DOCTORAL DISSERTATION

Exchange rate pass-through, the determinants of inflation and oil price issues:

An investigation of Vietnam and some ASEAN countries

Graduate School of International Social Sciences

YOKOHAMA NATIONAL UNIVERISTY

LE THANH BINH

September 2020

TABLE OF CONTENTS

LIST OF FIGURES

Chapter 2: Revisiting the exchange rate pass-through: The case of ASEAN5 countries

Chapter 3: The determinants of inflation in Vietnam: A threshold structural vector autoregression approach

Chapter 4: Does the oil price matter in Vietnam? An empirical investigation in a nonlinear framework

LIST OF TABLES

Chapter 2: Revisiting the exchange rate pass-through: The case of ASEAN5 countries

Chapter 3: The determinants of inflation in Vietnam: A threshold structural vector autoregression approach

Chapter 4: Does the oil price matter in Vietnam? An empirical investigation in a nonlinear framework

ACKNOWLEGMENTS

Doing a Ph.D. has never been easy for all students and takes a lot of efforts from us. This is one of greatest jobs that I have done in my life. In fact, I deeply understand that I was unable to finish this dissertation without the support from MEXT, my family, my supervisors, and my friends.

First, I would like to thank to the Ministry of Education, Culture, Sports, Science and Technology (MEXT) of Japan, who granted me a scholarship in three years. I also greatly appreciate the support from the staff in Yokohama National University, Graduate School of International Social Sciences.

I would like to give my sincere appreciation to my supervisor, Professor Kiyotaka Sato, for your knowledge, your patience, and your academic support. Thank you for your listening and your help in solving my Ph.D. troubles. I am also grateful for the discussions and comments from Professor Parsons and Associate Professor Shrestha at Yokohama National University.

More importantly, I am very grateful to my parents and my younger brother from whom I was inspired and supported in various ways in the research and at the life in Japan. I am also grateful to all friends both in Vietnam and various countries for their good friendship and sharing life experience for three years in Japan. In addition, I would like to thank all my Vietnamese friends for supporting, encouraging, standing by my side during my life in Japan.

Chapter 1: Introduction

Exchange rate pass-through (ERPT) is the degree to which the exchange rate movements have an impact on domestic prices. ERPT analysis is a key issue for macroeconomic policy. First, ERPT has an important effect on imports, exports, and investment (Égert and MacDonald, 2008). Second, ERPT plays a vital role in adjusting current account imbalances (Obstfeld, 2006). Third, ERPT is one of the most influential channels of the monetary transmission mechanism.

Recently, Vietnam has experienced different levels of inflation. The inflation rate reached 25 percent in 2008, which was the highest level since 1996 (Phan, 2014). As a result of the global economic slowdown, the inflation rate in Vietnam declined slightly in 2009. After then, the inflation rate climbed rapidly, peaking at roughly 20 percent in the third quarter of 2011. The impact of the tightened monetary policy contributed to a decline in the inflation rate to 4 percent in 2014, which was following by the domestic price deflation in several months of 2015.Inflation rate started to rise again in 2016. In short, Vietnam's economy presents an appealing situation to analyze the possible interaction of macroeconomic variables under different regimes of inflation.

Noticeably, Vietnam is one of the fasting growing economies in the world. The annual growth rate of this country was approximately 6 percent from 2012 to 2016 and forecast to increase in the next five years (OECD, 2019). Moreover, the demand for oil and other energy sources increases in order to maintain rapid economic growth. Consequently, the growing relative importance of developing countries such as Vietnam in world oil demand leads to an interest in examining the influence of oil price fluctuations on macroeconomic activities in these economies.

In order to examine these issues, this dissertation employs time-series methods including a Structural Vector Autoregression Model (VAR), and threshold Structural VAR model. The main idea is discussed in more detail in the next three chapters.

In chapter 2, "Revisiting the exchange rate pass-through: The case of ASEAN5 countries", using the Vector Autoregression framework, we investigate the exchange rate pass-through (ERPT) in ASEAN countries including Thailand, Indonesia, Malaysia, the Philippines and Vietnam. We find that exchange rate changes do matter for price levels in all sample countries. The ERPT are different cross-country due to the diversity of macroeconomic factors affecting ERPT. Moreover, monetary policy could play a vital role in controlling domestic inflation. The variance decomposition analysis shows that the exchange rate shock accounts for around 25 percent of CPI variation in Vietnam, which is highest among five economies. Lastly, the oil price shock is the important factor to explain the inflation rate in all sample countries.

In chapter 3, "The determinants of inflation in Vietnam: A threshold structural vector autoregression approach", we investigate the macroeconomic determinants of inflation in Vietnam while allowing for a non-linear relationship between those variables. This chapter employs a threshold structural vector autoregression model to examine the response of domestic prices to various macroeconomic shocks. Based on the estimated threshold level of inflation, we divide the sample period into high and low inflation regimes. The empirical results find evidence of a nonlinear relationship between inflation and some macroeconomic variables. The responses of domestic price to the monetary policy shock and the credit shock change significantly between the two inflation regimes. As a result, the source of price fluctuations depends on the inflation regime. Moreover, the reactions of monetary policymakers in Vietnam to the domestic price shock are different among the two inflation regimes.

In chapter 4, “Does the oil price matter in Vietnam? An empirical investigation in a nonlinear framework”, we investigate the nonlinear effect of oil price shocks on macroeconomic activities in Vietnam. We do that by conducting a threshold structural Vector autoregression (VAR) with five variables: world oil price, output gap, interest rate, nominal effective exchange rate (NEER), and domestic price (CPI). The model separates two regimes with the world oil price threshold. Our results indicate that the oil price shock and output gap, interest rate, NEER, and CPI have a regime-dependent relationship. We find that the macroeconomic responses are different among regimes. The monetary policy tools are more effective in the case of the low oil price regime than the high one.

Chapter 2: Revisiting the exchange rate pass-through: The case of ASEAN5 countries

Abstract

In recent years, exchange rate changes seem to have the less negative impact on inflation than they have had in the past for ASEAN countries including Thailand, Indonesia, Malaysia, the Philippines, and Vietnam. Although previous studies examine the impact of exchange rate fluctuations on domestic price in Vietnam, a small number of studies have compared the exchange rate pass-through in Vietnam with a group of ASEAN countries. Using the Vector Autoregression framework, we show that exchange rate changes do matter for price levels in all sample countries. The ERPT are different cross-country due to the diversity of macroeconomic factors affecting ERPT. Moreover, monetary policy could play a vital role in controlling domestic inflation. The variance decomposition analysis shows that the exchange rate shock accounts for around 25 percent of the CPI variation in Vietnam, which is highest among the five economies. Lastly, the oil price shock is an important factor to explain the inflation rate in all sample countries.

Keywords:

Exchange rates, Pass-through, Structural shocks, Monetary policy

1.Introduction

Exchange rate pass-through (ERPT) is the degree to which the exchange rate movements have an impact on the domestic prices. The ERPT analysis is a key issue for macroeconomic indications. First, ERPT has an important effect on imports, exports, and investment (Égert and MacDonald, 2008). Second, ERPT plays a vital role in adjusting current account imbalances (Obstfeld, 2006). Third, ERPT is one of the most influential channels of the monetary transmission mechanism.

The degree of ERPT is often investigated for its implication of macroeconomic policy analysis. A combination of currency depreciation and high inflation leads to the export competitiveness unchanged, whereas the enterprises that have net foreign-currency liabilities could become troubled by massive real debts (Ito and Sato, 2008). The pass-through to consumer price (CPI) leaves an increase in all price levels, which is bad for the economy. The policymakers should knowledge of this characteristic in order to operate the monetary policy.

In the case of low ERPT, the central bank is less concentrated on the response of domestic prices on exchange rate fluctuations. As a result, the central bank will concern about other objectives such as economic growth. On the other hand, when the ERPT is high, the central bank has to consider carefully about the impact of exchange rate changes on price levels, notably in the context of inflation targeting. Therefore, examining the ERPT is crucial for forecasting inflation and applying the monetary policy in every country.

In recent years, five ASEAN countries including Thailand, Indonesia, Malaysia, the Philippines, and Vietnam have experienced a change in inflation behavior, transferring from a high inflation scene to a low one (Jongwanich et al., 2016). Furthermore, exchange rate changes sound to have the less negative impact on inflation than they have had in the past for these

countries. Therefore, my motivation is examining the ERPT to domestic prices for these economies and trying to answer two following questions with the valuable policy implications: first, what is the impact of exchange rate changes on the domestic prices? Second, what is the main source of domestic prices fluctuations?

In particular, I would like to present stylized evidence on the issue for each of these above economies and produce cross-country comparison. It is notable that the ERPT varies considerably across countries. These variations in ERPT might be explained by the structural distinctions across economies. Since five above countries are absolutely different in numerous dimensions, they generate a great space to investigate the exchange rate pass-through issue.

My main findings emerge. First, exchange rate changes do matter for price levels in all above countries. Second, the ERPT to domestic prices are incomplete and decrease along the distribution chain. Third, the ERPT are different cross-country due to the diversity of macroeconomic factors affecting ERPT. Fourth, the possible interactions among macroeconomic variables indicate the critical role of monetary policy and exchange rate regime in order to control inflation in some cases. Fifth, the variance decomposition analysis shows that the exchange rate shock is the main source of CPI fluctuations in Vietnam. Lastly, the oil price shock is the important factor to explain the inflation rate in five countries.

The rest of the paper is structured as follows. Section 2 summarizes the previous studies on ERPT. Section 3 describes exchange rate changes and inflation in Thailand, Indonesia, Malaysia, the Philippines, and Vietnam. Section 4 introduces model specification. Section 5 presents the empirical analysis of this paper and discusses some implications of such. Section 6 concludes.

2. Literature review

The studies on ERPT vary from developed countries to developing countries. The empirical work of Goldberg and Knetter (1997), examining the degree of exchange rate pass-through in the United States, shows that the pass-through coefficient of Import Price Index (IMP) is 0.60. It means that 10 percent depreciation of exchange rate cause 6 percent increase in IMP. In addition, Takhatamanova (2008), investigating the ERPT in 14 OECD countries, indicates the coefficient of ERPT to IMP is 0.92. In the case of Columbia, Rowland (2003) estimates that the pass-through coefficient of IMP is 0.80 while the Producer Price Index (PPI) and Consumer Price Index pass-through coefficients are 0.28 and 0.15, respectively. In general, most of the empirical works find that the ERPT is incomplete.

Meanwhile, there are a lot of ERPT studies focusing on the effect of ERPT on the change in the supply chain of domestic prices including IMP, PPI, and CPI. By comparing the pass-through effect of IMP, PPI, and CPI, we can determine whether and how much the external shocks have more or less significant impact on the domestic price levels. The studies of Mc Carthy (2000), Hahn (2003) and Faruqee (2006), examining the ERPT in European countries, find that the response of CPI to exchange rate shocks is smaller than that of PPI and that of PPI is smaller than that of IMP. Moreover, Goldberg and Campa (2006) conclude that higher share of imported inputs reduces the extent of transmission of exchange rate changes to consumer prices.

The interaction between monetary policy and exchange rate fluctuations is also considered. For instance, Gagnon and Ihrig (2004) examine the relationship between monetary policy and ERPT to CPI. Using data from industrialized countries, they estimate the pass-through rate and the monetary policy parameters separately and calculate the correlation between them. In addition, Ito and Sato (2008) use Vector Autoregression (VAR) analysis to investigate

the ERPT in some Asian countries. By including monetary policy variables in VAR model, they find that Indonesia Bank had difficulty when applying the appreciated monetary policy in response to the exchange rate depreciation.

A number of studies attempt to examine the macroeconomic determinants of ERPT. Mann (1986) and Taylor (2000) show a list of macroeconomic variables accounting for ERPT to domestic prices such as country size, openness, exchange rate volatility, aggregate demand volatility, inflation and monetary policy environment. The empirical studies of Choudri and Hakura (2006) suggest that less exchange rate volatility leads to less ERPT. Moreover, lower ERPT is associated with the low inflation regimes in countries (e.g. Campa and Goldberg, 2005; Choudri and Hakura, 2006; Ozkan and Erden, 2015). Carranza et al. (2008), considering the degree of dollarization in some countries, finds that the domestic price responses to exchange rate shock increase in the country with the high degree of dollarization. Furthermore, Frankel et al. (2012) show that the ERPT in developing countries is greater and more rapid than the ERPT in high-income countries.

Recently, many researches analyze exchange rate pass-through issues in Asian countries. For example, Ito and Sato (2008) examine the exchange rate pass-through in Indonesia, Korea, Thailand, the Philippines, and Malaysia in the period from 1994 to 2006. They indicate that the degree of pass-through to import prices is high in all sample countries while the pass-through to CPI is low. The study of Prasertnukul et al. (2010) investigates the relationship between exchange rate pass-through and inflation targeting in Indonesia, South Korea, the Philippines, and Thailand during the period of 1990-2007. The authors demonstrate that the exchange rate pass-through has declined in South Korea and Thailand in the period of adopting inflation targeting policy whereas the effect of inflation targeting on exchange rate pass-through is not

clear in Indonesia and the Philippines. Jongwanich et al. (2016) examine the source of CPI and PPI inflation in some Asian countries including Indonesia, Malaysia, the Philippines, Singapore, Thailand, and Viet Nam. The authors conclude that the response of PPI to exchange rate fluctuations is higher than that response of CPI.

In the case of Vietnam, Minh (2009) employs a VAR model, using monthly data during the period 2000-2007, find that the pass-through coefficient is 0.08 in the first year and the impact of exchange rate on CPI remove after 15 months. Moreover, Nguyen and Nguyen (2010) report a larger and more significant role of currency depreciation in the CPI in the period 2008-2010. The results of two studies are different due to the exchange rate changes was more volatile in the last period. Bhattacharya (2014) employs both ordinary least squares (OLS) and VAR to investigate CPI inflation in Vietnam during 2000-2012, and indicates that in the short run the key driver of inflation in Vietnam is the nominal exchange rate changes.

To the best of my knowledge, much smaller studies have considered the exchange rate pass-through in Vietnam in comparing with a group of ASEAN countries. My research is one of the first attempts to examine the effect of exchange rate changes on domestic prices in ASEAN-5 countries from 2008 to 2016. This study is notably essential for Vietnam due to Vietnam experienced a high inflation in a long time and Vietnam dong (VND) depreciates from 2008 to now.

This paper contributes to this literature by providing a unique study on Vietnam and other ASEAN countries, presenting stylized facts, and concerning the empirical findings with the macroeconomic variables of these economies in vast details. Along with this line, my research is

closest to the Ito and Sato (2008) paper, which investigates the case of Indonesia, Korea, Thailand, the Philippines, and Malaysia.

3. Inflation and exchange rate changes in five ASEAN countries

In this section, we will discuss the changes in inflation rate and the exchange rate fluctuations in five ASEAN countries. In addition, we also introduce the monetary policy in each country.

Figure 2.1 illustrates the CPI inflation from 2008M1 to 2016M12 in the ASEAN5 economies included in my empirical analysis – Thailand, Indonesia, Malaysia, the Philippines, and Vietnam.

Figure 2.1 around here

It is notable that Vietnam had experienced the highest inflation rate among these sample countries before 2013. Vietnam's inflation rate reached 25 percent in early 2008, which is the highest level since 1990. Due to the global economic slowdown, the inflation rate in Vietnam declined slightly in 2009. Vietnam witnessed a high inflation rate in two years 2010 and 2011 when the inflation rate peaked at roughly 20 percent in 2011M9. From mid-2013 to now, Indonesia had highest CPI inflation among sample economies. The CPI inflation in Indonesia increased substantially after 2013, reaching to 8 percent at the end of 2014.

Since 2013, the inflation rate in these economies indicated a downward trend, except the case of Indonesia. Vietnam's inflation rate decreased significantly to 4 percent in 2014 since the impact of the tightened monetary policy at that time. Malaysia had witnessed a lower inflation rate after this economy experienced a CPI deflation in 2010. Thailand and Vietnam also

experienced CPI deflation in 2015 whereas the inflation rate continued relatively high in Indonesia.

Figure 2.1 also depicts the nominal effective exchange rate (NEER) fluctuation in five countries in my empirical analysis. The Indonesia rupiah depreciated sharply by 19 percent in 2009M2 and 2014M1 while the Malaysia currency reached the highest depreciation by 20 percent in 2015M9. In 2010, the currencies of Indonesia and Malaysia appreciated significantly whereas the Philippines peso and Thai baht appreciated by a small margin. From 2008 to 2011, the exchange rate in Vietnam was fluctuated sharply due to the impact of the global financial crisis. The currency of Vietnam (VND) depreciated strongly by 17 percent in 2010 and 2011.

The exchange rate regime and monetary policy regime in five ASEAN countries are diverse. In 1997, Thailand, Indonesia, and the Philippines changed from the fixed exchange rate regime (peg) to floating exchange rate regime. Malaysia shifted to floating exchange rate regime in short period from 1997 to 1998. After that, they started the US dollar (USD) peg policy from September 1998. In the case of Vietnam, the State Bank of Vietnam (SBV) has adopted the managed exchange rate policy in order to keep the stability of VND against USD.

One possible weakness of following a floating exchange rate regime is to fail the monetary discipline. Three countries – Thailand, Indonesia, and the Philippines – have employed the inflation targeting regime. In this case, the guarantee of price stability becomes accurate. The monetary policy in these above countries focuses on domestic objectives such as low and stable inflation and full employment (Ito, 2017). Although Malaysia sounds to have sufficient room to adopt inflation targeting, this country has not made the change. In Vietnam, the monetary policy

objective of SBV is to control the inflation and stabilize the macroeconomic environment, reflecting both domestic and external stability.

4. Analytical framework

There are many methods to examine the effect of exchange rate fluctuation to domestic prices. For instance, Feenstra (1989), Olivei (2002), Campa and Goldberg (2005), Campa et al. (2005) and Otani et al. (2005) employ a single-equation regression to examine the domestic price response to the exchange rate changes. The drawback of this method is it disregards the fact that domestic inflation may have an impact on the exchange rate (Ito and Sato, 2008). An alternative approach for exchange rate pass-through is a VAR analysis. McCarthy (2000), Hahn (2003), and Faruqee (2006) use a VAR model to analysis the pass-through of some types of shocks to domestic inflation in several advanced countries.

Ito and Sato (2008) state that employing a VAR analysis of the exchange rate pass-through is more appreciated than a single-equation approach due to some important reasons. Firstly, we are able to identify structural shocks through a Cholesky decomposition of innovations. Under a VAR framework, effects of structural shocks to other macroeconomic variables on domestic prices are also considered. Secondly, earlier studies typically take into account a single price index when using a single equation version of the pass-through analysis. In contrast, we can employ a set of domestic prices along the pricing chain to examine the exchange rate pass-through.

Similar to Ito and Sato (2008), I estimate the following VAR model (baseline model) with five endogenous variables, x_t = (Δoil_t ,gap_t , Δm_t ,$\Delta neer_t$,Δp_t)', where oil_t is the log of oil prices; gap_t is the output gap, m_t is the log of the money supply (narrow money), $neer_t$ is the

log of nominal effective exchange rate (NEER), and p_t is the log of domestic price (CPI, PPI or IMP). Δ represents the first different operator. In order to ensure the stationary of all variables, we use the first different of them except for gap_t . The details are described in Appendix A.

I select the variables in my baseline model with the following considered ideas. First, the selection of variables is similar to McCarthy (2000). The only difference is that I do not use CPI, PPI, and IMP simultaneously due to the short sample period and the data availability. Second, my study includes the oil price and the output gap in a VAR model as Ito and Sato (2008). The oil price represents the supply shock. The demand shock is captured by the output gap, which is generated by employing the Hodrick – Prescott filter (Lambda=14400) to industrial production index. Third, I use narrow money in order to assess the effects of monetary policy on domestic prices. Moreover, the interest rate is also employed as the monetary variable to investigate the results when using two different monetary variables.

The fundamental purpose of this research is to investigate the impact of the exchange rate and other macroeconomic shocks on domestic prices and also possible interactions among them. In order to identify the structural shocks, we need to determine the order of the endogenous variables with appropriate economic intuition. The oil price variable is placed first in the order because it is unlikely to be affected contemporaneous by any other shocks except oil price shocks while oil price shocks likely to affect other variables contemporaneously. The output gap is ordered second since it is affected contemporaneously by only oil price shocks and it is expected to have a contemporaneous effect on other variables except for oil price. The monetary policy variable is placed third on the assumption that monetary policy is affected by both oil price and output gap whereas monetary policy has an impact on NEER and price levels while they do not affect contemporaneously on monetary policy. The exchange rate is ordered fourth as

the exchange rate can be considered to be influenced by oil price, output gap, and monetary policy but does not affect them. Finally, the price variable is placed last, assuming that it is contemporaneously affected by all other shocks while the price shock has no contemporaneous effect on the other variables.

We employ a Cholesky decomposition of the matrix Ω, the variance-covariance matrix of the reduced-form VAR residuals to set up structural shocks. The relationship between the reduced-form VAR residual u_t and the structural disturbances ε_t can be described as follows:

$$\begin{pmatrix} u_t^{oil} \\ u_t^{gap} \\ u_t^{m} \\ u_t^{neer} \\ u_t^{p} \end{pmatrix} = \begin{pmatrix} S_{11} & 0 & 0 & 0 & 0 \\ S_{21} & S_{22} & 0 & 0 & 0 \\ S_{31} & S_{32} & S_{33} & 0 & 0 \\ S_{41} & S_{42} & S_{43} & S_{44} & 0 \\ S_{51} & S_{52} & S_{53} & S_{54} & S_{55} \end{pmatrix} \begin{pmatrix} \varepsilon_t^{oil} \\ \varepsilon_t^{gap} \\ \varepsilon_t^{m} \\ \varepsilon_t^{neer} \\ \varepsilon_t^{p} \end{pmatrix}$$

where ε_t^{oil} is the oil price (supply) shock, ε_t^{gap} is the output gap (demand) shock, ε_t^{m} is the monetary policy shock, ε_t^{neer} is the NEER shock, and ε_t^{p} is the price shock. Due to the k(k-1)/2 restrictions are imposed on the matrix S as zero restrictions, the structural model is identified. Given the ordering of endogenous variables, the obtaining lower-triangular matrix S indicated that some structural shocks have no contemporaneous effect on some endogenous variables.

5. Empirical analysis

In this section, we start by examining the impact of exchange rate changes on domestic prices by employing the VAR model. After that, we estimate the pass-through coefficients and compare our results with previous one in the literature. The cross-country comparison based on Spearman rank correlations is conducted to analyze the structural differences in pass-through among countries. Moreover, the possible interaction between oil price, output gap, monetary

policy variables, and exchange rate are investigated. Finally, we generate the variance decomposition analysis in order to examine the main source of price fluctuations in all sample countries.

5.1. Data

The data are on a monthly basis and the whole sample covers the period from January 2008 to December 2016, since the industrial production index in Vietnam is only available based on the international standard from 2008. All series are seasonally adjusted by using the Census X12 method. The NEER index (2010=100) is defined such that an increase in the index means depreciation. We employ the money supply- M1 as the monetary policy variable. The short-term interest rate is used as the alternative monetary policy variables in all countries. I apply the Hodrick – Prescott filter (Lambda = 14400) to the natural log of the industrial production index to calculate output gap as Hahn (2003, p.12) did. The sources of the data are IMF, *International Financial Statistics*, CD-ROM, and Datastream. The details are described in Appendix A.

The stationary of variables is examined by the Augmented Dickey-Fuller (ADF) test and the Phillipps-Perron (PP) test. The null hypothesis of the ADF and PP test is that the variable is not stationary. Table 2.1 reports the result of unit root test, implying that the output gap is stationary at the level, whereas other variables are stationary at the first different. Regarding the lag length of the VAR models, I employ the Akaike Information Criterion and the Bayesian Information Criterion to choose the number of lags. Table 2.2 represents the lag length selection results.

Table 2.1 and 2.2 around here

5.2. Exchange rate pass-through to domestic prices

Figure 2.2 shows the accumulated impulse response functions (over 24 months) of domestic prices to a positive one standard deviation exchange rate shock in all sample countries. The CPI responses to the exchange rate shock are positive, though it is only statistically significant in Vietnam. In the case of the Philippines, the response of PPI is positive and significant. This implies the producer will increase the price of their product to deal with the exchange rate depreciation. In Thailand, the IMP increases significantly in whole periods. It is evidence that the import price level is much more influenced by the external factors.

Figure 2.2 around here

These responses are consistent with the theoretical expectation that the depreciation of the domestic currency leads to the higher domestic prices. This finding is also similar to the previous study of Ito and Sato (2008), who examines the exchange rate pass -through in Asian countries from 1994 to 2006. Furthermore, the responses to the exchange rate shock are different across three prices. The response of IMP is largest in Thailand while the PPI response is larger than the CPI response in other sample countries. These results are closed to Mc Carthy (2000), Hahn (2003), Faruqee (2006), and Ito and Sato (2008).

5.3. The dynamic pass-through elasticities

In order to analyze the price response to the exchange rate shock, it is necessary to assess the extent of exchange rate pass-through by measuring the dynamic exchange rate pass-through elasticities as Ito and Sato (2008) did. The dynamic pass-through elasticity is calculated by dividing the impulse response of the price to the exchange rate shock after j months ($\hat{P}_{t,t+j}$) by the corresponding impulse response of the exchange rate to its own shock ($\hat{E}_{t,t+j}$).

$$PT_{t,t+j} = \sum_{j=1}^{T} \hat{P}_{t,t+j} / \sum_{j=1}^{T} \hat{E}_{t,t+j}$$

Table 2.3 reports the estimated pass-through elasticities for domestic prices for some horizons up to 24 months. First, the ERPT to domestic prices is incomplete at all horizons, which is suitable for the previous studies in the literature. Second, the ERPT to the IMP is largest (in Thailand) and the ERPT to the PPI is higher than that of CPI (in all sample countries). This also supports the evidence that the ERPT will decrease along the distribution chain as McCarthy (2000) mentioned. Third, the ERPT to the PPI is relatively rapid in the Philippines where the magnitudes of the PPI reach more than 0.5 after 6 months.

Table 2.3 around here

In general, I find several empirical regularities which are consistent with the previous literature. First, the ERPT is partial in all cases. This is a typical result in the prevailing literature on ERPT. Second, the ERPT to import prices is highest whereas the ERPT to consumer prices is lowest.

5.4. Literature differences in ERPT

In order to examine the ERPT estimates acquired from my study are commensurate with those in other studies, I compare my estimation with the results of some previous studies (Table 2.4). Regarding the ERPT to IMP, my outcome is lower than the study of Ito and Sato (2008) in all horizons for Thailand. For the ERPT to PPI and CPI, my estimation is higher for the case of Thailand, Malaysia, and the Philippines while it is lower for Indonesia. However, there is a higher PPI magnitude in my study comparing with the results of Ito and Sato (2008) while the CPI magnitude is in the medium range of their research.

My results are closed with the study of Prasertnukul et al. (2010) in the case of Thailand and Indonesia. The paper of Forbes et al. (2017) provides the similar ERPT coefficient in the

situation of Thailand and the Philippines. In the case of Vietnam, the response of CPI to exchange rate changes is highest among all sample countries in both previous studies and my paper. The CPI coefficient in Vietnam is in the medium range of the CPI coefficient in Indonesia in the period from 1994 to 2006.

Table 2.4 around here

In summary, compared to the computation of previous studies, my estimates on the PPI coefficients are relatively large whilst the CPI coefficients are small and in line with the previous study except for the Vietnam case. This difference is the contribution of the following important factors. One is that the central banks in ASEAN countries focus on stability the consumer prices instead of producer prices. Another reason is that the domestic producers are more willing to transfer the depreciation-induced cost raise to their commodity prices and less concerned about losing market share than domestic retailers (Choudhri and Hakura, 2006). In the case of Vietnam, the exchange rate depreciates rapidly from 2008 to 2012, triggering the highest pass-through coefficient among sample countries.

5.5. Cross-country differences in ERPT

In this section, I examine the potential factors that define the cross-country diversities in ERPT. Understanding the source of exchange rate pass-through to domestic prices is vital for the monetary policy implements. In order to capture the difference in ERPT among countries, I employ the Spearman correlation at numerous horizons between the ERPT coefficients and the macroeconomic variables which are assumed to affect ERPT. I consider the following factors: (1) the country size measured by GDP in US dollars using purchasing power parity; (2) The openness of an economy measured by the ratio between trade and GDP; (3) Exchange rate volatility calculated by the variance of the residuals from the exchange rate equation; (4)

Aggregated demand volatility measured by the variance of the residuals from the output gap equation; (5) Inflation environment measured by the average annualized CPI inflation rate in the sample period; (6) Monetary policy stability measured by the average monthly growth rate of money supply over the sample period. I follow McCarthy (2007) and An and Wang (2012) in measuring the above indicators.

Table 2.5 displays the descriptive summary statistics of the above macroeconomic variables for five ASEAN countries in my sample. Among these countries, Vietnam has highest inflation rate and output growth rate. As in the previous section, my results indicate that the ERPT coefficient in Vietnam is highest among sample countries. The money supply growth rates are higher than the inflation rate in all five countries. For the countryside, Indonesia is the largest economy whereas Vietnam is smallest one. All countries have high openness index which indicates the higher pressure on ERPT to domestic prices.

Table 2.5 and 2.6 around here

Table 2.6 shows the Spearman rank correlation between ERPT coefficients and the macroeconomic variables at horizons 6, 12, and 24 months. The size of a country is negatively correlated with the ERPT coefficients in all horizons. This is similar to the study of An and Wang (2012), who find the negative relationship between countryside and ERPT ratios in nine advanced economies. Then, we could support the Dornbusch (1987) prediction that smaller economies tend to have higher ERPT.

There is a positive correlation between openness and ERPT coefficients, indicating higher openness to trade leads to higher ERPT. The relationship between ERPT and exchange rate volatility are mixed in previous empirical works. Choudri and Hakura (2006) and

Kohlscheen (2010) find a positive correlation whereas McCarthy (2007) reports a negative one. Campa and Goldberg (2005) indicate that the impact of exchange rate volatility on ERPT is ambitious. My results indicate a negative correlation between ERPT to CPI and exchange rate volatility.

Aggregate demand volatility is positively correlated with ERPT coefficients in all horizons, confirming that more volatile aggregate demand have higher ERPT. McCarthy (2007) and An and Wang (2012) also find the positive relationship between ERPT and aggregate demand volatility in some cases.

The correlation between inflation rate and ERPT is positive in all horizons. This is consistent with the result of Choudhri and Hakura (2006). The monetary policy volatility is positively correlated with ERPT coefficients, suggesting that the higher stability of monetary policy is associated with lower ERPT as Devereux, Charles Engel, and Storgaard (2003) mention.

In general, the openness, output volatility, the inflation rate, and the monetary policy stability are positively correlated with the ERPT. On the other hands, the economy size and the exchange rate volatility is negatively correlated with the ERPT.

5.6. Oil price shocks and price levels

In this subsection, we consider the impact of external shocks as the oil price shock to domestic prices in all countries. The CPI responses to a positive one standard deviation oil price shock are positive and significant in Thailand, the Philippines, and Vietnam (Figure 2.3). This result is reasonable because all three countries are the oil-importing economy. The CPI response to the oil shock in Indonesia and Malaysia is positive but insignificant because Malaysia is oil-

exporting country and the Indonesia government has regulated the petroleum product prices. Therefore, the CPI in two countries has been less affected by the oil price shocks.

Figure 2.3 around here

The responses of PPI to the oil price shock in all sample countries (except Vietnam due to data availability) are positive and statistically significant for the whole period. It is evidence that oil price shocks lead the domestic producers to increase their product prices. My results demonstrate that domestic producers decide to pass the cost increase due to the oil price go up to their product prices instead of decreasing their profit margin. On the other hand, domestic producers absence effective means to deal with the risks related to oil price fluctuations.

Furthermore, the response of PPI to oil price shocks is higher in oil-exporting country. In Malaysia, the accumulated effect of oil price changes in PPI grows up from 0.006 in the first month to 0.015 in the seventh month. For other oil-importing countries, the impact of oil price fluctuations on PPI is smaller. Moreover, the response of domestic prices to oil price changes follows the distribution chain. The response is higher for PPI than CPI. One possible explanation is that the basket of PPI includes more oil and oil-related products than that of CPI (Jongwanich et al., 2016).

5.7. Output gap, monetary policy variables, and domestic inflation

In the case of the Philippines and Vietnam, the responses of output gap to the NEER shocks are positive and insignificant (Figure 2.4). When the currency becomes depreciate, export will increase. As a result, output gap will rise. On the other hand, the output gap response to the NEER shocks in Thailand is negative and insignificant. These results are opposite with the cases of Philippines and Vietnam.

Figure 2.4 also shows the impulse response of money supply to a positive one standard deviation the exchange rate shock. The M1 responses are positive and insignificant in Thailand and the Philippines. In Vietnam case, the M1 response is negative and significant after five months. For the case of Indonesia and Malaysia, the impact of exchange rate shock on money supply is negative and insignificant for whole periods. The results are consistent with Ito and Sato (2008), showing that the central bank's reaction to the exchange rate shocks is contrasting among countries.

Figure 2.4 around here

In the face of a large currency devaluation, the central bank often conducts tight monetary policy to prevent further depreciation of the currency. The pattern is observed in Vietnam where the money supply decreased during the crisis period. However, the impact of NEER shock on monetary policy only takes effect after five months. It means that past devaluation appears to negatively influence monetary policy with a five months lag, which indicates that the monetary policy is delayed and passive in response to NEER shocks.

To examine the monetary policy of central banks in response to exchange rate shocks, a VAR model with five-variables is estimated. In this model, I employ short-term interest rate instead of the money supply. Figure 2.5 shows the interest rate response to a one positive standard deviation NEER shock is positive and significant in the Philippines and Vietnam. In the other words, the central banks in two countries actually increase the interest rate to avoid larger depreciation of the domestic currency.

Moreover, when the CPI increases in response to the exchange rate depreciate, the interest rate rises, which reflects the response of monetary authorities in order to keep the

inflation stability. This result is consistent with the typical knowledge about the monetary policy rules and exchange rate regimes in ASEAN economies.

In Thailand case, the interest rate declines in response to the NEER shocks. Over the period 2008-2011, Thailand economy had to face the global financial crisis, the spillover of Japan earthquake, and the most destructive floods in at least 50 years. In order to reduce the impact of three major shocks, the BOT let the exchange rate depreciate and cut interest rate when appropriate (Alp and Elekdag, 2012). This discussion explains for reducing in interest rate in Thailand when the exchange rate changes.

Figure 2.5 and 2.6 around here

In order to discuss the effect of changing in monetary policy variables on CPI, the impulse response of CPI to a positive one standard deviation M1 shock is conducted (Figure 2.6). The CPI increase significantly for the case of Thailand and the Philippines after 2 or 3 months. It reflects that the fall in M1 would reduce the domestic prices. In Vietnam, the CPI response to M1 shock is negative but not statically significant in all periods.

5.8. Robustness: Alternative VAR orderings

The ordering of variables in a VAR system has an impact on the results of the impulse response function and variance decomposition. In Chapter 4, we discussed the selection of the variables' order in the baseline model. To examine the sensitivity of our results related to the ordering of the variables, we conduct VAR systems with alternative ordering, as investigated in Ito and Sato (2008).

First, we place the monetary policy variable after of the NEER in alternative model 1, namely, x_t = (Δoil_t , gap_t , $\Delta neer_t$, Δm_t , Δp_t)'. In this case, the monetary policy responds to the

exchange rate movements contemporaneously. However, exchange rate shocks are not affected by the change in monetary policy contemporaneously.

Second, alternative model 2 is x_t = (Δoil_t , Δm_t , $\Delta neer_t$, gap_t ,Δp_t)' . In this ordering, we place the monetary policy variable and the NEER ahead of the output gap. This model implies that when the monetary policy is determined, the NEER and output gap information is available with a time lag. Furthermore, the change in monetary policy and the fluctuation in the exchange rate can affect the output gap contemporaneously.

Third, another model is to allow the central bank's monetary policy reacting contemporaneously to all shocks in a model as in the previous study of McCarthy (2000). In this case, we place the NEER ahead of the output gap and monetary policy variable is at the bottom. Thus, alternative model 3 is x_t = (Δoil_t , $\Delta neer_t$, gap_t ,Δp_t ,Δm_t)'.

Figure 2.7 indicates the CPI responses to a positive one standard deviation NEER shock with the alternative VAR models. In this case, I employ M1 as the monetary policy variable. In general, the CPI responses to the exchange rate shock are similar across different ordering of VAR. Thus, this is confirmation that impulse responses do not demonstrate the sensitive to the variable ordering in my study.

Figure 2.7 around here

5.9. Variance decomposition analysis

Finally, I employ a variance decomposition analysis to investigate further problems related to the exchange rate pass-through. The variance decompositions of CPI and PPI are conducted. Table 2.7 shows the result of PPI variance decomposition over a forecast horizon of

24 months in the baseline model. When using CPI as domestic price variable, table 2.8 presents the result of CPI variance decomposition.

For the PPI, own innovation becomes the most important component of fluctuations at all forecast horizons, accounting for at least 46 percent of the variation. The second influential component is the oil price changes, explaining around 40 percent of PPI fluctuations in Malaysia whereas the percentage of its in Thailand and Indonesia is around 30 percent after six-month horizon. This can be described by the fact that oil is the fundamental material for numerous manufacturing sectors in Indonesia, Malaysia, and Thailand and therefore variation in oil prices has the noticeable effect on production costs and pricing determinations of domestic producers. The exchange rate shocks contribute 17 percent and 11 percent of PPI fluctuations in the Philippines and Indonesia respectively. Output gap and monetary policy shock have moderate effects on the change in PPI in all above countries.

Table 2.7 and 2.8 around here

For the CPI, the most important component of fluctuations is own CPI shocks, contributing to 98 percent at the peak in Indonesia. Oil price shock is the second prevailing source of CPI changes in Thailand and the Philippines. The percentage of oil price shock explains more than 20 percent of CPI fluctuations in these countries. In Vietnam, exchange rate shocks account for almost 25 percent of CPI changes after the six-month horizon whereas oil price shocks contribute to approximately 18 percent of price fluctuations. For the case of Thailand, monetary policy shock is vital for explaining CPI variation. It contributes to 11 percent of the variation after six-month horizon. Whilst the output gap shocks in Vietnam account for 10 percent of the CPI variation, becoming an important source of this variation.

To be short, the oil price fluctuations are the main source of PPI and CPI variations in all oil importing countries. The oil price shocks are more vital for interpreting the PPI inflation than CPI inflation in Thailand, Indonesia, and Malaysia. For oil exporting countries, the effect of oil price on CPI fluctuations is modest. One notable finding is here: the exchange rate shock is one of the most important sources of CPI fluctuations in Vietnam. This finding represents that the exchange rate stability is essential for the inflation rate in Vietnam. It can also explain the rigid exchange rate regime that Vietnam followed.

5.10. Discussion

This paper asserts that the exchange rate coefficients vary across countries. By employing the Spearman correlation, this study investigates macroeconomic factors that influence on cross-country exchange rate coefficients. My results suggest that a higher ERPT is associated with a smaller country size, greater openness, less exchange rate volatility, more volatile monetary policy, higher inflation rate and more volatile aggregate demand. These characteristics are persistent, indicating a long-lasting distinction in the pass-through rate of a country.

Moreover, this research confirms that monetary policy could play a vital role in controlling domestic inflation. In Thailand, Indonesia, and the Philippines where the central banks follow the managed floating exchange rates, shifts in monetary policy, i.e., adjustment in the interest rate or money supply, have an impact on exchange rate changes. Moreover, the change in monetary policy variables can substitute for the change in the exchange rate. In this case, the net effect on exchange rate change would be neutral. Therefore, the policymakers are able to increase the interest rate in order to reduce the domestic price.

One notable finding is that even when Vietnam adopts the rigid exchange rate regime, the response of CPI to exchange rate changes is higher than that response in other sample countries.

One possible reason is that Thailand, Indonesia, and the Philippines have implemented flexible exchange rate regimes incorporate with the inflation targeting. These policies are effective in somehow in order to maintain domestic prices stability under the impact of exchange rate depreciation. While the monetary policy in Vietnam includes several tasks such as control the inflation, stabilize the macroeconomic environment, and enhancing economic growth.

On the other hand, the change in monetary policy variables cannot substitute for the change in the exchange rate in Vietnam. In this paper, the impulse response functions indicate that an increase in the interest rate would help to reduce CPI in Vietnam. Equally important, the variance decomposition suggests that the monetary policy shock has a small effect on the CPI variation. It implies that the changing in monetary policy variables can offset only small part of the effect of exchange rate fluctuations on CPI in Vietnam. The variance decomposition analysis shows that exchange rate shocks account for around 25 percent of CPI variation in Vietnam, which is highest among five countries. Thus, one of the main components in CPI fluctuation in Vietnam is exchange rate shocks. Therefore, managing stability in the exchange rate is critical for price stability in Vietnam and adjusting interest rate, in this case, is not the main solution.

Furthermore, there is a trade-off between exchange rate depreciation and economic growth (Jiang and Kim, 2013). My results show that exchange rate depreciation can increase output gap in Vietnam due to improved export competitiveness. On the other hand, it also triggers the significant increase in price levels in the short term to medium term. Therefore, policymakers should not employ depreciation as a measure to achieve a high economic growth in Vietnam.

Lastly, the oil price fluctuations significantly affect the price levels (CPI, PPI) in all five countries. It also changes the price decisions of domestic producers. The variance decompositions indicate that oil price innovation accounts for very remarkably to the variation of PPI and CPI, and its contribution is larger than that of exchange rate shock. This reflects that external factors have increased their influence on domestic prices in recent years as the economy becomes more open.

6. Concluding remarks

This paper employs a structural VAR model to investigate the pass-through effect of exchange rate changes on price levels in Thailand, Indonesia, Malaysia, the Philippines, and Vietnam. The baseline model includes world oil price index, output gap, narrow money, nominal effective exchange rate, and price levels (CPI, PPI, IMP). We also use the short-term interest rate as the monetary variable in order to examine the role of central banks in all countries.

My study indicates that the domestic prices response to the exchange rate shock is positive in all five sample economies. The pass-through to the domestic prices is incomplete and it also follows the distribution chain. The ERPT depends on the macroeconomic determinants of each country. The possible interactions among macroeconomic variables indicate the critical role of monetary policy and exchange rate regime in order to control inflation in some cases. By using variance decomposition of CPI, the exchange rate shock is the main source of CPI fluctuations in Vietnam. Finally, the oil price plays an important role in determining the domestic price fluctuations in all five economies.

The empirical analysis gives several important insights. Pass-through does matter for domestic prices for all sample countries. The alternatives in the structure of the economy might

lead to the fluctuations in pass-through. Monetary policy could play a vital role in controlling domestic inflation. This reflects the success of adopting the flexible exchange rate regime and inflation targeting in some cases. For Vietnam, exchange rate stability is essential for price stability while depreciation could not employ as the means for encouraging economic growth because it will significantly increase CPI. The oil price fluctuations become more important sources of price changes in all sample countries.

References

Alp, H., & Elekdag, S. (2012). Shock Therapy! What Role for Thai Monetary Policy?. IMF Working Paper, No.12/269.

An, L., & Wang, J. (2012). Exchange Rate Pass-Through: Evidence Based on Vector Autoregression with Sign Restrictions. *Open Economic Reviews 23*, 359-380.

Bhattacharya, R. (2014). Inflation Dynamics and Monetary Policy Transmission in Vietnam and Emerging Asia. *Journal of Asian Economics 34*, 16–26.

Campa, J., M., & Goldberg, L., S. (2005). Exchange Rate Pass Through into Import Prices. *Review of Economic and Statistics 87*, 679-90.

Campa, J., M., Goldberg, L., S., & González-Mínguez, J., M. (2005). Exchange Rate Pass-Through to Import Prices in Euro Area. NBER Working Paper, No.11632, National Bureau of Economic Research.

Carranza, L., Galdon-Sanchez, J., & Gomez-Biscarri, J. (2009). Exchange Rate and Inflation Dynamics in Dollarized Economies. *Journal of Development Economics 89*, 98-108.

Choudhri, U., & Hakura, D.S. (2006). Exchange Rate Pass-through to Domestic Price: Does the Inflationary Environment Matter?". *Journal of International Money and Finance 25*, 614-639.

Devereux, M., Engel, C., & Storgarrd, P. (2003). Endogenous Exchange Rate Pass-through When Nominal Prices and Set in Advance. NBER Working Paper No. 9543, National Bureau of Economic Research.

Dornbusch, R. (1987). Exchange Rates and Prices. *American Economic Review 77*, 93-106.

Égert, B., & MacDonald, R. (2008). Monetary Transmission Mechanism in Central and Eastern Europe: Surveying the Surveyable. OECD Working Paper No.8559.

Faruqee, H. (2006). Exchange Rate Pass-Through in the Euro Area. *IMF Staff Papers* 53, 63-88.

Feenstra, R. C. (1989). Symmetric Pass-Through of Tariffs and Exchange Rates under Imperfect Competition: An Empirical Test. *Journal of International Economics 27*, 25-45.

Forbes, K., Hjortsoe, I., & Nenova, T. (2017). Shock Versus Structure: Explaining Differences in Exchange Rate Pass-through Across Countries and Time. Bank of England External MPC Unit Discussion Paper No.50.

Frankel, J., Parsley, D., & Wei, S. (2012). Slow Pass-Through around the World: A New Import for Developing Countries. *Open Economic Reviews 23*, 21-251.

Gagnon, J., E., & Ihrig, J. (2004). Monetary Policy and Exchange Rate Pass-through. *International Journal of Finance and Economics 9*, 315-338.

Goldberg, L., S., & Campa, J., M. (2006). Distribution Marigins, Imported Inputs, and the Sensitivity of the CPI to Exchange Rates. NBER Working Paper No. 12121, National Bureau of Economic Research.

Goldberg, P., & Knetter, M. (1997). Good Prices and Exchange Rates: What Have We Learned. *Journal of Economic Literature 35*, 1243-1272.

Hahn, E. (2003). Pass-Through of External Shocks to Euro Area Inflation. ECB Working Paper No.243, European Central Bank.

Ito, T. (2017). A New Financial Order in Asia: Will a RMB Bloc Emerge?" *Journal of International Money and Finance 74*, 232-257.

Ito, T., & Sato, K. (2008). Exchange Rate Changes and Inflation in Post-Crisis Asian Economies: VAR Analysis of the Exchange Rate Pass-Through. *Journal of Money, Credit and Banking*, Vol.40, No.7, 1407-1438.

Jiang, J., & Kim, D. (2013). Exchange Rate Pass-Through to Inflation in China. *Economic Modelling 33*, 900-912.

Jongwanich, J., Wongcharoen, P., & Park, D. (2016). Determinants of Consumer Price Inflation versus Producer Price Inflation in Asia. ADB Working Paper Series, No.491.

Kohlsheen, E. (2010). Emerging Floaters: Pass-Through and (some) New Commodity Currencies". *Journal of International Money and Finance 29*, 1580-1595.

Mann, C.L. (1986). Prices, Profit Margins, and Exchange Rates. *Federal Reserve Bulletin*, 366-379.

McCarthy, J. (2000). Pass-Through of Exchange Rates and Import Prices to Domestic Inflation in Some Industrialized Economies." Staff Reports, No.111, Federal Reverse Bank of New York.

McCarthy, J. (2007). Pass-Through of Exchange Rates and Import Prices to Domestic Inflation in Some Industrialized Economies. *Eastern Economic Journal 33*, 511-537.

Minh, V.V. (2009). Exchange Rate Pass-Through and Its Implications for Inflations in Vietnam." VDF Working Paper No.0902 Vietnam.

Nguyen, T.T.H., & Nguyen, D.T. (2010). Macroeconomic determinants of Vietnam's inflation 2000-2010: Evidence and Analysis. Vietnam Centre for Economic and Policy Research, University of Economics and Business, Vietnam National University.

Obstfeld, M. (2006). Pricing-to-Market, the Interest Rate Rule, and The Exchange Rate". NBER Working Paper No.12699.

Olivei, G. P. (2002). Exchange Rates and the Prices of Manufacturing Products Imported into the United States. *New England Economic Review*, Federal Reserve Bank of Boston, First Quarter, 3-18.

Otani, A., Shiratsuka, S., & Shirota, T. (2005). Revisiting the Decline in the Exchange Rate Pass-Through: Further Evidence from Japan's Import Prices. IMES Discussion Paper, No.2005-E-6, Institute for Monetary and Economic Studies, Bank of Japan.

Ozkan, I., & Erden, L. (2015). Time-varying Nature and Macroeconomic Determinants of Exchange Rate Pass-through. *International Reviews of Economics and Finance 38*, 56-66.

Prasertnukul, W., Donghun Kim, D., & Kakinaka, M. (2010). Exchange Rates, Price Levels, and Inflation Targeting: Evidence from Asian Countries. *Japan and the World Economy 22*, 173–182.

Rowland, P. (2003). Exchange Rate Pass Through to Domestic Price. Columbia: Banco de la Republica.

Takhatamanova, Y. (2008). Understanding Changes in Exchange Rate Pass Through. Federal Bank of San Francisco.

Taylor, J.B. (2000). Low Inflation, Pass-Through, and the Pricing Power of Firms." *European Economic Review 44*, 1389-1408.

Appendix A: Data description

The world oil price: The US dollar-basis oil price index (2010=100) that is an average of the three spot price indices of Texas, U.K. Brent, and Dubai. The world oil price is seasonally adjusted using the Census X12 method. Data source: IMF, *International Financial Statistics* (IFS), CD-ROM.

The output gap: The output gap is generated by applying the HP filter to eliminate a strong trend in the seasonally adjusted industrial production index. Data source for the industrial production index: IFS and Datastream.

Money supply: The seasonal adjusted M1 is used. Data source: IFS.

Interest rate: The interbank call rate (monthly average) is used. Data source: IFS.

Exchange rate: The NEER index (2010=100) is used. Data source: IFS and Datastream.

Prices: The monthly series of CPI, PPI, and IMP are taken from IFS.

GDP: GDP in US dollars using purchasing power parity. Data source: the World Development Indicators Database, World Bank.

Openness: The ratio between trade and GDP. Data source: the World Development Indicators Database, World Bank.

Table 2.1: Unit root tests (null hypothesis: unit root)

Variable (in natural log form)	Thailand	Indonesia	Malaysia	Philippines	Vietnam
			Augmented Dickey – Fuller (ADF) test		
oil	-1.38				
Δoil	-6.72***				
gap (in level)	-6.34***	-7.95***	-6.10***	-4.42***	-13.17***
m	-0.87	-2.48	0.10	-2.07	-2.97
Δm	-5.10***	-11.44***	-11.42***	-10.08***	-9.46***
int	-2.62	-1.90	-2.57	-2.08	-3.01
Δint	-3.62***	-6.27***	-3.85***	-4.36***	-5.69***
neer	-2.08	-1.92	-0.99	-2.43	-0.71
Δneer	-7.49***	-8.98***	-7.78***	-5.49***	-7.60***
cpi	-0.94	-2.30	-1.51	-2.55	
Δcpi	-5.51***	-7.36***	-10.38***	-5.59***	
ppi	-1.47	-2.44	-1.98	-2.96	
Δppi	-6.16***	-6.90***	-5.49***	-8.82***	
imp	-3.20*				
Δimp	-6.50***				
			Phillips – Perron (PP) Test		
oil	-1.87				
Δoil	-6.67***				
gap (in level)	-6.50***	-7.94***	-5.99***	-4.44***	-12.77***
m	-1.11	-2.40	-1.56	-2.30	0.42
Δm	-14.42***	-11.45***	-16.24***	-10.14***	-9.62***
int	-1.82	-2.22	-2.36	-1.76	-2.67
Δint	-5.51***	-7.92***	-5.65***	-9.05***	-9.16***
neer	-2.62*	-1.83	-0.69	-2.71*	-0.89
Δneer	-7.49***	-8.96***	-7.74***	-9.13***	-6.76***
cpi	-1.38	-2.96	-1.45	-2.88	-1.71
Δcpi	-8.05***	-7.15***	-10.38***	-5.61***	-4.49***
ppi	-1.91	-2.60	-1.99	-3.12	
Δppi	-5.86***	-6.92***	-5.70***	-8.89***	
imp	-2.01				
Δimp	-6.39***				

Note: (1) ***, **, and * denote the significance at the 1%, 5%, and 10% level respectively. (2) When testing a variable in level (except for the output gap), a constant and a time trend are included. (3) When testing a variable in first differences, only a constant is included.

Source: Calculated by the author

Table 2.2: Lag length selection for the VAR model

	Thailand	Indonesia	Malaysia	Philippines	Vietnam
VAR (CPI)	3	2	2	2	2
VAR (PPI)	2	2	3	2	
VAR (IMP)	2				
VAR (when including INT)	3	2	2	2	2
VAR (alternative model 1)	3	2	2	2	2
VAR (alternative model 2)	3	2	2	2	2
VAR (alternative model 3)	3	2	2	2	2

Note: Due to the data available, the VAR(IMP) is only conducted in Thailand while VAR(PPI) is not conducted in Vietnam

Source: Calculated by the author

Table 2.3 : Exchange rate pass-through elasticities

		T=1	T=6	T=12	T=18	T=24
Thailand						
	CPI	0.00	0.12	0.11	0.11	0.11
	PPI	0.19	0.42	0.43	0.43	0.43
	IMP	0.53	0.64	0.65	0.65	0.65
Indonesia						
	CPI	0.02	0.00	0.00	0.00	0.00
	PPI	0.17	0.18	0.18	0.18	0.18
Malaysia						
	CPI	0.02	0.09	0.09	0.09	0.09
	PPI	0.18	0.40	0.37	0.35	0.35
Philippines						
	CPI	0.00	0.12	0.12	0.12	0.12
	PPI	0.44	0.52	0.52	0.52	0.52
Vietnam						
	CPI	0.01	0.32	0.37	0.37	0.37

Note: The changes in prices divided by the changes in the NEER is reported. The pass-through elasticities are computed from the estimated impulse responses obtain from the baseline model.

Source: Calculated by the author

Table 2.4: Estimates of exchange rate pass-through from the literature

Country	Study	Data	Approach	Exchange rate pass-through to					
				CPI		PPI		IMP	
				SR	MR& LR	SR	MR& LR	SR	MR& LR
Thailand	My results	Monthly, 2008M1-2016M12	VAR	0.12	0.11	0.42	0.43	0.64	0.65
	Ito and Sato (2008, p.1423)	Monthly, 1994M1-2006M12	VAR	0.04	0.04	0.23	0.22	0.89	0.85
	Prasertnukul, Kim, and Kakinaka (2010, p.177)	Monthly, 2000M5-2007M6	Single equation	0.09	0.12	0.20	0.34		
	Forbes, Hjortsoe, and Nenova (2017, p.45)	Quarterly, 2000Q1-2015Q4	Single equation	0.12					
Indonesia	My results	Monthly, 2008M1-2016M12	VAR	0.02	0.00	0.18	0.18		
	Ito and Sato(2008, p.1423)	Monthly, 1994M1-2006M12	VAR	0.27	0.40	0.50	0.56		
	Prasertnukul, Kim, and Kakinaka (2010, p.177)	Monthly, 2005M7-2007M6	Single equation	0.02	0.06	0.17	0.15		
Malaysia	My results	Monthly, 2008M1-2016M12	VAR	0.09	0.09	0.40	0.37		
	Ito and Sato (2008, p.1423)	Monthly, 1994M1-2006M12	VAR	0.03	0.03	0.25	0.25		
Philippines	My results	Monthly, 2008M1-2016M12	VAR	0.12	0.12	0.52	0.52		
	Ito and Sato(2008)	Monthly, 1994M1-2006M12	VAR	0.01	0.04	0.16	0.17		
	Prasertnukul, Kim, and Kakinaka (2010, p.177)	Monthly, 2002M1-2007M6	Single equation	0.00	0.00	0.17	0.17		
	Forbes, Hjortsoe, and Nenova (2017, p.45)	Quarterly, 2000Q1-2015Q4	Single equation	0.13					
Vietnam	My results	Monthly, 2008M1-2016M12	VAR	0.32	0.37				
	Minh (2009, p.28)	Monthly, 2001M1-2007M2	VAR	0.13	-0.15				
	Bhattacharya (2014, p.22)	Quarterly, 2000Q1-2012Q2	VAR	0.16	0.26				

Note: SR is the short run, which is between 1 and 6 months, MR&LR is medium and long run, which is over 6 months.
Source: Author's results and related literature

Table 2.5: Descriptive summary statistic of inflation rate, GDP growth rate, and money supply growth rate

	Inflation rate (in percent)		Output growth rate (in percent)		Money supply growth rate (in percent)		GDP (PPP)	Openness	Exchange rate shock volatility	AD volatility
	Mean	SD	Mean	SD	Mean	SD				
Thailand	1.6	1.9	1.2	14	0.6	1.3	1228	1.37	0.000074	0.005761
Indonesia	5.2	1.6	4.1	3.4	0.9	3.8	3242	0.57	0.000458	0.000467
Malaysia	0.4	4.6	1.9	5.3	0.7	1.6	926	1.87	0.000154	0.000306
Philippines	3.2	1.3	3.3	10.9	1.2	1.2	874	0.85	0.000114	0.002043
Vietnam	6.7	5.2	8.5	6.5	1.2	3.0	643	1.36	0.000130	0.001018

Note: SD is standard deviation. PPP is purchasing power parity. AD is aggregate demand. Inflation rate is the year-on-year inflation rate calculated by using CPI data. Output growth rate is the year-on-year growth rate calculated by using the industrial production index data.
Source: Calculated by the author using data described in Appendix A

Table 2.6: Spearman rank correlation between CPI PT rates and factors influencing pass-through

Horizon factors	6	12	24
Country side	-0.82	-0.90	-0.90
Country openness	0.21	0.33	0.33
ER volatility	-0.67	-0.60	-0.60
AD volatility	0.56	0.50	0.50
Inflation rate	0.36	0.40	0.40
MP volatility	0.39	0.56	0.56

Note: MP is monetary policy.
Source: Calculated by the author

Table 2.7: Variance decomposition of PPI of VAR with OIL, GAP, M1, NEER, and PPI

Country	Percent of forecast variance attributed to					
	Forecast horizon	Oil price shock	Output gap shock	Monetary policy (M1) shock	NEER shock	PPI shock
Thailand						
	1	27.21	0.11	0.85	2.55	69.28
	6	27.05	0.45	5.40	5.43	61.67
	12	27.05	0.45	5.40	5.43	61.66
	18	27.05	0.45	5.40	5.43	61.66
	24	27.05	0.45	5.40	5.43	61.66
Indonesia						
	1	8.37	0.00	0.21	14.02	77.41
	6	29.46	1.17	1.31	11.34	56.72
	12	29.44	1.20	1.31	11.33	56.71
	18	29.44	1.20	1.31	11.33	56.71
	24	29.44	1.20	1.31	11.33	56.71
Malaysia						
	1	42.78	0.32	0.94	5.27	50.67
	6	40.05	4.62	1.56	6.55	47.18
	12	39.66	5.77	6.47	6.47	46.48
	18	39.66	5.79	6.47	6.47	46.46
	24	39.66	5.79	6.47	6.47	46.46
Philippines						
	1	0.09	0.21	1.53	19.75	78.42
	6	12.24	1.12	3.61	17.05	65.97
	12	12.24	1.13	3.61	17.05	65.97
	18	12.24	1.13	3.61	17.05	65.97
	24	12.24	1.13	3.61	17.05	65.97

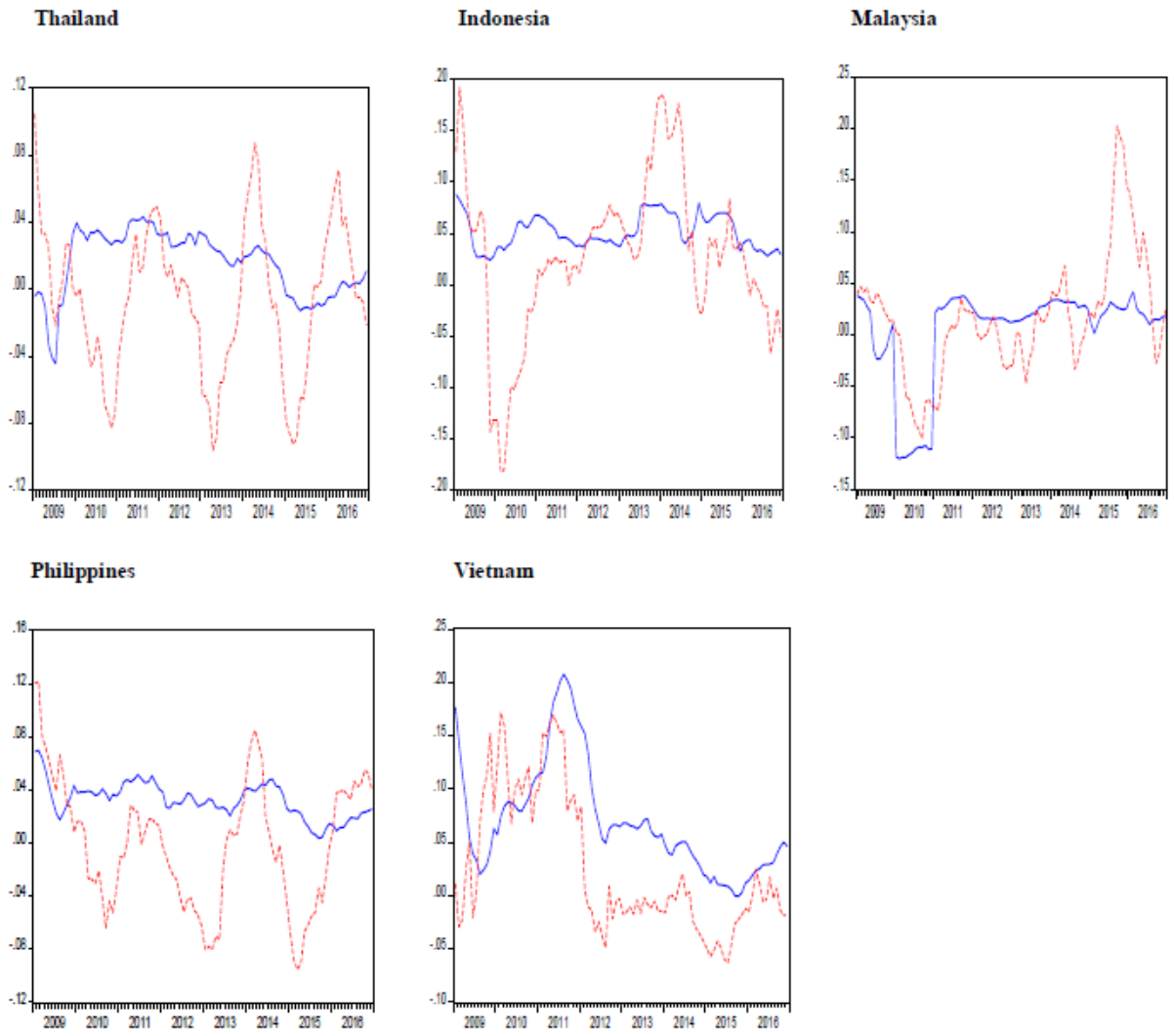
Source: Calculated by the author

Table 2.8: Variance decomposition of CPI of VAR with OIL, GAP, M1, NEER, and CPI

Country	Percent of forecast variance attributed to					
	Forecast horizon	Oil price shock	Output gap shock	Monetary policy (M1) shock	NEER shock	CPI shock
Thailand						
	1	27.21	0.11	0.85	2.55	69.28
	6	27.05	0.45	5.40	5.43	61.67
	12	27.05	0.45	5.40	5.43	61.66
	18	27.05	0.45	5.40	5.43	61.66
	24	27.05	0.45	5.40	5.43	61.66
Indonesia						
	1	0.01	0.19	0.09	0.95	98.76
	6	3.09	1.58	0.69	0.99	93.65
	12	3.09	1.58	0.69	0.99	93.65
	18	3.09	1.58	0.69	0.99	93.65
	24	3.09	1.58	0.69	0.99	93.65
Malaysia						
	1	0.12	0.19	1.95	0.02	97.72
	6	2.49	0.43	4.84	0.40	91.84
	12	2.50	0.43	4.85	0.40	91.81
	18	2.50	0.43	4.85	0.40	91.81
	24	2.50	0.43	4.85	0.40	91.81
Philippines						
	1	0.09	0.21	1.53	19.75	78.42
	6	12.24	1.12	3.61	17.05	65.97
	12	12.24	1.13	3.61	17.05	65.97
	18	12.24	1.13	3.61	17.05	65.97
	24	12.24	1.13	3.61	17.05	65.97
Vietnam						
	1	2.47	0.65	5.88	0.25	90.74
	6	17.73	9.06	4.30	24.88	44.03
	12	18.71	9.81	4.07	24.86	42.56
	18	18.74	9.84	4.06	24.85	42.50
	24	18.74	9.84	4.06	24.85	42.50

Source: Calculated by the author

Figure 2.1: Change in monthly CPI and NEER (year-over-year)



Note: (1) The solid line shows the CPI fluctuations. (2) The dotted line indicates the NEER changes. (3) Increase in the NEER means depreciation.
Source: Calculated by the author using data described in Appendix A

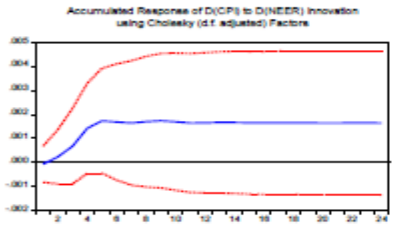
Figure 2.2: Impulse response of price levels to the NEER shocks

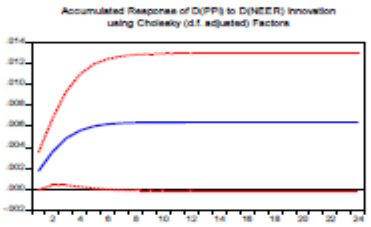
(1)Response of CPI

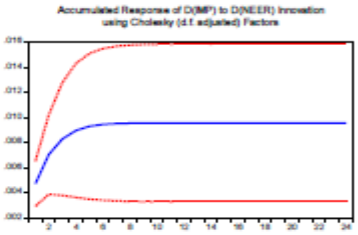
(2) Response of PPI

(3) Response of IMP

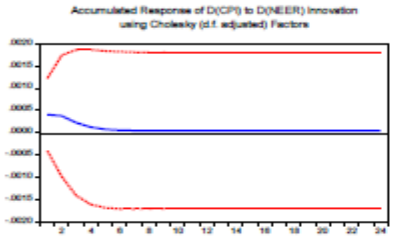
Thailand

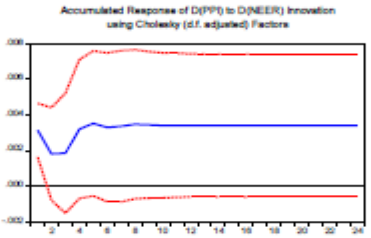




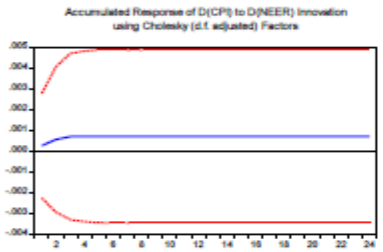


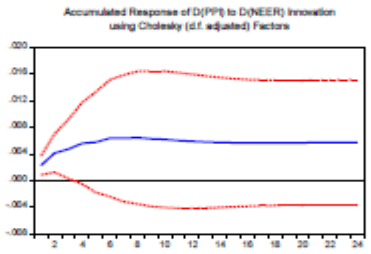
Indonesia



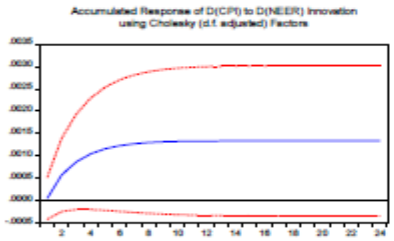


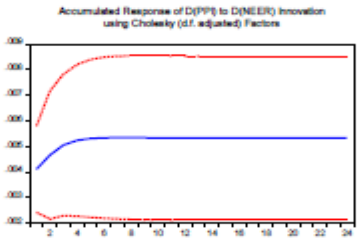
Malaysia



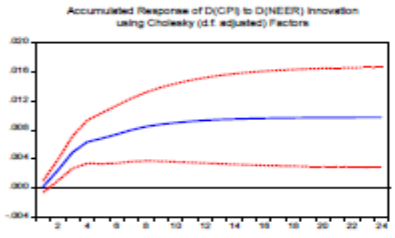


Philippines





Vietnam

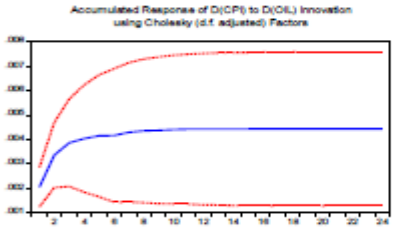


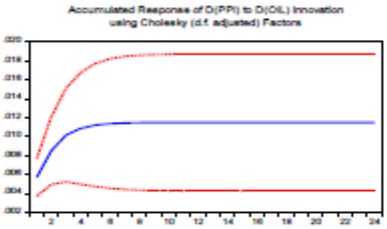
Note: (1) The solid line shows the accumulated response to the NEER shocks. (2) The dotted lines indicate a two standard-error confidence band around the estimate. (3) The vertical axis in the figures reports the approximate change in response to one positive standard deviation (S.D) NEER shock, while the horizontal axis is the time horizon. (4) D denotes for the first difference.

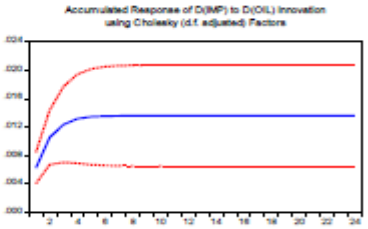
Figure 2.3: Impulse response of price levels to the oil price shocks

(1)Response of CPI (2) Response of PPI (3) Response of IMP

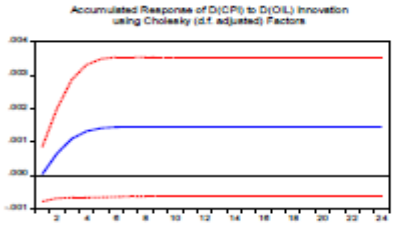
Thailand

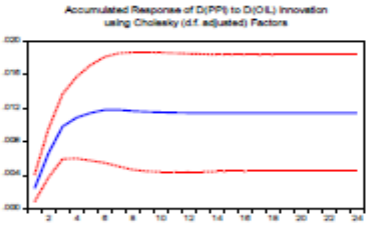




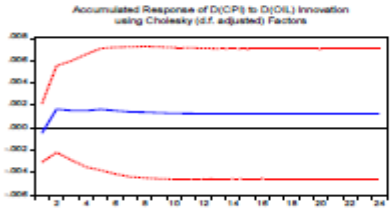


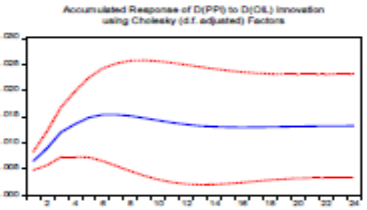
Indonesia



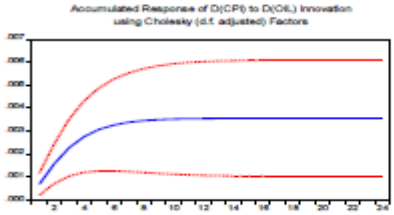


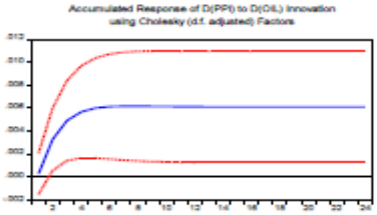
Malaysia



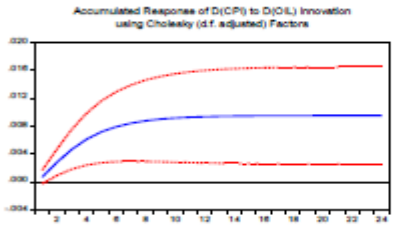


Philippines



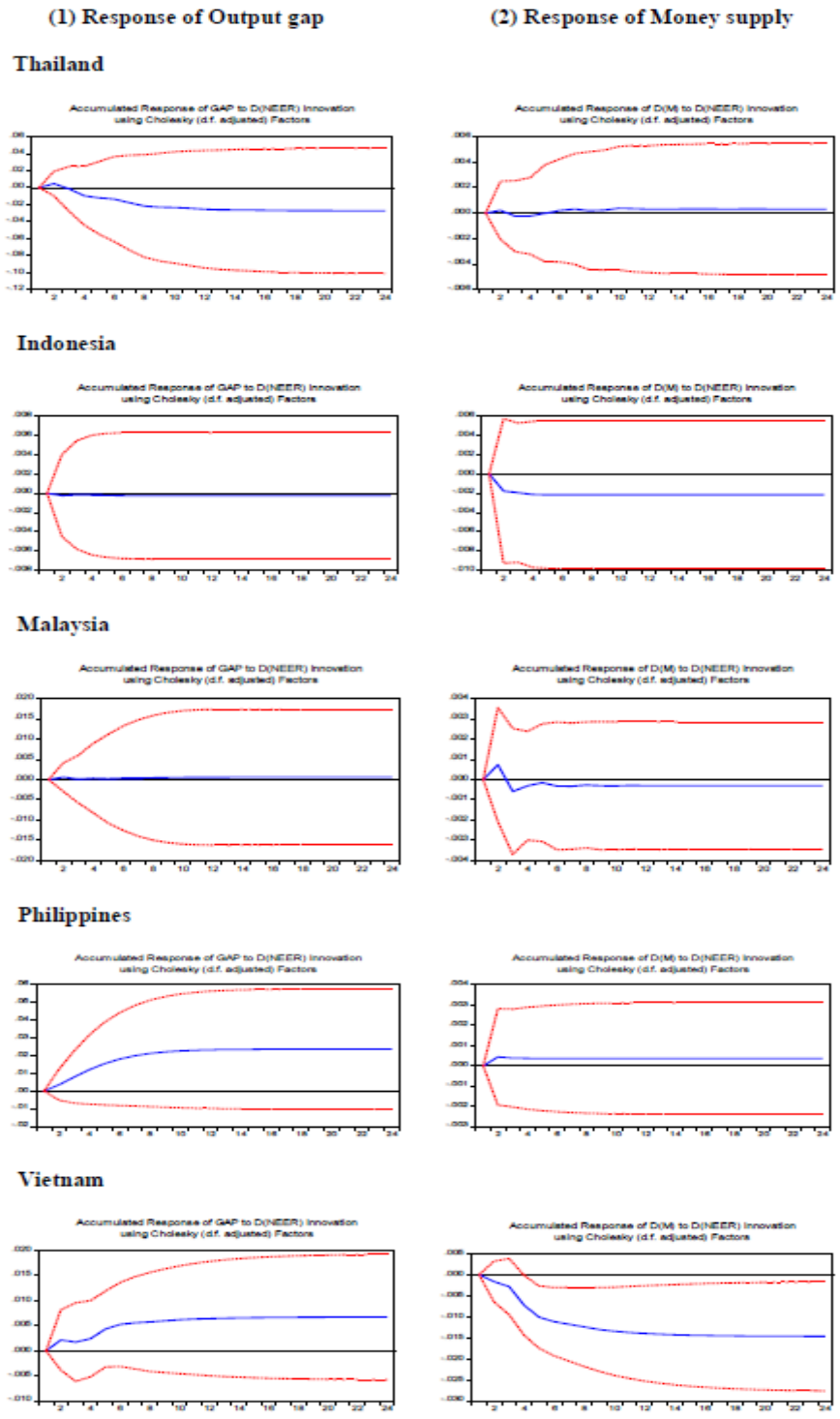


Vietnam



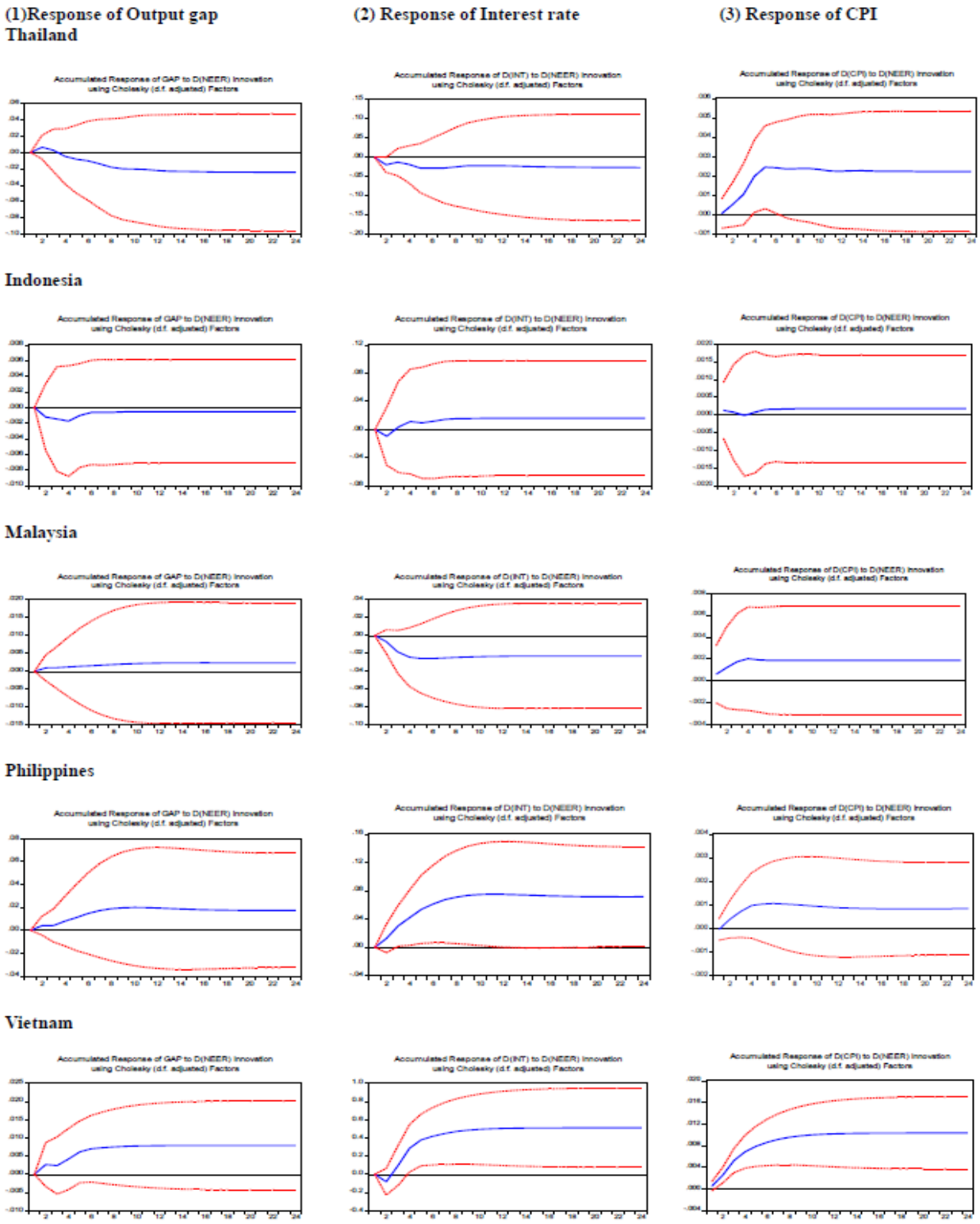
Note: (1) The solid line shows the accumulated response to the oil price shocks. (2) The dotted lines indicate a two standard-error confidence band around the estimate. (3) The vertical axis in the figures reports the approximate change in response to one positive standard deviation (S.D) oil price shock, while the horizontal axis is the time horizon. (4) D denotes for the first difference.

Figure 2.4: Impulse response of output gap and money supply to the NEER shocks



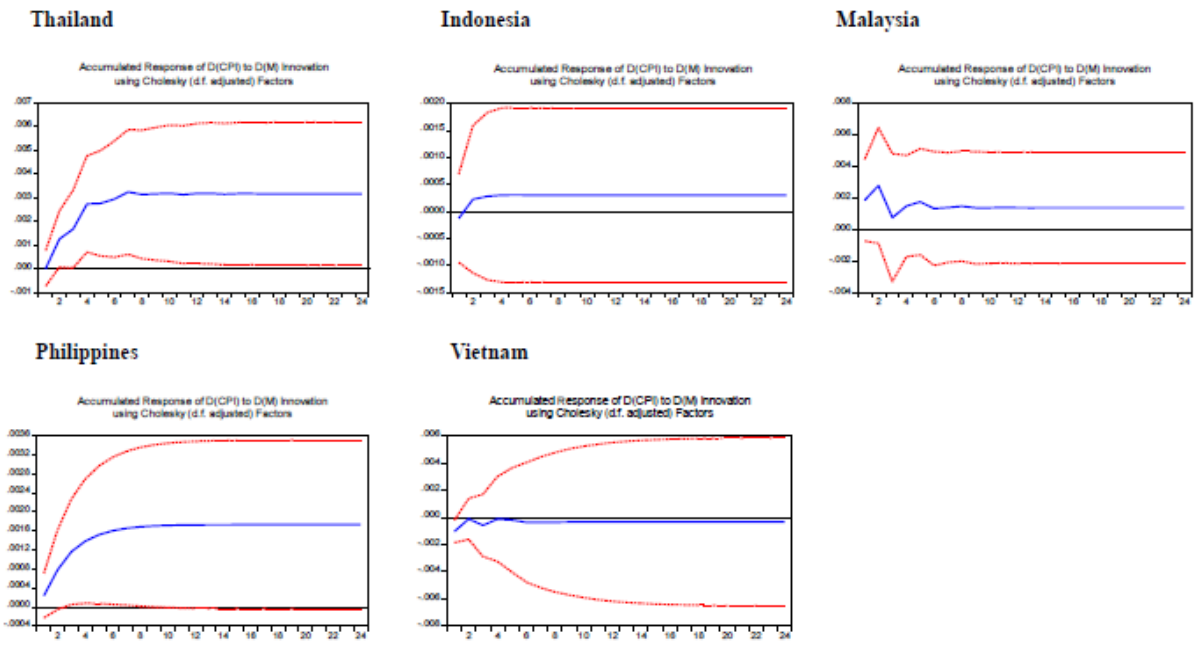
Note: (1) The solid line shows the accumulated response to the NEER shocks. (2) The dotted lines indicate a two standard-error confidence band around the estimate. (3) The vertical axis in the figures reports the approximate change in response to one positive standard deviation (S.D) NEER shock, while the horizontal axis is the time horizon. (4) D denotes for the first difference.

Figure 2.5: Impulse responses to the NEER shocks when including the interest rate in VAR models.



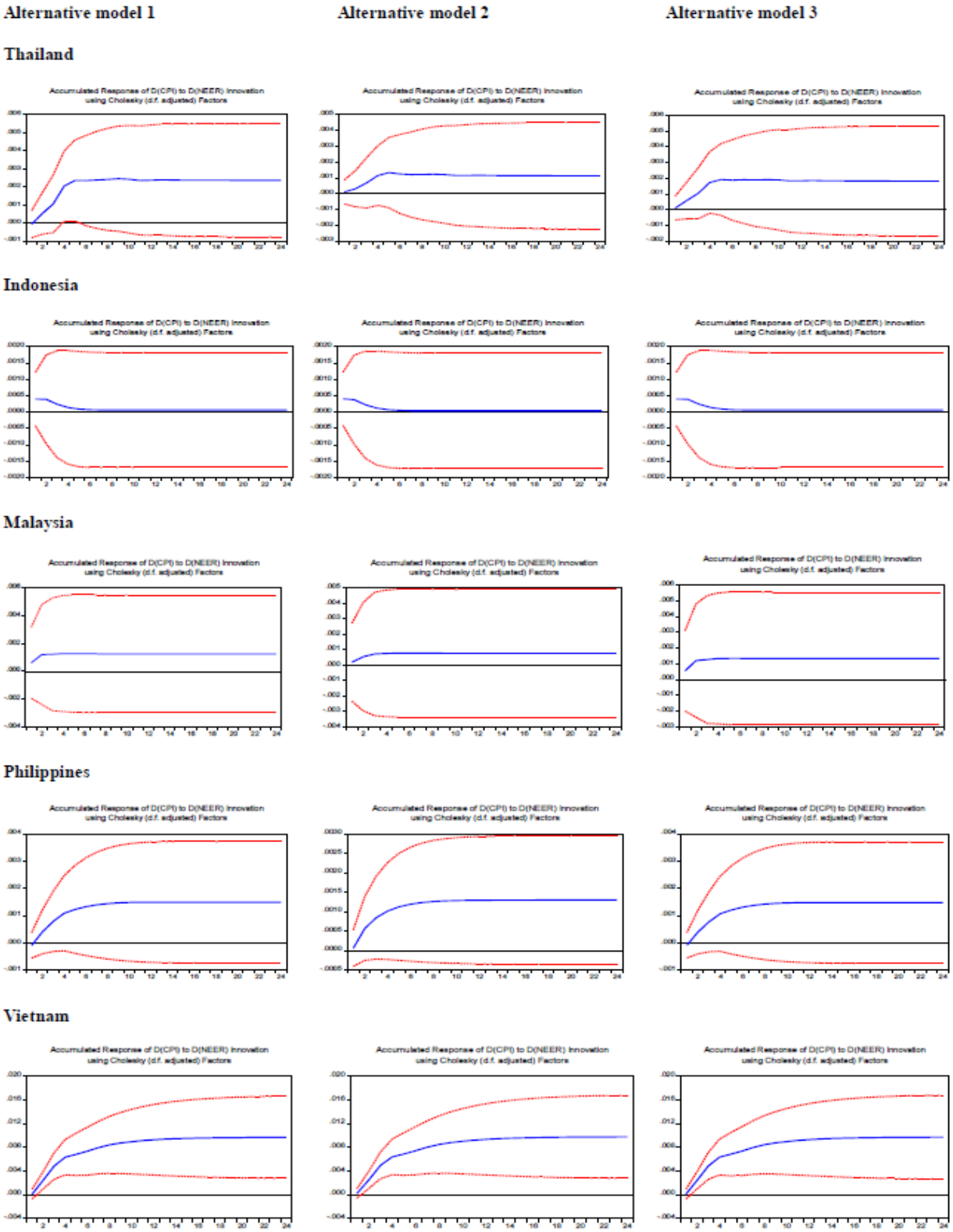
Note: (1) The solid line shows the accumulated response to the NEER shocks. (2) The dotted lines indicate a two standard-error confidence band around the estimate. (3) The vertical axis in the figures reports the approximate change in response to one positive standard deviation (S.D) NEER shock, while the horizontal axis is the time horizon. (4) D denotes for the first difference.

Figure 2.6: Impulse response of CPI to money supply shocks



Note: (1) The solid line shows the accumulated response to the money supply shocks. (2) The dotted lines indicate a two standard-error confidence band around the estimate. (3) The vertical axis in the figures reports the approximate change in response to one positive standard deviation (S.D) money supply shock, while the horizontal axis is the time horizon. (4) D denotes for the first difference.

Figure 2.7: Impulse responses of CPI to NEER shocks (alternative variable ordering)



Note: Alternative model 1: $x_t = (\Delta oil_t, gap_t, \Delta neer_t, \Delta m_t, \Delta p_t)$'. Alternative model 2: $x_t = (\Delta oil_t, \Delta m_t, \Delta neer_t, gap_t, \Delta p_t)$'. Alternative model 3: $x_t = (\Delta oil_t, \Delta neer_t, gap_t, \Delta p_t, \Delta m_t)$

Chapter 3: The determinants of inflation in Vietnam: A threshold structural vector autoregression approach

Abstract

As Vietnam is one of the most dynamic emerging countries in the East Asia region, this economy presents an interesting situation to analyze the impact of macroeconomic shocks on inflation. This paper investigates the macroeconomic determinants of inflation in Vietnam while allowing for a non-linear relationship between those variables. We employ a threshold structural vector autoregression model to examine the response of domestic prices to various macroeconomic shocks. Based on the estimated threshold level of inflation, we divide the sample period into high and low inflation regimes. The empirical results find evidence of a nonlinear relationship between inflation and some macroeconomic variables. The responses of domestic price to the monetary policy shock and the credit shock change significantly between the two inflation regimes. As a result, the source of price fluctuations depends on the inflation regime. Moreover, the reactions of monetary policymakers in Vietnam to the domestic price shock are different among the two inflation regimes.

JEL classification: C32, E31, E42, E58

Keywords: Inflation; threshold vector autoregression; macroeconomic shocks; Vietnam

1.Introduction

Recently, Vietnam has experienced different levels of inflation (Figure 3.1). The inflation rate reached 25 percent in 2008, which was the highest level since 1996 (Phan, 2014). As a result of the global economic slowdown, the inflation rate in Vietnam declined slightly in 2009. After then, the inflation rate climbed rapidly, peaking at roughly 20 percent in the third quarter of 2011. The impact of the tightened monetary policy contributed to a decline in the inflation rate to 4 percent in 2014, which was following by the domestic price deflation in several months of 2015.Inflation rate started to rise again in 2016. In short, Vietnam's economy presents an appealing situation to analyze the possible interaction of macroeconomic variables under different regimes of inflation.

Figure 3.1 around here

The literature suggests that the dynamic relationship between macroeconomic variables and inflation might differ between the stages of inflation (e.g., Taylor, 2000; Mandler, 2010). In particular, the relationship between economic growth and inflation depends on the level of inflation. Moreover, Taylor (2000) suggests that the impact of exchange rate fluctuations on domestic price is positively associated with the inflation level. The degree of inflation may lead to the changes in the monetary policy action function since the central bank might react differently to shocks depending on the size and direction of the deviation of the inflation rate from its target level (Aksoy et al., 2006).

Various factors play a vital role in driving inflation in the empirical literature. These factors include the money supply, interest rates, potential output, commodity prices, and the exchange rate (Bhattcharya, 2014; Osorio and Unsal, 2013). Furthermore, the relationships between some of these factors and inflation are associated with the level of inflation. As a result,

the inflation dynamics may change when the economy moves to different inflation scenarios. In this case, the inflation level is the threshold for the possible asymmetric impacts of macro-variables on inflation.

A diversity of determinants of inflation in Vietnam is considered among previous studies. For instance, Nguyen et al. (2012) argues that the main factors of consumer price inflation from 2001 to 2009 are the money supply, oil prices, and the price of rice. Bhattacharya (2014) investigated the domestic price changes from 2000 to 2012, and emphasized that the nominal effective exchange rate (NEER) is the critical issue of inflation in the short run. Moreover, credit growth plays an important role in inflation changes in the medium term while the interest rate has less impact on inflation. However, these papers do not account for the nonlinear relationship between inflation and macroeconomic variables when the economy moves from one inflation episode to another.

Against this backdrop, this paper investigates the macroeconomic determinants of domestic prices in Vietnam in association with the inflation level. Numerous papers apply different types of regime-switching models to investigate the nonlinear relationship among endogenous variables in their models. In this article, we employ the threshold structural vector autoregression (VAR) model, examining the source of domestic price fluctuations in different episodes of inflation. We focus on the response of consumer price index (CPI) in Vietnam to the shocks on world oil price, international monetary policy, output, monetary policy, domestic credit and the exchange rate.

The novelty of this research is described in the following points. First, this study sheds light on the possible asymmetric impacts of macroeconomic variables on inflation in Vietnam.

While numerous papers study the inflation determinants in Vietnam, the empirical works which focus on the nonlinear relationship between inflation and macroeconomic variables are still limited. Second, this research develops a non-recursive identification scheme in the threshold structural VAR model instead of the Cholesky decomposition employed in previous papers (e.g., Balke, 2000; Mandler, 2010; Catik et al., 2011; Aleem and Lahiani, 2014; Tran and Nguyen, 2016). The present paper is the first, at the time of this writing, to employ a threshold non-recursive structural VAR to investigate inflation determinants for the case of Vietnam.

The main findings of this research are as follows. First, there exists a nonlinear relationship between inflation and several macroeconomic variables. In particular, the responses of domestic price to the monetary policy shock and the credit shock change considerably as the economy moves from a high inflation regime to the low one. Second, the source of price fluctuations depends on the inflation regime. In the high inflation regime, the output shock and the credit shock are the main factors of price fluctuation whereas the external shocks play an important role in domestic price changes in low inflation regime. Third, the reactions of monetary policymakers in Vietnam to the domestic price shock differ among the two inflation regimes.

This paper is structured as follows. Section 2 summarizes the literature behind the inflation threshold. Section 3 introduces the threshold structural VAR model and the identification scheme of this model. Section 4 presents the data and preliminary analysis. Section 5 shows the empirical results for the inflation determinants under different inflation regimes in Vietnam. Section 6 concludes.

2. Literature behind the inflation threshold

In an economy, the agents tend to alter inflation expectations if the rate of inflation exceeds a certain threshold level. Firms note that any increase in production costs that goes beyond a certain threshold will become more persistent in the context of high inflation. Therefore, in a high inflationary environment, these companies tend to follow a higher price-adjustment frequency providing menu costs are given. They also transfer effects appearing from shocks in order to preserve their profits (Aleem and Lahiani, 2014; Alvarez et al., 2016). If other factors remain stable, only a small shock will lead to an accelerated fluctuation in domestic prices in the high inflation environment.

The literature suggests that the dynamic relationship between macroeconomic variables and inflation may differ between the stages of inflation. For instance, the aggregate demand-aggregate supply (AD-AS) model suggests a positive relationship between output and inflation. However, the empirical evidence suggests that if the inflation is above the threshold level of inflation, there is a negative relationship between inflation and economic growth (Gylarson and Herbertsson, 2001; Omay and Oznur Kan, 2010). In this case, the relationship between output and inflation is associated with the level of inflation.

Changes in the monetary policy reaction function could also depend on the inflation level since the central bank might respond distinctively to shocks based on the size and direction of the deviation of inflation from its target. Regime-dependent responses of monetary policy might be an outcome of credibility concerns. To demonstrate, small deviations of the inflation rate from its target could not lead to a loss in public confidence in the central bank's guarantee to the inflation target. On the other hand, large deviations might trigger the central bank to lose credibility with

the public. In order to solve this issue, the central bank might react more aggressively to the sizeable inflationary excess than to small ones (Aksoy et al., 2006).

Moreover, the exchange rate pass-through to domestic prices might be nonlinear. Taylor (2000) indicates that the impact of exchange rate fluctuations on domestic price is positively associated with the inflation level. Numerous studies estimate the degree of exchange rate pass-through to domestic prices in different inflation environments. These results show that the responses of domestic prices to exchange rate shocks are higher in the high inflationary case than in low inflationary case (Baqueiro et al., 2003; Aleem and Lahiani, 2014; Shintani et al., 2013).

Recent literature has considered the inflation level as the variable which leads to regime switching. For instance, the study of Mandler (2010), applying a threshold VAR model, examines the impact of monetary policy shock in the US. He illustrates that the response of inflation to monetary policy shock relies on the inflation level. Catik and Martin (2012) explore the changes to the macroeconomic transmission mechanism in Turkey. They find the response of output and prices to the real exchange rate, the amount of credit, and the policy interest rate are different across the high and low inflation regimes. Caporale et al. (2017) investigate asymmetry in the behavior of monetary policymakers in five countries, namely Indonesia, Israel, South Korea, Thailand and Turkey. They report that the reaction of central banks to the inflation gap and the output gap is distinct across the two inflation regimes in all sample economies.

There is some empirical evidence of the nonlinear relationship between inflation and macroeconomic variables in Vietnam. Su (2015) investigates the nonlinear relationship between inflation and economic growth in Vietnam and four ASEAN countries by applying Panel Smooth Transition Regression (PSTR). The results indicate that the relationship between inflation and

growth is statistically negative when the inflation rate is higher than the threshold level of 7.84 percent. On the other hand, Tran and Nguyen (2016) apply Threshold VAR to investigate the exchange rate pass-through and inflation issues in Vietnam. They find evidence for the nonlinearity of exchange rate pass-through to inflation. The levels of exchange rate pass-through are different in distinct regimes of the inflation rate.

3. Econometric methodology

The estimation of a threshold model is an effective method to model nonlinearities in the empirical research. If the threshold variable is higher than a given threshold value, the given point in time belongs to a specific regime. Tong and Lim (1980) introduce the univariate threshold autoregressive models. After that, Tsay (1998) and Balke (2000) expand to a multivariate threshold model to examine the regime influence in macroeconomic dynamics. The advantages of the multivariate threshold model are that it enables for the nonlinearity and regime changes in the economic relationship between macroeconomic variables.

The threshold VAR model with two inflation regimes is

$$Z_t = \alpha^1 + A^1 Z_t + B^1(L) Z_{t-1} + (\alpha^2 + A^2 Z_t + B^2(L) Z_{t-1})\, \mathrm{I}(C_{t-d}, \gamma) + \varepsilon_t \quad (1)$$

where the vector of variables (Z_t) includes the $Z_t = (oil_t, fed_t, gap_t, cpi_t, m_t, int_t, credit_t, neer_t)$, oil_t is the world oil price, fed_t is the federal funds rate, gap_t is the output gap, cpi_t is the consumer price index (CPI), m_t is money supply, int_t is the interest rate, $credit_t$ is the domestic credit, $neer_t$ is the nominal effective exchange rate. α^i represents the vector of constants, A^i represents the matrix of contemporaneous interaction coefficients, $B^i(L)$ is polynomials created from matrices of coefficients in the lag operator L. ε_t represents the vector of structural innovations.

I is an indicator that equals 1 if the threshold variable $C_{t-d}$is greater than or equal to the inflation threshold value γ ($C_{t-d} \geq \gamma$) and 0 otherwise. d are lagged periods. When I = 0, the relevant coefficients are $\alpha^1, A^1,$ and $B^1(L)$. When I =1, the relevant coefficients are α^1+α^2, A^1+A^2, and $B^1(L)$+$B^2(L)$.

This paper employs the Tsay (1998) method to test for the threshold nonlinearity of the model. This approach generates the C(d) test statistic followed by the estimation of an arranged regression. The null hypothesis that the model is linear H_0: α^2=0, A^2=0, $B^2(L)$=0. C(d) follows a chi-squared distribution with k(pk+qv+1) degrees of freedom. In this case, k and v represent the number of endogenous and exogenous variables, p and q are their corresponding lag orders. When the null hypothesis of linearity is rejected, we choose the delay parameter d as the value which maximizes the Tsay test statistic. Consequently, this research utilizes a grid search method and Akaike Information Criteria (AIC) to find the thresholds.

For each inflation regime, the present paper conducts non-recursive structural VAR analysis in order to describe the analytical framework. In order to identify the VAR, this article imposes a non-recursive identification scheme on the contemporaneous structural parameter B_0. The equations summarize the identification scheme based on $\varepsilon_t = B_0 e_t$ (ε_t are the structural disturbances, e_t are the residuals from the corresponding equations in the reduced form VAR).

$$\begin{pmatrix} \varepsilon_{oil} \\ \varepsilon_{fed} \\ \varepsilon_{gap} \\ \varepsilon_{cpi} \\ \varepsilon_{m} \\ \varepsilon_{int} \\ \varepsilon_{credit} \\ \varepsilon_{neer} \end{pmatrix} = \begin{pmatrix} 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ a_{21} & 1 & 0 & 0 & 0 & 0 & 0 & 0 \\ a_{31} & 0 & 1 & 0 & 0 & 0 & 0 & 0 \\ a_{41} & 0 & a_{43} & 1 & 0 & 0 & 0 & 0 \\ 0 & 0 & a_{53} & a_{54} & 1 & a_{56} & 0 & 0 \\ 0 & a_{62} & a_{63} & a_{64} & 0 & 1 & 0 & 0 \\ 0 & 0 & a_{73} & a_{74} & a_{75} & a_{76} & 1 & 0 \\ a_{81} & a_{82} & a_{83} & a_{84} & a_{85} & a_{86} & 0 & 1 \end{pmatrix} \begin{pmatrix} e_{oil} \\ e_{fed} \\ e_{gap} \\ e_{cpi} \\ e_{m} \\ e_{int} \\ \varepsilon_{credit} \\ e_{neer} \end{pmatrix} \quad (2)$$

where $\varepsilon_{oil}, \varepsilon_{fed}, \varepsilon_{gap}, \varepsilon_{cpi}, \varepsilon_{m}, \varepsilon_{int}, \varepsilon_{credit}, \varepsilon_{neer}$ are the structural disturbances, which is, oil price shocks, federal funds rate shocks, output shocks, CPI shocks, money supply shocks, interest rate shocks, credit shocks, and exchange rate shocks, respectively, and $e_{oil}, e_{fed}, e_{gap}, e_{cpi}, e_{m}, e_{int}, e_{credit}, e_{neer}$ are the residuals in the reduced form equations.

Now we explain our identifying restrictions. For the equations of the external variables including the oil price and the federal funds rate, we assume that the internal variables have no contemporaneous impact on the foreign variables. It is based on the fact that Vietnam is only a small open economy. The incorporation of the U.S. federal funds rate in our model is associated with the effect of international monetary policy on Vietnam's economy. US monetary policy substantially affects other economy's policies and Vietnam is no exception. Moreover, our assumption allows the oil price to contemporaneously affects the federal funds rate as the Federal Reserve will immediately adjust the interest rate in response to the international oil price fluctuations (Pham, 2016).

The next equation is the output equation. We assume that the oil price contemporaneously affects output since oil is an essential input for most sectors in Vietnam's economy. Following Sims and Zha (1998), we assume that the prices, the money supply, the interest rate, and the nominal exchange rate affect output with a one-period lag. The assumption for the price equation is similar. One possible reason for this identifying assumption is that domestic enterprises do not shift their output and price within a month in response to an unanticipated shock in internal financial signals like interest rate and exchange rate. However, they immediately respond to the oil price shock pursuing their mark-up rule (Kim and Roubini, 2000).

The money supply equation can be viewed as the reaction function of the State Bank of Vietnam (SBV). The SBV sets the money supply after observing the current level of output, price level, and the policy interest rate. This assumption is associated with the fact that the objectives of monetary policy in Vietnam are diverse including both price stability and enhancing economic growth. For the interest rate equation, the interest rate is affected contemporaneously by the federal funds rate, output, and domestic prices. This implies that the SBV monitors the policy interest rate based on the international interest rate and other macroeconomic variables.

For the credit equation, our assumption is that credit is not affected by external variables but all domestic variables except the exchange rate influence it. The exchange rate equation also represents the financial market equation. We assume that all variables contemporaneously affect the exchange rate as the exchange rate is a forward-looking asset price and responds to other information rapidly (Jiang and Kim, 2013).

To sum up, there are four blocks in the structural shocks. The first two equations describe the world economy. The next two represents the goods market equilibrium. The fifth and six equations are the money supply and interest rate equations which illustrate money market equilibria. The last two equations describe the financial market. As there are more zero restrictions than required to identify the model, the structural model is overidentified.

4. Data

We use monthly data from 2008M1 to 2016M12 on the world oil price, the federal funds rate, and Vietnam's industrial production index, CPI, money supply, policy interest rate, domestic credit, nominal effective exchange rate (NEER). The NEER index (2010=100) is

defined such that an increase in the index means depreciation. The sources of the data come from IMF – International Financial Statistic (IFS) and Datastream. The details are described in Appendix A.

All series are seasonally adjusted by using X-12 method in Eviews and then taken in natural logarithm form (except for the federal funds rate and policy interest rate) before estimation. We apply the Hodrick – Prescott filter (Lambda = 14400) to the natural log of the industrial production index to calculate the output gap as Hahn (2003) did. We also conduct the unit root test by using the Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) tests (Table 3.1). The results suggest that all series are stationary in first differences while the output gap is stationary in levels. After that, we set up the VAR estimation in first differences except for the output gap.

Table 3.1 around here

5. Empirical results

5.1. Estimation of the inflation threshold

Estimating the inflation threshold is essential for capturing the asymmetric and nonlinear effect in contrasting inflation periods. The inflation threshold leads to model nonlinearities empirically. Then, in this section, we employ the method of Tsay (1998) to decide the inflation threshold for Vietnam. Our objective is to separate the sample into the high and low inflation regimes using distinct sets of model parameters. Based on the value of the inflation threshold, the sample data during 2008 and 2016 can be split into high and low inflation cases. When the inflation threshold variable is higher than the given threshold value, the time points are classified as high inflation regimes. Otherwise, the points in time are classified as a low inflation regime.

We use the series of CPI inflation (month-on-month) cpi_t. Since contemporaneous inflation could not be selected as the threshold variable, this paper employs a six-month moving average of cpi_t as the threshold variable. Table 3.2 indicates the results of test statistic C(d) clearly rejecting the null hypothesis of the linear relationship in all cases of different starting numbers for recursive estimates ($m_0 = 30$ and $m_0 = 50$). We decide the threshold lag delay (d) is 1, corresponding to delay by a month. For two-regime models, we assume the threshold $\gamma \in$ [.000,.005] and use 300 grid points. The interval determination is based on the value of the threshold variable. The estimated threshold value for the inflation is 0.00413 with the smallest AIC of (-2606.633).

Table 3.2 around here

The low inflation regime is active when the threshold variable (the six-month moving average of CPI) is below the estimated threshold, 0.00413. It presents the dynamics which determine the relationship between inflation and other macroeconomic variables when the inflation is lower than its medium-term trend. Conversely, the high inflation regime indicates the dynamics that decide the economy when the inflation rises significantly faster than its medium-term trend.

Figure 3.2 shows a plot of the estimated inflation threshold value and the threshold variable (six-month moving average of domestic price changes). The estimated threshold value divides our sample into two regimes which are very consistent with the inflation development in Vietnam. The high inflation episode dominates the period including the middle of 2008 and other times from the end of 2009 to the middle of 2012. During this time the Vietnam economy experienced huge inflation. The low inflation episode is captured by the decline in inflation at the

third quarter of 2009 and the low and stable inflation rate from the middle of 2014 to the middle of 2016. The empirical model endogenously selects the separation of the sample.

Figure 3.2 around here

5.2. Coefficient identification, impulse response, and variance decomposition analysis

After splitting the sample into high and low inflation regime, we estimate the non-recursive structural VAR model in each regime. We assume three lags in both cases. Table 3.3 indicates the estimated coefficients and standard errors for our model. Kim and Roubini (2000) explain that large standard errors in some cases are the results of high correlations among variables rather than wrong identifying assumptions. The sign of some estimated coefficients is opposite in the two regimes. Moreover, some estimated coefficients are statistically significant in one regime but insignificant in another regime. Thus, the responses of inflation to macroeconomic shocks might be different in high and low inflation cases.

Table 3.3 around here

Figure 3.3 indicates the accumulated impulse response of CPI to a positive one standard deviation shock of oil price, the federal funds rate, money supply, interest rate, credit, and exchange rate respectively in high and low inflation regime.

Figure 3.3 around here

The impact of oil price shocks on the CPI is positive and significant in the entire period in the low inflation regime. In the high inflation regime, the CPI response is positive and significant in the initial seven months. Since Vietnam is a net oil importer, an increase in the oil price leads to a rise in inflation in both cases.

It is notable that an increase in the federal funds rate leads to an increase in CPI over the entire period in the low inflation case. One explanation is that as the federal funds rate rises, the US currency appreciates. As a result, the Vietnam dong (VND) depreciates, impacting to the CPI fluctuations. It implies that Vietnam's economy is strongly affected by international monetary policy shocks in the low inflation regime.

In response to a positive one standard deviation output shock, the CPI responses in the two regimes are different. In the high inflation regime, the CPI response is positive and significant after three months. In contrast, the CPI response is smaller and insignificant in the low inflation regime. It means that the economic growth creates pressure for the domestic price in the high inflation case. This explanation is consistent with a developing economy such as Vietnam.

The response of CPI to a positive one standard deviation money supply shock is modest in both regimes. In the high inflation regime, the CPI response is positive in the first seven months after it becomes negative. In low inflation regime, the CPI response is negative for the entire periods.

In low inflation episodes, an increase in the policy interest rate leads to a decline in the CPI. It implies that contractionary monetary policy is useful in the case of low inflation. However, in high inflation episodes, the price level increases after the interest rate shock, indicating the evidence of a price puzzle as Sims (1992) mentions. The study by Bhattacharya (2014) emphasizes that the price puzzle in Vietnam is the result of the high persistence of expected inflation and the passive behavior of the SBV in response to inflation.

In response to a positive one standard deviation credit shock, the CPI response is positive and significant after four months in the high inflation scenario. In a low inflation scenario, the CPI response is negative over the entire periods. When the economy is in a high inflation regime, the idle resources become scarce to be adapted. Then, the additional aggregate demand generated by the growth of credit volumes triggers a rise in domestic prices.

The response of CPI to a positive one standard deviation exchange rate shock is positive and significant in the first several months for both regimes. Intuitively, the exchange rate depreciation leads to increase the domestic price due to the higher import costs. The consumers will buy more expensive imported goods in the domestic market, triggering pressure on domestic prices. Then, the SBV should maintain the stability of VND in order to reduce the Vietnam domestic inflation.

In general, the price responses to an interest rate shock and credit shock differ more than that response of other shocks, showing a nonlinear relationship between prices and interest rate, and prices and credit in the high and low inflation scene.

Figure 3.4 shows the response of money supply, policy interest rate, and domestic credit to the CPI shock in the two inflation regimes. In a high inflation regime, money supply decreases, the policy interest rate rises, and domestic credit declines in the face of inflation pressure. This implies the fundamental forces of the SBV under the impact of the high inflation environment. In a low inflation regime, the policy interest rate significantly rises in response to an increase in the price level. The responses of the money supply and the domestic credit are positive in some periods. One possible explanation is that the objectives of the monetary policy in Vietnam are multifaceted, including not only the price stability, but also the economic growth.

These results represent the preference of the policymakers in Vietnam. When the inflation is low, the objective of SBV is enhancing the economic growth by expanding the money supply and domestic credit. In contrast, when the economy moves to the high inflation case, the SBV concentrates on the price stability by employing the tightened monetary policy. These reactions are confirmation of the objectives of balancing of growth and stability by the SBV (World Bank, 2017).

Figure 3.4 around here

Table 3.4 shows the variance decomposition of CPI in the two regimes over a forecast horizon of 24 months. Despite the CPI's own innovation, the output shock and the credit shock are the most significant components of CPI fluctuations, contributing to around 25 percent of its variation when the economy is in a high inflation episode. The output shock remains essential relative components of CPI variations whereas the impact of credit shock on CPI becomes modest in the low inflation episode. In the low inflation case, the oil price shock and the federal funds rate shock contribute more substantially to CPI fluctuations than these contributions in the high inflation case, contributing to a peak of 36 percent and 23 percent of CPI variation, respectively. The interest rate shock becomes the important relative source of CPI changes in the third-month when the inflation is higher than the threshold level, contributing to roughly 19 percent at peak. Other shocks have a modest impact on the CPI fluctuations in both inflation regimes.

Table 3.4 around here

5.3. Robustness check

In this section, we employ a different non-recursive matrix in order to investigate the robustness of the results in previous sections. The new identification scheme is:

$$\begin{pmatrix} \varepsilon_{oil} \\ \varepsilon_{fed} \\ \varepsilon_{gap} \\ \varepsilon_{cpi} \\ \varepsilon_{m} \\ \varepsilon_{int} \\ \varepsilon_{credit} \\ \varepsilon_{neer} \end{pmatrix} = \begin{pmatrix} 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ a_{21} & 1 & 0 & 0 & 0 & 0 & 0 & 0 \\ a_{31} & 0 & 1 & 0 & 0 & 0 & 0 & 0 \\ a_{41} & a_{42} & a_{43} & 1 & a_{45} & a_{46} & a_{47} & a_{48} \\ 0 & 0 & a_{53} & a_{54} & 1 & a_{56} & 0 & 0 \\ 0 & a_{62} & a_{63} & a_{64} & 0 & 1 & 0 & 0 \\ 0 & 0 & a_{73} & a_{74} & a_{75} & a_{76} & 1 & 0 \\ a_{81} & a_{82} & a_{83} & 0 & 0 & 0 & 0 & 1 \end{pmatrix} \begin{pmatrix} e_{oil} \\ e_{fed} \\ e_{gap} \\ e_{cpi} \\ e_{m} \\ e_{int} \\ \varepsilon_{credit} \\ e_{neer} \end{pmatrix} \quad (3)$$

where $\varepsilon_{oil}, \varepsilon_{fed}, \varepsilon_{gap}, \varepsilon_{cpi}, \varepsilon_{m}, \varepsilon_{int}, \varepsilon_{credit}, \varepsilon_{neer}$ are the structural disturbances, which are, oil price shocks, federal funds rate shocks, output shocks, CPI shocks, money supply shocks, interest rate shocks, credit shocks, and exchange rate shocks, respectively, and $e_{oil}, e_{fed}, e_{gap}, e_{cpi}, e_{m}, e_{int}, e_{credit}, e_{neer}$ are the residuals in the reduced form equations.

There are two distinct identifying restrictions in equation (3). First, we assume that the price is affected contemporaneously by all the variables in the system. This assumption is widespread in the empirical studies of inflation determination. Second, the oil price, the federal funds rate, and the output have a contemporaneously influence on the exchange rate. Other variables affect the exchange rate with a time lag.

Figure 3.5 illustrates the accumulated impulse response of CPI to other macroeconomic shocks in high and low inflation regimes using the new identification scheme. In general, the CPI responses in Figure 3.5 are similar to its responses in Figure 3. In this case, the results in Figure 5 indicate consisting with Figure 3.3, which is evidence that the empirical results in this paper are robustness.

Figure 3.5 around here

6. Conclusion and policy implications

This paper investigates the inflation determinants in the presence of possible nonlinear relationship among inflation and macroeconomic variables in Vietnam. We do that by employing a threshold non-recursive structural VAR model with eight variables. Our results present strong evidence for the nonlinear relationship between domestic price and some macroeconomic variables. The responses of CPI to the monetary policy shock and the credit shock change significantly between the two inflation regimes. As a result, the inflation determinants in Vietnam are regime-dependent. The variance decomposition analysis indicates that external shocks such as oil price and international monetary policy are vital for explaining domestic price changes in a low inflation regime. In contrast, the domestic shocks including output gap and credit are highly associated with the CPI fluctuations in a high inflation regime. Moreover, this paper confirms the aims of monetary policy in Vietnam, which are both balancing growth and price stability objectives.

This result represents a key aspect of implementing the monetary policy in Vietnam. Credit is a useful tool in the case of high inflation periods. On the other hand, the interest rate is a useful monetary policy instrument in the low inflation case. Therefore, the SBV can attain price stability through the credit channel in the high inflation period and the interest rate channel as the economy shifts to the low inflation case. Moreover, the SBV should pay attention to the impact of external shocks on inflation.

Moreover, the central bank should consider a inflation targeting policy when conducting monetary policy. The empirical results indicate that the inflation threshold of 0.00413 (around

5%/year) is suitable to capture the different impacts of macroeconomic indicators to inflation rate. Therefore, if the inflation is managed under the inflation threshold, the market confidence level is increasing. In this case, the central bank could give the effective policy on handing international capital inflows.

Future research could consider several issues in this area. First, the present analysis does not include fiscal policy variables to investigate the effect of such variables on domestic price. Second, the study does not account for the asset price market in Vietnam such as stocks, housing and land prices. Third, it may be interesting if future research could employ different threshold variables related to the financial conditions of a country.

References

Aksoy, Y., Orphanides, A., Small, D., Wieland, V., and Wilcox, D. (2006). A quantitative exploration of the opportunistic approach to disinflation. *Journal of Monetary Economics 53*, 1877-1893.

Aleem, A., and Lahiani, A. (2014). A threshold vector autoregression model of exchange rate pass-through in Mexico. *Research in International Business and Finance 30*, 24-33.

Alvarez, F., Beraja, M., Gonzalez-Rozada, M., and Neumeyer, P., A. (2018). From Hyperinflation to Stable Prices: Argentina's Evidence on Menu Cost Models. *The Quarterly Journal of Economics*, qjy022.

Avdjjev, S., and Zeng, Z. (2014). Credit growth, monetary policy and economic activity in a three-regime TVAR model. *Applied Economics 24*, 2936-2951.

Balke, N., S. (2000). Credit and economic activity: credit regimes and the nonlinear propagation of shocks. *Review of Economics and Statistics 82*, 516-536.

Baqueiro, A., Diaz de Leon, A., and Torres, A. (2003). Fear of floating or fear of inflation? The role of the exchange rate pass-through. *BIS papers* No 19, Monetary and Economic Department, Bank for International Settlements.

Bhattacharya, R. (2014). Inflation dynamics and monetary policy transmission in Vietnam and emerging Asia. *Journal of Asian Economics 34* , 16-26.

Jiang, J., & Kim, D. (2013). Exchange rate pass-through to inflation in China. *Economic Modelling 33* , 900-912.

Kim, S., & Roubini, N. (2000). Exchange rate anomalies in the industrial countries: A solution with a structural VAR approach. *Journal of Monetary Economics 45* , 561-586.

Mandler, M. (2012). Inflation-regime dependent effects of monetary policy shocks. Evidence from threshold vector autoregressions. *Economics Letters 116* , 422-425.

Mojon, B. (2008). When did unsystematic monetary policy have an effect on inflation? *European Economic Review 52* , 487-497.

Sim, C. (1992). Interpreting the macroeconomic time series facts: The effect of monetary policy . *European Economic Review 36* , 975-1000.

Sims, C. A., & Zha, T. (1998). Does monetary policy generate recessions? *Working Paper No.98-12.* Federal Reserve Bank of Atlanta.

Sims, C. A., & Zha, T. (1995). Error bands for impulse responses. *Working Paper No.95-6* , Federal Reserve Bank of Atlanta.

Su, T. D. (2015). Threshold effects of inflation on growth in the ASEAN-5 countries: A Panel Smooth Transition Regression approach. *Journal of Economics, Finance, and Administrative Science 20* , 41-48.

Tran, T. N., & Nguyen, T. T. (2016). Exchange rate pass-through in Vietnam under the impact of inflationary environment. *Journal of Economic Development 23(3)* , 89-109.

Tsay, R. S. (1998). Testing and modeling multivariate threshold models. *Journal of the American Statistical Association 93* , 1188-1202.

Zhang, L. (2013). Modeling China's inflation dynamics: An MRSTAR approach. *Economic Modelling 31* , 440-446.

Appendix A: Data description

Series	Definition	Source
World oil price	An average of the three spot price indices of Texas, U.K. Brent, and Dubai (2010=100)	International Financial Statistic
Federal funds rate	Federal funds rate	International Financial Statistic
Industrial production index	Industrial production index (2010=100)	Datastream
CPI	Consumer price index (2010=100)	International Financial Statistic
Money supply	Narrow money (M1)	International Financial Statistic
Policy interest rate	Refinancing rate	International Financial Statistic
Credit	Domestic credit	International Financial Statistic
NEER	Nominal effective exchange rate (2010=100)	Datastream

Table 3.1: Unit root test

	Augmented Dickey Fuller (ADF) test		Phillips-Perron (PP) test	
Variables	**Level**	**First differences**	**Level**	**First differences**
OIL	-1.96	-6.72***	-1.70	-6.67***
FED	-4.53	-7.90***	-18.80	-13.93***
GAP	-13.17***		-12.77***	
CPI	-2.01	-4.69***	-2.96	-4.49***
M	0.82	-9.46***	0.42	-9.62***
INT	-2.15	-5.69***	-2.12	-9.16***
CREDIT	-1.19	-3.95***	-2.12	-6.58***
NEER	-2.20	-7.60***	-2.36	-6.76***

Note: OIL is world oil price, FED is federal funds rate, GAP is output gap, CPI is consumer price index, M is money supply (M1), INT is interest rate, CREDIT is the credit, NEER is nominal effective exchange rate. *** denotes the significance at the 1% level.
Source: Author's calculation

Table 3.2: Result of the threshold test

Inflation threshold			
d	m_0	C(d)	p-value
1	30	119.38	0.000
1	50	101.86	0.012
γ	0.00413	AIC	-2606.633

Note: d is delay for the threshold variable, m_0 is starting number for recursive estimates, C(d) is test statistic based on the method of Tsay (1998). AIC is Akaike Information Criterion.
Source: Author's calculation

Table 3.3: Contemporaneous coefficients in the structural models

	High inflation regime		Low inflation regime	
	Coefficient	Standard error	Coefficient	Standard error
a_{21}	-0.815***	0.202	0.074	0.045
a_{31}	-0.191*	0.104	0.140***	0.037
a_{41}	-0.009	0.008	0.001	0.008
a_{43}	0.023*	0.012	0.025	0.032
a_{53}	-0.088	0.078	0.427*	0.220
a_{54}	0.933	1.024	2.877*	1.550
a_{56}	0.012*	0.007	-0.003	0.029
a_{62}	0.276	0.879	3.235***	1.234
a_{63}	-0.984	1.927	-1.747	1.192
a_{64}	-37.775	24.674	-27.155***	8.112
a_{73}	-0.006	0.029	-0.066*	0.037
a_{74}	-0.087	0.390	-0.536**	0.269
a_{75}	-0.189***	0.061	-0.236***	0.029
a_{76}	0.001	0.003	-0.008*	0.005
a_{81}	-0.030	0.027	-0.034**	0.016
a_{82}	-0.046**	0.019	-0.101**	0.048
a_{83}	0.034	0.035	0.114**	0.054
a_{84}	0.394	0.472	0.099	0.366
a_{85}	0.033	0.072	0.100**	0.045
a_{86}	-0.009***	0.003	-0.009	0.007

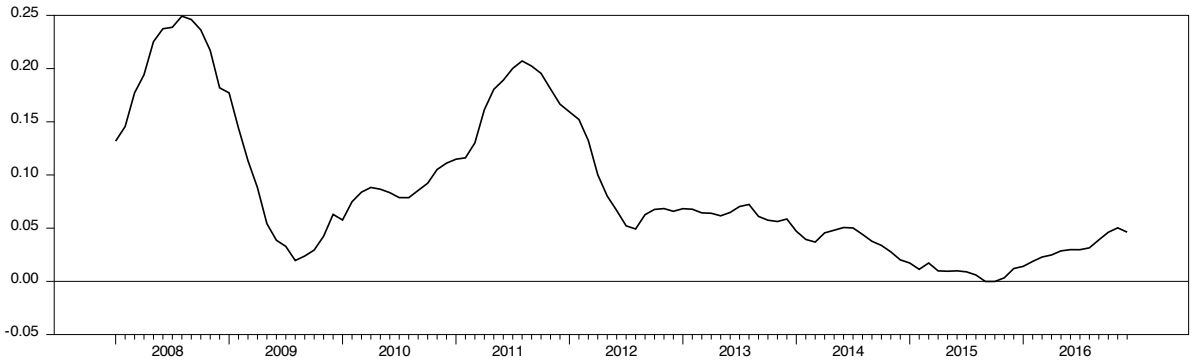
Note: According to equation (2), a_{ij} indicates the contemporaneous relationship between the structural disturbances and the reduced-form residuals. ***, **, and * denote the significance at the 1%, 5% and 10% level, respectively.
Source: Author's calculation

Table 3.4: Variance decomposition of CPI

Step	Standard error	OIL	FED	GAP	CPI	M	INT	CREDIT	NEER
High inflation regime									
1	0.002	0.665	0.000	8.172	91.162	0.000	0.000	0.000	0.000
3	0.004	10.744	2.069	6.771	38.176	7.821	19.531	4.292	10.595
6	0.006	6.365	8.104	19.484	18.886	4.119	10.747	24.614	7.680
12	0.008	7.800	10.440	26.676	10.132	4.863	7.997	26.542	5.551
24	0.010	9.837	12.802	25.966	7.169	5.702	8.661	24.636	5.228
Low inflation regime									
1	0.002	0.329	0.000	1.869	97.803	0.000	0.000	0.000	0.000
3	0.003	36.193	3.680	2.401	44.277	0.173	5.359	4.144	3.773
6	0.004	27.906	14.498	3.960	31.449	1.206	5.893	4.602	10.488
12	0.004	20.854	16.542	10.800	29.532	5.624	5.511	3.649	7.487
24	0.006	13.508	23.316	19.054	22.717	6.904	5.687	3.593	5.221

Note: OIL is world oil price, FED is federal funds rate, GAP is output gap, CPI is consumer price index, M is money supply (M1), INT is interest rate, CREDIT is the credit, NEER is nominal effective exchange rate.
Source: Author's calculation

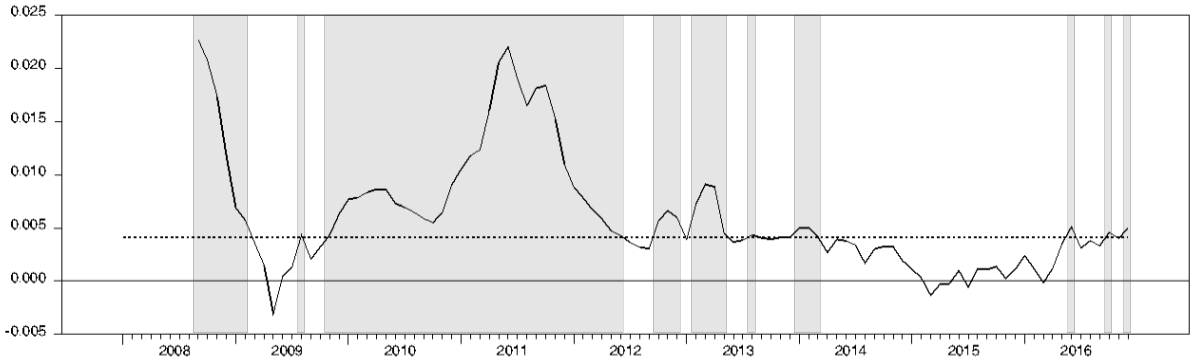
Figure 3.1: Inflation rate in Vietnam, 2008-2016



Note: The year-on-year CPI inflation rate is reported

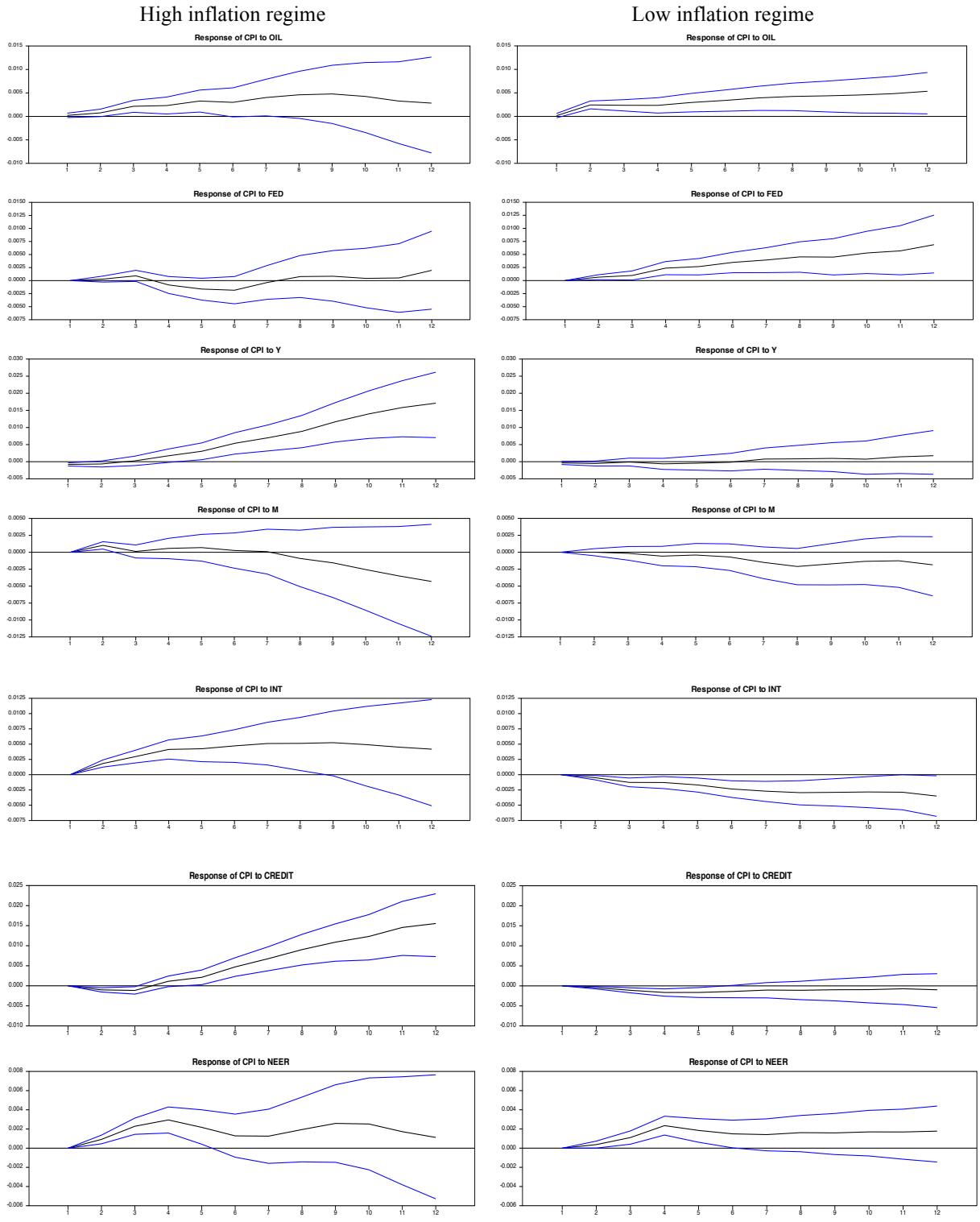
Source*:* IMF*, International Financial Statistic (IFS)* and author's calculation

Figure 3.2: Threshold variable and estimated threshold value



Note: The solid line illustrates the inflation threshold (six-month moving average of CPI changes), the dotted line indicates the threshold value (0.00413), and the shaded area is the high inflation period.
Source: Author's calculation

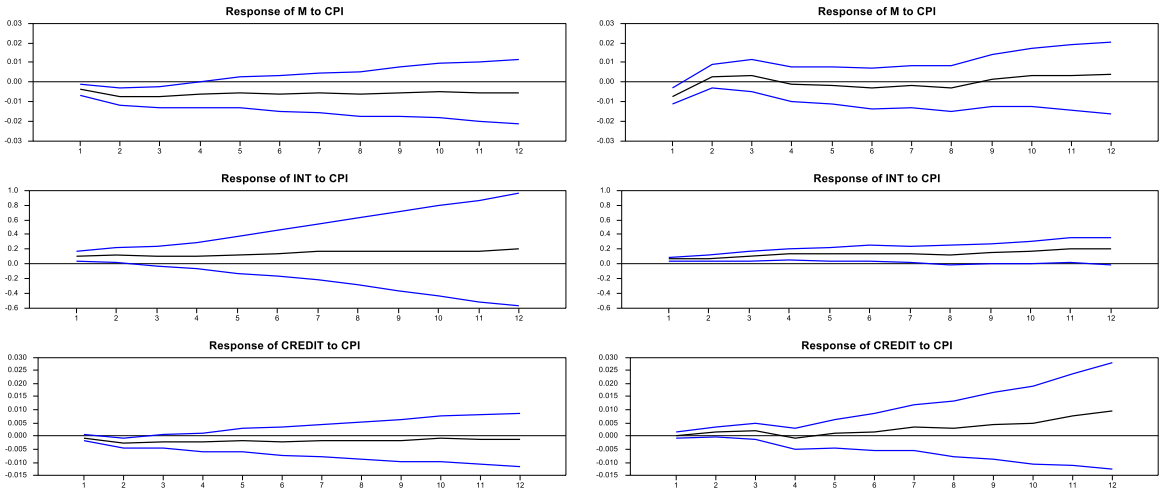
Figure 3.3: Regime-dependent impulse response of CPI to other shocks



Note: The impulse responses (mid-solid line) are presented over a 12-month period along the horizontal axis. 68% confidence intervals based on Monte Carlo simulation are plotted around each response (as per Sims and Zha, 1995).
Source: Author's calculation

Figure 3.4: **Regime-dependent impulse response of monetary policy variables and domestic credit to the CPI shock**

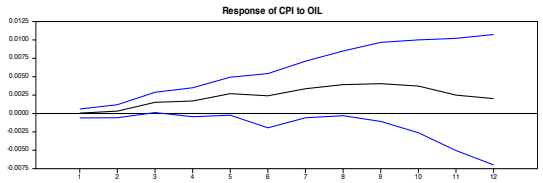
High inflation regime | Low inflation regime

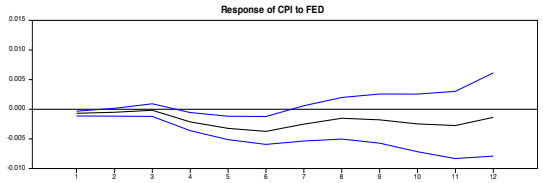


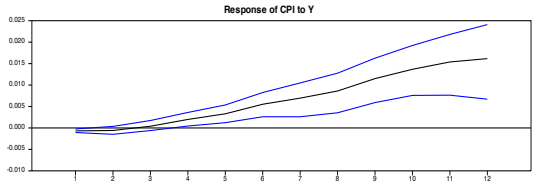
Note: The impulse responses (mid-solid line) are presented over a 12-month period along the horizontal axis. 68% confidence intervals based on Monte Carlo simulation are plotted around each response (as per Sims and Zha, 1995).
Source: Author's calculation

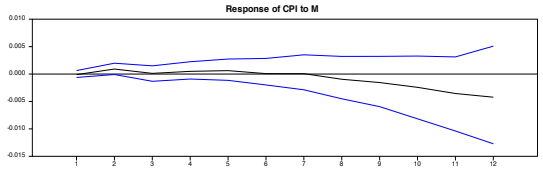
Figure 3.5: Regime-dependent impulse response of CPI to other shocks (using a different non-recursive matrix)

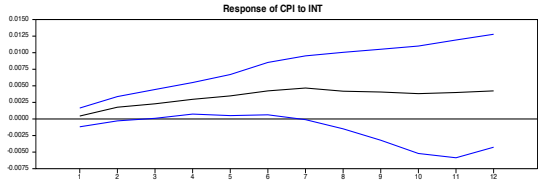
High inflation regime

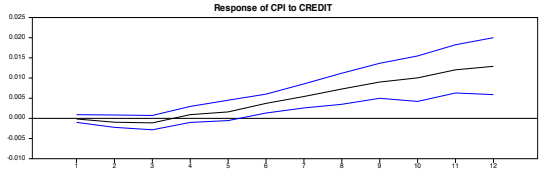


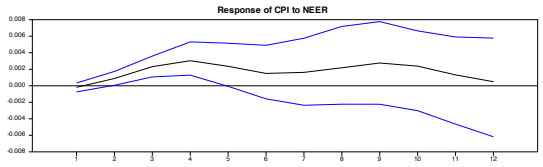




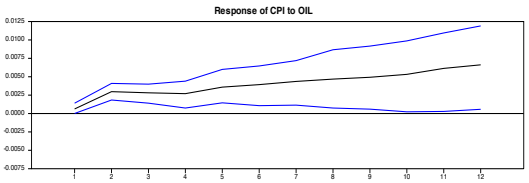


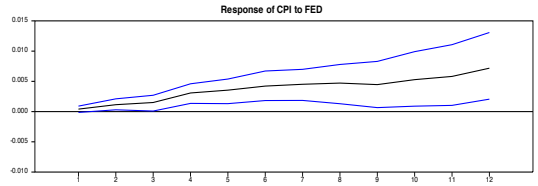


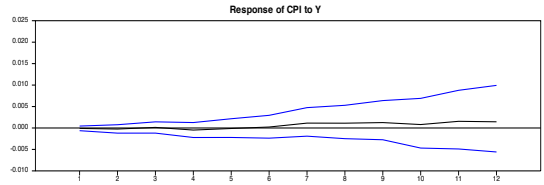


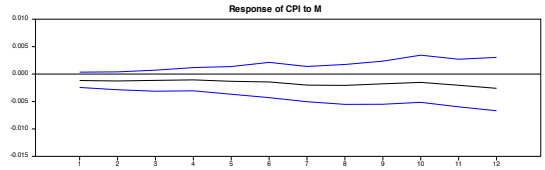


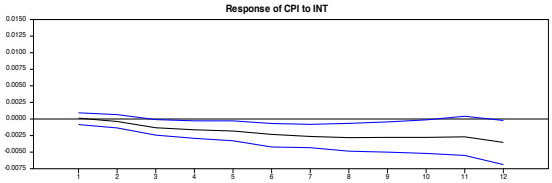
Low inflation regime

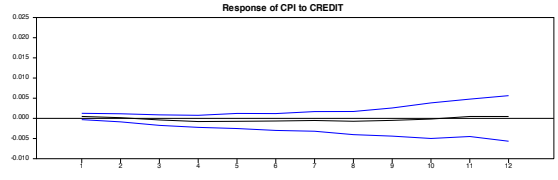


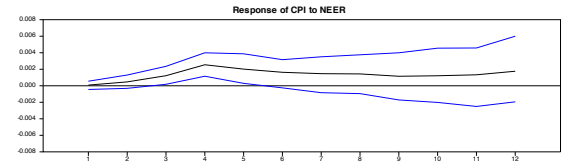












Note: The impulse responses (mid-solid line) are presented over a 12-month period along the horizontal axis. 68% confidence intervals based on Monte Carlo simulation are plotted around each response (as per Sims and Zha, 1995). Source: Author's calculation

Chapter 4: Does the oil price matter in Vietnam? An empirical investigation in a nonlinear framework

Abstract

This paper investigates the nonlinear effect of oil price shocks on macroeconomic activities in Vietnam. We do that by conducting a threshold structural Vector autoregression (VAR) with five variables: world oil price, output gap, interest rate, nominal effective exchange rate (NEER), and the domestic price (CPI). The model separates two regimes with the world oil price threshold. Our results indicate that the oil price shock and output gap, interest rate, NEER, and CPI have a regime-dependent relationship. We find that the macroeconomic responses are different among regimes. The monetary policy tools are more effective in the case of the low oil price regime than the high one.

JEL classifications: Q41; Q43; F41; F62

Keywords: Threshold vector autoregression; nonlinearity; oil price shock; Vietnam

1.Introduction

Since oil is a crucial input for production, an increase in oil price leads to a rise in production costs. As a result, output falls, and aggregate supply decreases. Moreover, an increase in oil prices could raise not only the production costs but also the distribution costs of goods and services. Therefore, the price level in the economy can go up. Furthermore, the currency is strongly affected by the oil price. An increase in oil price triggers the currency appreciation of oil-exporting economies since the demand for their domestic currencies in the foreign exchange market rises (Basnet et al., 2015).

Empirical work of the literature indicates evidence about the relationship between oil price and macroeconomic activities. Numerous papers investigate the effects of an exogenous, unanticipated increase in the imported oil price in the U.S. and other developed countries (Hamilton, 1983; Kilian, 2008, 2009, 2014; Baumeister and Peerman, 2013b). These results suggest that oil price shocks affect real economic output and trigger an economic slowdown. Moreover, Cunado and Perez de Gracia (2005) study the effect of oil price shocks on economic activities and inflation in Japan, Singapore, South Korea, Malaysia, Thailand, and the Philippines. Employing quarterly data from 1975Q1 to 2000Q2, they indicate that oil prices have a substantial impact on both economic growth and inflation in their sample countries.

The paper by Basher, Haug, and Sadorsky (2012) investigates the dynamic relationship between oil prices, exchange rates, and emerging market stock prices. They illustrate that the impact of positive oil price shocks on the emerging market stock prices and the U.S. dollar exchange rate is negative in the short run. Furthermore, a positive oil production shock leads to a decline in oil prices while oil prices increase in response to a positive shock to real economic activity.

Notably, the oil price measured by the West Texas Intermediate increases slightly to peak at 134 USD in June 2008. This was followed by a rapid decline to 39 USD of the oil price in February 2009. After that, the oil price rose again to 106 USD in June 2014 and decreases again to 37 USD at the end of 2015 (Figure 4.1). Intuitively, the rapid changes in oil price could hurt small open economies which rely on oil imports, as they often do not have enough capacity and power to respond to these shocks (Ran and Voon, 2012).

Figure 4.1 around here

However, the recent decline in world oil prices has not led to significant growth in the global economy (World Bank, 2018). This evidence shows that the positive supply shock could also harm the demand (Nasir et al., 2018). The paper by Mork (1989) finds that oil prices have an asymmetric effect on economic activities. The negative influence of increasing oil prices on economic indicators is more considerable than the positive influence of decreasing oil prices on the economy. The different aspects of the business cycle could lead to a change in asymmetric behaviors.

Several studies focus on the nonlinear relationship between oil price and macroeconomic variables. Hamilton (1996) suggests that rising oil prices are considerably more crucial than oil price declines. The work by Yang et al. (2002) indicates that higher oil prices trigger subsequent recessions for oil dependant economies. Cunado and Perez de Gracia (2003) found that oil prices have asymmetric impacts on production growth rates in 14 European countries.

Recently, Kocaarslan et al. (2019) find that the main macroeconomic indicators present an asymmetric behavior during a distinct time of the economic situation. Cheng and Cao (2019) investigate the connection between oil prices and food prices from 1990 to 2017. Using the

threshold Vector autoregression (VAR) model and Threshold Vector error correction model (VECM), the authors show that there exists a nonlinear relationship between oil price and food price. Kocaarslan and Soytas (2019) indicate the significant asymmetric effects among oil prices, interest rates, and the stock prices of clean energy firms.

According to the Institute of Energy Economics Japan (IEEJ) report, the world's primary energy consumption will rise due to the economic development and population growth. Energy consumption in the Organization for Economic Co-operation and Development (OECD) member countries tends to be declining despite their economic expansion. In contrast, China, India, and ASEAN nations are the main contributors to the net increase in energy consumption. Moreover, oil is the most significant component of energy consumption in the world. China and other Asian economies will become the biggest oil consumers by 2040.

Noticeably, Vietnam is one of the fasting growing economies in the world. The annual growth rate of this country was approximately 6 percent from 2012 to 2016 and forecast to increase in the next five years (OECD, 2019). Moreover, the demand for oil and other energy sources increases in order to maintain rapid economic growth. Consequently, the growing relative importance of developing countries such as Vietnam in world oil demand leads to an interest in examining the influence of oil price fluctuations on macroeconomic activities in these economies.

Figure 4.2 shows some essential macroeconomic information for Vietnam’s economy. Over the period 2008-2012, Vietnam experienced a high inflation rate (more than 20% in 2008M9). Meanwhile, the nominal effective exchange rate (NEER) had a significant depreciation. This situation represents the instability of Vietnam’s economy, following the large

fluctuation of the world oil price. During the period from 2013 to 2015, Vietnam's macroeconomic indicators become stable. Meanwhile, the world oil price changes modestly. Notably, Vietnam becomes a net oil importer from 2010. These developments give the first evidence that the impact of oil price shock on macroeconomic variables may be a different across oil price levels.

Figure 4.2 around here

Most literature on Vietnamese topics usually investigate the relationship between oil prices and macroeconomic activities without dealing with the nonlinear issue of this connection (e.g., Vu and Nakata, 2018; Pham and Sala, 2019). Therefore, this research aims to investigate the nonlinear effect of oil price shocks on economic activities in developing countries like Vietnam. Additionally, we utilize the nonlinear VAR model, which is different from the previous papers on this issue.

Our findings indicate that the oil price shock and output gap, interest rate, NEER, and CPI have a regime-dependent relationship. First, the favorable oil price shock has a modest impact on the output gap when the oil price is high. Second, the interest rate, NEER, and CPI responses are sizeably different across oil price regimes. Finally, monetary policy is more effective in the low oil price regime than the high one.

This paper is structured as follows. Section 2 summarizes the literature on the relationship between oil price and macroeconomic indicators in some ASEAN countries. Section 3 introduces the nonlinear structural vector autoregression (VAR) model. Section 4 presents the data and preliminary estimation. Section 5 shows the empirical results for the empirical analysis. Section 6 concludes.

2. Literature review on oil price shocks in ASEAN economies

Several papers analyze the effects of oil shocks in many economies, including few ASEAN countries. To demonstrate, Cunado et al. (2015) examine the macroeconomic impact of structural oil shocks in India, Indonesia, Japan, and Korea. They establish three different structural oil shocks via sign restrictions. Their results show that the responses of economic activity and prices to the different types of oil price shocks are very distinct. This paper is an improvement of existing literature related to ASEAN countries such as Abeysinhe (2001), Cunado and Perez de Garcia (2005), Ran and Voon (2012), Le and Chang (2013).

Few research papers concentrate exclusively on ASEAN countries. For instance, the study of Basnet and Updhyaya (2015), using the Structural VAR model, investigates the effects of oil price shock on real output, inflation, and real exchange rate in Thailand, Malaysia, Singapore, the Philippines and Indonesia. Their findings suggest that oil price fluctuations do not influence these economies in the long run. Razmi et al. (2016) analyze the vulnerability of domestic prices against oil price shocks through the monetary transmission mechanism in ASEAN-4 economies (Indonesia, Malaysia, the Philippines and Thailand). By employing a Structural VAR model, the authors indicate that the oil price transmits substantially to the consumer price index indirectly in the post-crisis period.

Focusing on economic structure and monetary regimes in each economy, the empirical work of Vu and Nakata (2018) investigates the effect of oil price shocks on macroeconomic activities in six ASEAN countries. By employing the VAR model with block exogeneity, they find that oil price is more important than other macroeconomic variables to explain the output and price variation in the Philippines, Singapore, and Thailand than Indonesia, Malaysia, and

Vietnam. Their research is close to the paper by Raghavan (2015), which considers the case of Indonesia, Malaysia, the Philippines, Singapore and Thailand.

For the study of a single ASEAN economy, Rafiq et al. (2009) investigate the impact of oil price volatility on the main macroeconomic activities of Thailand. By employing a VAR system, they find that oil price volatility has a significant influence on unemployment and investment during the period from 1993Q1 to 2006Q4. The research of Narayan et al. (2010) examines the impact of oil prices on the stock market in Vietnam during the period from 2000 to 2008. Their findings show that stock prices, oil prices, and nominal exchange rates are cointegrated. Moreover, the effect of oil prices on stock prices is positive and statistically significant. The study of Ahmed and Wadud (2011) analyses the response of Malaysian macroeconomic activities to oil price uncertainty. They illustrate that oil price uncertainty triggers an adverse effect on industrial production, a decline in the price level, and lower policy interest rate.

There are several observations obtained from the above empirical studies on ASEAN countries. First, oil price shocks have an impact on macroeconomic activities, such as output, price level, interest rate, and exchange rates. Second, most of the empirical works employ VAR models with different identifications such as block exogeneity, sign restrictions, and monetary transmission framework of Kim and Roubni (2000).

3. Methodology

The threshold VAR model with two regimes is

$$Z_t = \alpha^1 + A^1 Z_t + B^1(L) Z_{t-1} + (\alpha^2 + A^2 Z_t + B^2(L) Z_{t-1})\, \mathrm{I}(C_{t-d}, \gamma) + \varepsilon_t \quad (1)$$

where the vector of variables (Z_t) includes the Z_t = ($oil_t, gap_t, int_t, neer_t$, cpi_t,), oil_t is the world oil price, gap_t is the output gap, int_t is the interest rate, $neer_t$ is the nominal effective exchange rate, and cpi_t is the consumer price index (CPI). α^i represents the vector of constants, A^i represents the matrix of contemporaneous interaction coefficients, $B^i(L)$ is polynomials created from matrices of coefficients in the lag operator L. ε_t represents the vector of structural innovations.

I is an indicator that equals one if the threshold variable C_{t-d} is larger than or equal to the threshold value γ ($C_{t-d} \geq \gamma$) and 0 otherwise. d are lags. When I = 0, the relevant coefficients are $\alpha^1, A^1,$ and $B^1(L)$. When I =1, the relevant coefficients are $\alpha^1+\alpha^2$, A^1+A^2, and $B^1(L)+B^2(L)$.

In order to examine the threshold effects, we estimate the model by Ordinary Least Squares (OLS) on a grid of possible threshold values. Additionally, a set of Wald statistics of the null hypothesis of no threshold behavior is conducted as Balke (2000) describes. Under the null hypothesis of no threshold effects, the threshold value γ is not determined. By employing the simulation method of Hansen (1996), we obtain the p-values for the test statistics. Moreover, we select the threshold value as the one minimizing the log determinant of the variance-covariance matrix of the VAR residuals.

The VAR model contains monthly observations on the world oil price, output gap, interest rate nominal effective exchange rate (NEER), and CPI. In terms of ordering the variables, the world oil price is placed first because of the exogenous nature of oil price shocks in this model. The output gap is ordered second, followed by the interest rate and NEER. Assuming

that the CPI is contemporaneously affected by other shocks, we place the price variable last in this model.

4. Data and estimation

In this article, we collect monthly data on world oil prices, industrial production index (IPI), policy interest rate, nominal effective exchange rate (NEER), and consumer price index (CPI), and the world oil price. The NEER index (2010=100) is defined such that an increase in the index means depreciation. The data spans from January 2008 to December 2018. The variables are taken from IMF-IFS databases and Datastream. The details are described in Table 4.1.

Table 4.1 around here

We employ the spot market price on West Texas Intermediate crude oil price measured in dollars per barrel as our oil price. After that, we deflate them by the US consumer price index in order to get the real oil prices. The West Texas Intermediate crude oil price is widely recognized as a viewpoint for world oil markets.

All series are seasonally adjusted by using X-12 method and then taken in natural logarithm before estimation. We apply the Hodrick – Prescott filter (Lambda = 14400) to the natural log of the industrial production index to calculate the output gap as Hahn (2003) did. Table 4.2 presents the unit root test by using the Augmented Dickey-Fuller (ADF) test and the Phillips - Perron (PP) tests. The results suggest that all series are stationary in first differences while the output gap is stationary in levels. After that, we set up the VAR estimation in the first difference except for the output gap. The Akaike Information Criterion (AIC) test suggests two as the ideal lag length.

Table 4.2 around here

5. Results

We employ the lagged world oil price as the threshold variable. Table 4.3 indicates the test for the null hypothesis of no threshold effects in the VAR. The result shows that there is a threshold effect in our VAR model and identifies the estimated threshold value.

Table 4.3 around here

Figure 4.3 depicts the lagged world oil price and the estimated threshold value. The estimated threshold value, 66.96, divides our sample into two regimes, which roughly coincide with the changes in world oil prices. The low oil price regime is captured by the period from the end of 2008 and most of the time in 2009, and from 2015 to the middle of 2018. The high oil price regime is dominated by the beginning of 2008, the period from 2010 to 2014, and from the middle of 2018. The empirical model endogenously determines the sample division.

Figure 4.3 around here

Figure 4.4 shows the impulse response function (IRF) of the output gap, interest rate, NEER, and CPI to the oil price shock. The responses attained from positive one standard deviation shocks. In order to compare impulse responses under distinct regimes, we scale the responses of each variable by the standard deviation in each regime (Ender, 2003; Catik and Marin, 2012).

Figure 4.4 around here

The response of the output gap to the oil price shock is regime dependent. In all regimes, the output gap response is positive in whole periods. In the high oil price regime, the output gap

response is smaller than the same response in the low oil price regime. This result implies that an increase in the world oil price enhances the economic growth in Vietnam, especially in the low oil price period. The asymmetry is apparent when the economy is in a high oil price context, and the oil price shock leads to the diverse magnitude impact on the economic activity.

The interest rate responses are positive in all cases. This outcome presents the reaction of the State Bank of Vietnam (SBV) in response to oil price shocks. Notably, the tremendous response is when the economy in the high oil price regime. This situation is reasonable because Vietnam has been a net oil-importing country since 2010; a rise in oil price could be harmful to the price stability objective of SBV.

The NEER depreciates in response to positive oil price shocks. The paper of Narayan (2013) also shows that rising oil prices lead to a depreciation of the Vietnam dong (VND) in the short run. These NEER responses are larger when the economy is in the high oil price regime. This result supports the evidence of the regime-dependence relationship between oil price and exchange rate in Vietnam.

The impacts of the oil price shock on the CPI are consistent across the two regimes. An increase in the oil price leads to a rise in CPI in the whole period. Notably, the oil price shock triggers the more substantial effects in the high oil price regime than the low one. This result suggests that the retail oil price in Vietnam is intensely connected to the world oil price even that Vietnam's government uses the funds to regulate the oil price.

Figure 4.5 indicates the response of the CPI to the interest rate and NEER in high and low oil price regimes. The CPI becomes significantly negative in the first few months in response to positive interest rate shock in the low oil price regime. In the case of a similar shock, the CPI

increases in the first several months in the high oil price regime after decreasing insignificantly in the following months. It is suggested that the monetary policy is more effective in the low oil price case than the high one.

Noticeably, in response to the favorable exchange rate shock, the CPI response is positive and significant for whole period in the high oil price context. In contrast, the response is modest and insignificant for the whole period in an adverse situation. This result implies that the exchange rate pass-through to domestic price is strongly affected by the oil price regime.

6. Conclusion

This paper investigates the nonlinear effect of oil price shocks on macroeconomic activities in Vietnam. We do that by conducting a threshold structural VAR with five variables: world oil price, output gap, interest rate, NEER, and the CPI.

Our results indicate that the oil price shock and output gap, interest rate, NEER, and CPI have a regime-dependent relationship. We find that the impact of world oil prices on these indicators is different among oil price regimes.

The positive impact of oil price shocks on output provides the critical role of oil-exporting on Vietnam's economy since oil exploration, production, and distribution is a crucial sector of Vietnam's manufacturing. The average value of oil revenue minus production cost for Vietnam during the period from 1985 to 2017 is 4.11 percent (TheGlobalEconomy.com, 2017). Furthermore, the Vietnam government often utilizes money earned from oil revenue in order to upgrade transport infrastructure.

The State Bank of Vietnam (SBV) increases the policy interest rate in order to keep price stability in response to the rise in world oil prices. However, the interest rate tool is more

effective in the case of the low oil price regime than the high one. Furthermore, the CPI is greatly affected by the exchange rate in the high oil price context. This picture depicts the complication of the monetary policy in Vietnam.

In general, the impact of external shock such as world oil price on macroeconomic indicators in Vietnam is significant, and diverse across distinct oil price levels. In this case, the policymakers should continuously observe the oil price changes to implement the appropriate monetary and fiscal policy. Furthermore, the influence of the retail oil market stability instruments should be examined in future empirical work.

References

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

Ahmed, H.J.A, & Wadud, I.K.M.M. (2011). Role of oil price shocks on macroeconomic activities: An SVAR approach to the Malaysian economy and monetary policy response. *Energy Policy 39*, 8062-8069.

Balke, N.S. (2000). Credit and economic activity: credit regimes and the nonlinear propagation of shocks. *Review of Economics and Statistics 82*, 516-536.

Basher, S.A., Haug, A.A, & Sadorky, P. (2012). Oil prices, exchange rates and emerging stock markets. *Energy Economics 34*, 227-240.

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

Baumeister, C., & Peersman, G. (2013b). Time-varying effects of oil supply shocks on the US economy. *American Economic Journal: Macroeconomics 5*, 1-28.

Bernanke, B., Gertler, M., & Watson, M. (1997). Systematic monetary policy and the effects of oil shocks. *Brooking Papers on Economic Activity 1*, 91-157.

Catik, A.N.; & Martin, C. (2012) "Macroeconomic transitions and the transmission mechanism: Evidence from Turkey". *Economic Modelling 29*, 1440-1449.

Chen H., Liu L., Wang Y., & Zhu Y. (2016) "Oil price shocks and U.S. dollar exchange rates". *Energy 112*, 1036-1048.

Cheng, S., & Cao, Y. (2019). On the relation between global food and crude oil prices: An empirical investigation in a nonlinear framework. *Energy Economics 81*, 422-432.

Cunado, J., & Perez de Gracia, F. (2003). Do oil price shocks matter? Evidence for some European countries. *Energy Economics 72*, 137-154.

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

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

Enders, W. (2003). RATS programming manual. Evanston, IL, Estima.

Ghosh, S. (2011). Examining crude oil price-exchange rate nexus for India during the period of extreme oil price volatility. *Applied Energy 88*, 1886-1889.

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

Hamilton, J.D. (1996). This is what happened to the oil price – macroeconomic relationship. *The Journal of Monetary Economics 38*, 215-220.

Hahn, E. (2003). Pass-through of external shocks to euro area inflation. European Central Bank Working Paper Series.

Hansen, B.E. (1996). Inference when a nuisance parameter is not identified under the null hypothesis. *Econometrica 64*, 413-430.

IEEJ Outlook 2019, 2018, October.

Kilian, L. (2008). The economic effects of energy price shocks. *Journal of Economic Literature 46*, 871-909.

Kilian, L. (2009). Not all oil price shocks are alike: disentangling demand and supply shocks in the crude oil market. *American Economics Review 99*, 1053-1069.

Kilian, L. (2014). Oil price shocks: Causes and consequences. *Annual Review of Resource Economics 6*, 133-154.

Kilian, L, & Park, C. (2009). The impact of oil price shocks on the U.S stock market. *International Economic Review 50*, 1267-1287.

Kim, S., & Roubini, N. (2000). Exchange rate anomalies in the industrial countries: A solution with a structural VAR approach. *Journal of Monetary Economics 45*, 561-586.

Kocaarslan, B., & Soytas, U. (2019). Asymmetric pass-through between oil prices and the stock prices of clean energy firms: New evidence from a nonlinear analysis. *Energy Reports 5*, 117-125.

Kocaarslan, B., Soytas, U., Sari, R., & Ugurlu, E. (2019). The changing role of financial stress, oil price, and gold price in financial contagion among US and BRIC markets. *International Review of Finance 19(3)*, 541-574.

Le, T.H, & Chang, Y. (2013). Oil price shocks and trade imbalances. *Energy Economics 36*, 78-96.

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

Narayan, S. (2013). Foreign exchange markets and oil price in Asia. *Journal of Asian Economics 28*, 41-50.

Narayan, P.S., & Narayan, S. (2010). Modelling the impact of oil prices and Vietnam's stock prices. *Applied Energy 87*, 356-361.

Nasir, M.A., Naidoo, L., Shahbaz, M., & Amoo, N. (2018). Implications of oil price shocks for the major emerging economies: A comparative analysis of BRISC. *Energy Economics 76*, 2018, 76-88.

OECD Development Centre's Medium Term Projection Framework (MPF-2019). Economic Outlook for Southeast Asia, China and India, 2019.

Pham, T.B; & Sala, H. (2019). The macroeconomic effects of oil price and risk-premium shocks on Vietnam: Evidence from an over-identifying SVAR analysis. MPRA Paper No.96873.

Rafiq, S., Salim, R., & Bloch, H. (2009). Impact of crude oil price volatility on economic activities: An empirical investigation in the Thai economy. *Resource Policy 34*, 121-132.

Raghavan, M. (2015). The macroeconomic effects of oil price shocks on ASEAN-5 economies. Tasmanian School of Business and Economics Discussion Paper series N2015-10.

Ran, J., & Voon, J.P. (2012). Does oil price shock affect small open economies? Evidence from Hong Kong, Singapore, South Korea and Taiwan. *Applied Economics Letters 19*, 1599-1602.

Rafiq, S., Salim, R., & Bloch, H. (2009). Impact of crude oil price volatility on economic activities: An empirical investigation in the Thai economy. *Resource Policy 34*, 121-132.

Razmi F., Azali M., Chin L., & Habibullah M., S. (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*, 581-591.

TheGlobalEconomy.com. (2017). Vietnam oil revenue. https://www.theglobaleconomy.com/Vietnam/oil_revenue/, Accessed date: 7 January 2020.

Vu, T.K, & Nakata, H. (2018). Oil price fluctuations and the small open economies of South East Asia: An analysis using vector autoregression with block exogeneity. *Journal of Asian Economics 54*, 1-21.

World Bank. (2018). With the benefit of hindsight: The impact of the 2014-16 oil price collapse. Global Economic Prospects, Special Focus 1.

Yang, C.W; Hwang, M.J; & Huang, B.N. (2002). An analysis of factors affecting price volatility of the US oil market. *Energy Economics 24*, 107-119.

Table 4.1: Data description

Series	Definition	Source
World oil price (OIL)	West Texas Intermediate oil price	U.S. Energy Information Administration
Industrial production index (IPI)	Industrial production index (2010=100)	Datastream
Interest rate (INT)	Refinancing rate	International Financial Statistic
Consumer price index (CPI)	Consumer price index (2010=100)	International Financial Statistic
Nominal effective exchange rate (NEER)	Nominal effective exchange rate (2010=100)	Datastream

Table 4.2: Unit root tests

	Augmented Dickey Fuller (ADF) test		Phillips-Peron (PP) test	
Variables	**Level**	**First differences**	**Level**	**First differences**
OIL	-2.45	-8.02***	-2.34	-8.02***
GAP	-3.71**		-7.71***	
INT	-2.24	-6.31***	-2.18	-10.15***
CPI	-1.47	-5.09***	-2.04	-4.83***
NEER	-1.52	-8.11***	-1.65	-7.90***

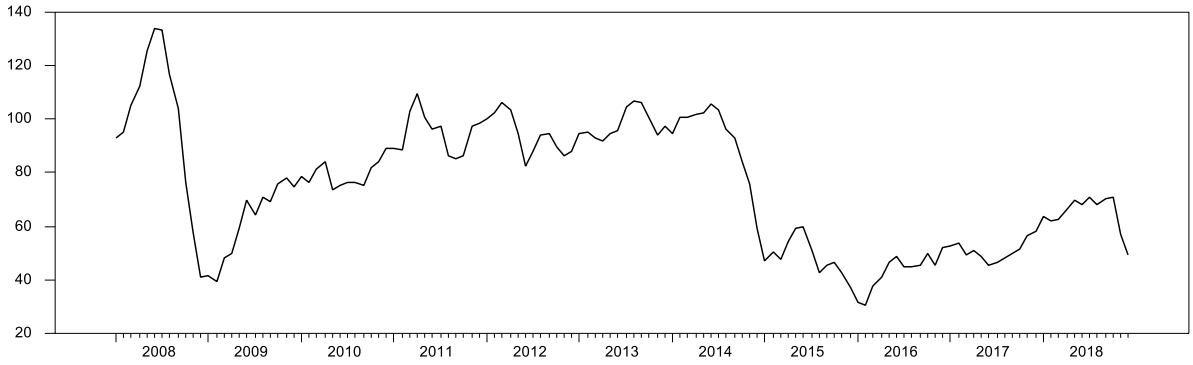
Note: Notation: OIL is world oil price, GAP is output gap, INT is the interest rate, CPI is consumer price index, NEER is nominal effective exchange rate. ***, **, and * denote the significance at the 1%, 5%, and 10% level respectively. When testing a variable in level, a constant and a time trend are included. When testing a variable in first differences, only a constant is included.
Source: Author's calculation

Table 4.3: Test for threshold VAR

Variables: OIL, GAP, INT, CPI, NEER				
Threshold variable	Threshold estimate	Sup-Wald	Avg-Wald	Exp-Wald
Oil price	$\gamma = 66.96$	198.36	161.50	96.65
Lag = 1		(0.00)	(0.00)	(0.00)

Note: The sample period is 2008M1-2018M12. P-values in parentheses are following Hansen (1996) procedure with 1000 replications.
Source: Author's calculation

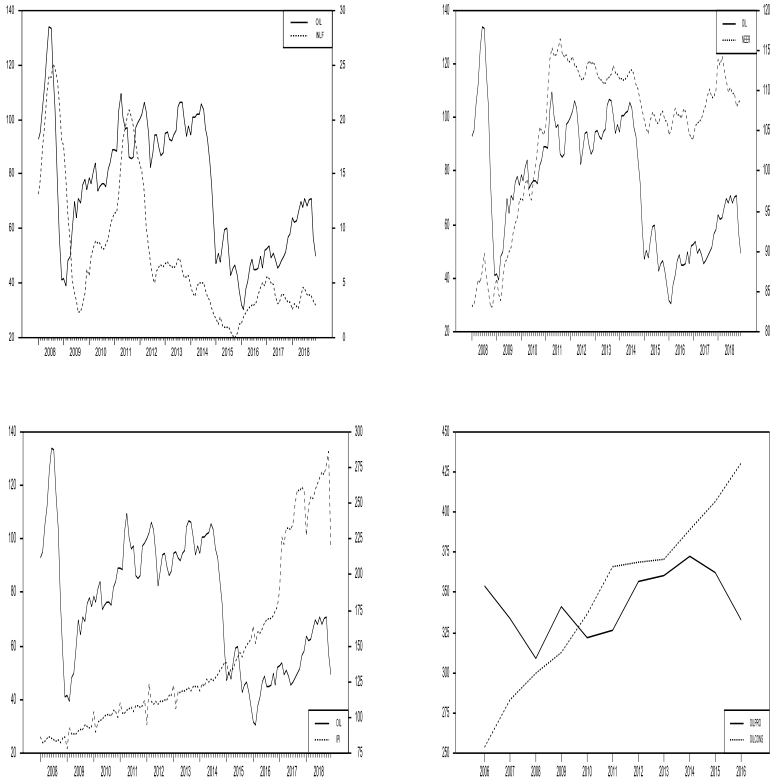
Figure 4.1: World oil price (2008-2018)



Note: The monthly West Texas Intermediate oil price is reported

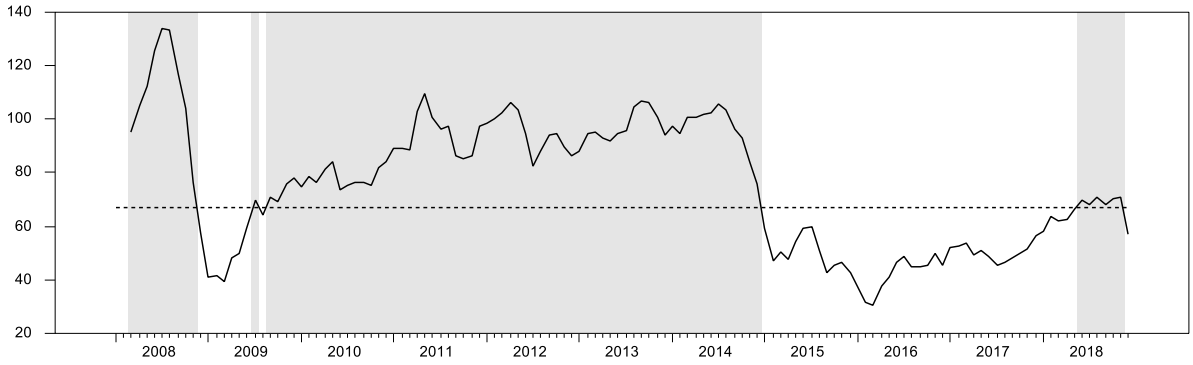
Source: U.S. Energy Information Administration

Figure 4.2: Time series fluctuations



Source: U.S. Energy Information Administration, IMF-IFS databases, and Datastream

Figure 4.3: Threshold variables

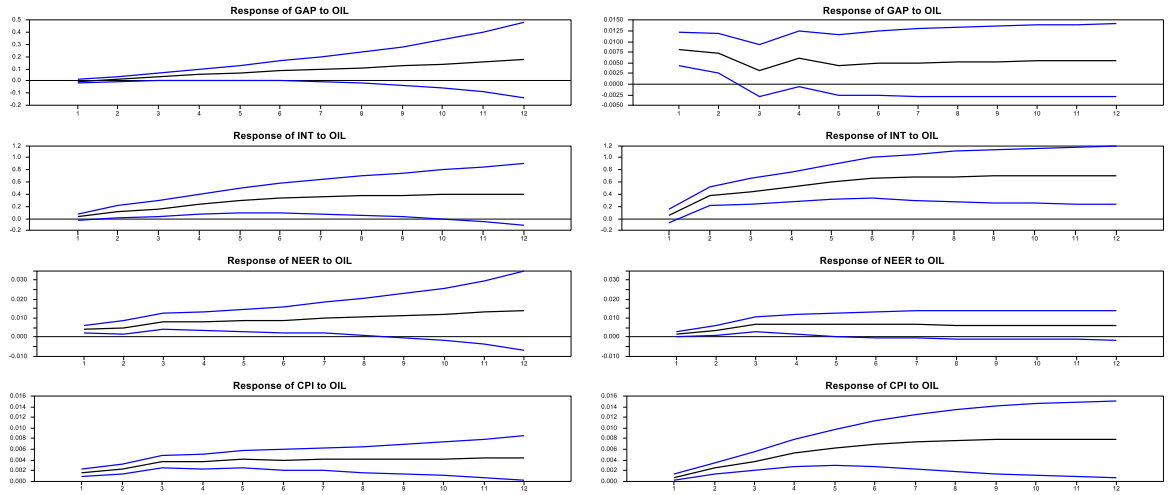


Note: The solid line illustrates the threshold variable (the world oil price with one lag), the dotted line indicates the threshold value (66.96), and the shaded area is the high oil price period.

Source: Author's calculation

Figure 4.4: IRFs of macroeconomic variables to one standard deviations oil price shock

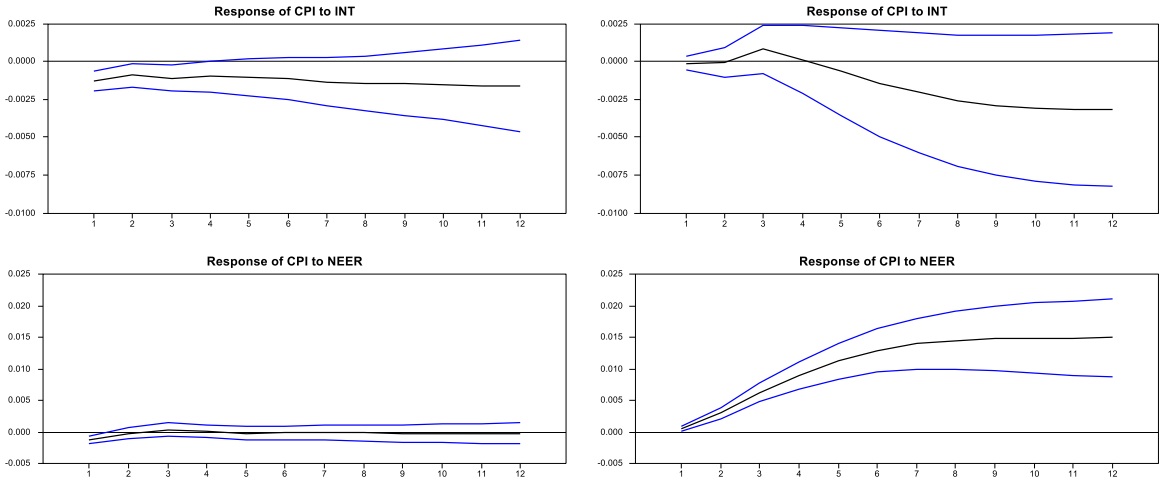
Low oil price | High oil price



Note: Notation: OIL is world oil price, GAP is output gap, INT is the interest rate, NEER is nominal effective exchange rate, and CPI is consumer price index. The impulse responses (mid-solid line) are presented over a 12-month period along the horizontal axis. 68% confidence intervals based on Monte Carlo simulation are plotted around each response.
Source: Author's calculation

Figure 4.5: IRFs of CPI to one standard deviation interest rate shock and exchange rate shock

Low oil price | High oil price



Note: Notation: OIL is world oil price, INT is the interest rate, NEER is nominal effective exchange rate, and CPI is consumer price index. The impulse responses (mid-solid line) are presented over a 12-month period along the horizontal axis. 68% confidence intervals based on Monte Carlo simulation are plotted around each response.
Source: Author's calculation

Chapter 5: Conclusion

The main ideas of the three empirical works are as follows:

Chapter 2 employs a structural VAR model to investigate the pass-through effect of exchange rate changes on price levels in Thailand, Indonesia, Malaysia, the Philippines, and Vietnam. This chapter shows that the domestic prices response to the exchange rate shock is positive in all five samples economies. The pass-through to the domestic prices is incomplete and it also follows the distribution chain. The ERPT depends on the macroeconomic determinants of each country. The possible interactions among macroeconomic variables indicate the critical role of monetary policy and exchange rate regime in order to control inflation in some cases. By using variance decomposition of CPI, the exchange rate shock is the main source of CPI fluctuations in Vietnam. Finally, the oil price plays an important role in determining the domestic price fluctuations in all five economies.

The empirical analysis gives several important insights. Pass-through does matter for domestic prices for all sample countries. The alternatives in the structure of the economy might lead to the fluctuations in pass-through. Monetary policy could play a vital role in controlling domestic inflation. This reflects the success of adopting the flexible exchange rate regime and inflation targeting in some cases. For Vietnam, exchange rate stability is essential for price stability while depreciation could not employ as the means for encouraging economic growth because it will significantly increase CPI. The oil price fluctuations become more important sources of price changes in all sample countries.

Chapter 3 investigates the inflation determinants in the presence of possible nonlinear relationship among inflation and macroeconomic variables in Vietnam. We do that by employing a threshold non-recursive structural VAR model with eight variables. Our results present strong

evidence for the nonlinear relationship between domestic price and some macroeconomic variables. The responses of CPI to the monetary policy shock and the credit shock change significantly between the two inflation regimes. As a result, the inflation determinants in Vietnam are regime-dependent. The variance decomposition analysis indicates that external shocks such as oil price and international monetary policy are vital for explaining domestic price changes in a low inflation regime. In contrast, the domestic shocks including output gap and credit are highly associated with the CPI fluctuations in a high inflation regime. Moreover, this paper confirms the aims of monetary policy in Vietnam, which are both balancing growth and price stability objectives.

This result represents a key aspect of implementing the monetary policy in Vietnam. The credit is a useful tool in the case of high inflation periods. On the other hand, the interest rate is a useful monetary policy instrument in the low inflation case. Therefore, the SBV can attain price stability through the credit channel in the high inflation period and the interest rate channel as the economy shifts to the low inflation case. Moreover, the SBV should pay attention to the impact of external shocks on inflation.

Chapter 4 investigates the nonlinear effect of oil price shocks on macroeconomic activities in Vietnam. We do that by conducting a threshold structural VAR with five variables: world oil price, output gap, interest rate, NEER, and CPI. Our results indicate that the oil price shock and output gap, interest rate, NEER, and CPI have a regime-dependent relationship. We find that the impact of world oil prices on these indicators is different among oil price regimes.

In general, the impact of external shock such as world oil price on macroeconomic indicators in Vietnam is significant, and diverse across distinct oil price levels. In this case, the

policymakers should continuously observe the oil price changes to implement the appropriate monetary and fiscal policy. Furthermore, the influence of the retail oil market stability instruments should be examined in other empirical research papers.

In summary, this dissertation contributes some interesting key findings to academic research. It also provides some ideas for monetary policy implement in Vietnam.