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The time-varying impact of US monetary policy spillovers on small open economies: Evidence from Indonesia

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Abstract

This study examines the impact of the US monetary policy spillover on Indonesia's macroeconomic and financial variables using quarterly data for the period 2000–2020 for both domestic and US variables. The study uses a Bayesian form of a time-varying parameter (TVP) vector autoregressive (VAR) model with stochastic volatility to look at how real GDP, inflation, the exchange rate, the stock market return, and the monetary policy rate react to a shock in US monetary policy. We find that US monetary policy spillovers, on average, boost Indonesia's real GDP, stock market returns, and bilateral exchange rate vis a vis the US Dollar but also trigger domestic inflation beyond what Indonesia's policy reaction could counteract. However, there are significant differences between the variables' responses to easing and tightening shocks, on the one hand, and conventional vs. unconventional monetary policy, on the other. Finally, we found substantial time variation corresponding to major global events, including the Global Financial Crisis and implementation of unconventional monetary policy, the taper tantrum of 2013–2014, and the severe lockdown in the wake of the COVID-19 pandemic in 2019–2020. These findings underscore the importance for policymakers in Indonesia to closely monitor and anticipate the impact of US monetary policy spillovers on domestic macroeconomic variables. This knowledge can inform more effective policy responses and risk management strategies to safeguard economic stability and promote sustainable growth.

Keywords: Indonesia, Macroeconomic variables, Monetary policy spillover, Small open economy, Time-varying VAR, US.
JEL Classification: F33; F41; F42.

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Contents

Contribution of this paper to the literature
First, we employ a consistent measure of US monetary policy to estimate dynamic effects over time. Secondly, we differentiate between easing and tightening cycles, as well as conventional and unconventional policy eras. Lastly, we incorporate time-varying parameters to study the complex dynamics of US monetary policy spillovers on the Indonesian economy.

1. Introduction

Economic theory widely accepts the use of monetary policy to influence domestic output and prices in the short run, and empirical monetary and macroeconomic literature well documents its effectiveness. However, these dynamics have been put into question following the Global Financial Crises (GFCs) in 2008 and the implementation of Unconventional Monetary Policy (UMP) in the US and other Advanced Economies (AEs) in the wake of the crisis. The spillover from UMP, such as Quantitative Easing (QE) and forward guidance, has increased the complexity of the conduct of monetary policy across the globe. This is especially motivated for Small Open Economies (SOEs) with strong trade and financial ties with AEs. While monetary policy has always had spillover effects, recent decades have amplified the uncertainties and risks surrounding these effects (Danladi, 2022). A better understanding of these dynamics is crucial for understanding how monetary policy works and for the efficient conduct of monetary policy. While there has been a renewed interest in studying the transmission of foreign shocks to emerging market economies in recent decades, surprisingly, fewer research efforts that specifically answer these questions for the Indonesian macro-economy have been made.

To provide additional insight, this study examines the propagation of US monetary policy shocks to Indonesia's economy. Our choice of the US and Indonesia is largely motivated by the rising trade and financial ties between Indonesia and AEs, including the US (see Figure 1 and 2 in section 2 below). Over the years, Indonesia's financial markets have been exposed to capital flows driven by the global financial cycle and fluctuations in exchange rates. These and other factors have contributed to the inclusion of Indonesia in the "Fragile Five" in recent times (see Shin (2014)). Several investment and policy concerns can also be highlighted for our choice of the Indonesian economy. From a policy point of view, since monetary policy spillovers from the core economies can substantially limit the effectiveness of domestic monetary policy in SOEs (Cao & Dinger, 2022), the effect of monetary policy spillovers from the US, if not well understood and managed, could complicate domestic monetary policy challenges for Indonesia. This can endanger capital flows in the form of capital reversal or at least a sudden stop in capital inflows (see (Bundesbank, 2020; Gajewski et al., 2019)). The risk of losing monetary policy autonomy (a situation where authorities adjust rates in addition to the desire to keep domestic inflation or output under control) can be costly. Portfolio investors, who are mostly risk-averse agents, are always concerned about how much build-up risk may affect their investment as they rebalance their portfolios towards the SOEs. Studying Indonesia's economy allows us to make small open-economy assumptions and study the dynamics of such propagation.

This study makes three contributions to the existing literature. First, we focus on estimating the dynamic effects of US monetary policy shocks using a consistent measure of US monetary policy over time. Second, we disentangled the shock series into easing and tightening cycles, on the one hand, and partitioned the dataset into conventional and *unconventional monetary policy* eras, on the other. These allow us to understand how the Indonesian economy responded to US monetary policy easing and tightening cycles, as well as conventional and unconventional monetary policy eras. Third, we consider a variant of the structural VAR (SVAR) model that features time variation in the parameters to ascertain whether the transmission has changed over time. Over the years, prominent issues that have beset this area of research include, among others: finding an appropriate policy variable to identify the monetary policy that correctly accounts for zero lower bounds and widely implemented UMP; dealing with possible structural breaks and nonlinearities occasioned by major domestic and global events in the recent past; and controlling for the outside world. To solve these problems, we use Krippner (2020) short shadow rate (SSR) as a stand-in for the monetary policy rate and build a block-exogenous time-varying parameter-vector autoregressive (TVP-VAR) model.

Our approach consists of three steps. First, we use the structural vector autoregression (SVAR) model, which has parameters that change over time and stochastic volatility, to figure out how the US monetary policy shock affected Indonesia's most important macroeconomic and financial variables. Second, we extended the benchmark VAR by replacing the US monetary policy shock with US positive and negative shocks, which we disentangled using an asymmetric nonlinear autoregressive distributive lag (ARDL) model. This allowed us to compare the effects of US monetary policy tightening and easing cycles on Indonesian macroeconomic and financial variables. Finally, we partitioned the dataset into a conventional era when the policy rate was the main tool in the US and an UMP era when the policy rate was at Zero Lower Bound (ZLB) and the economic slacks persisted. We then compared their effects on the selected variables for the Indonesian economy.

The study finds that US monetary policy spillovers, on average, boost Indonesia's real GDP, stock market returns, and bilateral exchange rate vis-à-vis the US dollar and trigger inflation beyond what the corresponding policy reaction could counteract. However, decomposing the shock into easing and tightening shocks reveals significant differences. We find that the effect of US monetary policy shocks on real GDP, the exchange rate, and the policy rate is asymmetric, as the variables appreciate in response to tightening and easing shocks. Conversely, we find a symmetrical effect on inflation and stock market returns. Indonesia's inflation responded positively to US monetary policy tightening shocks and negatively to easing shocks. Stock market returns responded positively to US monetary policy easing shocks and negatively to tightening, respectively.

We also found that macroeconomic variables responded differently to US conventional and UMP shocks. While real GDP and inflation responded positively to US conventional monetary policy shocks, UMP shocks, on the other hand, depressed both GDP and inflation. The exchange rate appreciates in response to US UMP shocks and depreciates in response to conventional monetary policy shocks. While stock market returns responded positively to both shocks, the response to UMP was stronger and longer. To stimulate declining output, policy rates rise in response to conventional monetary policy shocks and fall in response to UMP shocks. Finally, we also found substantial time variation in the effects corresponding to major global events, including the GFC and implementation of UMP, the taper tantrum of 2013–2014, and the great lockdown in the wake of the COVID-19 pandemic in 2019–2020.

Our findings are robust to alternative uses of effective federal fund rates to identify US monetary policy. While the IRFs for the full sample and UMP sub-sample are significantly different from the baseline model, the IRFs for the conventional monetary policy sample are quite similar. The only difference is in the exchange rate variable. Our findings have implications that encourage further research. Our analysis only considered monetary policy spillovers from the US to Indonesia. This is an important starting point. The next extension is to consider other advanced economies with strong trade and financial ties with Indonesia, such as Japan and the Euro Area. We couldn't include them here, as we leave this significant gap for future research.

We organized the rest of the study as follows: In Section 2, we present some stylized facts about the Indonesian economy. In Section 3, we describe the methodology and data that are deployed in this paper. In Section 4, we present the results. Section 5 shows how our results are robust to alternative measurements of the US monetary policy stance. Section 6 concludes the paper.

2. Stylized Facts

2.1. Motivation for the Choice of US

Figure 1 represents Foreign Portfolio Investment (FPI) from AEs to Indonesia over the sample period (2000–2020). The figure on the left-hand side shows that over the sample period, the magnitude of FPI from AEs to Indonesia generally increases in absolute terms. This suggests increasing interconnectedness between Indonesia and the AEs on the one hand and significant vulnerability to foreign shocks on the other. Comparing the FPI from the AEs to Indonesia, the figure on the right-hand panel indicates that the US has the largest FPI, followed by the Euro Area, the UK, Japan, and Canada. China, Italy, Australia, and France had the least FPI in Indonesia during the period under review. This justifies the US's decision to conduct this study.

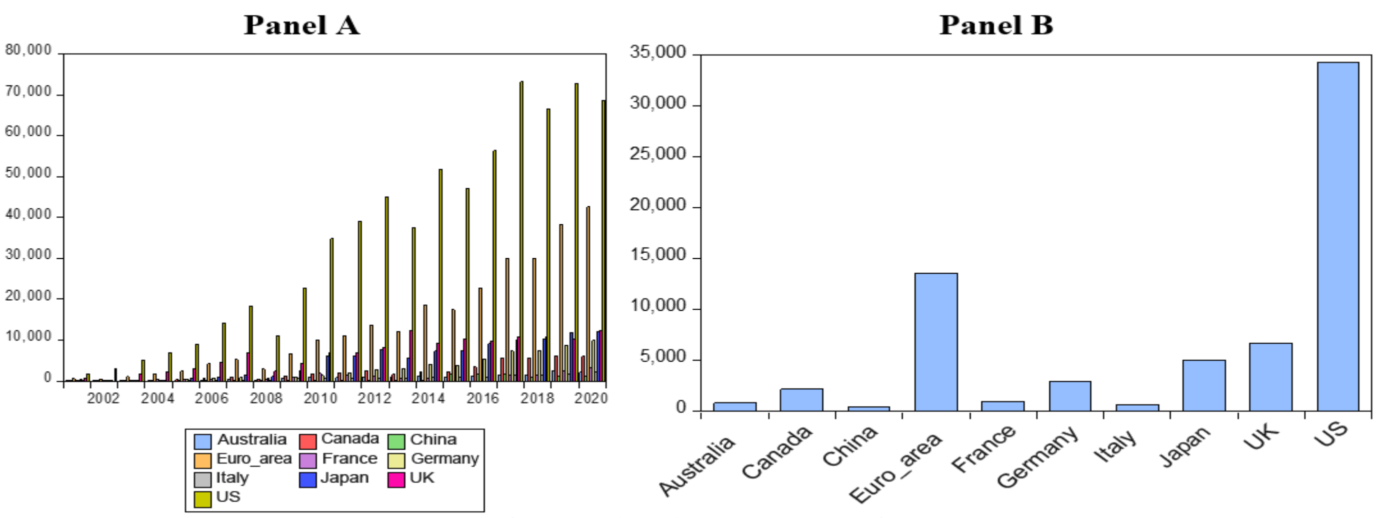


Figure1. Magnitude of portfolio inflows from AEs to Indonesia 2000-2020.

Source: Computed from IMF consolidated portfolio investment survey.

Figure 2 shows that portfolio investment flow from the US to Indonesia has increased substantially over the years. However, the flows featured occasional declines, depicting major events in the US. For example, we can see a decline in US portfolio flows in 2008, presumably due to uncertainties surrounding the first round of quantitative easing in the US. Up until 2013, taper tantrums mainly caused a decline in the flow. The flow rose in 2014 and fell again in 2015, following a 25 basis point hike in the federal fund rate for the first time since 2008. After reaching its peak in 2017, the flow declined in 2018 and rose again in 2019, followed by another decline, arguably due to the great lockdown in 2020.

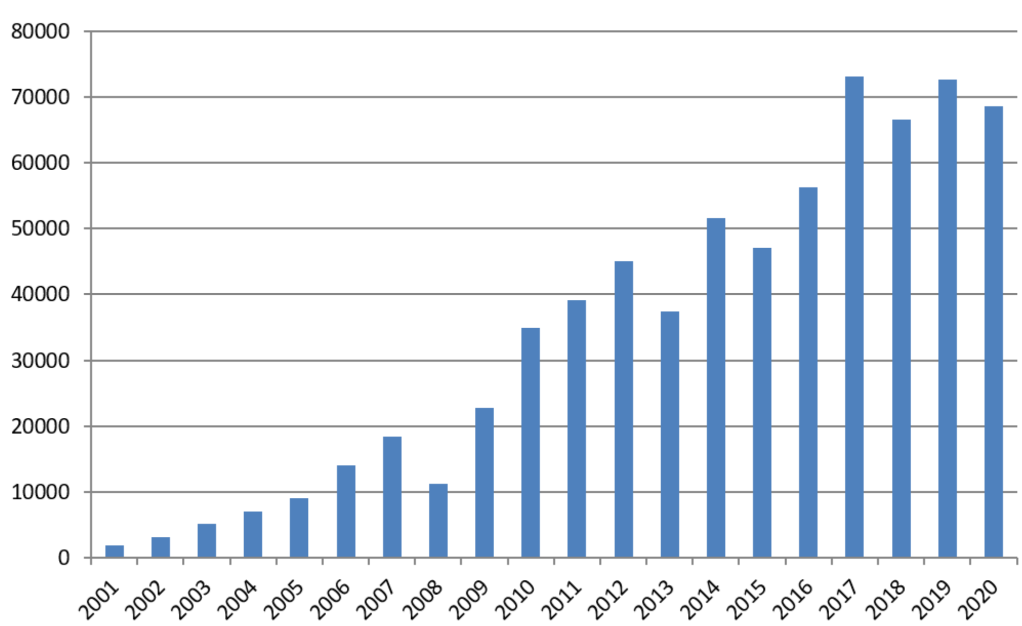


Figure 2. Portfolio investment from the US to Indonesia.

Source: Computed from IMF consolidated portfolio investment survey.

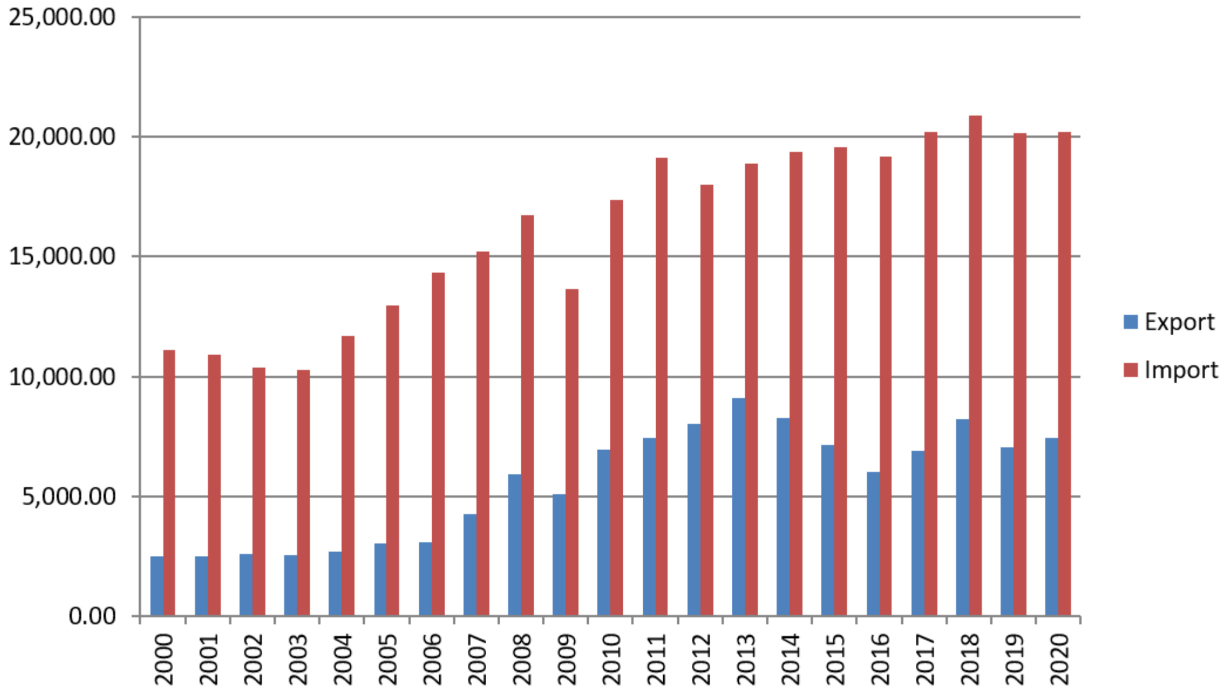


Figure 3. Trade between the United States and Indonesia 2000 -2020.

Figure 3 also shows that the trade relationship (measured in terms of exports and imports) between the United States and Indonesia increased on average over the years. However, there has been considerable fluctuation. For example, the trade value in 2009 declined compared to 2008 and 2010. We also observed a similar decline in 2012 and 2016. The observed trend affected both import and export volumes.

2.2. Shadow Rate as a Consistent Measure of Monetary Policy Stance

Figure 4 shows the estimated US shadow rate and Fed Federal Fund Rate (FFFR) from 2000 to 2020. At first glance, the shadow rate closely resembles the FFR during the conventional monetary policy era (from 2000 to 2008). This boosts our confidence in using the shadow rate to measure monetary policy stances. Furthermore, between 2008 and 2016, it can be observed that while the FFFR remained at zero, suggesting Zero Lower Bound (ZLB), the shadow rate, on the other hand, turned negative, reflecting the unconventional monetary policy (UMP) measures implemented by the US Fed in the wake of the Global Financial Crisis (GFC). The US Fed hiked the policy rate by 25 basis points once per year after it remained at ZLB until 2015. In 2017, the Fed raised the rate three times, and in 2018, the rate was raised four times. However, the COVID-19 pandemic forced the Fed to cut the policy rate three times in 2019 to stimulate the economy and bring it back to another round of ZLB. We can describe this phase as the period of policy normalization, where we adjusted the policy rate in response to economic dynamics.

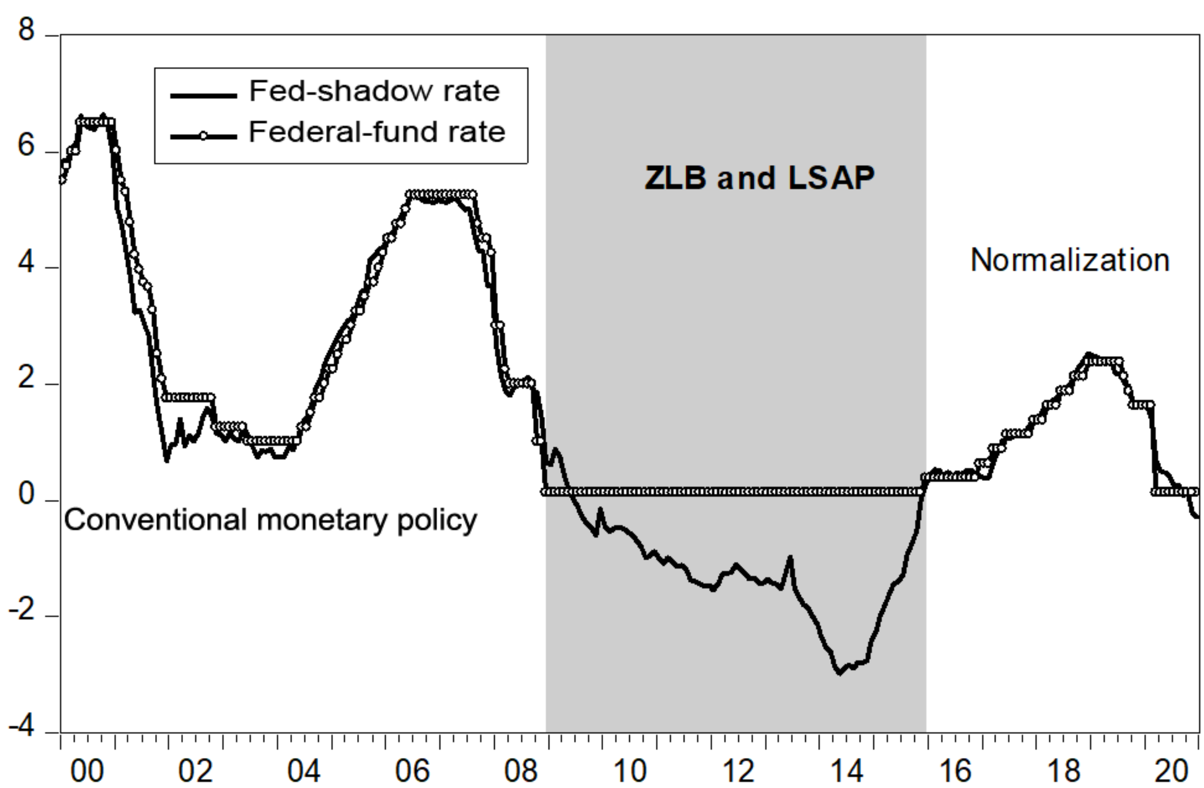


Figure 4. Trend of US fed-shadow rate & federal fund rate.

3. Data and Methodological Framework

3.1. Data

To identify US monetary policy shocks, we utilized quarterly data from 2000Q1 to 2020Q4 on the Industrial Production Index (IPI), Consumer Price Index (CPI), and US shadow policy rate. We extracted the IPI and CPI from the International Financial Statistics of the International Monetary Fund (IMF) and used alternative variables. Namely, real Gross Domestic Product (RGDP), GDP Deflator, and effective federal fund rate (FFR) were obtained from the Federal Reserve Bank of St. Louis (FRED). We take the shadow rate provided by Krippner (2020) as our measure of monetary policy to account for ZLB and the entire stimulus occasioned by UMP implemented in the wake of GFC.

To conduct our empirical analysis, we utilized quarterly data from 2000Q1 to 2020Q4 for the Indonesian economy to examine the spillover effects of US monetary policy shocks. The dataset used for this purpose consists of Indonesia's RGDP, CPI, bilateral exchange rate, stock market index, and short-term monetary policy rate (MPR). The alternative variables used were the 3-monthly inter-bank rate, IPI, and GDP deflator. We obtained the data from the International Financial Statistics of the IMF, FRED, and Bank Indonesia databases. RGDP, IPI, CPI, and stock market index were transformed to their respective growth rates, computed as 100*Log (series/series (-1). The global oil price obtained from the FRED database is used in this study to control for global factor.

3.2. Methodological Framework

The current study builds on the work of Salisu and Gupta (2021) and Mumtaz and Theodoridis (2020) by estimating a structural vector-autoregressive model with time-varying parameters and stochastic volatility (TVP-SVAR-SV model) to show how monetary policy changes in the US affect the Indonesian economy. The behavioral model is of the following form:

$$y_{it} = a_{0,it} + \sum_{k=1}^{p} \beta_{i,t}\, y_{t-k} + \sum_{\ell=0}^{P^*} \Gamma_{i,\ell}\, \chi_{i,t-\ell} + \sum_{\ell=0}^{q} \Phi_{i\ell}\, \tilde{h}_{t-\ell} + \Omega_{it}^{1/2}\, e_{it}, \mathrm{e}_{it} \leftrightarrow N(0,1), \qquad (1)$$

Where the vectors of endogenous variables for the Indonesia economy in period t are given by

$$y_{i,t} = (Re\,a\,l\,GDP_t, \mathrm{INF}_t, \mathrm{MPR}_t, \mathrm{SMR}_t, \mathrm{EXR}_t) \qquad (1.1)$$

Similarly, $X_{it}$is a vector of weekly exogenous variables, in this case, US monetary policy shock and global oil prices as a measure of US monetary policy spillover and global factor respectively.

$$\mathrm{X}_{i,t} = (MPR_t^{US}, OilP_t^{US}) \qquad (1.2)$$

In Equation 1 $\alpha_{0,it}$denotes intercepts and a vector of time-varying coefficients of constants for each i,y_{it} which denotes a vector of Indonesia's endogenous variables used in this study. This comprises both macroeconomic and financial variables of interest defined as Real Gross Domestic Product (RGDP), Domestic CPI Inflation (INF), Domestic monetary policy rate (MPR), Stock Market Returns (SMR), and Exchange rate (EXR). X_{it} represents the vector of exogenous variables that control for external shocks (US monetary policy spillover and global oil prices). A crucial variable is our choice of $\mathrm{MPR}^{\mathrm{US}}$. Our primary measure of US monetary policy is the US shadow rate, as provided by Krippner. The shadow rate is derived from an estimated term structure model. One major pro of this measure of monetary policy is that it is used as a single indicator across monetary policy regimes, i.e., for both the period before the ZLB became binding and after (Tillmann, Kim, & Park, 2019).

Th$\bar{h}_{it} = [h_{1t}, h_{2t}, \ldots, h_{Nt}]$ is refers to vectors of stochastic volatilities of the structural shocks in the VAR. Theβ, $\Gamma$and Φ are the time-varying coefficients of endogenous lag variables, lag exogenous variable, and volatility of the structural shocks, respectively. The subscripts i = 1, 2,…, N, t = 1,…, T denotes time, and k is the optimal lag length of the VAR model to be chosen with the aid of the Schwarz Information Criterion (SIC). The time-subscripts t attached to the coefficients in Equation 1 indicates that the coefficients are time-varying and not constant.

$$\Omega_{it} = A^{-1} H_{it} A^{-1'}. \qquad (2)$$

Equation 2 is a vector of random disturbances with$H$ being a diagonal matrix of orthogonalized volatility shocks and$A$ a matrix of contemporaneous effects. Hence, the time-varying matrices $H_{it}$and A in Equation 2 are given by

$$H_t = \begin{pmatrix} exp(h_{1t}) & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & exp(h_{2t}) & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & exp(h_{3t}) & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & exp(h_{4t}) & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & exp(h_{5t}) & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & exp(h_{6t}) & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & exp(h_{7t}) \end{pmatrix} \begin{pmatrix} \varepsilon_t^{\mathrm{OILP}} \\ \varepsilon_t^{\mathrm{MPRS^{US}}} \\ \varepsilon_t^{\mathrm{RGDP}} \\ \varepsilon_t^{\mathrm{INF}} \\ \varepsilon_t^{\mathrm{MPR}} \\ \varepsilon_t^{\mathrm{SMR}} \\ \varepsilon_t^{\mathrm{EXR}} \end{pmatrix} \qquad (3)$$

The structure of the A (the structural matrix) is carefully chosen to model the contemporaneous relationship among the reduced-form shocks. The choice of the structure of the A matrix is of the form:

$$A = \begin{pmatrix} \Delta OILP_t \\ \Delta MPR_t^{US} \\ \Delta RGDP_t \\ \Delta INF_t \\ \Delta MPR_t \\ \Delta SMR_t \\ \Delta EXR_t \end{pmatrix} = \begin{pmatrix} 1 & 0 & 0 & 0 & 0 & 0 & 0 \\ \tilde{a}_{2,1} & 1 & 0 & 0 & 0 & 0 & 0 \\ \tilde{a}_{3,1} & \tilde{a}_{3,2} & 1 & 0 & 0 & 0 & 0 \\ \tilde{a}_{4,1} & \tilde{a}_{4,2} & \tilde{a}_{4,3} & 1 & 0 & 0 & 0 \\ \tilde{a}_{5,1} & \tilde{a}_{5,2} & \tilde{a}_{5,3} & \tilde{a}_{5,4} & 1 & 0 & 0 \\ \tilde{a}_{6,1} & \tilde{a}_{6,2} & \tilde{a}_{6,3} & \tilde{a}_{6,4} & \tilde{a}_{6,5} & 1 & 0 \\ \tilde{a}_{7,1} & \tilde{a}_{7,2} & \tilde{a}_{7,3} & \tilde{a}_{7,4} & \tilde{a}_{7,5} & \tilde{a}_{7,6} & 1 \end{pmatrix} \begin{pmatrix} \mu_t^{\mathrm{OILP}} \\ \mu_t^{\mathrm{MPRS^{US}}} \\ \mu_t^{\mathrm{RGDP}} \\ \mu_t^{\mathrm{INF}} \\ \mu_t^{\mathrm{MPR}} \\ \mu_t^{\mathrm{SMR}} \\ \mu_t^{\mathrm{EXR}} \end{pmatrix} \qquad (4)$$

To recover the information in the structural equation, we impose restrictions in matrix A and H in Equation 4 and 5, explained in section 3.2.4. The terms$\varepsilon_t^{OILP}, \varepsilon_t^{MPR^{US}}, \varepsilon_t^{RGDP}, \varepsilon_t^{INF}, \varepsilon_t^{MPR}, \varepsilon_t^{SMR}, \varepsilon_t^{EXR}$ are the structural shocks associated with respective equations and $\mu_t^{OILP}, \mu_t^{MPR^{US}}, \mu_t^{RGDP}, \mu_t^{INF}, \mu_t^{MPR}, \mu_t^{SMR}, \mu_t^{EXR}$are residuals in the reduced-form disturbances to both the exogenous foreign and endogenous domestic variable, which represents an unexpected movement (given information in the system) of each variable. The transition equation for the stochastic volatility is of the form:

$$h_{it} = \sum_{j=1}^{p} k_j y_{t-j} + \sum_{j-1}^{p} \theta_j \tilde{h}_{t-j} + \eta_{it,}\ \eta_{it} \leftrightarrow N(0, Q_i),\ E(e_{it,}\eta_{it}) = 0 \qquad (5)$$

And the elements of $A_t$follow a first-order autoregressive process.

$$a_{jt} = \rho_j a_{jt-1} + q_j^{1/2} v_{jt} j = 1..n \qquad (6)$$

There are two noteworthy features of the complete system defined by Equation 1, 2, and 5. First, Equation 1 allows the volatility of the structural shocks $\tilde{h}_t$to have a (lagged) impact on the endogenous variablesy_t. In our specification, the log volatility enters the VAR equations rather than its level. This is primarily because the level of volatility is sensitive to the scaling of the endogenous variables, which can sometimes result in computational instability. Second, note that the structure of matrix A in Equation 2 determines the interpretation of structural shocks, and hence their volatility$\tilde{h}_t$. Equation 4's lower triangular structure for A suggests that we can interpret the monetary policy shock's log volatility, limiting its impact on GDP growth and inflation during the current period. The appropriate placement of the economic interpretation of the structural shocks is important because it allows the model to tackle the analysis of volatility's impact in a theoretically consistent manner. Alternatively, one may consider inequality or sign restrictions on the off-diagonal elements of A as a device to identify the shocks. Third, the transition Equation 5 allows for dynamic interaction among volatilities and endogenous variables, thus capturing any feedback effects that may be present in the data.

3.2.1. Identification Scheme

The structure of β_i and Φ_i incorporates a small open economy assumption for Indonesia. We incorporate the prior belief that lagged Indonesia's endogenous variables and (lagged and contemporaneous) stochastic volatilities have a negligible impact on the exogenous variables (global oil prices and US monetary policy). In our benchmark model, the contemporaneous and the lagged value of$\tilde{h}_{it}$ affect$Z_t$ed. The global oil prices and US monetary policy is assumed to be completely exogenous to the domestic variables. It is common knowledge to identify that the foreign variable does not respond contemporaneously or with lags to the movement in the domestic variables in a small-open economy because such economies have no powerful impact on the advanced economy. It is important to note that the way variables influence each other is based on economic theory and depends on their position in the identification scheme. Hence, we assume that domestic variables are deemed not to affect the foreign variables, and the transmission of foreign shocks to the domestic economy can be very rapid (Berkelmans, 2005).

The non-zero coefficients ($\tilde{a}_{kj}$) in the matrices indicate that the variable$j$ affects the variable$k$ instantaneously. In the A matrix above, the first two rows measure the effect of global oil prices and US monetary policy spillovers on Indonesia's economy. The third and fourth equations represent output and inflation dynamics. Based on the small open economy New Keynesian model, inflation is a function of output, monetary policy, and exchange rate, while output dynamics is modelled as a function of output, inflation, monetary policy, and exchange rate. Therefore, while the real GDP responds instantaneously to oil prices and US monetary policy, INF, and MPR, inflation responds contemporaneously to MPR^{US}, GDP, and MPR. The fifth row indicates the monetary policy equation for Indonesia in accordance with the modified SOE-Taylor's rule, where MPR responds contemporaneously to MPR^{US}, INF, and GDP. Rows 6 and 7 indicate that while stock market returns respond to global oil prices, US monetary policy, domestic monetary policy, output, and inflation, the exchange rate responds instantaneously to all the variables (see Elbourne and de Haan (2006)).

3.2.2. Identification of US Monetary Policy Shocks

To identify the US monetary policy shock, we follow the lead of Tillmann et al. (2019) and Canova (2005) to derive the shock component from an estimated VAR for the US. The auxiliary VAR includes real economic activity measured by the change in industrial production and the change in the consumer price index, as well as the change in Krippner (2020) shadow rate. We estimated the shock component of the shadow rate, i.e., the unexpected changes in US monetary policy stance that are not the result of the stability of the US economy. The shocking series obtained by imposing a Cholesky decomposition of the covariance matrix was fed into the VAR model for the Indonesian economy to account for the spillover effects.

3.2.3. Estimation Technique

The models were estimated using a standard Markov Chain Monte Carlo (MCMC) method (see Liu and Morley (2014)). The technique is appealing more because of its ability to address pile-up problems (see Sargan and Bhargava (1983); Shephard and Harvey (1990) and Stock and Watson (1998)). The high dimensionality and nonlinearity of the problem contribute to the preferability of this econometric technique. Such a model may be characterized by multiple peaks, some of which are in uninteresting or implausible regions of the parameter space. Bayesian methods efficiently deal with the high dimension of the parameter space and the model's nonlinearities, splitting the original estimation problem into smaller and simpler ones. Here, we use Gibb's sampling for the posterior numerical evaluation of the parameters of interest. Gibb's sampling is a particular variant of Markov chain Monte Carlo (MCMC) methods that consists of drawing from lower-dimensional conditional posteriors. When direct sampling proves difficult, it aids in obtaining an approximate sequence of observations from a specified multivariate probability distribution. Finally, observe that MCMC is a smoothing method and therefore delivers smoothed estimates, i.e., estimates of the parameters of interest based on the entire available set of data.

4. Results and Discussions

4.1. Preliminary Analysis

Table 1 displays the basic descriptive statistics of the data used in this study. The variables described include real activity (GDP), inflation (INF), and monetary policy rate (MPR) for both Indonesia and the US; stock market returns (SMR); and exchange rate (EXR) for Indonesia; and global oil prices as a proxy for global factors. The average real GDP, inflation, and policy rate in Indonesia are higher than in the US, according to the table.

Table 1. Summary statistics.

Variables	Mean	Std. dev.	Max.	Min.
Endogenous				
Real GDP	1.20	1.06	3.20	-7.14
Inflation	1.49	1.37	9.84	-0.22
Policy rate	7.75	3.14	18.38	3.30
Stock returns	3.41	10.82	29.99	-45.58
Exchange rate	10915.65	2165.43	14754.34	8413.00
Exogenous				
Real GDP	0.07	2.53	10.69	-14.46
Inflation	0.51	0.69	2.17	-2.87
Policy rate	0.94	2.61	6.55	-3.74
Oil price	0.23	10.96	25.56	-60.32

Note: Std. dev., max., and min. denotes standard deviation, maximum, and minimum, respectively.

4.1.1. Unit Root Tests

Table 2 displays the results of unit root tests conducted to determine the data's time series properties. We conducted and reported three unit root tests for this purpose: the Augmented Dickey-Fuller (ADF), Phillips Perron (PP), and ADF with a structural break. We find a mixed order of integration among the variables. While most of the variables (such as real GDP, inflation, stock market returns, and shadow rate) are stationary at this level, other variables (exchange rate and short-term policy rate) become stationary after the first difference. However, all of the variables reveal structural breaks at different dates. Given this, we conducted a nonlinear ARDL and decomposed the shock series into positive and negative values for further analysis.

Table 2. Unit root test results.

Country	ADF unit root test			PP unit root test		ADF test with structural break		
	Variables	t-stat.	I(d)	t-stat.	I(d)	t-stat.	I(d)	Break date
Indonesia	GDP	-9.08	I(0)	-9.13	I(0)	-18.65	I(0)	2020Q2
	INF	-7.20	I(0)	-7.29	I(0)	-11.29	I(0)	2005Q4
	MPR	-4.11	I(1)	-4.11	I(0)	-5.18	I(0)	2005Q4
	EXR	-9.39	I(1)	-9.39	I(1)	-10.14	I(1)	2001Q2
	SMR	-6.63	I(0)	-6.40	I(0)	-7.79	I(0)	2008Q4
US	US-SSR	-4.26	I(0)	-4.14	I(0)	-5.24	I(0)	2008Q1

Note: GDP, INF, MPR, SMR, EXR and US-SSR denote real activity, inflation, monetary policy rate, stock market returns, exchange rate, and shock to US shadow rate, respectively. While t-stat denotes t-statistics, I(d) represents the order of integration indicated by the test statistics employed.

4.1.2. Parameter Stability Test

In this section, we reported three test results, the Hansen (1992) and Pesaran (1997) parameter stability test results, also known as Hansen Lc test (Table 3), the Quandt-Andrews breakpoint test for one or more unknown structural breakpoints (Table 4), the cumulative sum of recursive residuals (CUSUM) tests, and the cumulative sum (CUSUM) of recursive residuals and CUSUM of square (CUSUMSQ) tests for parameter stability Figure 6[1].

Table 3. Hansen parameter instability.

Lc statistics	Stochastic trends (m)	Deterministic trend (k)	Excluded trends (p2)	Probability
7.19	6	0	0	<0.01

Table 4. Quandt–Andrews unknown breakpoint test.

Statistics	Value	*p*-value
Max.LR F-stat.(2018Q1)	43.6	0.00
Max. Wald F-stat. (2018Q1)	305	0.00
Exp LRF-stat.	17.9	0.00
Exp Wald F-stat.	148	0.00
Ave LRF-stat.	7.16	0.00
Ave Wald F-stat.	50.1	0.00

Two of the three-parameter stability tests—the Lc test and the CUSUMSQ test—fail to accept the null hypothesis of no sudden shift in the regime. This implies that there is strong evidence that parameters are not stable for the US monetary policy shock-Indonesia macroeconomic variables relationship. Similarly, the three Quandt-Andrews tests reported in Table 4 reject the null hypothesis of no breakpoints within a 15% trimmed sample period, suggesting the existence of breakpoints. This further justifies the use of TVP-VAR. The test is conducted based on the maximum statistic, the Exp statistic, and the Ave statistic. We calculated the probability values using Hansen's method and compared a total of 55 breakpoints.

4.2. Results from the US Structural VAR

Figure 5 depicts the shock-to-US shadow rate determined by the US structural VAR model. Upon first glance, the shock appears to be episodic, allowing for the easy identification of several episodes. The period from 2000–2003, where the shock series were mostly negative, was followed by a positive period from 2004–2007. We observed the largest contraction in the period 2008–2013, which trended at a decreasing rate. From 2014 to 2019, the shock showed a positive trend, followed by another contraction. The observed shocks from 2008 are arguably due to the global financial crisis and the massive US UMP implementation. The taper tantrum runs from 2013 to 2014. The last negative episode from 2019 to 2020 corresponds to the period of the COVID-19 pandemic's great lockdown. In sum, the identification approach recovers disturbances that are structurally interpretable and have a time path that

[1] The CUSUM test identifies systematic changes in the regression coefficients, while the CUSUMSQ test detects sudden changes from the constancy of the regression coefficients.

accounts for selected historical episodes reasonably well. The next section investigates the transmission of these shocks to Indonesia's economy.

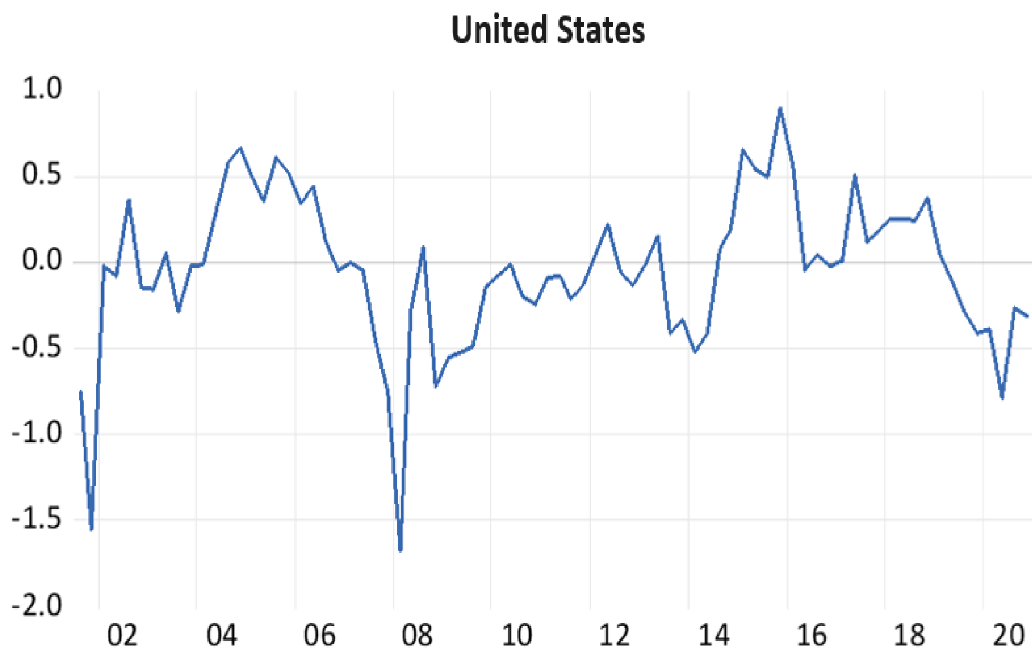


Figure 5. Time path of US monetary policy shock.

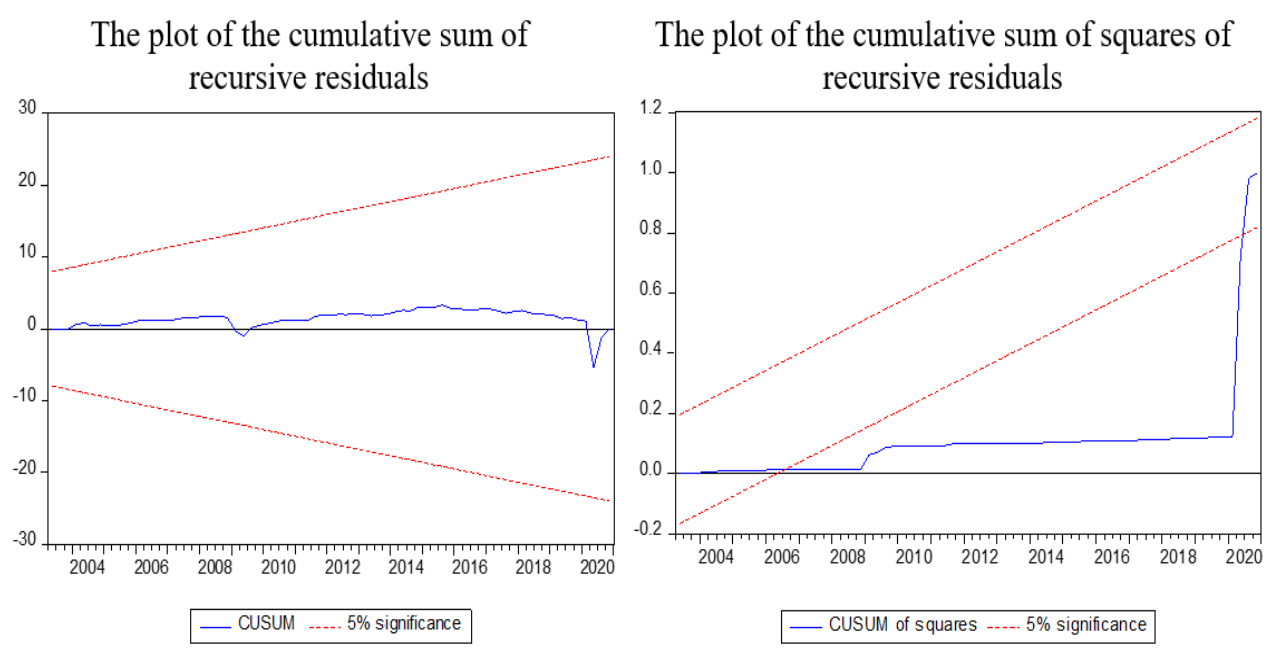


Figure 6. CUSUM and CUSUMSQ tests for parameter stability.

4.3. Results from the Indonesia SVAR

This section presents the TVP-VAR result, which estimates the impact of US monetary policy spillover on Indonesia's macroeconomic and financial variables. We contrast the effect of US monetary policy contraction and expansion shocks with a total shock that combined both tightening and easing shocks. We also contrast the total shock during the conventional monetary policy era in the US with the Unconventional Monetary Policy (UMP). Both the constant coefficient and time-varying impulse response functions (IRFs) of Indonesia's real and financial variables to US monetary policy are presented and discussed. While the tightening and easing shocks are presented in Figure 7a and Figure 7b, the conventional and UMP shocks are also reported in Figure 8a and Figure 8b.

4.3.1. Spillover Effects from US Monetary Policy Tightening Vs Easing Shocks to Indonesia

Figure 7a shows the constant coefficient impulse response of Indonesia's macroeconomic and financial variables to US monetary policy tightening and easing shocks. Indonesia's real GDP responded positively to both monetary policy easing and tightening shocks. While the responses are weak, the easing shock has a stronger effect than the tightening cycle. A two-country Mundell-Fleming model predicts the dominance of the US output expansion impact, as evidenced by the rise of Indonesia's real GDP in response to US monetary policy easing, which can lead to a rise in export demand from Indonesia and, consequently, an increase in output. However, the asymmetry suggested by the positive responses of real GDP to both easing and tightening cycles is quite puzzling.

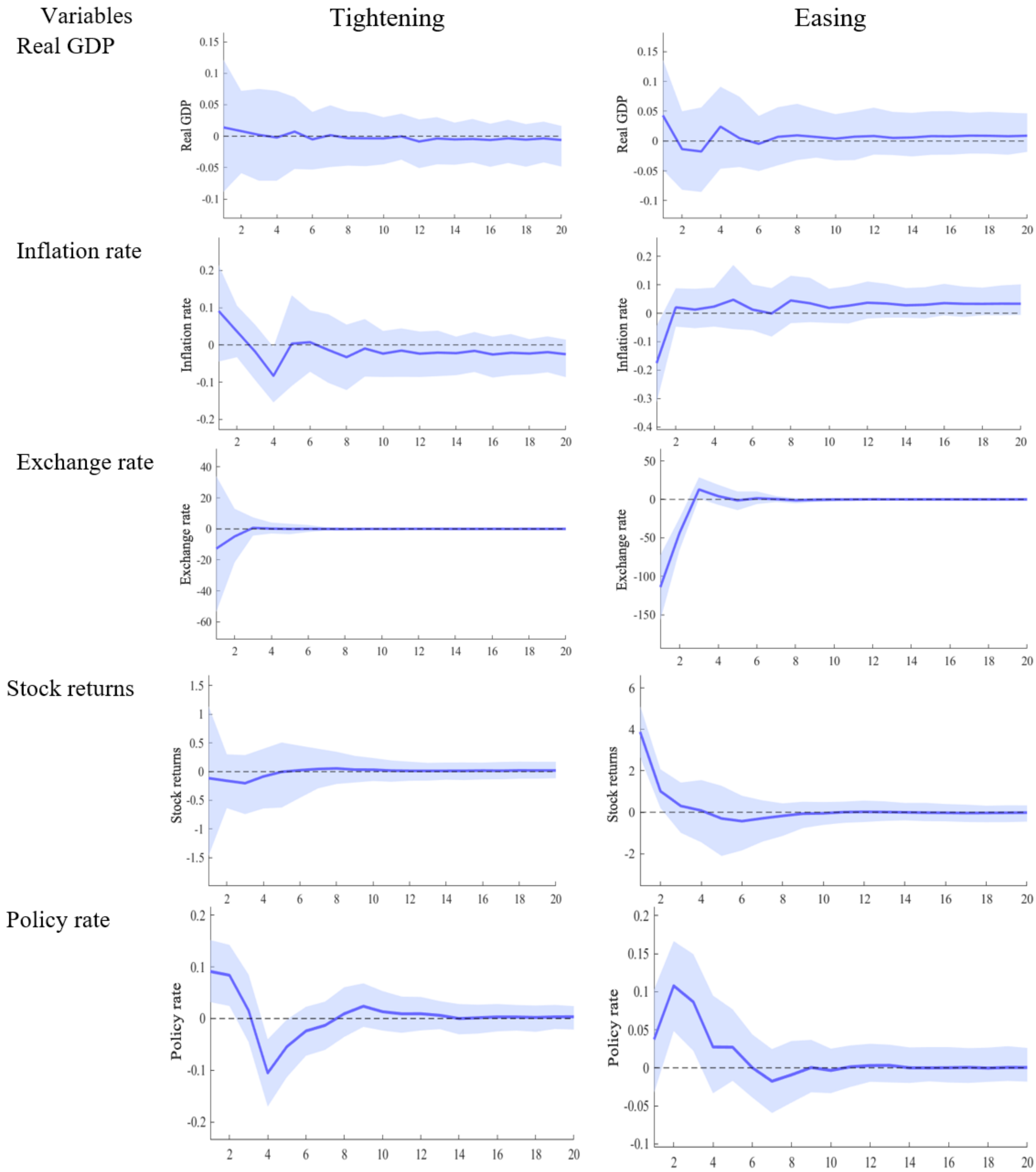


Figure 7a. Impulse response function (IRF) of Indonesia's real and financial variable to US monetary policy tightening and easing shocks.

Inflation's response to US monetary policy easing and tightening shocks resembles symmetry. While inflation declined in response to the easing shock for about two quarters before it turned positive, the inflation rate's response to the tightening cycle was positive on impact and turned negative after three quarters. Both the exchange rate's responses to US easing and tightening shocks were negative. This suggests an exchange rate appreciation in favor of the Indonesian lira. Although the appreciation is stronger and longer in response to the easing cycle compared to the tightening cycle, this suggests a weak form of asymmetric effect. The response to the easing cycle turned positive (depreciation) after the second quarter, while the response to the tightening cycle died out after the second quarter.

The figure further shows that while stock market returns in Indonesia responded positively to the US monetary policy easing cycle, the returns responded negatively to the tightening cycle. Although the effect of easing shock is stronger compared to tightening shocks. This suggests a symmetrical effect of US monetary policy spillovers on Indonesia's stock market returns. This finding is at variance with Tillmann et al. (2019). They found that US tightening has a stronger impact on emerging financial markets than an easing policy does.

The Bank of Indonesia responded positively to both monetary policy tightening in the US and the easing cycle. The response approximates the asymmetric effect of US monetary policy spillovers on Indonesia's policy rate. However, the dynamics are in line with some of the previous studies. For example, the response to Indonesia's monetary policy rate collaborates with the findings of Eterovic, Sweet, and Eterovic (2022). They discovered that when US rates ease, the absolute value of policy rates in emerging markets changes more than when they tighten.

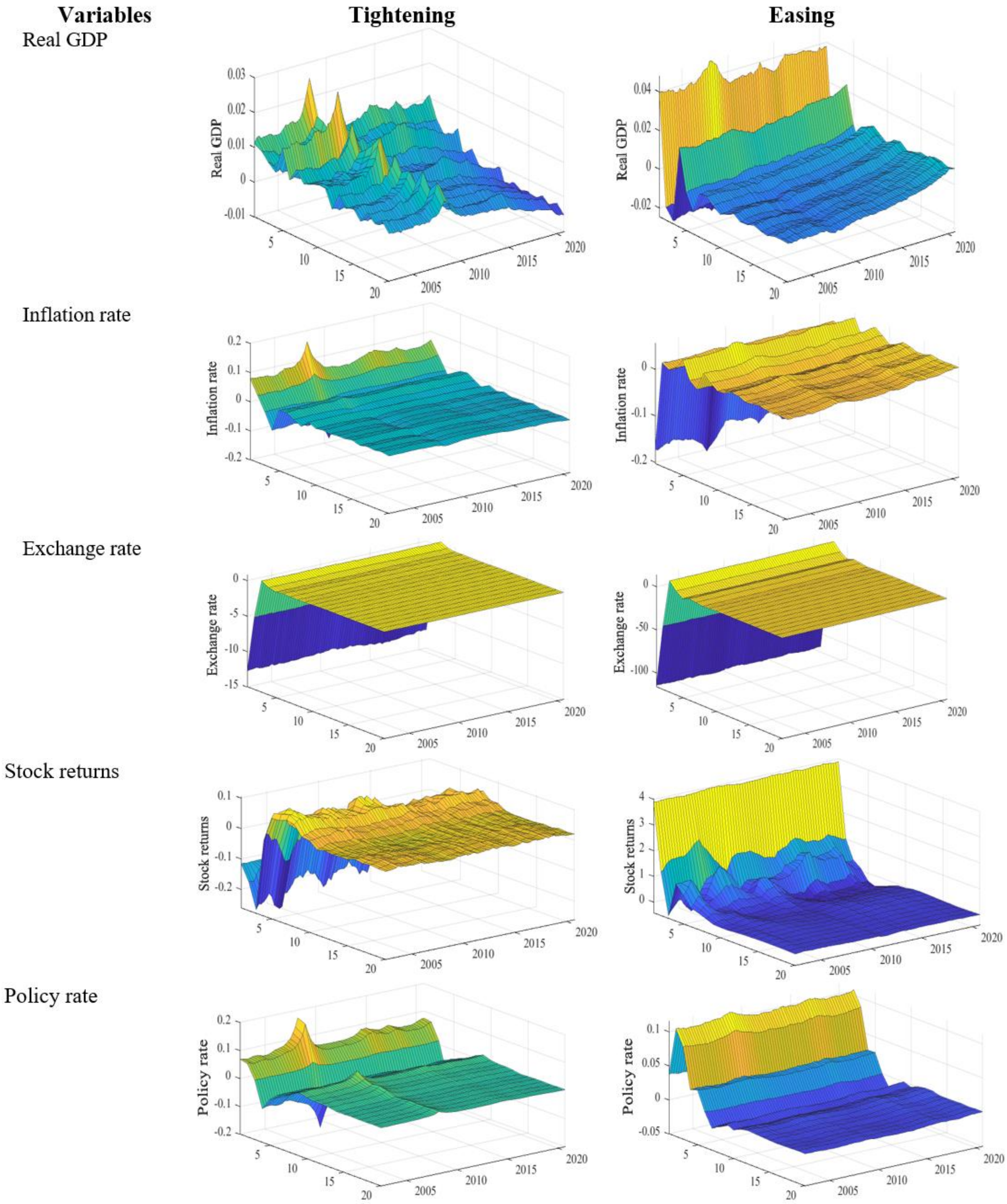


Figure 7b. Time-Varying IRF of Indonesia's real and financial variable to US monetary policy tightening and easing shocks.

Figure 7b shows Indonesia's time-varying cumulative impulse responses to monetary policy tightening and easing shocks from the US Fed to real and financial variables. These responses, with the exception of exchange rates and stock returns, clearly feature time variation over time. In 2008, the strongest time variation, which is also common to almost all variables, was observed. Peaks in 2017 and 2020 are weaker than in 2008. These variations can be attributed to various factors, such as the global financial crises, the implementation of UMP by the US Fed in 2008, the three consecutive hikes in FFR in 2017, and the advent of COVID-19, which led to a significant lockdown.

4.4. Spillovers Effects from AEs Conventional Vs Unconventional Monetary Policy Shocks

In this section, we compare the spillovers of Conventional and Unconventional Monetary Policy (UMP) to ascertain whether Indonesia's macroeconomic and financial variables respond differently over the periods. A handful of empirical studies (e.g., (Hajek & Horvath, 2018; Kucharčuková, Claeys, & Vašíček, 2016)) found that while spillovers from conventional monetary policy have a stronger effect on macroeconomic variables, the effect of UMP is stronger on the exchange rate but muted and less significant on macroeconomic variables. For this purpose, we split the sample period into conventional and UMP eras. While the period from 2000 – 2007 is classified as the conventional monetary policy era, the period from 2008 – 2015 is classified as UMP.

Figure 8a and 8b present the constant coefficient and time-varying impulse responses of Indonesia's macroeconomic and financial variables to US conventional and UMP shocks. From Figure 8a shows that the endogenous variables' responses to conventional and UMP are consistent with the existing literature. First, compared to conventional monetary policy, the exchange rate response to the UMP is stronger. Second, conventional monetary policy exerts stronger effects on other macroeconomic variables compared to UMP. While the impact of conventional monetary policy shocks on real GDP is positive and has remained largely so for over three years, the impact of UMP on real GDP was initially positive and turned negative from the 4th quarter through the rest of the horizon. The effect of conventional monetary policy was inflationary in Indonesia and lasted for over three years before it died out. On the other hand, the effect of UMP on inflation is negative, but it turned positive after the 2nd quarter and continued to fluctuate thereafter.

While stock market returns responded positively to both conventional and UMP, the effect of UMP was stronger and lasted for over six quarters before it finally died out. Surprisingly, the policy rate responded positively to conventional monetary policy shocks and negatively to UMP shocks. However, the US monetary policy spillovers over the sample period boost Indonesia's real GDP, stock market returns, and bilateral exchange rate vis-à-vis the US dollar, triggering inflation beyond what the corresponding policy reaction could counteract.

According to Figure 8b, while the coefficients of most of the variables are approximately constant, there are elements of time variation in the response of exchange rates and stock returns to conventional monetary policy shocks. Stock returns and policy rates respond to the UMP policy, as well as some time variation.

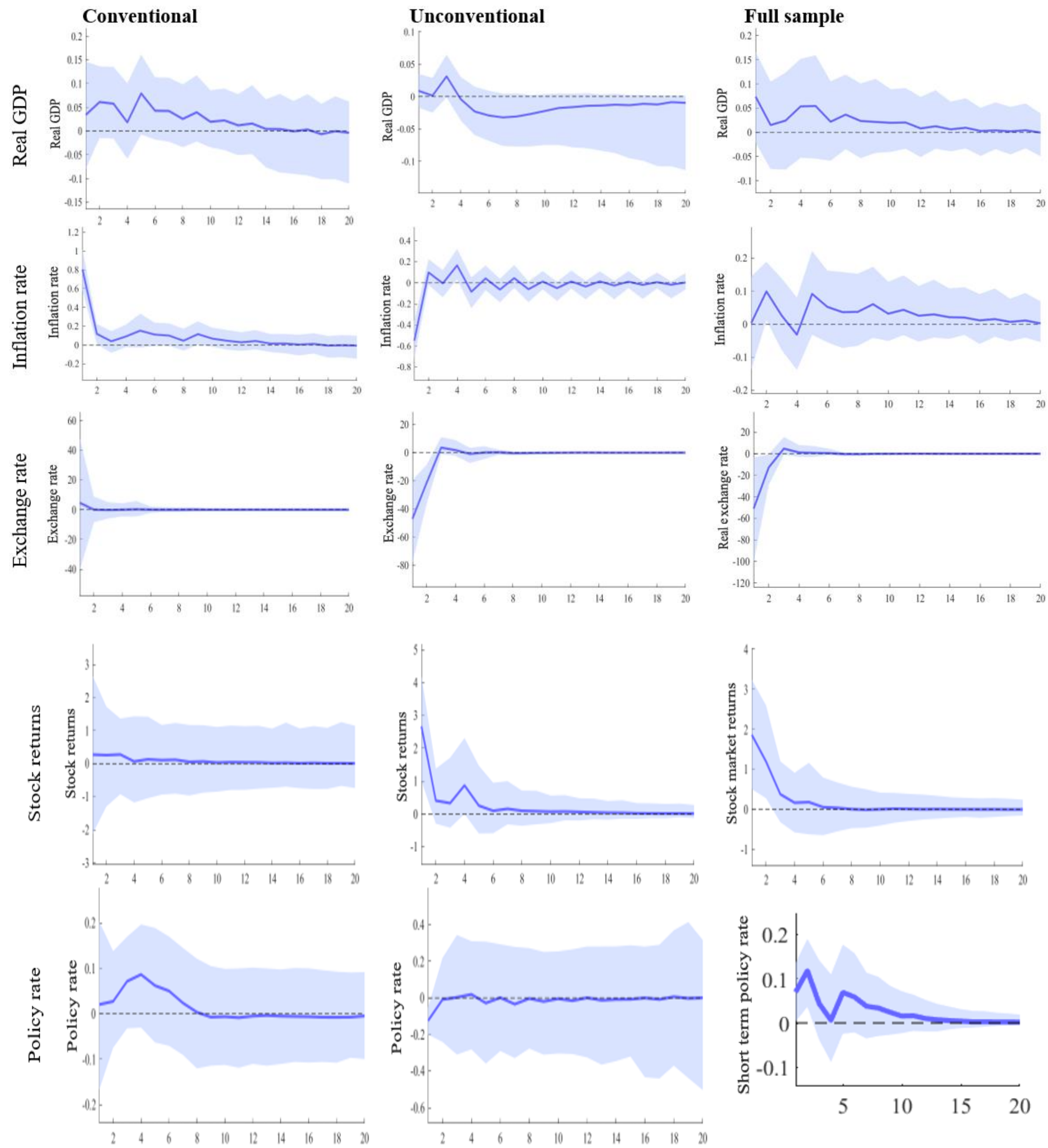


Figure 8a. IRFs of spillovers from US conventional Vs unconventional monetary policy to Indonesia.

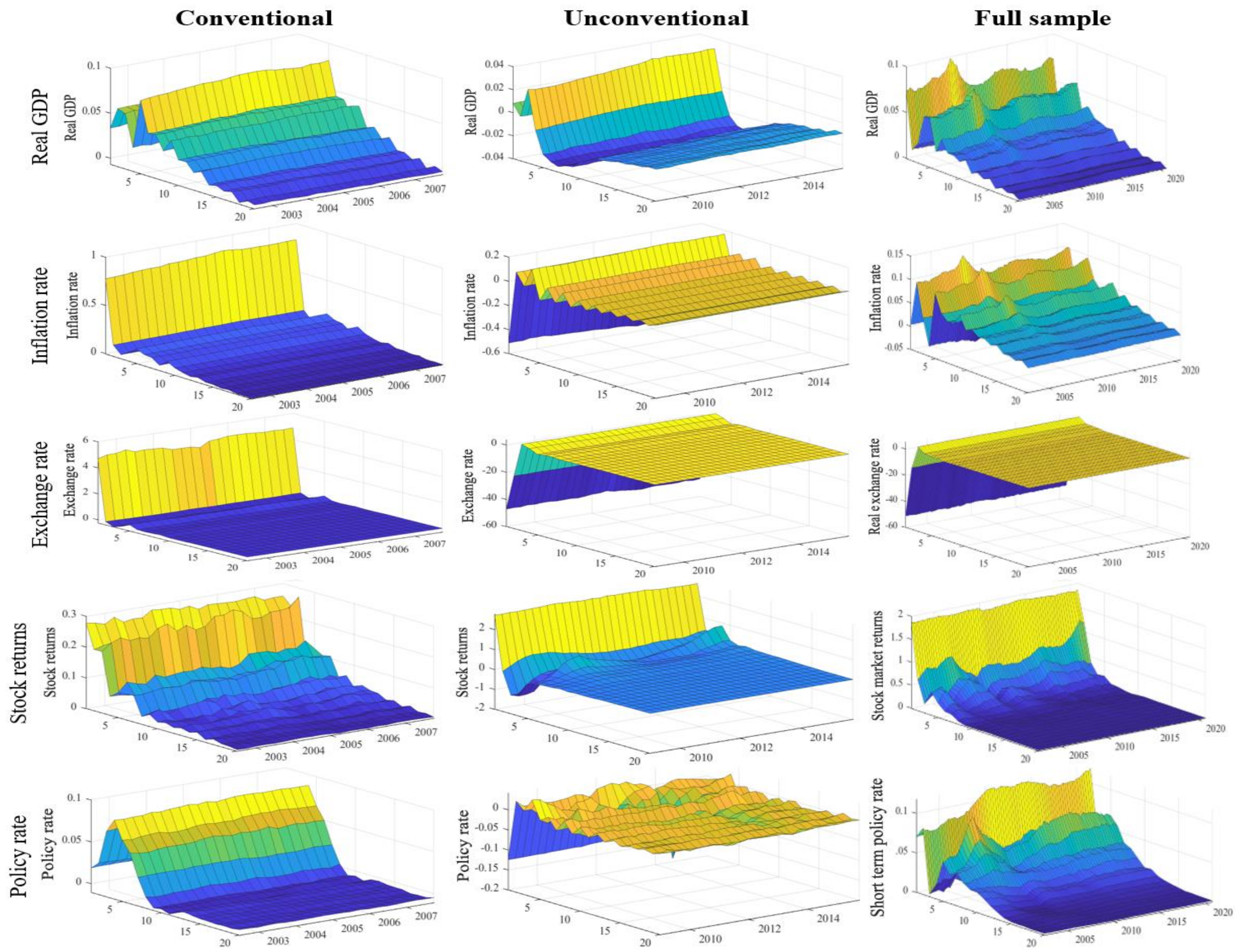
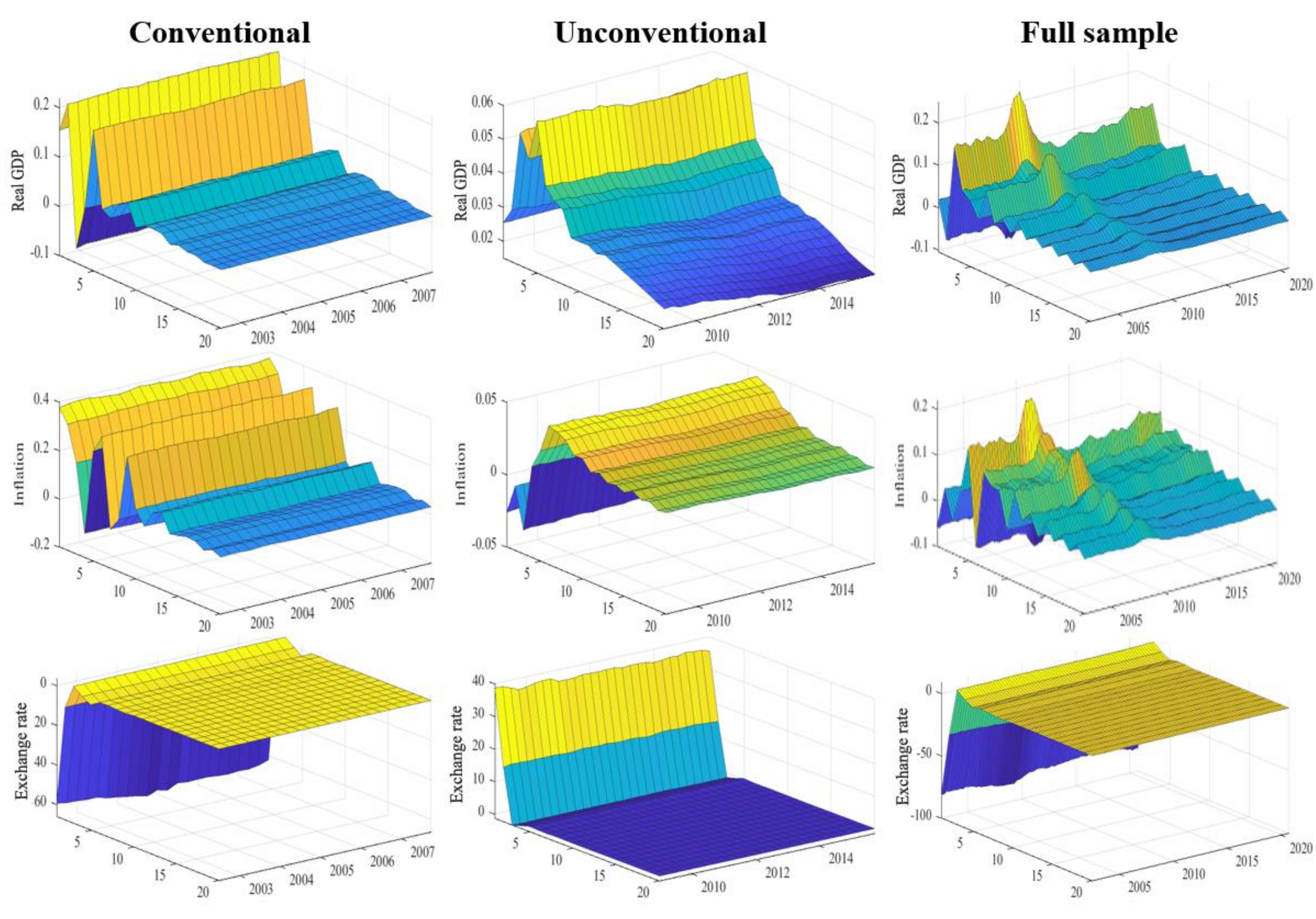


Figure 8b. Time-varying IRFs of spillovers from us conventional vs unconventional monetary policy to Indonesia.

5. Robustness of the Results

In this section, we identify US monetary policy shocks using the Effective Federal Funds Rate (EFFR) as opposed to using the shadow rate. We then contrast the time-varying impulse responses obtained using EFFR (Figure 9) to the ones identified using the US shadow rate (Figure 8b). The goal is to determine whether the shadow rate is effective in identifying US monetary policy shocks. Since the shadow rate went beyond zero and became negative from 2008 to 2015 compared to EFFR (Figure 4), we expect some differences, at least within that period. Therefore, we incorporate EFFR instead of shadow rate in this segment in the US SVAR model. We then treat the residuals as unanticipated shocks in US policy rates and use them in the Indonesia TVP-VAR model by following the same procedure.



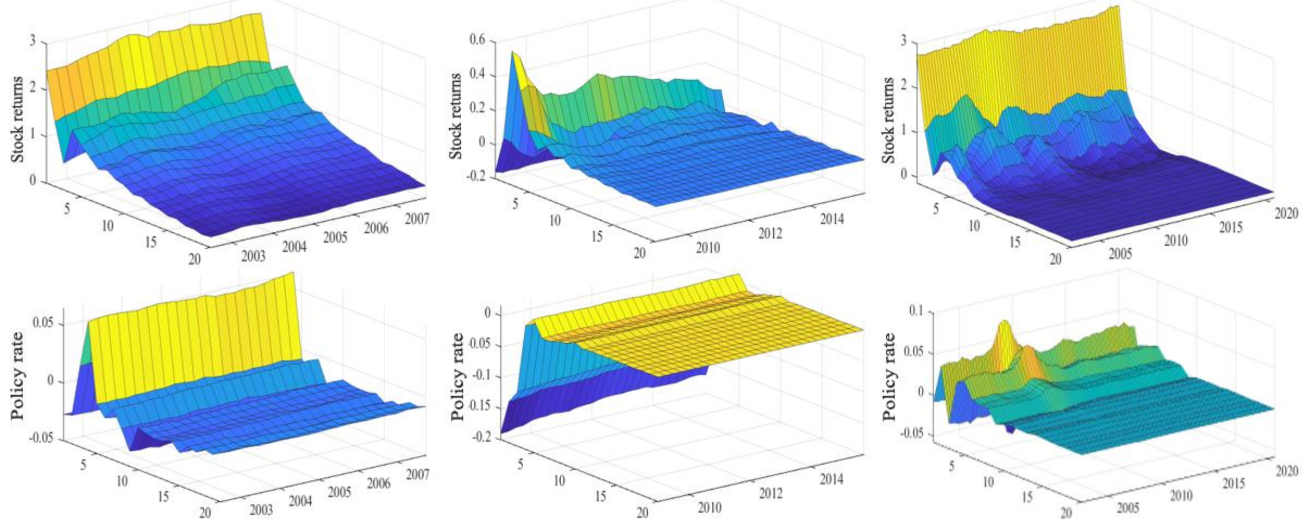


Figure 9. Time-varying IRFs of spillovers from US conventional Vs unconventional monetary policy to Indonesia.

The baseline model for both the US SVAR and Indonesia SVAR models is the same as in the later model. The estimates from this model are presented in Figure 9. While the responses from this approach for the full sample and unconventional sub-sample substantially differ from our earlier results, the result of the conventional sub-sample, except for the exchange rate, is quite similar. From the full sample IRFs, the period between 2001 to 2008 is quite similar in the two scenarios. This reflects the period where the shadow rate significantly mimics the EFFR (Figure 4). The observed difference during the unconventional period in the two scenarios highlights the importance of using the shadow rate to identify US monetary policy shocks. The difference is substantially explained by the unconventional monetary policy (UMP) implemented in the wake of the GFC. This is the point where the shadow rate falls below zero to reflect the effect of the UMP. Therefore, disaggregating the IRFs into conventional and unconventional era shows that the full sample analysis using shadow rate and time-varying VAR model is apt and fit the data substantially.

6. Conclusion

This study examines the propagation of US monetary policy spillover to the Indonesian economy over the period 2000–2020. Our study primarily focuses on the transmission of US monetary policy spillover effects on Indonesia's real GDP, inflation, exchange rate, stock market returns, and policy rate. We conducted the data analysis in two stages: First, we identified the unanticipated shocks in a US SVAR model using the Cholesky decomposition identification scheme to find the residuals from this model. Secondly, we then incorporate these shocks into our Indonesian TVP-VAR-X model to capture the spillover effects of the US monetary policy stance on the Indonesian economy using the IRFs obtained.

The study finds that US monetary policy spillovers, on average, boost Indonesia's real GDP and stock market returns, appreciate the bilateral exchange rate vis-à-vis the US dollar, and trigger inflation beyond what the corresponding policy reaction could counteract. However, decomposing the shock into easing and tightening shocks reveals significant differences. We find that the effect of US monetary policy shocks on real GDP, the exchange rate, and the policy rate is asymmetric, as the variables appreciate in response to both tightening and easing shocks. On the contrary, the effects on inflation and stock market returns are symmetrical. Indonesia's inflation responded positively to US monetary policy tightening shocks and negatively to easing shocks. The stock market's returns responded positively and negatively to US easing and tightening shocks, respectively. We also found that macroeconomic variables responded differently to US conventional and UMP shocks. While real GDP and inflation responded positively to US conventional monetary policy shocks, UMP shocks, on the other hand, depressed both GDP and inflation. The exchange rate appreciates in response to US UMP shocks and depreciates in response to conventional monetary policy shocks. While stock market returns responded positively to both shocks, the response to UMP was stronger and longer. To stimulate declining output, policy rates rise in response to conventional monetary policy shocks and fall in response to UMP shocks. Finally, we also found substantial time variation in the effects corresponding to major global events, including the GFC and implementation of UMP, the taper tantrum of 2013–2014, and the great lockdown in the wake of the COVID-19 pandemic in 2019–2020.

The contribution of the study is twofold. First, we investigate the spillover effects of US monetary policy on the Indonesian economy using the shadow rate against the FFR. This choice of shadow rate is motivated by the desire to capture the effects of UMP implemented in the wake of GFC. Secondly, we constructed a block-exogenous SVAR model that features time-varying parameters. The rationale behind this decision is to deal with potential structural breaks and nonlinearities caused by major domestic and global events in the past. Our findings have implications that encourage further research. In our analysis, we only considered spillovers of monetary policy from the United States to Indonesia. This is an important starting point. The next extension is to consider other advanced economies with strong trade and financial ties with Indonesia, such as Japan and the Euro Area. We were unable to include them in our analysis, leaving a significant gap for future research.

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