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Spillovers of United States and People's Republic of China shocks on small open economies: The case of Indonesia

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ADB Working Paper Series

**SILLOVERS OF UNITED STATES
AND PEOPLE'S REPUBLIC
OF CHINA SHOCKS ON SMALL
OPEN ECONOMIES: THE CASE
OF INDONESIA**

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Abstract

This paper examines the impact of certain external shocks originating from the United States (US) and People's Republic of China (PRC) on Indonesia as a small open economy. The spillover effects of tapering off, an interest rate hike, exchange rate devaluation, and real gross domestic product (GDP) are analyzed. Two versions of the global vector autoregression model are employed, which covers 33 countries and considers both financial and trade relations among countries. Spillover assessments are conducted through impulse responses with 1,000 bootstrap replications, and compared to the responses of peer countries.

The results suggest that the main risk for Indonesia's real GDP is a shock to the PRC's real GDP, while a US interest rate hike is the greatest risk to Indonesia's exchange rate depreciation in the short term, especially compared to the US tapering off. Moreover, the dominant transmission channel of US monetary tightening is through finance, dampening economic growth in small open economies.

JEL Classification: C32, E17, F47

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1. INTRODUCTION

Since the global financial crisis, economists and policy makers have become more aware of risk and the potential impact of policies adopted in dominant economies, like those of the United States (US) and People's Republic of China (PRC). Economic integration through trade and financial relations allows the transmission of shock from developed countries to other countries, including Indonesia, a small open economy. The International Monetary Fund (IMF 2014) argued that the main source of spillover in the global economy is unbalanced growth. Two expected trends are relevant: (i) the recovery of developed countries, which indicates normalization of monetary policy easing that tightens global liquidity; and (ii) slowing growth of developing countries, which potentially hampers global demand.

An increase of the US interest rate is likely to trigger an interest rate hike in emerging markets (Edwards 2010). Further, it reduces gross domestic product (GDP) in emerging economies (Druck, Magud, Mariscal 2015), including Indonesia (Harahap 2013b). In this paper, the global vector autoregression (GVAR) approach is employed, which was first developed by Pesaran, Shuermann, and Weiner (2004) and includes 11 countries. The model was extended by Déés et al. (2007) to include 26 countries,¹ and by Chudik and Smith (2013) to include 33 countries, with the US treated as a dominant economy. The GVAR has been applied in various empirical assessments, such as an examination of GDP spillovers among eurozone countries (Sun, Heinz, Ho 2013) and evaluation of the effects of quantitative easing (Chua et al. 2013, Chen et al. 2015).

In this paper, two versions of the GVAR model are applied: one with six endogenous variables (Déés et al. 2007, Smith and Galesi 2014), and then a slightly modified one with five endogenous variables. Both models account for 33 countries, which cover almost 90% of world GDP.² The matrix is further modified to accommodate both trade and financial relationships. The responses of macroeconomic variables in Indonesia are highlighted as an example of a small open economy. Accordingly, a few scenarios are applied, resembling the US tapering off, a Federal Reserve System fund rate hike, an increase of US GDP growth, decelerating GDP growth in the PRC, and depreciation of the PRC real exchange rate. The responses are compared to those of several other countries, and to different sources of shocks.

The main findings are as follows. First, a US interest rate hike or a decline of US broad money is transmitted mostly via the financial channel and, therefore, has a negative impact on GDP in Indonesia. Second, the greatest risk to Indonesia's economic growth is economic growth slowdown in the PRC. Third, the greatest risk for Indonesia's exchange rate depreciation is a US interest rate hike, especially if it is unanticipated. Implicitly, the research thus suggests policy countermeasures across different type of shocks.

2. SPILLOVER CHANNELS

Monetary policy in developed countries can have spillover effects on other countries through several channels. The first is the portfolio rebalancing channel. Chua et al. (2013) showed that normalizing monetary policy in developed countries, such as the

¹ With the eurozone treated as a single economy.

² The original model only accounts for trade.

US, will increase US long-term bond yields and encourage investors to rebalance their portfolios. Investors will also switch from developing-country assets to developed-country assets that have lower risk. Financial asset prices in developing countries therefore will fall, and long-term interest rates will increase, indicating tightening financial conditions in developing countries.

The second channel is international financial markets, combining liquidity, asset prices, and risk-taking channels. Lavigne, Sarker, and Vasishtha (2014) and Dahlhaus and Vasishtha (2014) found that, in an integrated global market, tapering-off and normalization may reduce global liquidity and increase policy rates in developed countries, which reduces the interest rate differential between developed and developing countries, thus diminishing the incentive to carry trade. Accordingly, capital will flow from developing to developed countries, after considering the return and risk (i.e., risk-adjusted return). Subsequently, this causes a decline in financial asset prices and consumer prices in developing countries.

The third channel is the exchange rate. Mohanty (2014) posited that normalizing monetary policy in developed countries causes their currencies to appreciate but causes developing countries' currencies to depreciate. This may encourage speculation and increase the amount and volatility of capital flows. In countries with managed floating regimes, central bank intervention may cause the decline of foreign exchange reserves and lower domestic credit.

Normalization can directly impact developed countries through international trade. If normalization in developed countries is triggered by strong economic growth, it may push real demand for goods and services from developing countries, especially with their weakened currency. However, impact depends on the degree of elasticity of imports in developed countries.

A slowdown in developing countries may be transmitted into the global economy through trade, commodities, and financial relations. For Indonesia, the slowdown in major emerging markets such as the PRC could be significantly transmitted through trade, considering the PRC is Indonesia's main export destination. A slowdown in PRC output could also lower commodity prices, as PRC influence on commodity markets is substantial. The decline in commodity prices further affects Indonesia as a commodity-exporting country. A PRC slowdown could also be induced through investment.

3. EMPIRICAL FRAMEWORK

This paper implements the GVAR model, a modeling approach that combines time series, panel, and factor analysis to elucidate macroeconomic and financial issues. Smith and Galesi (2014) wrote that the GVAR model has several advantages, such as: (i) national and international interrelationships that are transparent and can be tested empirically; (ii) long-term relationships that are consistent with the theory as well as short-term relationships that are coherent with the data; and (iii) it allows the creation of solutions that are consistent with economic theory, despite the serious issues related to the dimension of global economic modeling.

Technically, GVAR is a global model that connects the vector autoregression (VAR) model of each country, where domestic variables are associated with foreign variables specific to each country. Foreign variables are associated with domestic variables of such countries through trade, financial, or other patterns. A foreign variable is constructed as a weighted average of a trading partner. As explained in Chua et al. (2013), suppose there are $N + 1$ countries in the global economy with an index

$i = 0, 1, 2, \dots, N$ where 0 is used as a reference country. The individual VARX* (p_i, q_i) for each country is

$$x_{it} = a_{i0} + a_{i1}t + \sum_{s=1}^{p_i} \Phi_i x_{i,t-s} + \sum_{s=0}^{q_i} \Lambda_i x_{i,t-s}^* + \varepsilon_{it}, \quad (1)$$

$$\varepsilon_{it} \sim i.i.d(0, \Sigma_i)$$

where x_{it} is a vector of domestic variable $k_i \times 1$, and x_{it}^* is a vector of foreign variable $l_i \times 1$ with

$$x_{it}^* = \sum_{j=0}^N \omega_{ij} x_{jt} \quad (2)$$

where ω_{ij} is weighted with $\sum_{j=0}^N \omega_{ij} = 0$. Weight ω_{ij} for country i is built based on the portion of the flow from country j to the total flow received by country i , which represents the relationship between country i and country j . Country-specific foreign variables x_{it}^* are assumed as weakly exogenous. In the model, the coefficient of the error-correction term is set to zero in the equation's foreign variables, which means that the dynamics of foreign variables are not affected by the long-run equilibrium path, in contrast to domestic variable. Each country model is also estimated through reduced rank regression and ordinary least squares to obtain the parameters of individual countries.

Meanwhile, the weight ω_{ij} is based on a blend of trade and financial relations among countries. The default matrix in Smith and Galesi (2014) is thus modified. Along with Chen et al. (2015), the weights are obtained through the following equation:

$$\omega_{ij,t}^{agg} = w_{i,t}^T \omega_{ij,t}^T + w_{i,t}^F \omega_{ij,t}^F \quad (3)$$

where $\omega_{ij,t}^T$ and $\omega_{ij,t}^F$, respectively, are the weights of trade and financial relations bilaterally. $w_{i,t}^T$ and $w_{i,t}^F$, respectively, are the degrees of relative importance between the flow of trade and financial flows in the economy. Two variables are formed from the current value of trade (exports and imports) and financial flows (inbound and outbound) relative to the total value of the two components. Weights between i and j are then fixed and obtained through

$$\omega_{ij} = \frac{1}{T} \sum_{t=1}^T \omega_{ij,t}^{agg} \quad (4)$$

Trade and financial weight are represented by trade and financial relations, respectively, using data from 2011 to 2014. The trade relationship is based on the flow of exports and imports. Financial flows are represented by international bank lending from the Bank for International Settlements. Due to incomplete financial flow data of a particular country at a particular time, the relative importance of financial weight on that economy is assumed to be zero, and therefore only the trade weight is used for a small number of cases.

This paper employs two versions of the GVAR model. The first model refers to Déés et al. (2007), which includes real GDP, inflation, short-term interest rate, long-term interest rate, real exchange rate (RER), and index of equity prices as domestic variables. All variables, except RER, are also included in foreign variables. The second model specifically aims to assess the impact of the US tapering off. It includes real GDP, inflation, broad money growth, RER, and an index of equity prices as domestic variables, while those variables, except RERs, are also included as foreign variables. Exogenous variables used in both models are oil, metal, and raw material prices.

Other variables are also considered: credit growth, current account balance, housing prices, credit default spread, and the Chicago Board Options Exchange Volatility Index (VIX). However, the variables are limited because:

- (i) The number of endogenous variables must be restricted, as the computation covers many countries, so the use of credit growth and current account balance is excessive.
- (ii) The impact on the fundamental context rather than short-term volatility is more pressing, so the use of the credit default spread and VIX is less appropriate.
- (iii) The availability and general relevance of the variables on all economies are key.

Quarterly data are employed from 1979Q2 to 2014Q4 taken from International Financial Statistics, Bank for International Settlements, Bloomberg, CEIC Data, and Organisation for Economic Co-operation and Development. From 2009, the Wu–Xia shadow policy rate (Wu and Xia 2015) is used as the US short-term interest rate to better represent the US monetary policy stance at zero lower bound.³ Most of the data are converted into natural log form, except for the variables in percentage form. The data cover 33 countries,⁴ which represent almost 90% of world GDP.

Some additional settings in the GVAR estimation also follow Déés et al. (2007). First, in relation to the role of the US as a benchmark of global financial markets, the US VARX specification does not include several foreign variables such as index of equity prices, interest rates, and broad money (Appendixes 7 and 8). Second, concerning the difference in the degree of integration, the trend restriction is given on interest rates, inflation, and broad money variables, respectively.

After obtaining a VAR model for each country, the GVAR model is estimated. Although estimation is done separately for each country, the GVAR model is solved entirely ($k_i \times 1$ global vector variable, $k = \sum_{i=0}^N k_i$) because of its dependence on the same period between x_{it} domestic variable to foreign variable x_{it}^* . The solution of the GVAR estimation can be used to obtain the impulse response.

Following Chua et al. (2013), if $z_{it} = (x_{it}, x_{it}^*)'$, equation (1) can be written as

$$A_i z_{it} = a_{i0} + a_{i1}t + \sum_{s=1}^{p_i} B_{is} z_{i,t-s} + \varepsilon_{it} \quad (5)$$

where $A_i = (I_{k_i} - \lambda_{i0})$, $B_{is} = (\Phi_{is} \lambda_{is})$.

From equation (2) $z_{it} = W_i x_t$ can be obtained, where W_i is the weighting matrix, sized $(k_i + l_i) \times k$, and defined from country-specific weights ω_{ij} . Thus, equation (5) can be transformed into

$$A_i W_i x_t = a_{i0} + a_{i1}t + \sum_{s=1}^{p_i} B_{is} W_i x_{t-s} + \varepsilon_{it} \quad (6)$$

and the individual country models are gathered into a global model x_t :

³ The data are available via the Federal Reserve Bank of Atlanta.

⁴ Argentina, Australia, Austria, Belgium, Brazil, Canada, PRC, Chile, Finland, France, Germany, India, Indonesia, Italy, Japan, Republic of Korea, Malaysia, Mexico, Netherlands, Norway, New Zealand, Peru, Philippines, South Africa, Saudi Arabia, Singapore, Spain, Sweden, Switzerland, Thailand, Turkey, United Kingdom, and US.

$$G_0 x_t = a_0 + a_1 \cdot t + \sum_{s=1}^{p_i} G_s x_{t-s} + \varepsilon_t, \quad (7)$$

$$\text{where } a_0 = \begin{pmatrix} a_{00} \\ a_{10} \\ \dots \\ a_{N0} \end{pmatrix}, a_1 = \begin{pmatrix} a_{01} \\ a_{11} \\ \dots \\ a_{N1} \end{pmatrix}, G_0 = \begin{pmatrix} A_{00}W_0 \\ A_{10}W_1 \\ \dots \\ A_{N0}W_N \end{pmatrix}, G_s = \begin{pmatrix} A_{0s}W_0 \\ A_{1s}W_1 \\ \dots \\ A_{Ns}W_N \end{pmatrix}, \varepsilon_t = \begin{pmatrix} \varepsilon_{0t} \\ \varepsilon_{1t} \\ \dots \\ \varepsilon_{Nt} \end{pmatrix},$$

By multiplying equation (7) with G_0^{-1} , the following equation is formed:

$$x_t = G_0^{-1}a_0 + G_0^{-1}a_1 \cdot t + \sum_{s=1}^p G_0^{-1}G_s x_{t-s} + G_0^{-1}\varepsilon_t, \quad (8)$$

Equation (8) can be solved recursively to obtain the future value and impulse response.

The type of impulse response generated is the generalized impulse response function (GIRF) as proposed by Pesaran and Shin (1998) with 1,000 bootstrap replications. The bootstrap method also gives a confidence interval of each impulse response. One standard deviation shock is converted into a 1% shock by using the VECMX residual on the corresponding variable. Based on previous GVAR studies performed by Pesaran and Smith (2006), Déés et al. (2007), Chudik and Fratzscher (2011), and Chen et al. (2015), the confidence intervals of the GIRF tend to be wide and flanked zero. This is due to the limited degree of freedom in estimating many variables.

The GIRF approach has the advantage of not requiring a strong prior belief in the shock or country ordering. However, the GIRF still provides information about the transmission dynamics of the model on the individual shock.⁵

The shock scenarios are based on the condition and prospects of the global economy in 2015. Five types of scenarios are considered: (i) a decline in US broad money as a proxy of US tapering-off, (ii) an increase of US real GDP, (iii) a US interest rate hike, (iv) a decline of PRC real GDP, and (v) a PRC RER depreciation. Besides comparing responses between different shocks, this paper also examines the impulse responses of two types of shock that have a negative impact on Indonesia's economy—a US interest rate hike and decline of the PRC's GDP.

4. RESULTS

Impulse responses are available for 40 periods after the shock, but this analysis focuses on innovation in a shorter time (i.e., fourth quarter, 8th quarter, and the maximum rate over the first 12 quarters). The discussion on the shorter period follows several studies (Sun, Heinz, Ho 2013; Chudik and Smith 2013; IMF 2014) and focuses on the period when the results are more credible (Sun, Heinz, Ho 2013).

Several tests conducted on the GVAR estimates show that the models are stable and can be used for analysis. The results of the weak exogeneity test (Appendixes 1 and 2) indicate that external variables are weakly exogenous at least in 93% of cases for model 1 and 97% of cases for model 2.⁶ Contemporaneous effects on domestic variables are generally in line with the shocks on the same external variables, except in two countries—India and Peru.

⁵ The orthogonalized impulse response function approach was also carried out by order of variables in accordance with Déés et al. (2007): oil prices, short-term interest rates, long-term interest rates, index of equity prices, inflation, and GDP. These results appear to be relatively similar to GIRF responses, so the results are not reported here.

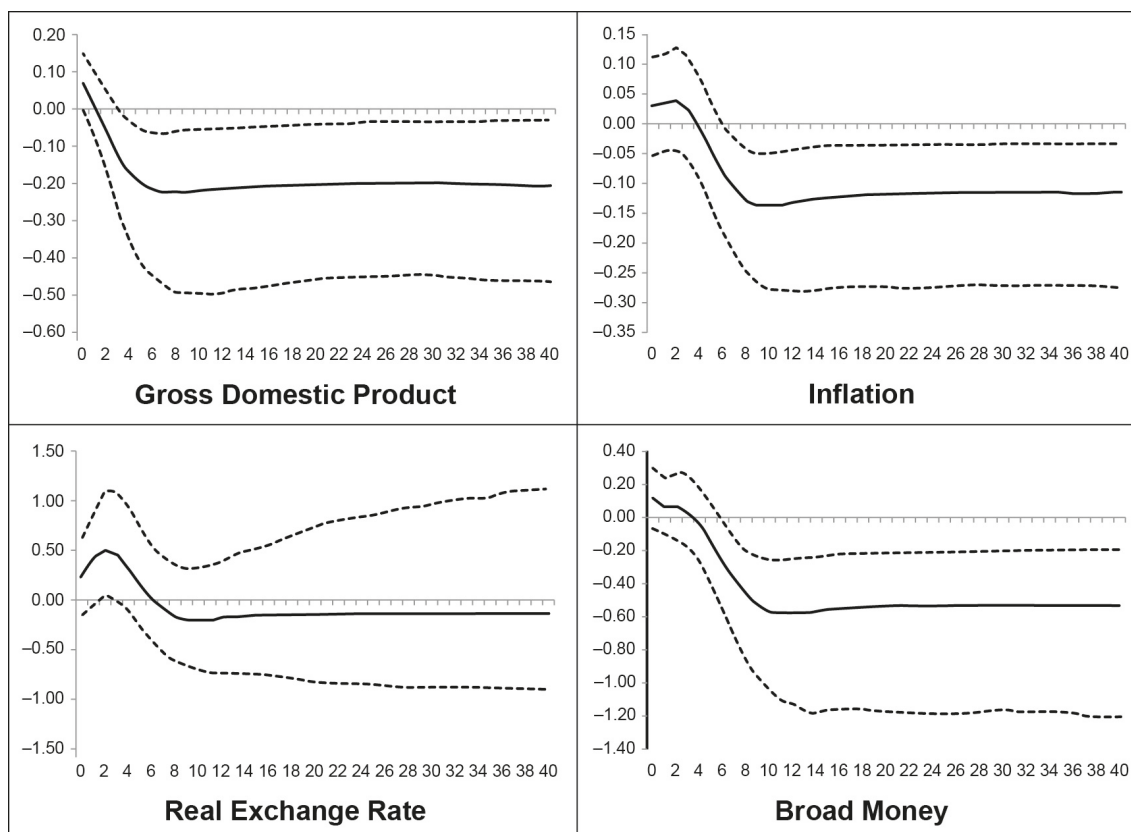
⁶ For model 1, only 16 of 234 cases are found to be significant; for model 2, only 5 of the 174 cases are found to be significant.

The correlation residuals in each VECMX equation are relatively small, 0–0.3 (Appendixes 5 and 6), which shows that the estimated models explain the variations in the endogenous variables data. The low residual correlation also indicates that the GVAR models are effective in explaining the interrelationships among countries (Sun, Heinz, Ho 2013).

4.1 Impact of United States Broad Money Shock

Tapering-off, represented by a decrease in US broad money growth, likely tightens global liquidity. Accordingly, it makes Indonesia's RER depreciate in the short term through capital outflow. Given that the tapering-off is equivalent to a decrease in quantitative easing, the results are consistent with Dahlhaus, Hess, and Reza (2014), where the quantitative easing transmission from the US to Canada was shown to be more dominant through the financial channel.

Figure 1: Indonesia's Impulse Responses to a 1% Decrease of United States Broad Money (%)



Note: x-axis represents periods (quarters) after the shock.

Capital outflow causes a contraction in Indonesia's real GDP (about 0.18% in the first year and 0.22% in the second), which is in line with Harahap et al. (2013b) and Soares (2011), who also found that the financial channel is more dominant relative to the trade channel. Druck, Magud, and Mariscal (2015) described declines in developing countries' real GDP as US exchange rate appreciation (associated with US monetary contraction) lowers commodity prices. Real GDP rises temporarily, which also indicates

that transmission via the trade channel is faster than through the financial channel. Indonesia's inflation increases in the short term due to imported inflation, following exchange rate depreciation. Inflation and broad money would fall in line with output contraction, given the decline in output gap as well as demand for money.

The contraction of Indonesia's real GDP is lower than that of other Association of Southeast Asian Nations (ASEAN) countries.⁷ The GIRF is relatively equivalent to the results of the GVAR analysis carried out by Chudik and Smith (2013), with a 0.25% decline in the United Kingdom's GDP due to the US tapering-off. The RER in Indonesia depreciates 0.31% in the first year, which is lower than in Brazil, one of the "Fragile Five," but still higher than in Malaysia.

Table 1: Comparison of Gross Domestic Product Responses to a 1% Decrease of United States Broad Money
(%)

	4th Quarter	8th Quarter	Maximum over 12 Quarters
Brazil	-0.12	-0.19	-0.20
Indonesia	-0.18	-0.22	-0.22
Japan	-0.07	-0.10	-0.10
Republic of Korea	-0.36	-0.33	-0.36
Malaysia	-0.32	-0.37	-0.37
Philippines	-0.25	-0.30	-0.30
Singapore	-0.49	-0.60	-0.62
Thailand	-0.32	-0.38	-0.38

Table 2: Comparison of Real Exchange Rate Responses to a 1% Decrease of United States Broad Money
(%)

	4th Quarter	8th Quarter	Maximum over 12 Quarters
Brazil	1.37	1.29	1.37
Indonesia	0.31	-0.17	0.51
Japan	-0.13	-0.07	-0.06
Republic of Korea	0.90	0.83	0.90
Malaysia	0.22	0.22	0.23
Philippines	0.75	0.73	0.82
Singapore	0.49	0.73	0.78
Thailand	0.61	0.78	0.80

4.2 Impact of a United States Gross Domestic Product Shock

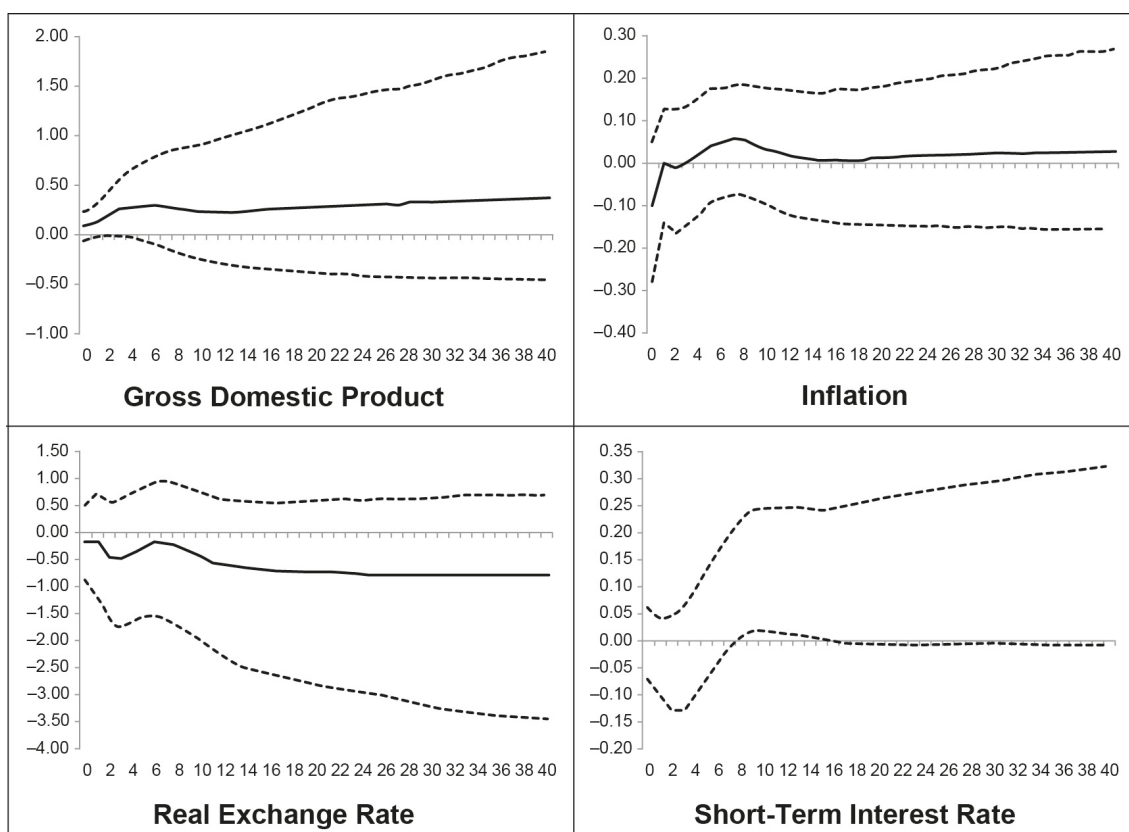
The GVAR impulse responses show that an increase in US real GDP is likely to drive Indonesia's export demand, which, in turn, affects the appreciation of its RER, particularly in the first year, as well as an increase in Indonesia's real GDP. The size of a country affects the sensitivity of trading partners in responding to shocks on the country's GDP (Sun, Heinz, Ho 2013). The US is the world's largest economy, and one of Indonesia's major trading partners.

⁷ Malaysia, Philippines, Singapore, and Thailand.

The impulse response indicates that Indonesia's inflation falls as the RER appreciation reduces imported inflation. These impacts occur instantaneously and immediately become normal. Subsequently, in the second year, Indonesia's inflation rises, driven by the increase in real GDP and hence the output gap. Overall, the response of Indonesia's inflation shows that the transmission that occurs through imported inflation tends to be faster than via trade balance and output gap. Nominal interest rates go down in the first year along with the appreciation of the exchange rate, keeping the real interest rate relatively constant. However, the nominal interest rate increases further due to rising inflation.

Indonesia's real GDP rises by 0.32% in the first year and 0.34% in the second. These findings are consistent with IMF (2014), which argued that a 1% real GDP shock on developed countries results in developing countries' real GDP decreasing by 0.4%–0.5% after 4 quarters. RER appreciation, however, is estimated at around 0.56% in the first year due to the 1% increase in the US real GDP. The impact is lower than in Brazil, Japan, the Republic of Korea, the Philippines, Singapore, and Thailand.

Figure 2: Indonesia's Impulse Responses to a 1% Increase in United States Gross Domestic Product (%)



Note: x-axis represents periods (quarters) after the shock.

Table 3: Comparison of Gross Domestic Product Responses to a 1% Increase in United States Gross Domestic Product (%)

	4th Quarter	8th Quarter	Maximum over 12 Quarters
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Brazil	0.16	0.02	0.17
Indonesia	0.28	0.26	0.30
Japan	0.17	0.11	0.17
Republic of Korea	0.48	0.49	0.59
Malaysia	0.46	0.31	0.47
Philippines	0.11	0.01	0.13
Singapore	0.80	0.61	0.80
Thailand	0.36	0.19	0.38

Table 4: Comparison of Real Exchange Rate Responses to a 1% Increase in United States Gross Domestic Product (%)

	4th Quarter	8th Quarter	Maximum over 12 Quarters
Brazil	-4.07	-4.43	-4.92
Indonesia	-0.39	-0.26	-0.59
Japan	0.97	0.99	0.00
Republic of Korea	-1.69	-1.64	-1.77
Malaysia	-0.22	-0.09	-0.22
Philippines	-1.22	-1.11	-1.22
Singapore	-0.71	-0.80	-0.81
Thailand	-0.74	-1.04	-1.19

4.3 Impact of United States Interest Rates

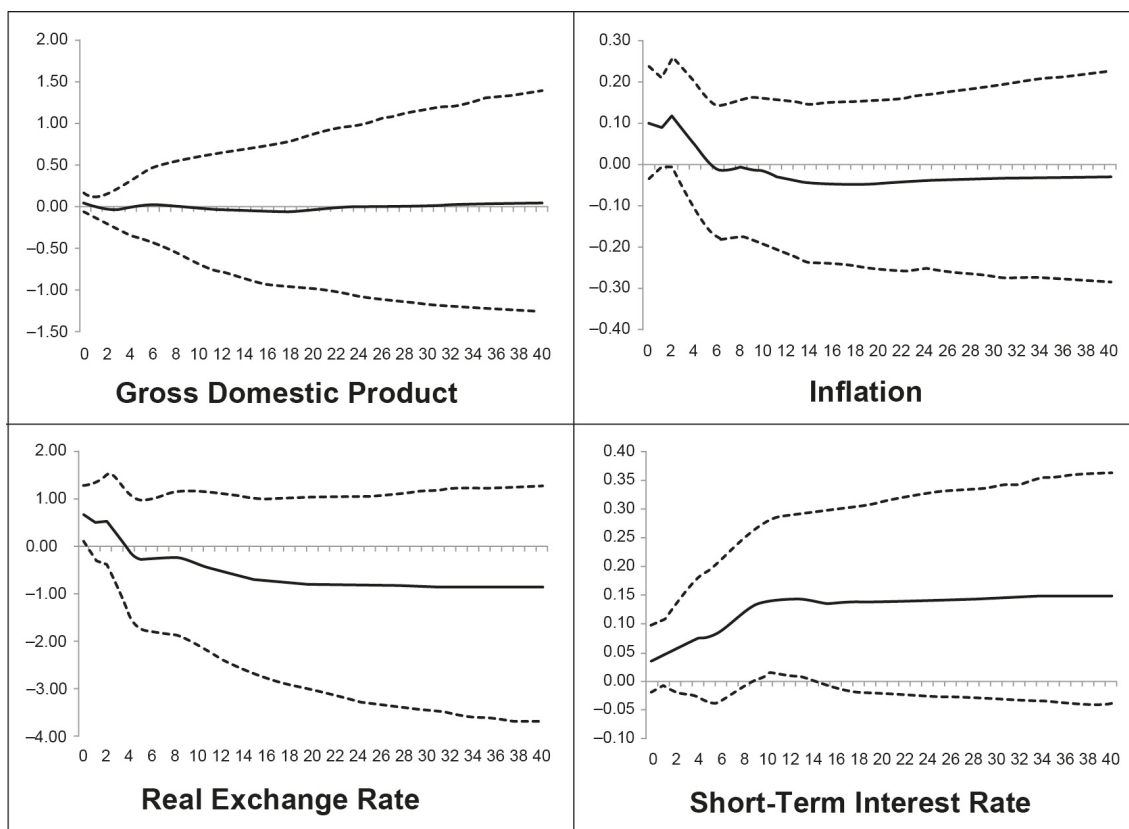
Based on the results of GVAR impulse responses, a US interest rate hike causes capital outflow and triggers RER depreciation in Indonesia in the short term due to changes in the real interest rate differential between Indonesia and the US. The nominal interest rate in Indonesia is also pushed upward due to capital outflow. The results are consistent with Chudik and Smith (2013), which showed a 20 basis-point hike in US interest rates is followed by a 15 basis-point rise in United Kingdom interest rates in the first year. Edwards (2010) also found that an increase in US interest rates by 50 basis points increases interest rates by 15 basis points in Asia contemporaneously.

The median of the impulse response shows that a rise in US interest rates has a negative impact on Indonesia's real GDP. Although greater US interest rates lead to depreciation, thereby increasing real GDP via the trade channel, real GDP is expected to fall only slightly due to rising interest rates in Indonesia via the financial channel. These results are consistent with Harahap et al. (2013b) and Soares (2011), in which the transmission of a US interest rate hike was more potent through the financial rather than trade channel.

Bootstrap replication suggests that the confidence interval widens over time. Druck, Magud, and Mariscal (2015) described a path that does not explicitly appear in the GVAR: an increase in US interest rates pushes US exchange rate appreciation and lowers commodity prices, reducing developing countries' real GDP. Inflation is predicted to rise in the short term because of imported inflation due to depreciation. Along with inflation, the reverse adjustment in the form of RER appreciation gradually occurs in the medium term.

Indonesia's real GDP declines 0.04% in the first year, more than in other countries in general. Indonesia's RER also depreciates by 0.06% in the first year. The maximum impact for the first 12 quarters is higher than in Malaysia, the Philippines, Singapore, and Thailand. However, a rise in US interest rates can have a contradictory impact between different countries.

Figure 3: Indonesia's Impulse Responses to a 1% Increase in the United States Short-Term Interest Rate (%)



Note: x-axis represents periods (quarters) after the shock.

Table 5: Comparison of Gross Domestic Product Responses to a 1% Increase in the United States Short-Term Interest Rate (%)

	4th Quarter	8th Quarter	Maximum over 12 quarters
Brazil	0.30	0.09	-0.03
Indonesia	-0.02	-0.01	-0.06
Japan	-0.01	0.01	-0.07
Republic of Korea	0.33	0.46	-0.11
Malaysia	0.12	0.11	-0.07
Philippines	0.22	0.14	-0.02
Singapore	0.43	0.35	-0.04
Thailand	-0.02	-0.21	-0.27

Source: Authors' calculations.

Assuming that there is price rigidity in the short term, the nominal exchange rate response is instantaneous and large. It strongly indicates that US interest rates could make Indonesia's nominal exchange rate overshoot. An instant impact occurs under conditions of the Dornbusch Overshooting Model, where a rise in US interest rates is assumed to be unanticipated. If an interest rate shock is anticipated, however, the nominal exchange rate is likely to respond more gradually and be realized in full after the shock.

Table 6: Comparison of Real Exchange Rate Responses to a 1% Increase in the United States Short-Term Interest Rate (%)

	4th Quarter	8th Quarter	Maximum over 12 Quarters
Brazil	-4.24	-5.49	-0.47
Indonesia	-0.12	-0.24	0.69
Japan	2.27	2.07	2.27
Republic of Korea	-1.87	-1.77	-0.07
Malaysia	0.17	0.18	0.26
Philippines	-0.97	-0.98	-0.01
Singapore	-0.22	-0.34	0.02
Thailand	-0.65	-1.35	0.07

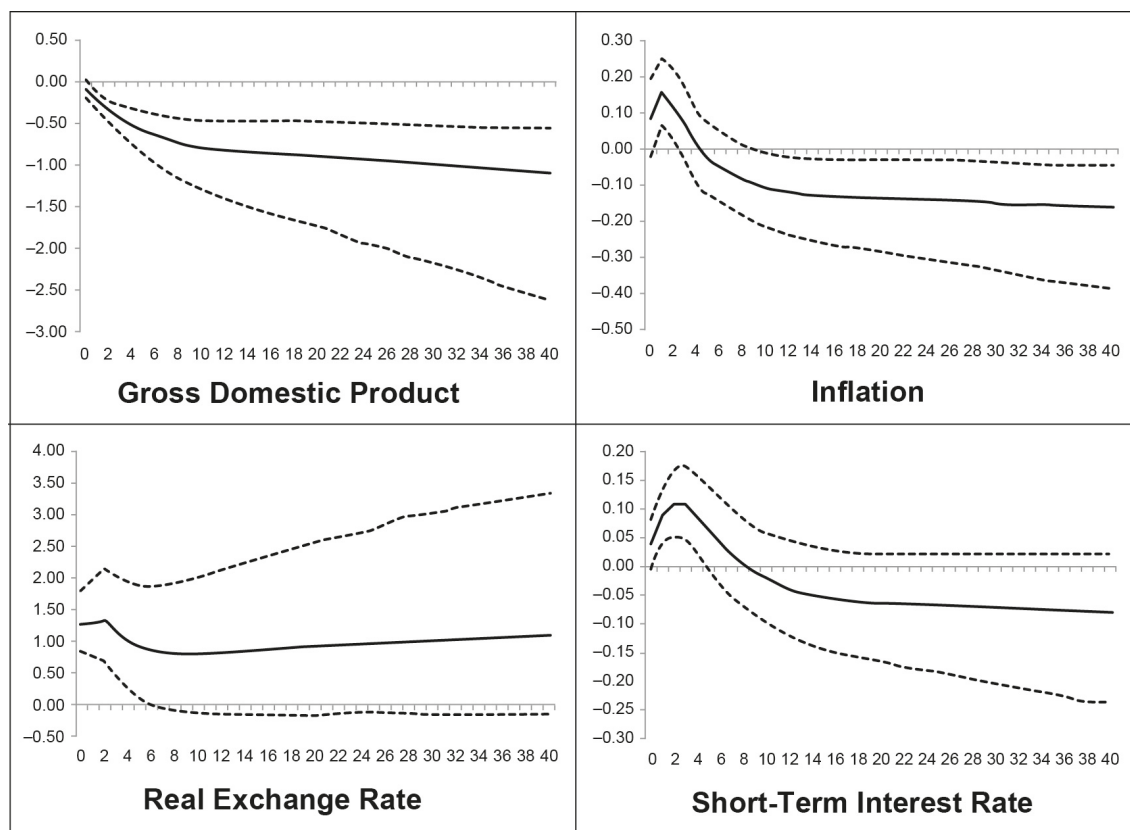
4.4 Impact of the People's Republic of China's Gross Domestic Product Slowdown

As expected, the results indicate that a decline in the PRC's real GDP reduces demand for exports from Indonesia, thereby decreasing Indonesia's real GDP. This is consistent with Anglingkusumo et al. (2014), who explained that a decline in the PRC's real GDP would significantly lower the GDP of 10 countries in Asia.

A decline in Indonesia's exports also pushes its RER to depreciate. Inflation thus rises in the short term, driven by this depreciation, but 1 year after the shock inflation in Indonesia goes down due to the decline in real GDP and the output gap. Interest rates rise in the short term to maintain the level of real interest rates and real interest rate parity. However, the nominal interest rate falls because of the decline in real GDP and inflation.

Indonesia's real GDP declines by 0.52% in the first year and by 0.75% in the second year—higher than in Brazil (0.15%), Japan (0.38%), and Republic of Korea (0.14%), but lower than in Malaysia (0.64%) and Singapore (0.82%). The impacts in developed countries are relatively consistent with IMF (2014), which stated that a 1.0% decline in real GDP in developing countries reduces real GDP in developed countries by 0.2%. Indonesia's RER, however, depreciates by 1.03% in the first year—higher than in Malaysia and the Philippines but lower than in Brazil.

Figure 4: Indonesia's Impulse Responses to a 1% Decline of the People's Republic of China's Gross Domestic Product (%)



Note: x-axis represents periods (quarters) after the shock.

Table 7: Comparison of Gross Domestic Product Responses to a 1% Decrease in the People's Republic of China's Gross Domestic Product (%)

	4th Quarter	8th Quarter	Maximum over 12 Quarters
Brazil	-0.15	-0.21	-0.23
Indonesia	-0.52	-0.75	-0.84
Japan	-0.38	-0.46	-0.49
Republic of Korea	-0.14	-0.08	-0.16
Malaysia	-0.64	-0.72	-0.73
Philippines	-0.09	-0.10	-0.11
Singapore	-0.82	-0.96	-0.98
Thailand	-0.55	-0.70	-0.75

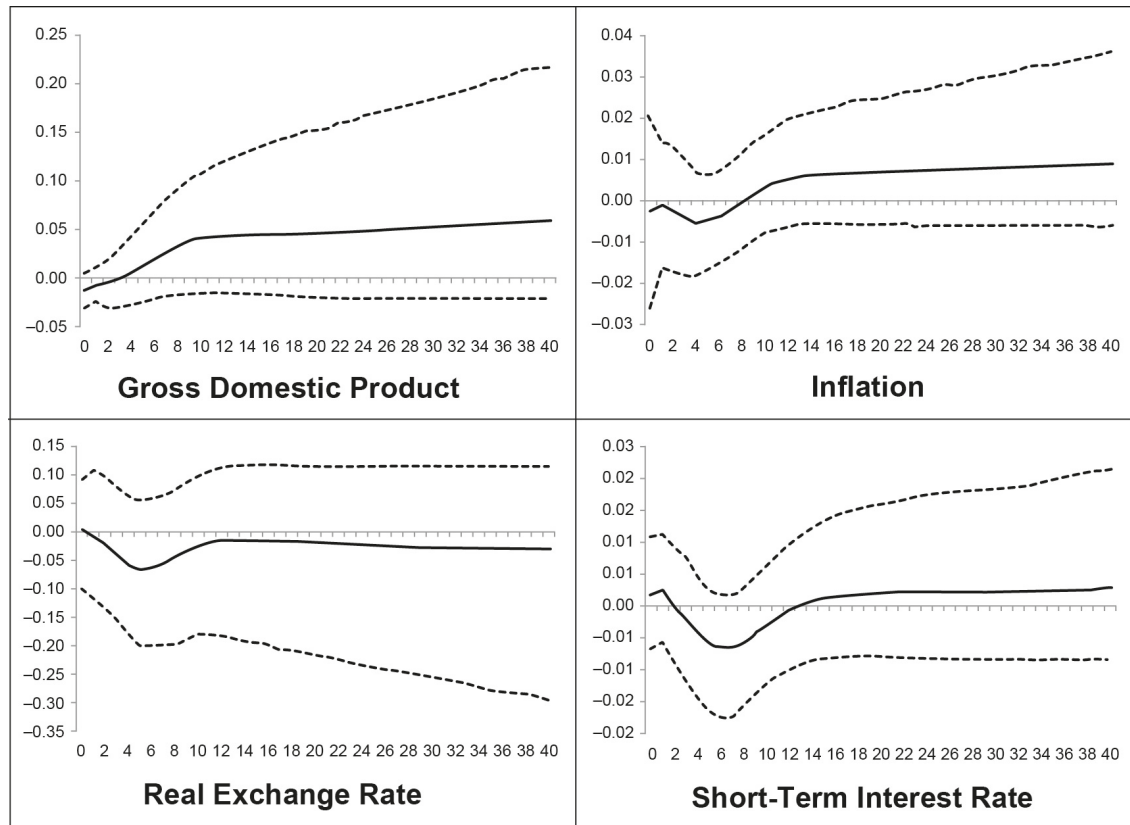
Table 8: Comparison of Real Exchange Rate Responses to a 1% Decrease in the People’s Republic of China’s Gross Domestic Product (%)

	4th Quarter	8th Quarter	Maximum over 12 Quarters
Brazil	1.38	1.77	2.05
Indonesia	1.02	0.80	1.31
Japan	1.04	1.12	1.12
Republic of Korea	0.69	0.95	0.97
Malaysia	0.24	0.23	0.25
Philippines	0.45	0.68	0.89
Singapore	0.71	1.12	1.31
Thailand	0.17	0.16	0.21

4.5 Impact of Depreciation of the People’s Republic of China’s Real Exchange Rate

RER depreciation is expected to boost PRC exports. By holding Indonesia’s RER constant, the PRC’s RER depreciation in the short term increases PRC exports’ competitiveness. Given the competition between Indonesian and PRC exports, PRC’s RER depreciation would make Indonesia’s exports less competitive.

Figure 5: Indonesia’s Impulse Responses to a 1% Depreciation of the People’s Republic of China’s Real Exchange Rate (%)



Note: x-axis represents periods (quarters) after the shock.

Indonesia's real GDP then decreases in the short term (i.e., up to 1 year after the shock). However, the rise of the PRC's RER increases the PRC's real GDP, increases demand for Indonesia's exports, and raises Indonesia's real GDP after the first year.

As Indonesia's exports increase, Indonesia's RER may then appreciate. A higher RER pushes down nominal interest rates and reduces inflation by decreasing imported inflation. However, long-term inflation goes up as real GDP and the output gap increase.

Indonesia's real GDP response to the PRC's RER depreciation is estimated to be relatively small; the impact is similar to that in several other countries. However, Indonesia's RER appreciated by 0.06% in the first year, more than in some developing countries.

Table 9: Comparison of Gross Domestic Product Responses to a 1% Depreciation of the People's Republic of China's Real Exchange Rate (%)

	4th Quarter	8th Quarter	Maximum over 12 Quarters
Brazil	0.01	0.02	0.03
Indonesia	0.00	0.03	0.04
Japan	0.03	0.05	0.05
Republic of Korea	0.02	0.03	0.03
Malaysia	0.00	0.02	0.02
Philippines	0.00	0.00	0.00
Singapore	0.02	0.05	0.06
Thailand	0.01	0.04	0.04

Table 10: Comparison of Real Exchange Rate Responses to a 1% Depreciation of the People's Republic of China's Real Exchange Rate (%)

	4th Quarter	8th Quarter	Maximum over 12 Quarters
Brazil	-0.04	-0.12	-0.13
Indonesia	-0.06	-0.04	-0.07
Japan	-0.10	-0.13	-0.14
Republic of Korea	-0.06	-0.10	-0.10
Malaysia	0.06	0.05	0.04
Philippines	-0.02	-0.05	-0.05
Singapore	-0.02	-0.06	-0.08
Thailand	0.06	0.06	0.02

4.6 Comparison of Responses to Shocks

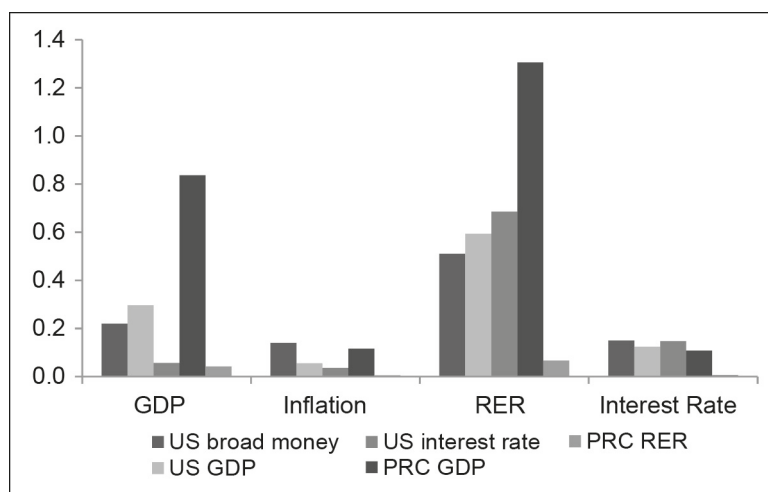
A rise in US short-term interest rates in a quarter influences Indonesia's RER more than the decline in broad money in the same quarter. A shock on short-term US interest rates is also more influential than a shock on US real GDP. This indicates that if the risk originates from the US, the increase in US interest rates is the main factor in continuing RER volatility in the short term. Since the maximum effect occurs in a shorter period, assuming price rigidity in the short term, US short-term interest rates

are the major risk for volatility of Indonesia’s nominal exchange rate. Further, risk to Indonesia’s RER volatility also appears from shocks that originate from the PRC, especially its real GDP.

The negative shock on the PRC’s real GDP is the greatest risk for Indonesia’s real GDP, compared with four other shock sources, including the US real GDP. However, this result is different from the findings of Anglingkusumo et al. (2014), i.e., that the impact of US real GDP is slightly higher than the impact of PRC GDP.

Comparing the impact of different shocks that originate from the US, Indonesia’s real GDP is more sensitive to the shock on US real GDP than either the shock on US short-term interest rates or US broad money. This indicates that the global variable shock transmitted directly through the trade channel affects Indonesia’s real GDP more than global financial variables.

Figure 6: Maximum Responses of Indonesia’s Macro Variables to Several Shocks (%)



GDP = gross domestic product, PRC = People’s Republic of China, RER = real exchange rate, US = United States.

Note: First 12 quarters, absolute terms.

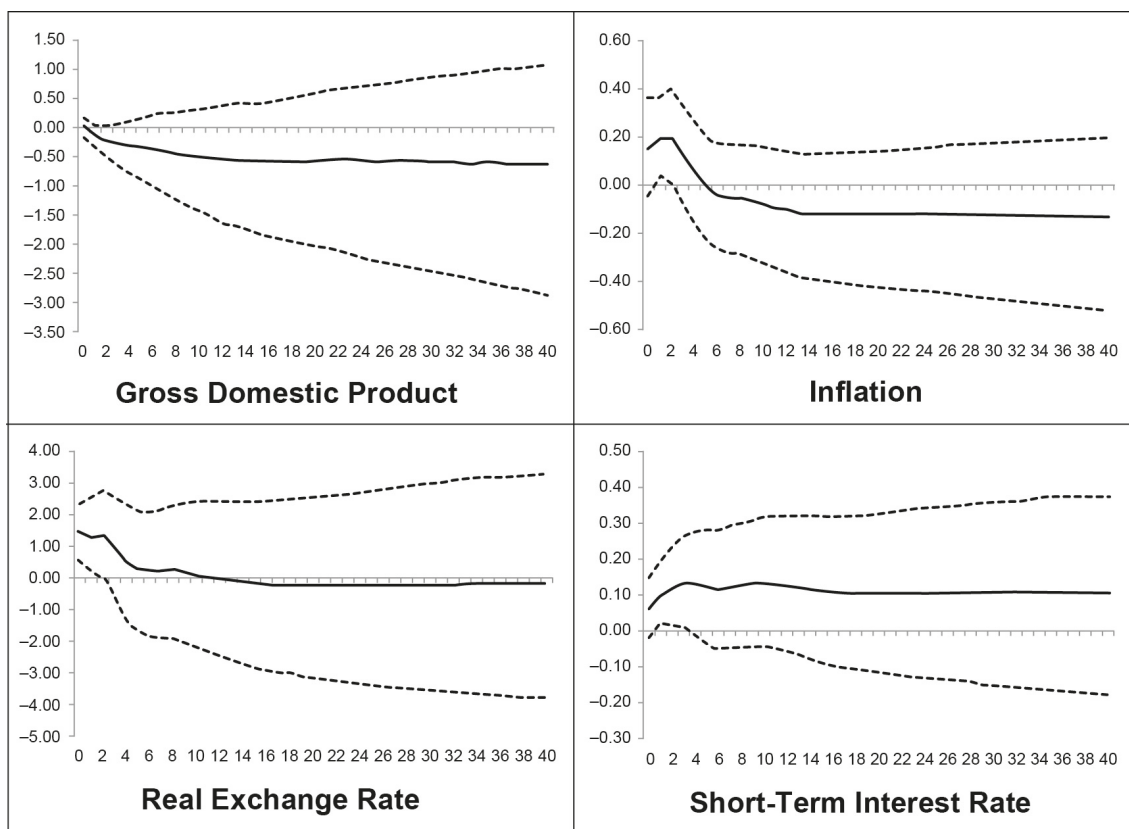
4.7 Impact of Combined Shocks

A combined shock is a mixture of two main sources of external risks to the economy of Indonesia in 2015: (i) an increase in US interest rates by 25 basis points, which is the market expectation throughout 2015; and (ii) a decline of PRC GDP by 0.6%, as estimated by the IMF (2015). Both of these conditions are assumed to occur simultaneously.

As the impact of the shock varies, Indonesia’s GDP slightly decreases, by 0.3%–0.4%, after 4 quarters, and then the GDP is still at risk of falling. However, the results of bootstrap replications indicate that these effects tend to be inconclusive in the long term. In terms of competitiveness, the RER depreciates about 1.5% instantaneously. Depreciation is expected to last at least a year after the shock occurs, thanks to capital outflows from changes in interest rates relative to the position of the US. Further, the upper bound of the confidence interval shows that the maximum rate of RER depreciation due to these two shocks is around 3%.

Inflation rises in the short term (approximately 0.2%), which may be a result of imported inflation due to RER depreciation. Inflation then falls in the second year as inflationary pressure relaxes following a decrease in GDP. On the financial side, the bootstrap replications indicate that the maximum rise of short-term interest rates is about 27 basis points in the first year and 31 basis points in the second year after the shock.

Figure 7: Indonesia’s Impulse Responses to Combined Shocks (%)



Note: x-axis represents periods (quarters) after the shock.

5. CONCLUSIONS

US monetary tightening is transmitted mostly via financial channels, and therefore has a negative impact on real GDP. Also, the greatest risk to Indonesia’s economic growth is a slowdown in the PRC’s economic growth, and the greatest risk to Indonesia’s RER is a US interest rate hike. Finally, the results indicate that, fundamentally, the maximum short-term depreciation effect on Indonesia’s RER is only 3% due to a US interest rate hike and the PRC’s slowdown in 2015.

As there may be a gradual tightening of US monetary policy rather than a one-shot policy, the spillover effect on emerging markets in responding to sequential and repetitive shocks should be examined. Second, the effect of a US interest rate hike that is anticipated—rather than unanticipated, as examined in this paper—should be analyzed. This assessment can also be extended to the recent development that the interest rate hike has been delayed, although this had been expected by the global market.

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APPENDIX 1: WEAK EXOGENEITY TESTS OF FOREIGN VARIABLES, MODEL 1

Country	F Test	GDP	Inflation	Equity Price	Exclusion Rate
Argentina	F(2,118)	0.8	1.6	0.0	
Australia	F(5,120)	1.0	2.8	0.6	
Brazil	F(2,125)	2.7	0.5	0.8	
Canada	F(3,122)	5.6	2.0	1.1	
People's Republic of China	F(2,125)	0.2	0.5	0.3	
Chile	F(2,114)	0.2	0.1	0.4	
Eurozone	F(2,123)	3.5	0.3	1.5	
India	F(2,124)	5.0	2.2	1.6	
Indonesia	F(3,124)	0.5	1.0	1.9	
Japan	F(2,123)	2.8	1.1	0.4	
Republic of Korea	F(4,121)	0.7	0.4	3.4	
Malaysia	F(2,124)	2.9	2.8	0.5	
Mexico	F(3,124)	0.4	2.5	1.4	
Norway	F(3,122)	4.0	1.3	1.0	
New Zealand	F(2,123)	1.1	0.4	0.9	
Peru	F(4,123)	0.5	0.9	0.3	
Philippines	F(2,124)	0.1	1.6	0.8	
South Africa	F(3,122)	0.0	0.5	1.3	
Saudi Arabia	F(2,126)	0.6	1.6	2.2	
Singapore	F(2,124)	0.5	1.5	3.0	
Sweden	F(2,123)	1.0	0.6	0.0	
Switzerland	F(3,122)	5.1	1.5	0.8	
Thailand	F(3,123)	0.6	0.4	0.7	
Turkey	F(1,126)	0.1	0.5	0.1	
United Kingdom	F(3,122)	3.5	0.7	0.7	
United States	F(2,127)	0.4	2.9		0.2

Appendix 1 continued

Country	Short-Run Interest Rate	Long-Run Interest Rate	Oil Price	Raw Material Price	Metal Price
Argentina	4.2	0.3	1.7	2.4	1.4
Australia	0.9	2.0	0.3	0.9	0.4
Brazil	0.3	6.9	1.5	0.1	0.6
Canada	0.7	0.9	1.4	0.4	2.0
People's Republic of China	2.1	0.7	1.7	0.2	1.0
Chile	0.1	1.3	0.8	0.7	2.2
Eurozone	0.2	2.4	0.1	0.0	0.3
India	3.7	0.8	1.4	0.4	2.7
Indonesia	0.9	0.1	1.3	0.8	1.1
Japan	0.2	0.6	0.4	0.7	2.0
Republic of Korea	0.8	1.7	1.0	0.8	0.3
Malaysia	3.6	0.0	0.7	1.6	0.0
Mexico	0.7	1.5	1.5	1.4	4.1
Norway	1.0	1.2	0.3	0.7	1.1
New Zealand	0.4	0.2	1.0	0.1	1.2
Peru	1.5	0.9	0.4	1.6	1.9
Philippines	1.5	1.0	1.6	0.5	1.5
South Africa	2.3	2.1	0.8	0.0	0.3
Saudi Arabia	1.1	1.7	0.2	2.7	1.6
Singapore	1.4	1.7	2.6	0.1	4.0
Sweden	0.1	1.3	0.4	0.5	1.9
Switzerland	0.9	0.4	0.7	1.0	0.4
Thailand	0.6	1.4	0.1	0.1	0.4
Turkey	0.1	2.5	0.7	0.0	0.0
United Kingdom	0.3	2.6	0.7	1.0	1.5
United States			0.7	3.4	2.6

GDP = gross domestic product.

Note: Bold indicates significance at 5%.

APPENDIX 2: WEAK EXOGENEITY TESTS OF FOREIGN VARIABLES, MODEL 2

Country	F Test	GDP	Inflation	Equity Price	Exclusion Rate
Argentina	F(1,126)	0.6	3.4	4.7	
Australia	F(3,124)	1.5	2.2	0.1	
Brazil	F(1,114)	0.1	1.8	0.9	
Canada	F(2,126)	3.0	0.9	0.8	
People's Republic of China	F(2,126)	0.0	0.8	0.1	
Chile	F(1,127)	0.0	0.0	0.1	
Eurozone	F(1,126)	0.0	0.1	0.8	
India	F(1,126)	0.0	0.2	2.7	
Indonesia	F(3,125)	0.4	0.7	3.6	
Japan	F(1,126)	0.9	0.0	0.1	
Republic of Korea	F(1,126)	2.3	0.3	0.6	
Malaysia	F(1,126)	2.5	0.0	1.4	
Mexico	F(3,125)	0.2	1.4	1.9	
Norway	F(2,126)	1.0	1.0	0.6	
Peru	F(3,125)	0.6	1.3	0.7	
Philippines	F(2,126)	0.0	2.4	0.7	
South Africa	F(1,127)	0.1	0.9	0.3	
Saudi Arabia	F(2,127)	1.4	0.1	1.8	
Singapore	F(2,125)	0.2	2.8	1.9	
Sweden	F(1,126)	0.0	2.3	0.0	
Switzerland	F(2,125)	1.8	2.9	1.0	
Thailand	F(3,124)	2.0	0.2	1.4	
Turkey	F(1,127)	0.1	0.0	0.7	
United Kingdom	F(1,126)	0.0	0.4	0.0	
United States	F(2,128)	1.0	4.4		0.8

Appendix 2 *continued*

Exclusion Rate	Broad Money	Oil Price	Raw Materials Price	Metal Price
Argentina	0.3	7.7	0.5	0.0
Australia	0.1	1.3	0.8	0.0
Brazil	0.0	2.5	0.0	2.0
Canada	1.7	0.1	0.3	0.7
People's Republic of China	0.5	0.1	0.1	0.6
Chile	1.0	0.2	0.1	0.0
Eurozone	0.0	0.5	0.0	3.2
India	1.0	1.4	0.2	0.1
Indonesia	1.7	1.8	0.8	1.1
Japan	0.1	0.7	0.3	1.1
Republic of Korea	0.0	1.0	0.3	0.0
Malaysia	0.0	1.4	0.1	1.2
Mexico	1.9	2.0	2.3	2.1
Norway	0.1	1.9	0.3	0.2
Peru	0.7	0.4	1.4	1.2
Philippines	1.1	0.9	1.4	0.7
South Africa	0.8	0.6	0.0	0.8
Saudi Arabia	1.1	0.5	3.3	0.5
Singapore	0.5	1.5	0.6	2.2
Sweden	4.3	0.9	0.2	0.1
Switzerland	0.8	0.1	1.7	0.0
Thailand	0.3	0.2	0.7	0.6
Turkey	1.8	0.1	0.2	0.0
United Kingdom	3.6	0.1	1.4	0.0
United States		2.4	1.5	2.0

GDP = gross domestic product.

Note: Bold indicates significance at 5%.

APPENDIX 3: CONTEMPORANEOUS EFFECTS OF FOREIGN VARIABLES, MODEL 1

Country	GDP	Inflation	Equity Price	Short-Run Interest Rate	Long-Run Interest Rate
Argentina	0.10	-3.07	1.54	3.63	
Australia	0.25	0.50	0.81	0.43	0.87
Brazil	0.19	2.31		1.18	
Canada	0.52	0.42	0.91	0.34	0.97
People's Republic of China	0.59	0.11		0.01	
Chile	0.58	0.11	0.58	0.10	
Eurozone	0.50	0.16	1.06	0.05	0.63
India	-0.36	0.51	0.72	-0.13	
Indonesia	0.34	0.73		0.08	
Japan	0.70	-0.05	0.75	-0.03	0.49
Republic of Korea	0.39	0.45	0.84	-0.16	0.38
Malaysia	1.23	0.74	1.19	0.01	
Mexico	0.42	-0.13		-0.04	
Norway	0.38	0.86	1.01	0.04	0.78
New Zealand	0.45	0.55	0.72	0.55	0.56
Peru	-0.62	4.04		-0.15	
Philippines	0.11	-0.25	1.03	0.57	
South Africa	0.29	0.37	0.85	0.07	0.21
Saudi Arabia	0.66	0.35			
Singapore	1.30	0.06	1.19	0.19	
Sweden	1.31	0.85	1.10	0.25	0.95
Switzerland	0.43	0.35	0.91	0.13	0.47
Thailand	0.78	0.57	1.11	0.22	
Turkey	1.56	0.70		1.60	
United Kingdom	0.59	0.63	0.82	0.07	0.81
United States	0.61	0.16			

GDP = gross domestic product.

APPENDIX 4: CONTEMPORANEOUS EFFECTS ON FOREIGN VARIABLES, MODEL 2

Country	GDP	Inflation	Equity Price	Broad Money
Argentina	0.17	0.80	1.77	0.01
Australia	0.32	0.25	0.79	-0.01
Brazil	0.43	1.04		1.27
Canada	0.73	0.52	0.94	
People's Republic of China	0.25	0.17		-0.09
Chile	0.82	0.04	0.60	
Eurozone	0.55	0.15	1.06	0.06
India	-0.43	0.15	0.85	-0.20
Indonesia	0.34	0.64		-0.61
Japan	0.77	0.06	0.75	0.05
Republic of Korea	0.21	0.15	1.01	-0.22
Malaysia	1.40	0.65	1.23	-2.94
Mexico	0.45	-0.26		0.56
Norway	0.61	0.44	1.14	
New Zealand	0.39	0.56	0.74	
Peru	-0.05	0.04		-0.21
Philippines	0.02	-0.04	0.90	
South Africa	0.31	0.23	0.84	
Saudi Arabia	0.71	0.09		
Singapore	1.14	0.21	1.21	-0.24
Sweden	1.30	0.97	1.10	0.30
Switzerland	0.55	0.32	0.95	0.94
Thailand	0.70	0.17	1.05	-0.11
Turkey	1.39	0.50		0.91
United Kingdom	0.57	0.24	0.85	0.35
United States	0.54	0.16		

GDP = gross domestic product.

APPENDIX 5: CORRELATION OF VECMX RESIDUAL, MODEL 1

Country	GDP	Inflation	Equity Price	Exclusion Rate	Short-Run Interest Rate	Long-Run Interest Rate
Argentina	0.00	0.03	-0.02	0.04	0.00	
Australia	0.02	0.02	0.02	0.19	0.03	0.00
Brazil	0.03	-0.04		0.10	-0.03	
Canada	-0.01	0.05	0.03	0.15	0.10	-0.03
Chile	-0.08	-0.02		0.04	0.01	
People's Republic of China	0.01	0.01	0.04	0.15	-0.03	
Eurozone	-0.03	0.06	-0.12	0.26	0.07	-0.06
India	-0.01	0.02	-0.04	0.15	0.05	
Indonesia	-0.01	0.03		0.08	0.04	
Japan	-0.03	0.03	-0.11	0.11	0.00	-0.05
Republic of Korea	0.00	0.03	-0.04	0.13	0.04	-0.05
Malaysia	0.00	0.02	0.02	0.18	0.03	
Mexico	0.03	0.00		0.02	0.01	
New Zealand	-0.01	0.03	0.05	0.27	0.01	0.00
Norway	0.04	0.02	-0.01	0.24	0.01	0.01
Peru	0.02	-0.05		0.05	0.04	
Philippines	0.01	0.00	-0.01	0.13	0.02	
Saudi Arabia	0.04	0.02	0.06	0.18	0.04	-0.01
Singapore	-0.01	0.02		0.01		
South Africa	-0.02	0.03	0.01	0.21	0.03	
Sweden	0.03	0.05	-0.02	0.23	0.00	0.02
Switzerland	0.02	0.05	0.01	0.26	0.01	0.03
Thailand	0.01	0.02	0.01	0.18	0.04	
Turkey	0.00	0.00		0.12	0.03	
United Kingdom	-0.02	0.00	-0.01	0.19	0.05	-0.03
United States	-0.04	0.06	0.00		0.03	-0.01

GDP = gross domestic product.

APPENDIX 6: CORRELATION OF VECMX RESIDUAL, MODEL 2

Country	GDP	Inflation	Equity Price	Exclusion Rate	Broad Money
Argentina	-0.01	-0.02	0.05	0.04	-0.02
Australia	0.02	-0.04	0.25	0.03	0.01
Brazil	0.03	0.01	0.13	-0.05	
Canada	0.00		0.20	0.03	0.02
Chile	0.01		0.16	0.02	0.04
People's Republic of China	-0.09	0.04	0.05	-0.02	
Eurozone	-0.02	-0.01	0.30	0.05	-0.11
India	-0.01	-0.02	0.17	0.02	-0.03
Indonesia	-0.02	0.01	0.15	0.03	
Japan	-0.04	0.01	0.17	0.03	-0.10
Republic of Korea	-0.01	0.00	0.19	0.01	-0.05
Malaysia	-0.01	0.02	0.22	0.04	0.02
Mexico	0.03	0.02	0.00	-0.01	
New Zealand	0.05		0.26	0.05	0.00
Norway	-0.01		0.30	0.06	0.04
Peru	0.02	-0.03	0.03	-0.02	
Philippines	0.00		0.13	-0.01	0.02
Saudi Arabia	-0.01		0.03	0.03	
Singapore	-0.02	0.04	0.29	0.02	0.01
South Africa	0.04		0.24	0.00	0.05
Sweden	0.03	0.02	0.26	0.03	-0.01
Switzerland	0.01	0.02	0.30	0.04	-0.01
Thailand	-0.01	0.01	0.22	0.03	0.02
Turkey	-0.01	0.01	0.15	-0.03	
United Kingdom	-0.02	-0.01	0.25	0.05	-0.02
United States	-0.03	0.03		0.08	0.00

GDP = gross domestic product.