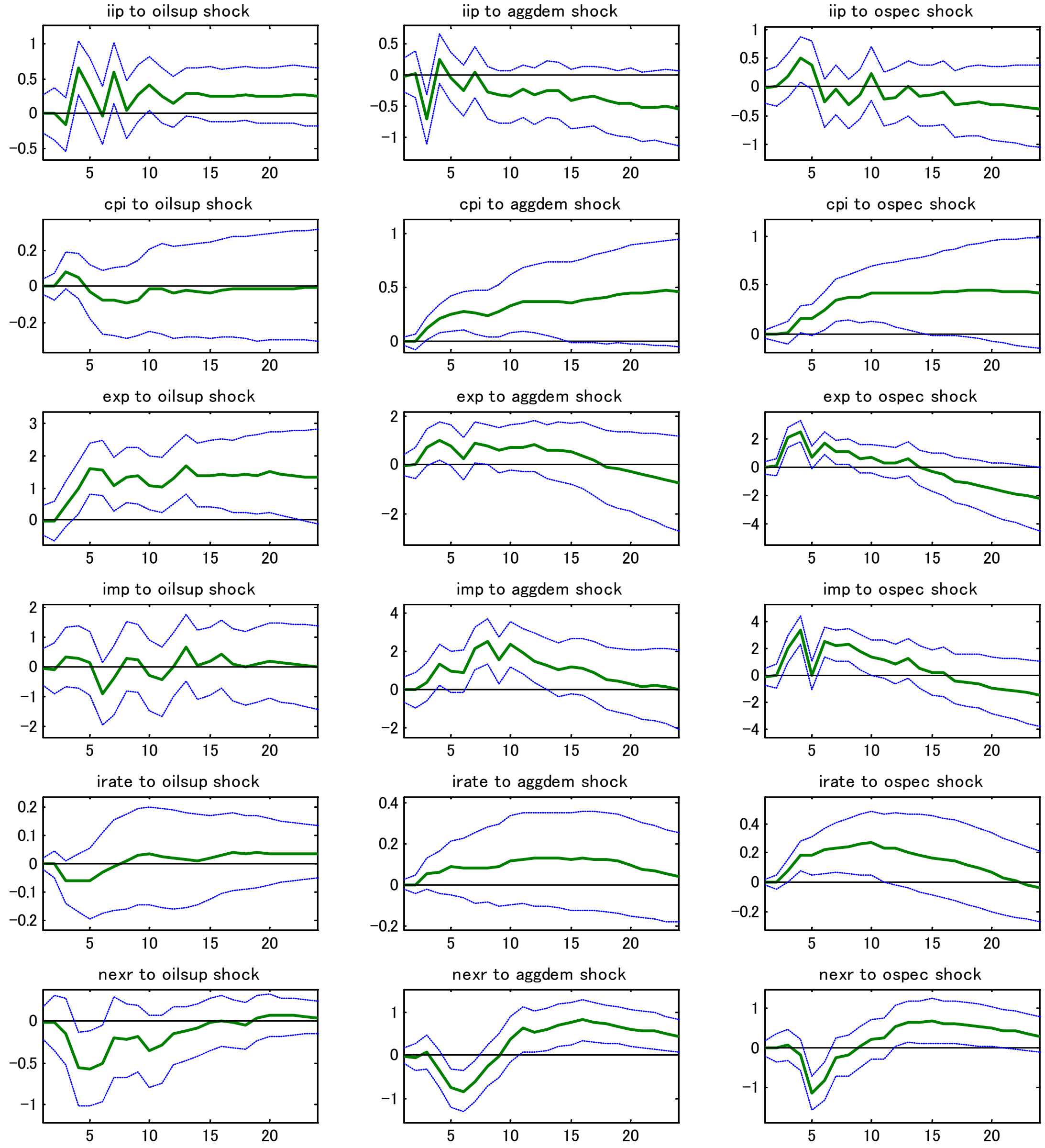
Figure 1: IRFs of world oil market variables to one standard deviation world oil market shocks



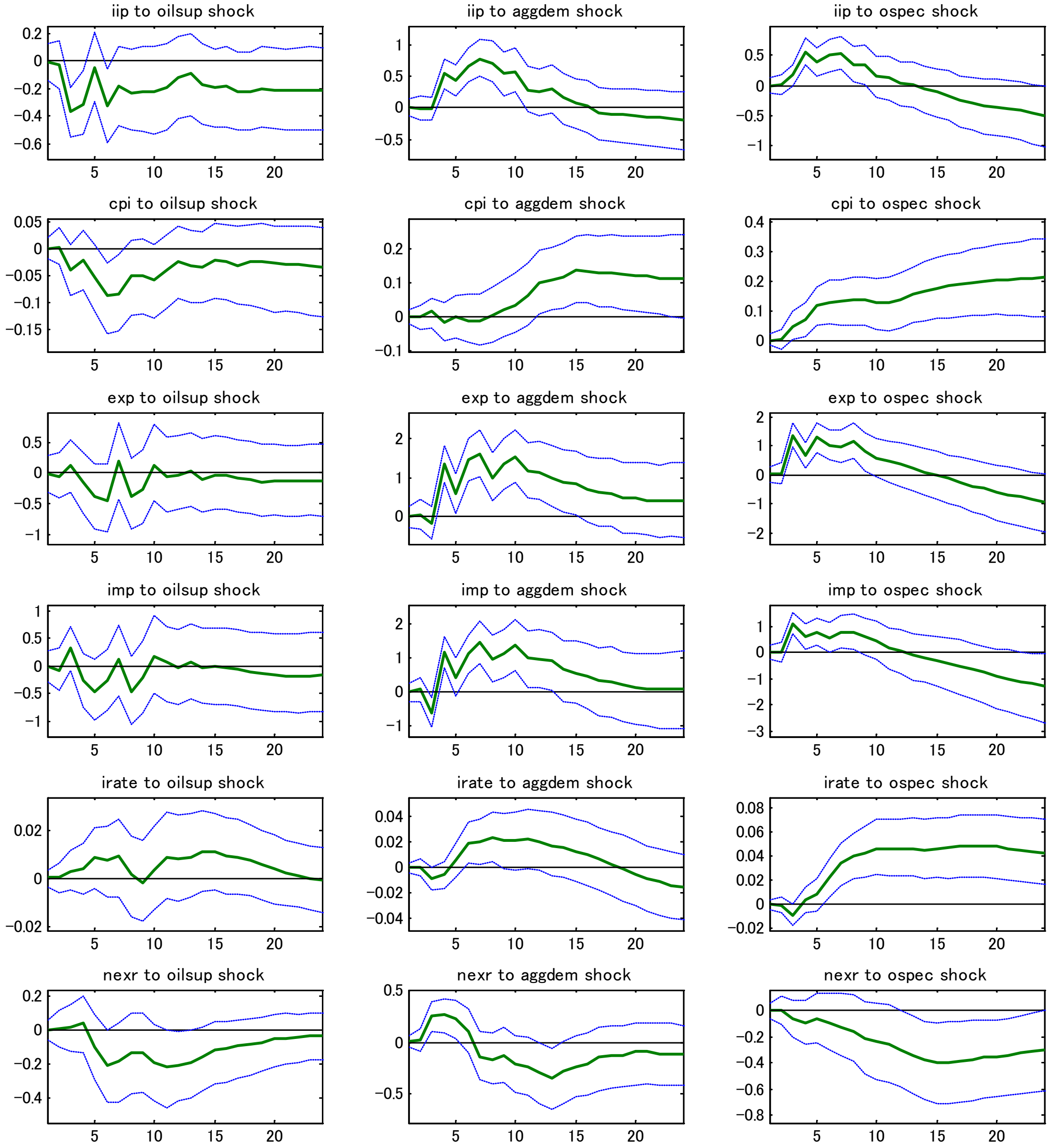
Note: Notations: *oprod*: world oil production, *rea*: global real economic activity, *ospec*: world oil market specific shock, *oilsup*: oil supply, *aggdem*: aggregate oil demand, *nop*: world market nominal oil price. In each box, numbers in the horizontal axis denote the number of months after the occurrence of shocks, and those in the vertical axis denote the percentage change in the corresponding variable. Dashed lines are 16th and 84th quantiles, and solid lines are point estimates. An oil supply shock is defined as one that reduces world oil production (i.e. a negative shock).

Figure 2: IRFs of macroeconomic variables to one standard deviation world oil market shocks, country: Indonesia



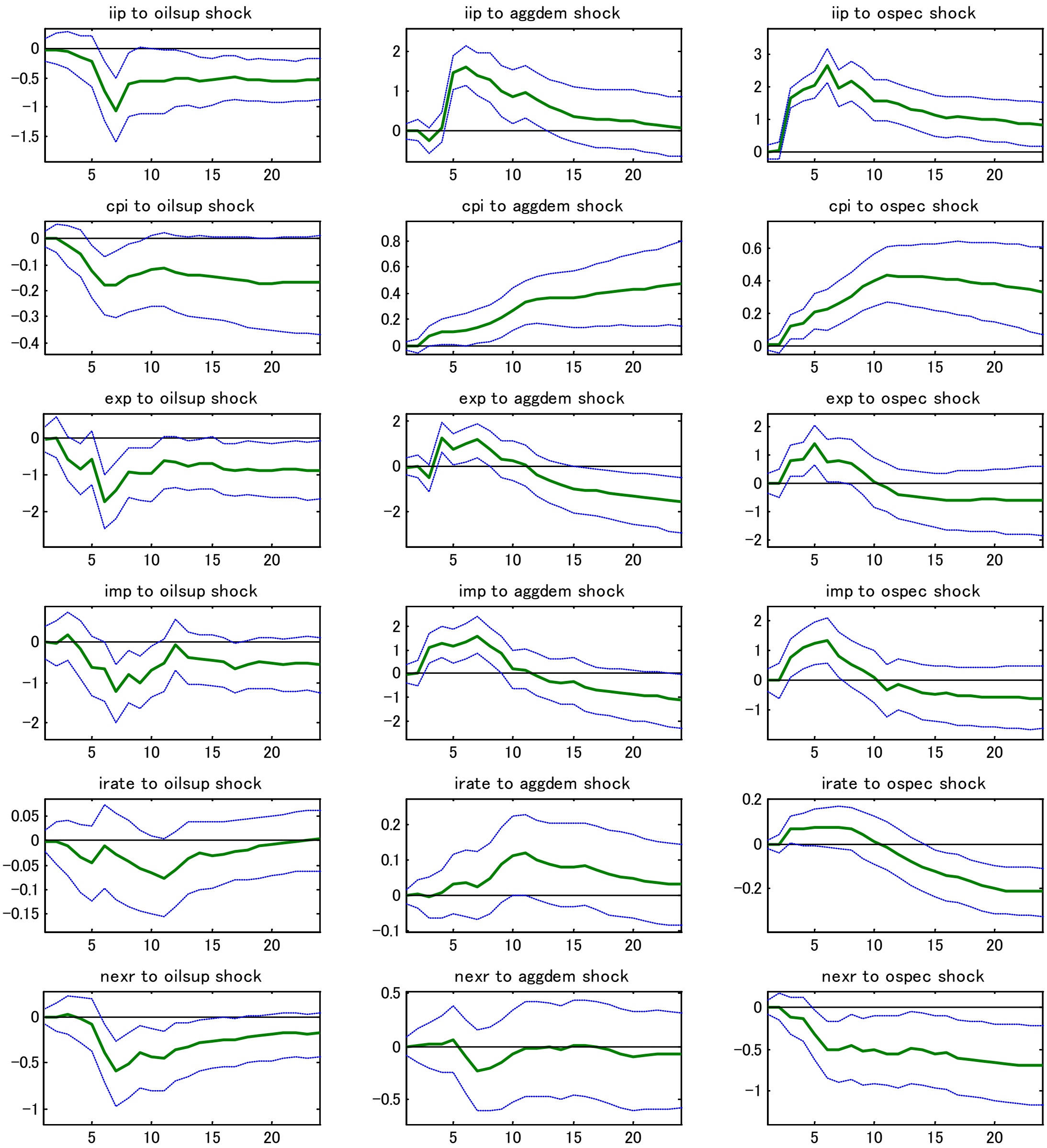
Note: Notations: *iip*: index of industrial production, *cpi*: consumer price index, *exp*: real export, *imp*: real import, *irate*: nominal interest rate, *nexr*: nominal exchange rate against the US dollar. See Figure 1 for further notes.

Figure 3: IRFs of macroeconomic variablesto one standard deviation world oil market shocks, country: Malaysia



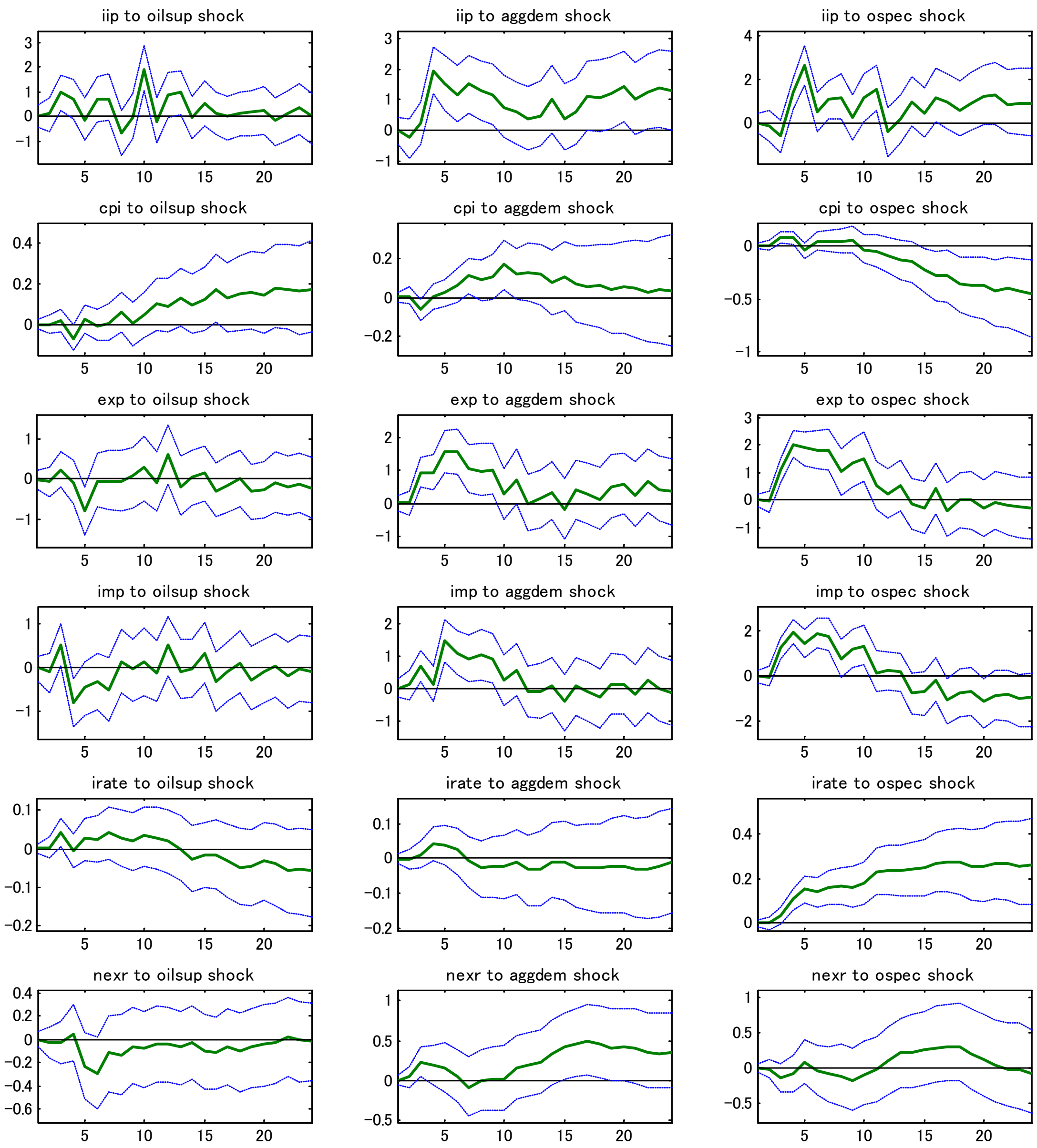
Note: See the notes in Figures 1 and 2.

Figure 4: IRFs of macroeconomic variablesto one standard deviation world oil market shocks, country: Philippines



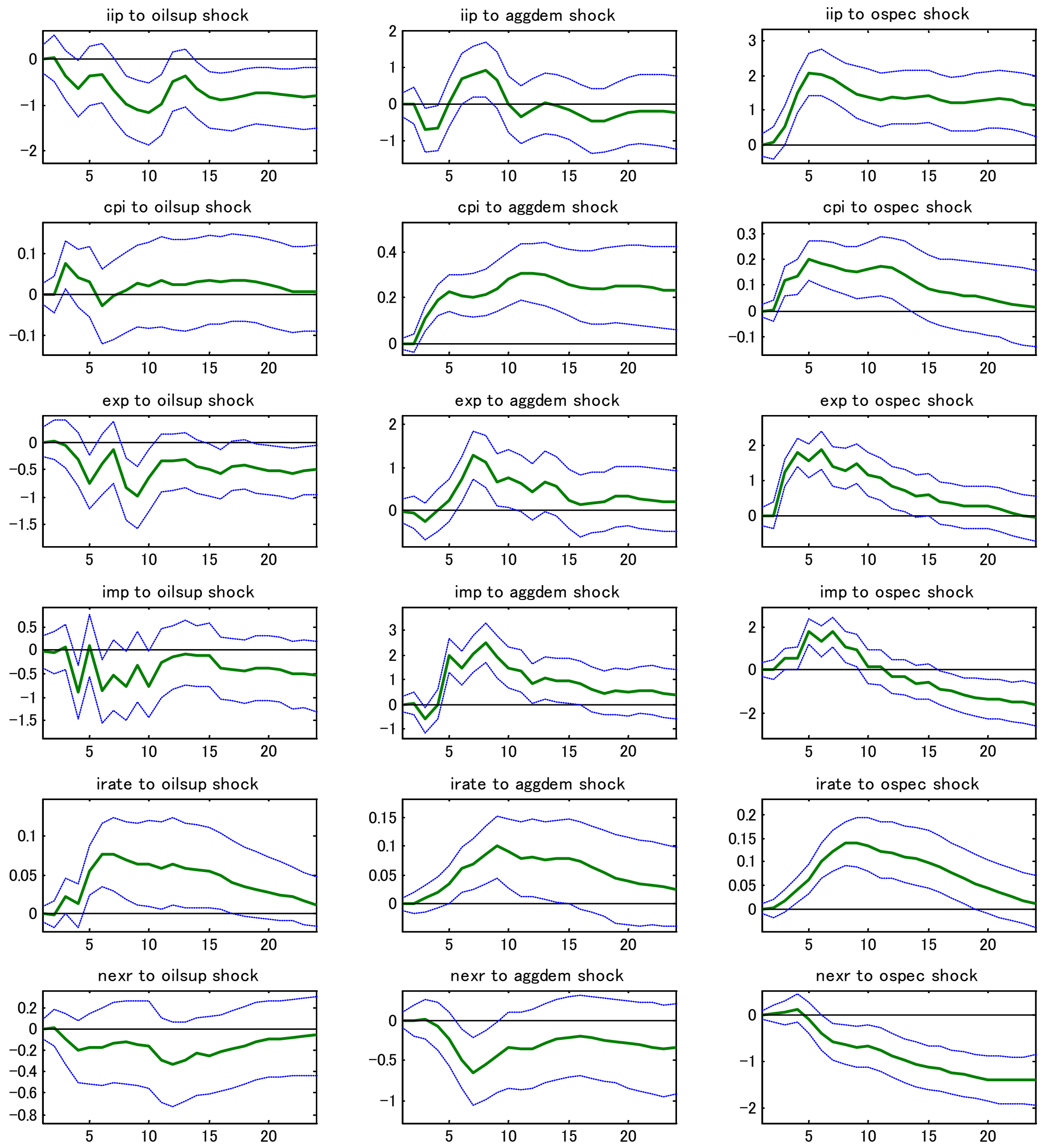
Note: See the notes in Figures 1 and 2.

Figure 5: IRFs of macroeconomic variablesto one standard deviation world oil market shocks, country: Singapore



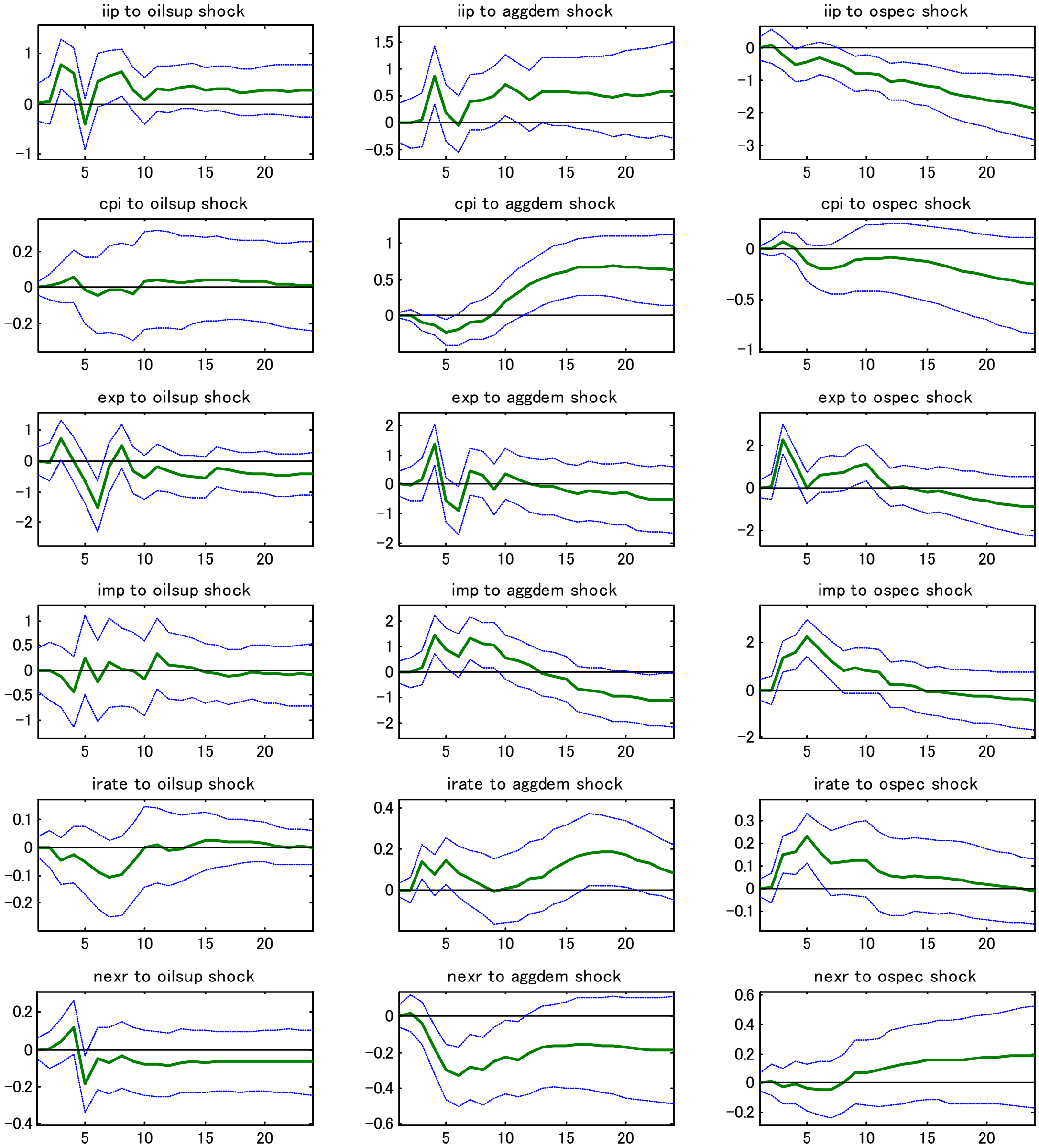
Note: See the notes in Figures 1 and 2.

Figure 6: IRFs of macroeconomic variablesto one standard deviation world oil market shocks, country: Thailand



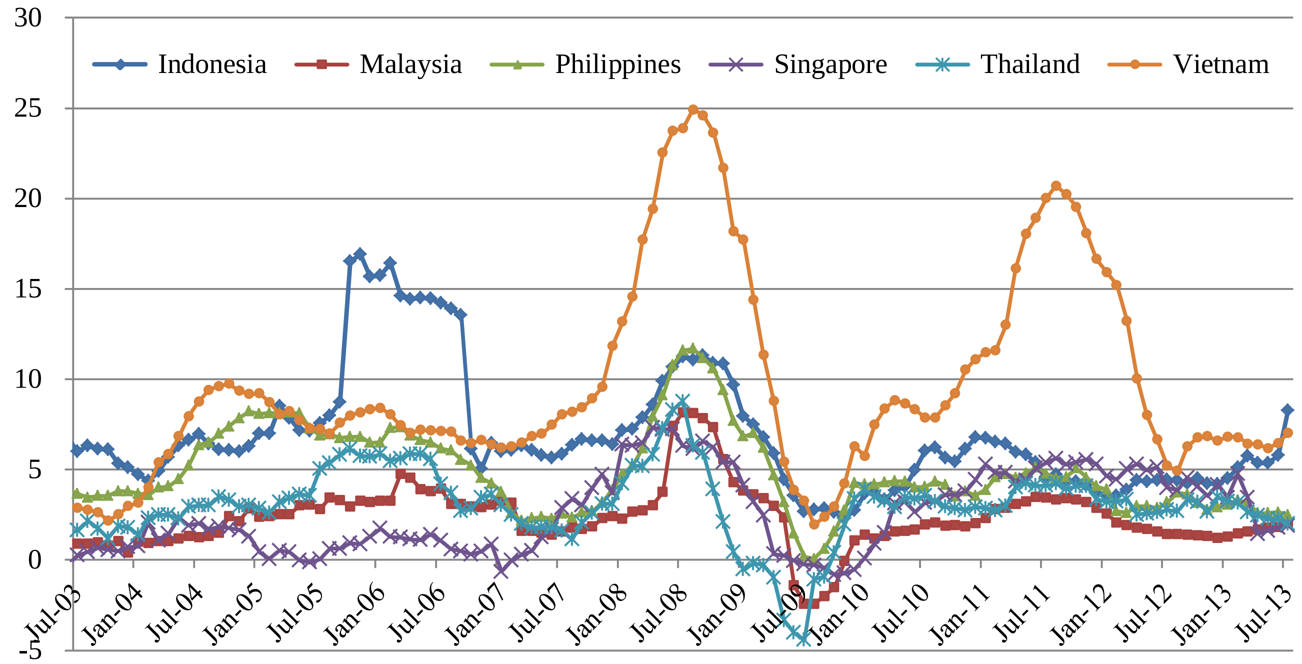
Note: See the notes in Figures 1 and 2.

Figure 7: IRFs of macroeconomic variablesto one standard deviation world oil market shocks, country: Vietnam



Note: See the notes in Figures 1 and 2.

Figure 8: Year-on-year inflation rate of ASEAN countries in 2003-2013



Note: Numbers in the vertical axis are in percentage. The year-on-year inflation rate is calculated as the rate of change in the price level in one month compared to the one in the same month of the previous year.

Figure 9: Historical decomposition for world market nominal oil price in 2000-2013

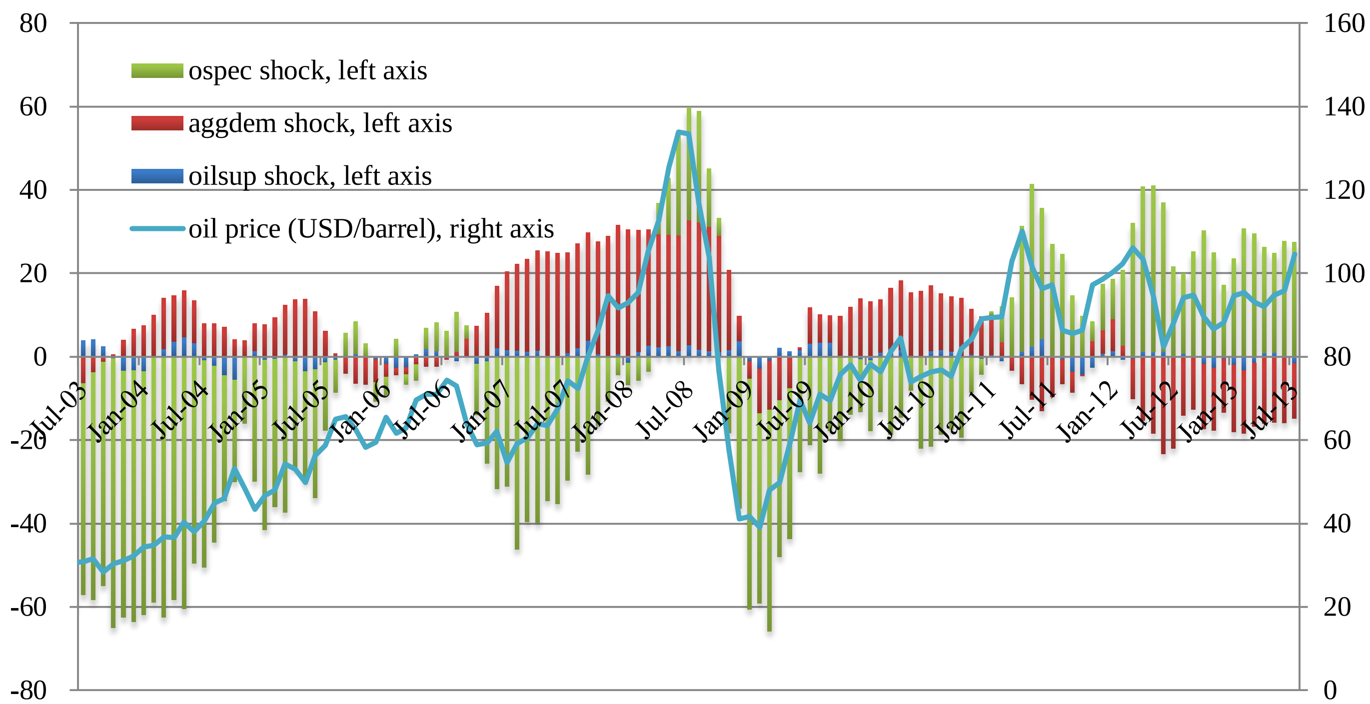


Figure 10: Historical decomposition for inflation of ASEAN countries in 2007-2009

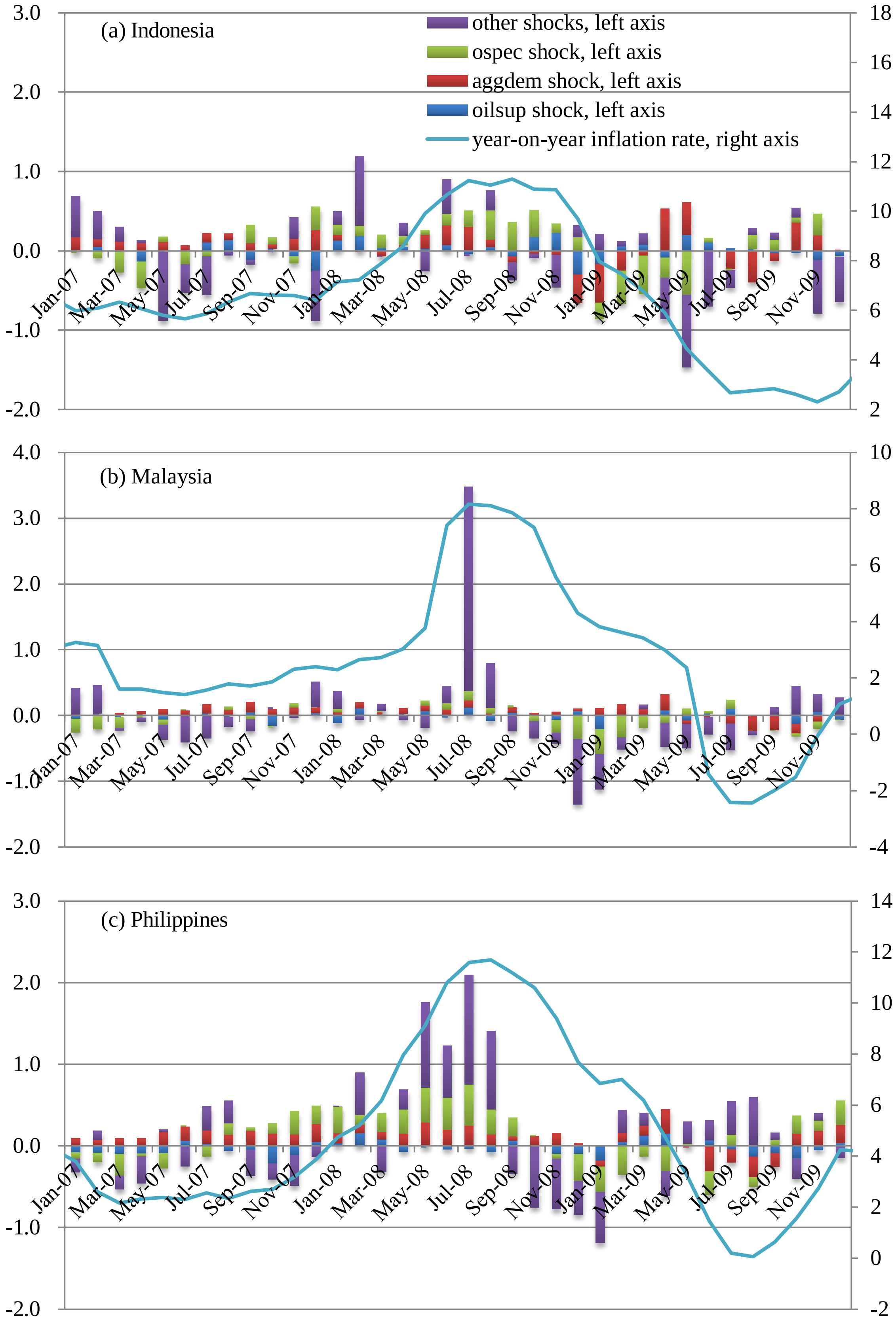


Figure 10 (continued)

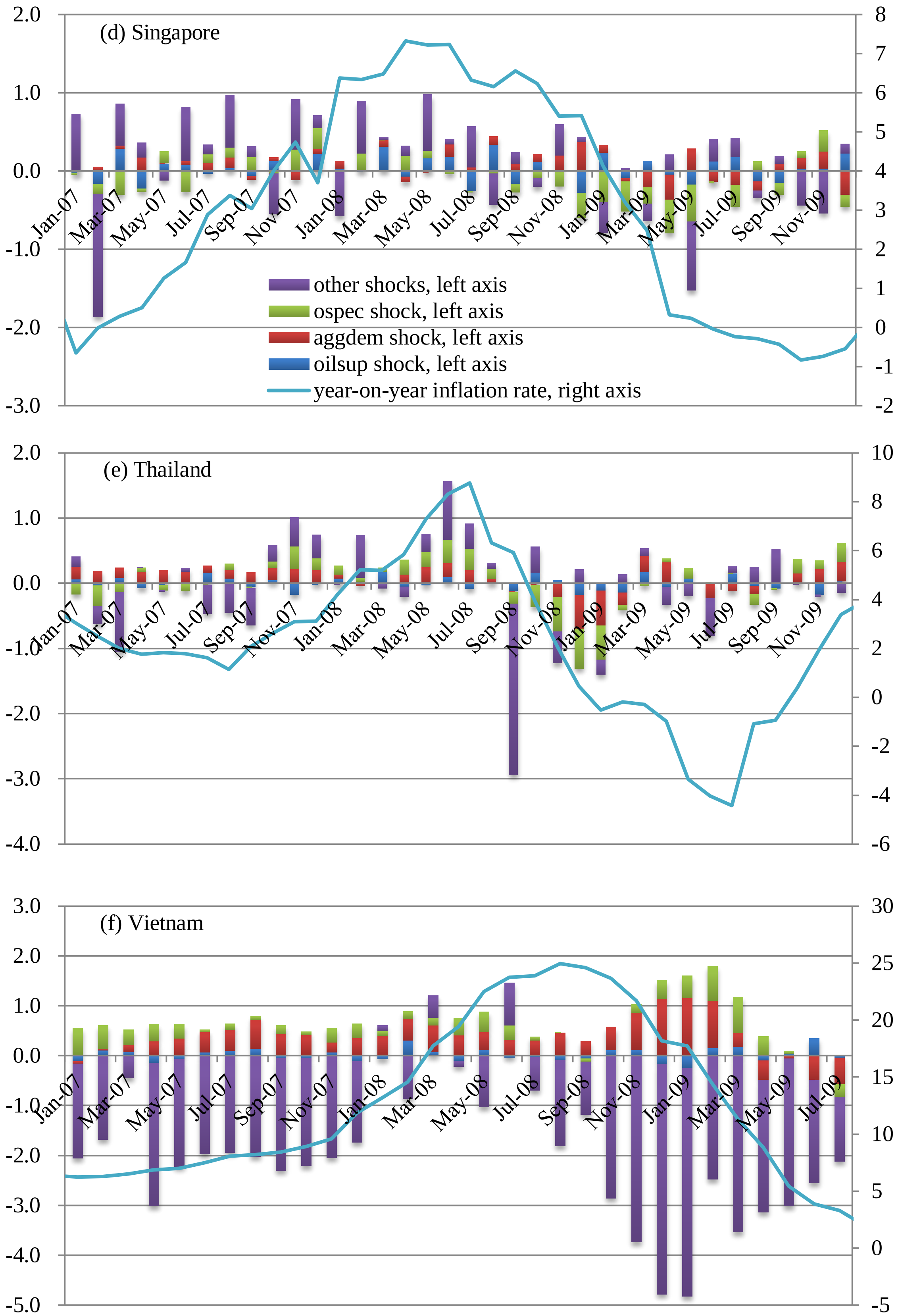


Table 1: Variance decomposition for macroeconomic variables of ASEAN countries

Variable	Shock	Horizon	Indonesia	Malaysia	Philippines	Singapore	Thailand	Vietnam
Industrial production index	oil supply shock	3 months	1.7	1.1	0.3	0.9	1.1	0.5
		12 months	2.4	3.3	3.4	9.4	3.0	3.0
		36 months	2.4	3.4	3.5	10.2	3.2	3.0
	global agg dem. shock	3 months	4.0	5.0	1.1	4.1	1.1	0.7
		12 months	4.2	6.5	8.9	4.4	3.5	1.4
		36 months	4.3	6.9	9.1	5.2	3.7	1.4
	oil-market spec dem. shock	3 months	0.6	3.0	15.7	3.8	5.3	0.3
		12 months	3.2	4.1	13.5	7.8	6.9	0.5
		36 months	3.3	4.5	13.6	8.2	7.0	0.9
CPI	oil supply shock	3 months	1.4	1.9	1.1	3.4	3.0	0.5
		12 months	2.4	3.2	3.9	6.6	4.4	2.2
		36 months	2.5	3.3	3.8	7.5	4.5	2.0
	global agg dem. shock	3 months	2.1	0.9	1.7	4.4	9.4	3.6
		12 months	3.6	3.1	4.8	5.8	10.3	12.3
		36 months	3.7	3.4	5.4	6.2	10.2	13.4
	oil-market spec dem. shock	3 months	2.1	4.2	7.4	4.3	13.7	1.1
		12 months	4.1	5.6	11.5	9.4	13.4	3.1
		36 months	4.2	6.2	12.2	14.7	14.3	5.1
Exports	oil supply shock	3 months	0.8	0.3	1.0	1.4	0.4	3.6
		12 months	2.5	1.6	3.5	3.6	4.3	6.6
		36 months	2.6	1.6	3.6	3.9	4.4	6.8
	global agg dem. shock	3 months	1.9	6.6	8.3	2.5	0.8	5.7
		12 months	3.0	8.2	8.3	4.9	2.1	8.6
		36 months	3.1	8.1	8.6	7.1	2.4	8.6
	oil-market spec dem. shock	3 months	5.7	2.9	1.0	6.5	6.8	6.7
		12 months	10.0	3.3	2.5	5.7	6.7	7.3
		36 months	10.9	3.9	2.5	7.9	7.1	7.6

Note: Numbers are in percentage.

Table 1 (continued)

Variable	Shock	Horizon	Indonesia	Malaysia	Philippines	Singapore	Thailand	Vietnam
Imports	oil supply shock	3 months	0.5	1.1	1.4	5.8	4.1	0.2
		12 months	1.7	1.9	3.4	4.4	5.2	1.2
		36 months	1.9	1.9	3.5	4.7	5.3	1.2
	global agg dem. shock	3 months	1.2	11.9	3.0	2.6	1.4	3.2
		12 months	3.4	11.9	4.5	5.6	6.3	4.1
		36 months	3.4	11.9	4.8	7.3	6.2	4.4
	oil-market spec dem. shock	3 months	4.7	2.9	2.1	4.1	1.0	3.0
		12 months	10.9	2.9	3.9	5.9	4.3	4.1
		36 months	11.2	3.6	4.0	8.4	4.7	4.1
Nominal interest rate	oil supply shock	3 months	0.2	0.0	2.3	1.9	2.4	0.2
		12 months	1.1	0.2	2.3	1.8	9.0	0.5
		36 months	1.3	0.4	1.4	0.6	9.9	0.6
	global agg dem. shock	3 months	0.3	2.1	0.3	3.1	1.8	0.6
		12 months	0.1	3.4	1.3	1.0	7.6	0.5
		36 months	0.3	5.5	2.5	0.7	8.8	7.8
	oil-market spec dem. shock	3 months	0.7	1.6	1.5	7.1	5.1	4.1
		12 months	3.6	23.6	1.8	28.3	29.6	4.0
		36 months	4.4	43.8	26.7	39.5	31.3	3.8
Nominal exchange rate	oil supply shock	3 months	0.9	0.3	0.2	4.8	0.4	0.8
		12 months	1.6	0.8	3.7	3.0	1.4	0.4
		36 months	1.4	1.3	3.6	3.7	0.9	0.1
	global agg dem. shock	3 months	2.1	7.0	0.0	1.9	1.0	1.8
		12 months	9.0	4.9	1.6	0.7	9.9	6.5
		36 months	13.4	6.5	2.4	6.6	6.9	4.6
	oil-market spec dem. shock	3 months	0.7	5.8	0.5	9.4	0.4	0.1
		12 months	6.9	4.2	4.6	4.6	5.4	0.2
		36 months	10.9	9.7	29.7	3.2	50.8	0.1

Note: Numbers are in percentage.