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How Does Monetary Policy Affect Economic Vulnerability to Oil Price Shock as against US Economy Shock?

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Abstract

This paper investigates the role of the monetary policy in protecting the economy against the external shocks of US output and oil price during the 2007-2009 financial crisis. It also considers economic vulnerability caused by these external shocks after the crisis abated. The application of the structural vector auto regression (SVAR) model using monthly data from 2002:M1 to 2013:M4 for Indonesia, Malaysia, and Thailand shows that poor influence of monetary policies on monetary policy transmission channels (namely, interest rate, exchange rate, domestic credit, and stock price) in the pre-crisis period could not shield these economies from shocks of oil price and US output. The results of post-crisis period indicate a significant increase in the positive impact of monetary policy on channels of monetary transmission channels compared to the pre-crisis period. However, these economies continue to remain vulnerable to oil price shocks.
Keywords: monetary transmission; global financial crisis; monetary policy; domestic credit; stock price; exchange rate; interest rate; oil price shock; US economy
JEL Classification Codes: E0; E60

1. Introduction

Monetary policy is designed to reach economic goals and is transmitted to the economy through well-known channels of monetary transmission mechanisms including the interest rate, exchange rate, credit, and asset prices (Bernanke, 1992; Bernanke and Gertler, 1995; Mishkin, 1995, 1996, 2001; Taylor, 1995). In order to achieve economic objectives, it is vital to ensure that the monetary policy impacts the monetary transmission mechanisms effectively. Therefore, many economic studies have investigated monetary transmission by considering the effects of monetary policy on the interest rate (e.g. Chong, 2010; Karagiannis Panagopoulos, and Vlamis, 2010), on the exchange rate (e.g. Aleem, 2010; Montes, 2013; Ono, 2013), on domestic credit (Juurikkala, Karas, and Solanko, 2011; Kishan and Opiela, 2006; Sengonul and Thorbecke, 2005), and on asset price (e.g. Koivu, 2012; Laopodis, 2013; Li, İşcan, and Xu, 2010). Although these four variables are factors of monetary policy transmission, monetary policy is not the only factor influencing these channels. Thus, the influences of other factors might prevent policy makers from achieving their intended economic goals.

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Oil price, which serves as a stress factor in most economies, have been studied extensively (Ali Ahmed and Wadud, 2011; Bachmeier, 2008; Creti, Ftiti, and Guesmi, 2014; Dagher and El Hariri, 2013; Fowowe, 2014; Iwayemi and Fowowe, 2011; Narayan and Narayan, 2010; Rahman and Serletis, 2010; Wu and Ni, 2011; Zhang and Chen, 2011). Besides oil price, many researchers have focused on the US economy, given its role as a major international trade partner to many countries and thus its effects on their economies (Beaton, Lalonde, and Snudden, 2014; Berument and Kilinc, 2004; Eickmeier and Ng, 2015; Valadkhani and Chen, 2014; Yamamoto, 2014). Besides the roles played by the US economy and oil price in the international economy, the role of these variables in global crises, such as the recent crisis of 2007-2009, is considerable. Many economic studies have investigated the impacts of oil price and the US economy on other economies regarding this role (Bagliano and Morana, 2012; Cuñado and Pérez de Gracia, 2003; Hamilton, 1983, 2011). During global financial crises, the channels of monetary policy transmission can also be affected by the oil price and the US economy. Similarly, a country can withstand oil price and US economy shocks causing the global crisis if its monetary policy, namely, the effect of the monetary policy on the channels of monetary transmission mechanisms, is robust. Thus, it stands to reason that if a monetary policy was robust enough, it could withstand the external shocks from oil price and US economy and minimize their effects on a country's economy during periods of financial crisis. Therefore, it would be interesting to study the circumstances under which a monetary policy allows/disallows external shocks to pose a threat to the economy. Thus, this study considers the effects of monetary policy as well as oil price and US output, as representation of US economy, shocks on select economies during the pre- and post-crisis periods of the 2007-2009 global financial crisis.

The following two hypotheses are tested for the pre-crisis and post-crisis periods. First, in countries affected by the global crisis, the weaker the effectiveness of the monetary policy against oil price and US output shocks on channels of monetary transmission mechanisms during the pre-crisis period, the greater the downturn during the crisis. Second, in the post-crisis period, the strength of the monetary policy in the face of oil price and US output increases due to economic reforms instituted during the crisis, and thus, the economy is no longer vulnerable to external shocks during this period.

This study focuses on the strength of the monetary policies of 3 countries, Indonesia, Malaysia, and Thailand, during the global financial crisis of 2007-2009. A review of gross domestic product (GDP) growth and inflation suggests that these countries experienced an economic downturn during 2007-2009. Figures 1 and 2 use normalized data from the World Bank Dataset and show high inflation and low output growth in these 3 countries during 2007-2009. Unlike Indonesia, Malaysia and Thailand were severely affected by the global crisis. However, despite the considerable impact of external shocks in these countries during the crisis period, no study has considered the role of monetary transmission mechanisms during 2007-2009 specifically. While some studies have studied the monetary transmission mechanisms in these countries during specific periods (e.g. Azali, 2003; Azali and Matthews, 1999; Disyatat and Vongsinsirikul, 2003; Hesse, 2007; Raghavan and Silvapulle, 2008; Raghavan, Silvapulle, and Athanasopoulos, 2012), there is a gap in the literature regarding the most recent global financial crisis. This study aims to fill this gap. Moreover, although many studies have focused on monetary policy and monetary transmission mechanisms, to the best of our knowledge, no researcher to date has studied an economy's vulnerability to oil price and US output due to the prevailing interest rate, exchange rate, credit, and asset prices. Therefore, this study is the first of its kind to show that the economic vulnerability of the above-mentioned countries during the 2007-2009 crisis was a result of a weak monetary policy, which could not protect the channels of monetary transmission mechanisms against oil price and US output shocks. The study also shows that despite experiencing the global financial crisis, the countries' vulnerability against the same external shocks has not necessarily diminished.

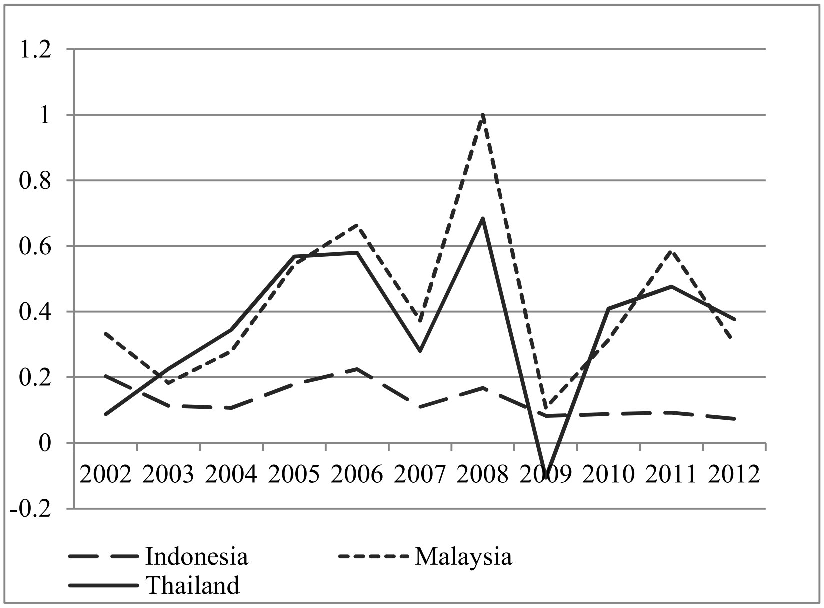

Figure 1. GDP growth
Notes: Data are normalized and from World Bank Dataset

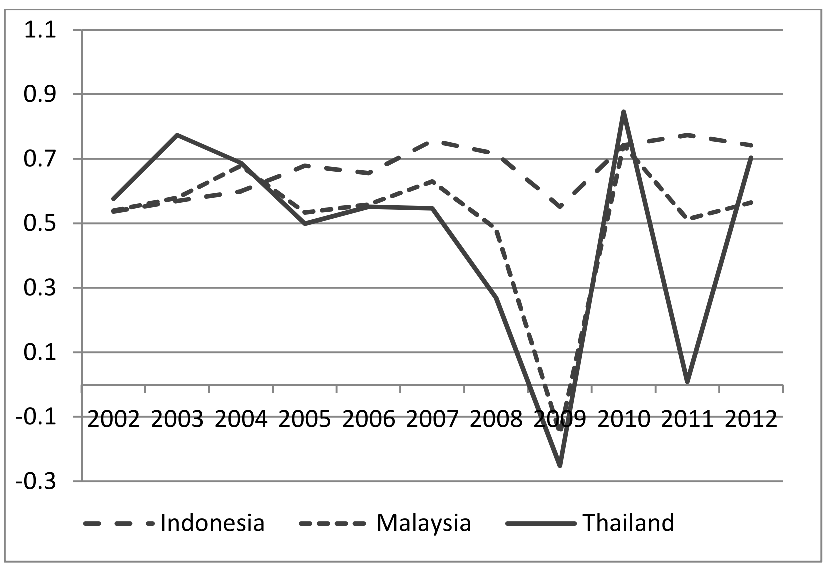

Figure 2. Rate of inflation
Notes: Data are normalized and from World Bank Dataset

2. Model and Methodology

2.1. Data

This paper uses monthly data from 2002:M1 to 2013:M4. y_t represents the vector of variables: y_t= $[int \quad m2 \quad cpi \quad ip \quad oil \quad USip \quad dc \quad eer \quad sp]$, where *int*, *m2*, *cpi*, *ip*, *oil*, *USip*, *dc*, *eer*, and *sp* stand for interest rate, broad money, consumer price index, industrial production, oil price, US industrial production, domestic credit, effective exchange rate, and stock price, respectively. All the variables, except *int*, are in the logarithmic form and in level. VAR in level is generally the norm in studies on monetary policy (e.g. Bernanke & Mihov, 1995; Bernanke & Mihov, 1997; Peersman and Smets, 2001; Shibamoto & Shizume, 2014). Using stationary variables is not important as long as analysis relies on impulse response and variance decomposition in short time. According to Brooks (2014) differencing removes the information about co-movements in variables.

Following Zivot and Andrews (1992), we split the sample into pre-and post-crisis periods. Instead of using joint variables, we test each variable for structural breaks, to find the variables most affected by the crisis. Moreover, testing for structural breaks in series improves VAR performance and forecasting quality (Hassani, Heravi, and Zhigljavsky, 2009). Several researchers divide their samples based on the existence of structural breaks in each series (Baek and Koo, 2010; Bayrak and Esen, 2013; Narayan, 2004; Okunev, Wilson, and Zurbruegg 2002; Pala, 2013; Gerlach, Wilson, and Zurbruegg, 2006). Table 1 presents the results of the two models of the Zivot–Andrews test: (i) intercept and (ii) intercept and trends.

The pre-crisis period ends with the first statistically significant structural break date during 2007-2009, and the post-crisis period starts with the last statistically significant structural break date during the same period. For example, for Indonesia, 2007:12 and 2008:08 are respectively the first and last statistically significant dates showing structural breaks. Thus, the pre-crisis period ranges from 2002:01 to 2007:11, and the post-crisis period ranges from 2008:09 to 2013:04, with a dummy variable for 2005:10. The corresponding samples of the other countries are as follows: 2002:01 to 2008:07 and 2009:01 to 2013:04 for Malaysia, and 2002:01 to 2007:12 and 2008:11 to 2013:04 for Thailand, with a dummy variable for 2011:10.

Table 1. Zivot-Andrews Structural Break Results

	Variable	Intercept	Intercept and trend
	OP	2008:08***	2008:08***
	USIP	2008:08***	2008:08***
Indonesia	*ip*	2005:11	2005:11
	cpi	2005:10***	2005:10***
	m2	2011:05	2010:03
	int	2005:08	2005:01
	eer	2009:10	2009:10
	dc	2007:12***	2007:12**
	sp	2010:06	2008:08**
Malaysia	*ip*	2008:09**	2008:09
	cpi	2008:04	2008:04
	m2	2011:08	2010:04
	int	2008:12*	2008:12***
	eer	2010:03	2010:03
	dc	2011:03	2009:05
	sp	2008:03	2008:06
Thailand	*ip*	2011:10**	2007:09
	cpi	2008:10**	2008:10**
	m2	2010:10	2008:01
	int	2008:10*	2008:10
	eer	2006:06	2006:01
	dc	2010:10	2010:01
	sp	2007:08	2008:06*

Notes: ***, **, and * show significance at 1%, 5%, and 10%, respectively, *oil*: oil price, *USip*: *US* industrial production, *ip*: industrial production, *cpi*: consumer price index, *m2*: broad money, *int*: interest rate, *eer*: effective exchange rate, *dc*: domestic credit, *sp*: stock price.

2.2. Model and Identification

VAR models are typically employed in studies on monetary policy since they assess the responses of variables to monetary policy shocks. However, the pure VAR model is a theoretical in nature, and thus, it has been criticized by economists. The structural VAR approach is preferable to VAR given that the latter depends on partial identification and Cholesky decomposition (Elbourne, 2008). The structural VAR model of this paper is based on Kim and Roubini (2000) with some modifications.

Equation (1) shows the reduced form of the VAR.

$$\mathcal{A}_0 X_t = \mathcal{A}(L)\, X_{t-1} + \nu_t \qquad (1)$$

Where $X_t$denotes endogenous variables, $X_{t-1}$is the lagged valued, and ν_t is a vector of error terms. The vector auto regression in reduced form is shown in equation (2):

$$X_t = \mathcal{C}(L) X_{t-1} + u_t \qquad (2)$$

where $\mathcal{C}$(L) = $\mathcal{A}_0^{-1}\mathcal{A}(L)$ indicates the coefficients of lagged variables, and $u_t = \mathcal{A}_0^{-1}\varepsilon_t$ is the observed vector of residuals linked to the structural shocks. Thus,

$$\varepsilon_t = \mathcal{A}u_t \tag{3}$$

The variance–covariance between the observed element, u_t, and the non-observed element, ε_t, is shown in equation 3.

$$\Omega=\begin{bmatrix} {\sigma_1}^2 & \sigma & . & . & . & . & \sigma_{1n} \\ \sigma_{21} & {\sigma_2}^2 & . & . & . & . & \sigma_{2n} \\ \sigma_{31} & . & . & . & . & . & . \\ . & . & . & . & . & . & . \\ . & . & . & . & . & . & . \\ . & . & . & . & . & . & . \\ \sigma_{n1} & \sigma_{n2} & . & . & . & . & {\sigma_n}^2 \end{bmatrix} \tag{4}$$

σ_{ij}in matrix Ω can be calculated as $\sigma_{ij} = 1/\mathrm{T}\sum_{t=1}^{T} u_{it}\, u_{jt}$. The variance–covariance of Ω includes (n^2+n)/2 distinct elements, $\mathcal{A}$ includes $n^2 - n$ unknown values, and $var\varepsilon_{ij}$ contains n unknowns. Thus, we have $n^2 - n + n = n^2$unknowns and (n^2+n)/2 knowns; consequently, the restriction on the system is$n^2 - \frac{n^2+n}{2} = \frac{n^2-n}{2}$. Therefore, 36 restrictions are needed to identify the 9 variables in the structural VAR model used in this study.

2.2.1. Identification

Equation 5 is drawn from $\varepsilon_t = \mathcal{A}u_t$ and displays the restrictions on the structural VAR model in this study.

$$\begin{bmatrix} \varepsilon_{oil} \\ \varepsilon_{usip} \\ \varepsilon_{ip} \\ \varepsilon_{cpi} \\ \varepsilon_{m} \\ \varepsilon_{int} \\ \varepsilon_{dc} \\ \varepsilon_{eer} \\ \varepsilon_{sp} \end{bmatrix} = \begin{bmatrix} 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ \alpha_{21} & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ \alpha_{31} & \alpha_{32} & 1 & 0 & 0 & 0 & 0 & 0 & 0 \\ \alpha_{41} & 0 & \alpha_{43} & 1 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & \alpha_{53} & \alpha_{54} & 1 & \alpha_{56} & 0 & 0 & 0 \\ \alpha_{61} & 0 & 0 & 0 & \alpha_{65} & 1 & 0 & 0 & 0 \\ \alpha_{71} & 0 & \alpha_{73} & 0 & 0 & \alpha_{76} & 1 & 0 & 0 \\ \alpha_{81} & \alpha_{82} & \alpha_{83} & \alpha_{84} & \alpha_{85} & \alpha_{86} & \alpha_{87} & 1 & 0 \\ \alpha_{91} & \alpha_{92} & \alpha_{93} & \alpha_{94} & \alpha_{95} & \alpha_{96} & \alpha_{97} & \alpha_{98} & 1 \end{bmatrix} \begin{bmatrix} u_{oil} \\ u_{usip} \\ u_{ip} \\ u_{cpi} \\ u_{m} \\ u_{int} \\ u_{dc} \\ u_{eer} \\ u_{sp} \end{bmatrix} \tag{5}$$

In the first two rows of equation (5) *oil* and *USip* represent exogenous variables that disconnect supply side shocks from monetary policy shocks. They assume the role of international exogenous shocks that affect economies during global financial crises. According to Bagliano and Morana (2012), the downturns of the US economy can be transmitted through US output to Latin America and Southeast Asian countries.

cpi and ip, which are the equations referring to the commodity markets, must be in equilibrium. oil price as inflation expectations affect industrial production and *cpi* since monthly information on inflation is unavailable. The US influences the industrial production of countries as it is one of their major trade partners. In the fifth row, m denotes money demand, which is theoretically influenced by the *int*, *cpi*, and *ip*. int also refers to the money supply reaction function, a function of money and oil price, as a price expectation. dc or domestic credit is contemporaneously influenced by industrial production and the real interest rate (i.e. interest rate minus inflation), since borrowers are concerned about the real cost of credit

(Wulandari, 2012). The two final equations denote the effective exchange rate, *eer*, and stock price, *sp*. The sensitivity of these two variables to the news, given their forward-looking property, causes them to be influenced contemporaneously by all the variables in the system. However, this study is similar to previous studies (Elbourne and Salomons, 2004; Li, İşcan, and Xu, 2010) in that the exchange rate contemporaneously influences stock price. The one-way direction from the exchange rate to stock price was discovered by Liang, Lin, and Hsu (2013) for ASEAN-5 countries.

3. Empirical Results

This study selects the lags for three lags for the pre-crisis period and two lags for the post-crisis period depending on the results of the Akaike information criterion (AIC), Bayesian information criterion (BIC), and likelihood ratio (LR) tests, the emphasis being on the least serial correlation in the residuals (Buckle, Kim, Kirkham, McLellan, and Sharma, 2007; Voss, 2002). The over identifying restrictions in the structural VAR models are not rejected for any of the three countries (Table 2).

Table 2. Chi-squared for over-identifying restrictions

	Pre-crisis	Significant level	Post-crisis	Significant level
Indonesia	12.49	0.130	7.30	0.504
Malaysia	9.52	0.300	10.75	0.215
Thailand	8.16	0.417	3.70	0.882

Tables 3 and 4 show the contributions of oil price and US industrial production as external shocks, and of money supply and interest rate as monetary policy shocks, respectively. The tables present the fluctuations in each channel of monetary transmission mechanisms in the first, sixth, and twelfth months during the pre-and post-crisis periods. The last two columns indicate the roles of (a) both external shocks and (b) monetary policy variable-related shocks, and they include interest rate and money supply in the twelfth month. The outcomes of variance decomposition (Table 3) show that money had the greatest impact on interest rates given the monetary policy stance prevailing in Malaysia and Thailand during the pre-crisis period. The results showing the role of the monetary policy in exchange rate fluctuations—*m2* accounts for 27% of the variations in exchange rates in Indonesia—suggests that the monetary policy in that country was mainly focused on the exchange rate during the pre-crisis period. Considering the effects of exogenous variables on the variables of the monetary transmission mechanisms, oil price plays the greatest role in explaining fluctuations in all four channels of the monetary transmission mechanisms in Thailand, while the monetary transmission mechanisms in Malaysia was mostly influenced by US industrial production during the pre-crisis period. A common point in the monetary transmission mechanisms in these countries is stock price, which was affected significantly by external shocks. With the exception of Indonesia, oil price had a significant impact on stock price in all countries during the pre-crisis period. Oil price accounted for a maximum of 31% and 21% of variations in stock prices in Malaysia and Thailand, respectively, during the pre-crisis period (Table 3). The stock price was also greatly influenced by US industrial production in all countries during the pre-crisis period; US industrial production explained variations in stock prices of up to about 15% for Indonesia, 24% for Malaysia, and 23% for Thailand during this period.

Comparing the contribution of monetary policy shocks versus external shocks to fluctuations in the four channels of monetary transmission mechanisms in the twelfth month shows the weakness of the monetary policy against oil price and US output in Malaysia and Thailand. On the other hand, monetary policy performed fairly well in Indonesia during the same time period. According to Figures 1 and 2, unlike Indonesia, Malaysia and Thailand experienced a significant economic downturn during the global crisis. Thus, the first hypothesis stands proved, namely, a stronger effect of monetary policy against oil price and

US output on channels of monetary transmission mechanisms can protect the economy from external shocks, thus the economy experience less downturn during the crisis period.

Table 3. Variance decomposition of monetary transmission channels due to monetary policy and external shocks during pre-crisis period

country	shocks	*Oil*			*USip*			*m2*			*int*			External	Monetary Policy
	variable \ month	0	6	12	0	6	12	0	6	12	0	6	12	12	12
Indonesia	*Interest rate*	12	13	11	0	7	8	4	3	3	83	44	40	20	43
	Domestic credit	9	9	9	0	7	9	0	10	9	0	1	2	18	11
	Exchange rate	4	8	7	1	16	15	27	24	19	0	1	3	22	22
	Stock price	7	6	5	0	11	15	15	9	9	2	14	11	20	20
Malaysia	*Interest rate*	1	4	14	0	10	21	74	17	6	0	8	3	35	9
	Domestic credit	6	3	1	0	13	27	0	6	5	0	4	3	28	8
	Exchange rate	0	3	7	1	12	21	0	1	1	0	0	4	28	5
	Stock price	1	31	16	2	9	24	1	1	4	6	7	4	40	8
Thailand	*Interest rate*	0	51	57	0	5	12	34	4	1	64	15	6	69	7
	Domestic credit	2	28	38	0	3	17	0	9	6	0	4	3	55	9
	Exchange rate	1	53	47	2	4	11	7	12	10	1	2	5	58	15
	Stock price	1	14	21	1	10	23	15	7	5	0	6	6	45	11

Table 4 presents the results of the variance decomposition. They indicate the minor impact of US industrial production as well as the considerable contribution of monetary policy on fluctuations in the channels of monetary transmission mechanisms during the post-crisis period. Oil price continued to play an important role in explaining the fluctuations of these variables. Compared to oil price, monetary policy played a weaker role in all channels except for the exchange rate of Indonesia, domestic credit of Malaysia, and interest rate of Thailand. Monetary policy could explain 39% of fluctuations in the exchange rate in Indonesia, 23% of the fluctuations in domestic credit in Malaysia, and 39% of volatility in interest rates in Malaysia and Thailand in last month. Despite reducing the impact of external shocks and improving the effectiveness of the monetary policy at peaks compared to the pre-crisis period, oil price continued to provide significant external shocks, especially to stock prices. Oil price explained 33%, 18%, and 37% of fluctuations in stock prices for Indonesia, Malaysia, and Thailand, at peaks, respectively. The role of US industrial production in affecting the channels of monetary transmission mechanisms, however, weakened. However, it continued to pose a threat to the economies of Indonesia and Malaysia through the exchange rate channel. US industrial production accounted for 11% and 22% of the fluctuations in exchange rates in Indonesia and Malaysia, respectively. In general, these countries were still vulnerable to external shocks in the post-crisis period; especially those provided by oil price, and thus, the second hypothesis cannot be accepted.

Table 4. Variance decomposition of monetary transmission channels due to monetary policy and external shocks during the post-crisis period

country	shocks	*Oil*			*USip*			*m2*			*int*			External	Monetary Policy
	month / variable	0	6	12	0	6	12	0	6	12	0	6	12	12	12
Indonesia	*Interest rate*	15	10	17	0	2	2	6	7	8	79	25	18	19	24
	Domestic credit	5	27	30	0	0	0	0	5	5	9	7	6	30	11
	Exchange rate	11	6	17	1	11	11	35	42	30	8	13	9	28	39
	Stock price	11	21	33	1	5	4	1	6	4	27	21	13	37	17
Malaysia	*Interest rate*	5	6	10	1	21	19	72	35	32	17	9	7	29	39
	Domestic credit	1	5	5	0	6	6	0	16	15	0	9	8	11	23
	Exchange rate	0	4	12	0	22	20	8	11	9	0	6	7	32	16
	Stock price	8	15	18	2	6	8	20	14	13	4	6	6	24	19
Thailand	*Interest rate*	0	16	9	0	6	4	64	46	34	20	5	5	13	39
	Domestic credit	0	9	15	0	4	9	0	5	4	0	16	22	24	26
	Exchange rate	0	18	16	2	5	8	1	5	13	6	1	1	24	15
	Stock price	25	37	22	0	2	9	3	6	11	4	14	10	31	21

5. Conclusion

This research investigated whether monetary policy could protect the economies of Indonesia, Malaysia, and Thailand against oil price and US output, the two shocks that are known to have played important roles in the global financial crisis of 2007-2009. It also considered whether the same external shocks continued to pose a threat to the economies after the crisis. The study tested the efficiency of the monetary policy on four known channels of monetary transmission mechanisms, namely, interest rate, exchange rate, domestic credit, and stock price, during the pre-crisis and post-crisis periods. To do so, it tested two hypotheses for the pre-crisis and post-crisis periods. The first hypothesis, for the pre-crisis period, states that the weaker the influence of the monetary policy on monetary transmission mechanisms, the higher the impact of the global crisis on the economies. The second hypothesis, for the post-crisis period, states that the countries are not vulnerable against external shocks because of the strength of their respective monetary policies, which affect the channels of monetary transmission; in other words, the economic reforms undertaken by these economies have helped them avoid another financial crisis.

The results suggest that the monetary policies of both Malaysia and Thailand, countries that experienced depression during the crisis, were weak at influencing channels of monetary transmission mechanisms, while that of Indonesia was fairly good, thus leading the country to experience a smaller economic downturn during the crisis. Therefore, we conclude that monetary policy weakly influences channels of monetary policy transmission mechanisms, leading to spillover effects of the global crisis in these countries. In other words, the first hypothesis is accepted. After the crisis, however, the monetary policies of these countries were shown to have been generally more effective, as they impacted the channels of monetary transmission mechanisms to a greater extent than in the pre-crisis period. The impact of oil price on the channels of monetary policy continued to be considerable; therefore, these countries may be at risk of facing an oil price-related shock. Thus, the second hypothesis is rejected. The vulnerability of the channels of monetary transmission mechanisms to US output shocks declined greatly after the crisis. This may be attributed to the fact that these ASEAN countries replaced the US with China as their biggest trade partner. However, shocks to the US economy are still transmittable to Indonesia and Malaysia through the exchange rate route. It should be noted that although the countries showed differences in the impacts of external shocks on the channels of monetary transmission mechanisms, the stock prices in all these economies were considerably affected by oil price and US output during both periods. Future studies in this area could include the effects of external shocks on other kinds of assets, such as gold and housing prices. Moreover, a comparison between the strengths of the monetary policy and fiscal policy can help policy makers understand how they may protect the economy against external shocks.

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