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Monetary and Macroprudential Policies in the Presence of External Shocks: Evidence from an Emerging Economy

Abstract

Purpose – This paper examines the impact of using the reserve requirements, combined with FX intervention, as key instruments in an inflation-targeting framework.

Design/methodology/approach – In the context of a Dynamic Stochastic General Equilibrium (DSGE) framework and using Bayesian techniques we estimate a model for the Indonesian economy using quarterly data spanning the period 2005Q2 to 2019Q4.

Findings –The *reserve requirement is found to assume a complementary role to that of the interest rate policy and FX intervention when used to stabilise the macroeconomy*

Originality/value – this paper provides a benchmark for other emerging countries that consider adopting the ITF framework and impose an FX intervention as part of their monetary policy

Keywords: monetary policy, macroprudential policy, foreign exchange intervention, reserve requirement, DSGE

1. Introduction

The role of reserve requirements has been revived in the aftermath of the recent global financial crisis. This instrument is being utilised to achieve price and financial stability. Some recent examples can be drawn from China, which frequently uses the reserve requirement to curb domestic credit growth (Glocker and Towbin, 2015). The reserve requirement is also used to absorb excess or extend liquidity following a foreign exchange (FX) rate intervention which can be seen in other Asian as well as Latin American countries (Federico *et al.*, 2014; Montoro and Moreno, 2011).

The use of reserve requirements can also be attributed to the volatility of capital flows in emerging markets. Many policymakers use the instrument to tackle this volatility. In the event of

massive capital inflows, many countries resort to the reserve requirement because increasing the policy rate to tackle the pressure of domestic inflation would instead attract more capital inflows (Montoro and Moreno, 2011). During a period of capital outflows, the reserve requirement can be used to neutralise the increasing policy rate due to the need to defend the currency (Federico *et al.*, 2014). This extensive utilisation of the reserve requirement instrument has triggered a long and wide-reaching debate. As previously mentioned, it may be difficult to determine the main objective of the reserve requirement since it varies across countries (Gray, 2011). In addition, the reserve requirement has served as a macroprudential instrument in several countries, including Malaysia and Turkey (Glocker and Towbin, 2012), the aim being to reduce the intensity of the financial cycle and restrain financial vulnerabilities that may occur as a result.

In another case, in 2010, Indonesia introduced an additional measure to the reserve requirement, linking it to the loan-to-deposit ratio (LDR) of banks, on top of their primary reserve requirements. This measure imposed a reserve requirement penalty if a bank had an LDR below or above target (Bank Indonesia, 2010). It is now called the macroprudential intermediary ratio (Bank Indonesia, 2018)[1]. The macroprudential intermediary ratio is intended to drive the banking industry's intermediation function in the real sector in accordance with their capacity and macroeconomic stability, while maintaining precautionary principles. The LDR target can function as a signalling tool regarding the credit condition that is preferred by the central bank (Satria *et al.*, 2016).

Despite its implementation, and long and extensive debates regarding the effectiveness of using the reserve requirement, the findings in this area are still far from reaching a conclusion. On the other hand, Lubis et al. (2019) highlight that FX intervention complements interest rate policy, particularly in tackling external shocks such as risk appetite shocks, in stabilising the macroeconomy. Therefore, it is critical to analyse the reserve requirement within the framework of the central bank, along with interest rate and FX interventions.

[1] Details regarding Bank Indonesia's macroprudential instrument can be accessed at https://www.bi.go.id/id/peraturan/ssk/Pages/PBI_200418.aspx

In this paper, we explore – in the context of an emerging market – the impact of using the reserve requirements, combined with FX intervention, as key instruments in an inflation-targeting framework. Other studies such as Glocker and Towbin (2015) and Tovar *et al.* (2012) use Structural Vector Autoregression (SVAR) to examine the effect of reserve requirement on the macroeconomy. However, their study did not discuss the dynamics between monetary policy, FX intervention and reserve requirements, three main policies for the emerging economies that adopt inflation-targeting framework to tackle current challenges, particularly the capital flows volatility.

Therefore, this paper uses a simplified medium-scale Dynamic Stochastic General Equilibrium (DSGE) model with the banking sector developed by Agénor *et al.* (2018) to investigate these dynamics. Agénor *et al.* (2018) study the impact of external shock to the economy by using the world interest rate shock as the source of shock whereas, whilst we incorporate in our model the risk appetite of investors as a shock to the economy as Indonesia is one of the emerging economies to have been affected by capital flow volatility capture and enhance the reserve requirement with the Indonesian context.

By using DSGE, we are able to observe the role of domestic and external financing in the banking sector and analyse the importance of monetary policy, FX intervention and reserve requirements in affecting the macroeconomy particularly when risk appetite worsens in the global market. In this context, Chawwa (2021), has investigated the effect of reserve requirements on the economy using a DSGE model for Indonesia but the policy implications are somewhat limited as the study focuses on a closed economy. Finally, using data for the Indonesian economy, we examine the impact under three different regimes: (i) when interest rate policy is used to stabilise inflation and output, known as the full-fledged Inflation Targeting Framework (ITF), (ii) when interest rate policy is combined with FX intervention to stabilise inflation, output and the exchange rate and; (iii) when a mix of interest policy, FX intervention and reserve requirement are considered to stabilise inflation, output and the exchange rate.

As such, this study's contribution is of paramount importance for policy makers, as it incorporates in the DSGE model three types of policy: monetary policy, FX intervention, reserve requirement, and examine the impact under the combination of those policies to stabilise inflation, output and the exchange rate. Furthermore, by utilizing data for one of the largest emerging market

economies that have been affected by capital flow volatility, this paper provides a benchmark for other emerging countries that consider adopting the ITF framework and impose an FX intervention as part of their monetary policy.

The remainder of the paper is organised as follows: Section 2 highlights the related literature on reserve requirements, whilst section 3 presents the small open-economy model. Section 4 touches on the empirical estimation as well as discussing the generated evidence, and finally, section 5 provides some concluding remarks.

2. Related Literature

A commercial bank is required to maintain a minimum reserve against its liability, mainly in the form of balances at the central bank (Gray, 2011). This practice has already been abandoned by some developed countries but is still largely practised in emerging markets. Federico et al. (2014) find that most of the emerging markets use reserve requirements as a countercyclical policy tool to stabilise the macroeconomy, whilst the policy rate assumes the procyclical role. According to Federico et al. (2014), this reflects the fact that many emerging economies use policy rates to defend their exchange rates, whilst the reserve requirement acts as a substitute for the policy rate.

The use of reserve requirements has become increasingly complex, and it has become very difficult to delineate their main objective. Policymakers in emerging markets have been using reserve requirements to cope with the implications of capital flows. Early observations can be drawn from Reinhart and Reinhart (1999), who document the use of reserve requirements to absorb or expand the monetary base in many countries in Asia and Latin America, such as Malaysia, Thailand, Chile, Argentina and Brazil during an FX operation that follows an episode of capital flows.

The practice of using reserve requirements to tackle massive capital flow episodes can also be spotted in the most recent global financial crisis. Glocker and Towbin (2012) point out that China actively used the reserve requirement in 2010, while Turkey increased its reserve requirement in the same year. Several Latin American countries were also observed using the instrument at this time, such as Brazil, Colombia, and Peru (Montoro and Moreno, 2011).

Using the reserve requirement may restrict the expansion of financing conditions but without drawing more capital flows as occurs with an increase in policy rate (Montoro and Moreno, 2011). Banks can adjust their deposit and lending rates, as reserve requirements act as a tax on financial intermediation, without having to make adjustments to the policy rate. Lowering the reserve requirement during an episode of capital outflows provides relief in liquidity and also directly affects the credit supply. This is particularly helpful in emerging countries where the financial markets are still less developed and a low pass-through from the policy rate (Moreno, 2008). In addition, the use of the reserve requirement may achieve financial stability by restraining credit growth in the upswing of the business cycle, whilst giving the reserve back to the banking sector in the downturn of the business cycle (Montoro and Moreno, 2011). In this context, countercyclical reserve requirement has also been found to stabilise the credit growth volatility (Chawwa, 2021).

This practice has attracted new interest in studying the impact of the reserve requirement on the macroeconomy. Analytical implications regarding the use of the reserve requirement can be drawn from Glocker and Towbin (2012). They find that the reserve requirement helps stabilise the macroeconomy in the presence of a financial stability objective. The presence of foreign currency debt also increases the effectiveness of the reserve requirement.

However, FX intervention is absent from Glocker and Towbin's (2012) model. Agénor et al. (2018) therefore complement their analysis with FX intervention. They also introduce a time-varying reserve requirement that links countercyclically to a credit-based measurement. They find that this credit-based reserve requirement instrument helps stabilise the macroeconomy and financial volatilities. Further, they argue that the reserve requirement and FX sterilisation are partial substitutes for one another.

In addition, in the aftermath of the 2008 financial crisis, many ITF central banks implemented FX rate intervention as a complementary policy to the interest rate (Ghosh *et al.*, 2016). The excess liquidity in the global market needs to be channelled, mainly to emerging markets, which creates the volatility of the exchange rate for the emerging market. Ghosh et al. (2016) find that the use of FX rate intervention helps achieve price stability. Blanchard et al. (2015) also find that the FX intervention helps

dampen exchange rate pressures and can be considered part of the ITF central bank's toolset for stabilising the macroeconomy.

The use of FX intervention is not only intended to move the exchange rate towards a certain target but also to prevent the exchange rate moving too fast to a new equilibrium (Daude *et al.*, 2016). By using panel data of 18 emerging market economies, Daude *et al.* (2016) find that FX intervention when there is a large deviation from the equilibrium to be more effective. In addition, Fratzscher *et al.* (2019) argue that FX intervention has a better performance when moving towards long-run equilibrium along with sizeable measure and along with a prior path.

The volatility of the exchange rate is also amplified by the volatility of the market participants' risk appetite. Early studies such as Henderson and Rogoff (1982) have reported that an adjustment in the risk appetite of market participants may affect the stability of the exchange rate. This phenomenon is popularly called the 'Risk On/Risk Off' phenomenon (Smales, 2016). Cadarajat and Lubis (2012) find that the impact of the exchange rate volatility in Indonesia increases after the global financial crisis. This volatility increase is driven mainly by the off-shore market, which represents foreign investors' risk appetite.

In other studies, Bustamante and Hamann (2015) find that countercyclical reserve requirements help in reducing consumption volatility when banks become more risk averse. The imperfect substitution between bank deposits and loans from the central bank is attributed to the effectivity of reserve requirements. Leduc and Natal (2018) argue that adding macroprudential instruments, such as a reserve requirement, which is connected to credit growth, helps diminish the endogenous feedback loop between asset prices and economic fluctuations. This condition helps monetary policy to focus on tackling price stability.

Agénor et al. (2018) and Iacoviello (2005) use housing as credit collateral. This is important as housing collateral backs up many credits. This link provides the collateral effect that allows the model to match the positive feedback of real spending to housing prices.

Turning to empirical evidence, extensive work has been performed examining the role of reserve requirements in the economy. Reinhart and Reinhart (1999) find that the reserve requirement helps prevent monetary expansion during an episode of massive capital outflows, in sample countries

including Malaysia, Kenya, and Chile. It is also observed that the deposit interest rate is lowered, the lending rates are increased, and therefore, the spread between these rates is widened. In addition, Glocker and Towbin (2015) find that an increase in reserve requirements in Brazil lowers domestic credit which leads to a higher unemployment rate, a depreciation in the exchange rate, a better performance in the current account and a higher price level.

Armas et al. (2014) find that the reserve requirement in Peru helps curb the effect of large capital inflows that follow an expansion policy in developed countries. In addition, Armas et al. (2014) argue that using this instrument has helped develop the capital market in Peru by increasing the cost of credit. Firms are instead encouraged to use the capital market when seeking funding.

Loeffler (2015) examines the impact of the use of reserve requirements on the real exchange rate in Latin American, East Asian, and Eastern European countries. He finds that the reserve requirement drives a depreciation in the real exchange rate.

Regarding the relationship with output and credit growth, Crespo Cuaresma et al. (2019) perform an analysis using quarterly data on reserve requirements in 60 countries. They find that reserve requirements affect output growth negatively during tranquil times and positively during crises. They also argue that the impact of reserve requirements on credit as a proportion of GDP is positive in the long run. Tovar et al. (2014), meanwhile, report that, based on data from Latin America, reserve requirements have an effect on credit growth. They also argue that reserve requirements complement monetary policy.

3. A Small Open-Economy Model

We consider a discrete-time model with infinite horizon that features nominal and real rigidities along the lines of Agénor et al. (2013, 2018) among others. We assume that wages and prices have nominal rigidity. We also set the banking sector up to have an imperfectly competitive environment. We include an interest policy combined with FX intervention, and a reserve requirement, as the stabilisation

policies. However, we assume that the central bank may not be able to fully utilise the FX reserves, and has to maintain a certain amount of FX reserves[2].

The market clearing equilibrium conveyed as follows:

A resource constraint implies

$$Y_t = C_t + I_t + G_t + EX_t - IM_t \tag{1}$$

where imports, IM_t, can be written as

$$IM_t = C_{F,t} + I_{F,t} \tag{2}$$

The trade balance, TB_t, can be formulated as

$$TB_t = \frac{P_{D,t}}{P_t} C^*_{D,t} + \frac{P_{D,t}}{P^I_t} I^*_{D,t} - \frac{P_{F,t}}{P_t} C_{F,t} - \frac{P_{F,t}}{P^I_t} I_{F,t} \tag{3}$$

The stock of foreign bonds held by households, in home-country consumption units, $B_{F,t}$, accumulates according to

$$B^*_t = TB_t + B^*_{t-1}\left(1 + r^*_{t-1}\right)\left(1 - \Phi^B_{t-1}\right)\left(\frac{1+\pi^S_t}{1+\pi_t}\right) - FX_t + FX_{t-1}\left(1 + r^*_{t-1}\right)\left(\frac{1+\pi^S_t}{1+\pi_t}\right) + l^F_t - l^F_{t-1}\left(\frac{1+\pi^S_t}{1+\pi_t}\right) \tag{4}$$

Then, the price inflation of the total consumption goods (π_t) can written as

$$1 + \pi_t = \left[\nu_C \left(1 + \pi^D_t\right)^{1-\mu_C} + (1 - \nu_C)\left(1 + \pi^F_t\right)^{1-\mu_C}\right]^{\frac{1}{1-\mu_C}} \tag{5}$$

while the price inflation of imported consumption goods (π^F_t) is given by

$$1 + \pi^F_t = \left(1 + \pi^S_t\right)\left(1 + \pi^*_t\right) \tag{6}$$

The structural shock processes in the log-linearised form are assumed to follow AR(1):

$$ln\, A_t = \rho_A \ln A_{t-1} + \varepsilon_{A,t} \tag{7}$$

$$ln\, C^*_t = (1 - \rho_C) \ln \overline{C}^* + \rho_C \ln C^*_{t-1} + \varepsilon_{C^*,t} \tag{8}$$

$$ln\, I^*_t = (1 - \rho_I) \ln \overline{I}^* + \rho_I \ln I^*_{t-1} + \varepsilon_{I^*,t} \tag{9}$$

$$r^*_t = (1 - \rho_{r^*})\overline{r^*} + \rho_{r^*} r^*_{t-1} + \varepsilon_{r^*,t} \tag{10}$$

[2] The problem of the agents and the full set of derivation of the model with a detailed description are reported in the Technical Appendix, which is available upon request.

$$\pi_t^* = (1-\rho_\pi)\,\overline{\pi^*} + \rho_\pi\,\pi_{t-1}^* + \varepsilon_{\pi^*,t} \tag{11}$$

Variables names without subscriptions denote variables with steady-state values.

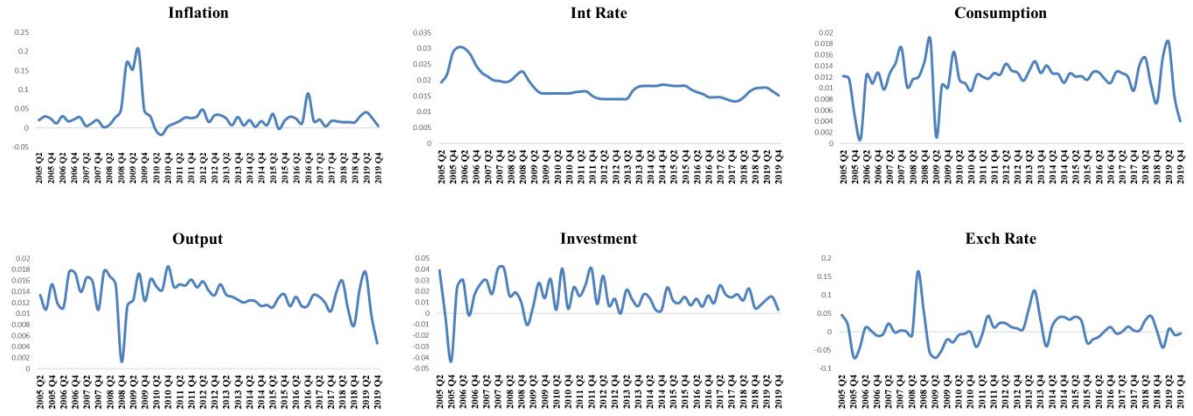
4. Empirical Analysis and Results

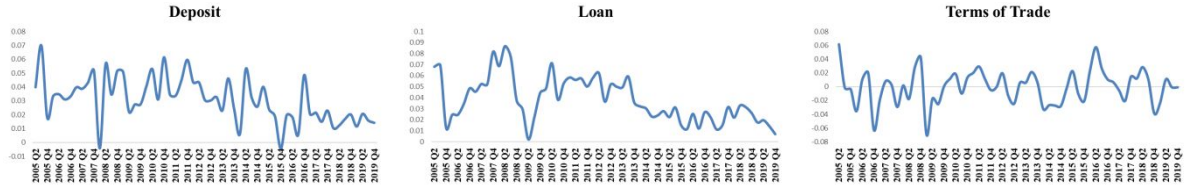
4.1. Data

Following our model construction, we use the Bayesian techniques to estimate the model's parameters. We employ quarterly data for Indonesia from 2005Q2 to 2019Q4. We take our sample after the Asian Financial Crisis and the implementation of the policy rate in the second quarter of 2005. We use quarterly growth rates of output, consumption, investment, and domestic inflation, all obtained from the Indonesian Statistics Agency (BPS). We also use policy rate, quarterly growth rates of exchange rate, commercial bank deposits and commercial bank loans obtained from the central bank (Bank Indonesia) and terms of trade quarterly growth rates obtained from Thomson-Reuters.

The output, consumption, investment, commercial bank deposits and commercial bank loans are in real terms, while the policy rate and exchange rate are in nominal terms. The exchange rate is USD/IDR. Domestic inflation is given by the CPI with 2012 as the base year. For terms of trade, we use the indices of export and import prices constructed by Thomson-Reuters. Figure 1 illustrates the historical and smoothed variables.

Figure 1 Historical and Smoothed Variables





In addition, we construct measurement equations to incorporate the measurement error in our observable variables. Table 1 describes our measurement approach.

Table 1 Measurement Equations

Observable	Model Variables
Output growth	$\Delta ln\, Y_t^{obs} = \Delta(ln\, Y_t - ln\, \overline{Y}) + m\varepsilon_{Y,t}$
Consumption growth	$\Delta ln\, C_t^{obs} = \Delta(ln\, C_t - ln\, \overline{C}) + m\varepsilon_{C,t}$
Investment growth	$\Delta ln\, I_t^{obs} = \Delta(ln\, I_t - ln\, \overline{I}) + m\varepsilon_{I,t}$
CPI inflation	$\pi_t^{obs} = \pi_t - \overline{\pi}$
Interest rate	$r_t^{obs} = R_t - \overline{R}$
Exchange rate inflation	$\pi_t^{S,obs} = \pi_t^S - \overline{\pi}^S$
Loan growth	$\Delta ln\, L_t^{obs} = \Delta(ln\, L_t - ln\, \overline{L}) + m\varepsilon_{L,t}$
Deposit growth	$\Delta ln\, D_t^{obs} = \Delta(ln\, D_t - ln\, \overline{D}) + m\varepsilon_{d,t}$
Terms of trade growth	$\Delta ln\, ToT_t^{obs} = \Delta(ln\, ToT_t - ln\, \overline{ToT}) + m\varepsilon_{ToT}$

Note: Variable names without subscriptions denote variables with steady-state values.

4.2. Parameter Calibration

To estimate the model, we calibrate some parameters based on previous studies so that they are consistent with the mean values in the data. The discount factor β is set at 0.99, which gives an annual steady-state real interest rate of around 4%, in line with many studies (e.g. Smets and Wouters (2007)). The capital share α is set according to Harmanta et al. (2014). Following Schmitt-Grohé and Uribe (2003), we set the elasticity of the risk premium to the level of debt θ_B, 0.001. Table 2 lists the parameters' calibrated values.

Table 2 Calibrated Parameter Values

Parameter	Value	Description
α	0.33	exponent of capital in the production function
β	0.99	discount rate
ψ_X	0.02	liquidity utility parameter
ψ_H	0.02	housing utility parameter
ω	0.35	money and deposit preference parameter
θ_B	0.001	bond risk premium parameter
η	2	Inverse Frisch elasticity of labour supply
ϵ_p	10	elasticity of domestic goods demand
ϵ_w	10	elasticity of wage demand
ν_{C^*}	0.62	foreign consumption degree of openness

Parameter	Value	Description
ν_{I^*}	0.62	foreign investment degree of openness
μ_{C^*}	3.5	elast of subs between domestic & foreign cons goods in foreign countries
μ_{I^*}	3.5	elast of subs between domestic & foreign inv goods in foreign countries
ϕ_K	14	investment adjustment cost parameter
δ	0.02	capital depreciation
ρ_{RR}	0.05	reserve requirement
ϕ_{Fx}	4	multiplication of import value for self-insurance

4.3. Analysis of Results

We estimate the posterior mode by numerically maximising the log posterior density function, using a combination of prior information and the likelihood of the data. Then, we estimate the full posterior distribution using the Metropolis-Hastings algorithm. We begin with our prior and posterior results, which are displayed in Table 3, and shocks that are presented in Table 4.

Table 3 Estimation Results: Parameters

Param	Prior Mean	Post Mean	90% HPD Interval		Prior	Pstdev	Description
ψ_N	7.055	7.0556	6.9729	7.1373	norm	0.05	labour disutility
θ_C	0.046	0.0437	0.0276	0.0592	beta	0.01	central bank lending premium
χ	0.5	0.5282	0.3438	0.7085	beta	0.1	internal habit
ϕ_w	0.7	0.5289	0.3512	0.7006	beta	0.1	probability of wage adjustment
ϕ_p	0.7	0.4286	0.3271	0.5332	beta	0.1	probability of price adjustment
ζ_w	0.7	0.6844	0.5199	0.8473	beta	0.1	wage persistence
ζ_p	0.7	0.6119	0.4287	0.7995	beta	0.1	price persistence
ν_C	0.5	0.4301	0.2694	0.6001	beta	0.1	degree of openness in consumption
ν_I	0.5	0.572	0.4125	0.7334	beta	0.1	degree of openness in investment
μ_C	1.5	1.3805	1.0651	1.6916	norm	0.2	elasticity of subs between domestic & foreign cons goods in domestic country
μ_I	1.5	1.4705	1.1446	1.7937	norm	0.2	elasticity of subs between domestic & foreign inv goods in domestic country
φ_1	0.1	0.0911	-0.0731	0.2587	norm	0.1	elasticity of repayment probability for collateral
φ_2	0.3	0.175	0.068	0.2794	beta	0.1	elasticity of repayment probability for cyclical output
ϵ_D	3	2.9676	2.8038	3.1397	norm	0.1	elasticity of deposit substitution
ϵ_L	4.5	4.4996	4.337	4.6635	norm	0.1	elasticity of loan substitution
$\epsilon_{fx,1}$	0.5	0.5006	0.3342	0.663	beta	0.1	exchange rate smoothing for FX rule
$\epsilon_{fx,2}$	0	0.0029	-0.0786	0.0865	norm	0.05	persistence for foreign reserves rule
κ_F	0.8	0.8003	0.6367	0.9699	norm	0.1	sterilisation coefficient
κ_W	0.8	0.8088	0.6495	0.9656	norm	0.1	proportion of working capital loan
γ	0.2	0.1927	0.0254	0.3384	norm	0.1	proportion of collateral
θ_F	0.35	0.476	0.3343	0.6279	beta	0.1	foreign loan risk premium
ρ_1	0.1	0.165	0.0525	0.2712	beta	0.05	autocorrelation reserve requirement
ρ_A	0.7	0.5663	0.4168	0.7109	beta	0.1	autocorrelation technology shock
ρ_G	0.5	0.497	0.3331	0.6617	beta	0.1	autocorrelation government spending shock
ρ_M	0.5	0.6478	0.5309	0.7597	beta	0.1	autocorrelation monetary policy shock

Param	Prior Mean	Post Mean	90% HPD Interval		Prior	Pstdev	Description
ϕ_π	1.75	1.493	1.079	1.9154	norm	0.25	Taylor rule coeff of inflation
ϕ_Y	0.2	0.2292	0.149	0.3099	norm	0.05	Taylor rule coeff of output gap
ϕ_{π^s}	0.2	0.2421	0.1629	0.3216	norm	0.05	Taylor rule coeff of exchange rate
ρ_C	0.5	0.5027	0.3416	0.6667	beta	0.1	autocorrelation of fgn cons shock
ρ_I	0.5	0.5036	0.341	0.661	beta	0.1	autocorrelation of fgn inv shock
ρ_π	0.5	0.1333	0.0865	0.1831	beta	0.1	autocorrelation of fgn inflation shock
ρ_{r^*}	0.5	0.4997	0.3356	0.6611	beta	0.1	autocorrelation of fgn int rate shock

Table 4 Estimation Results: Shocks

Std dev of shocks	Prior Mean	Post Mean	90% HPD Interval		Prior	Pstdev	Description
ε_a	0.1	0.0238	0.0181	0.0295	invg	2	technology shock
ε_M	0.1	0.0167	0.0129	0.0202	invg	2	monetary policy shock
ε_G	0.1	0.0641	0.0242	0.1055	invg	2	government spending shock
ε_C	0.1	0.029	0.0199	0.0379	invg	2	foreign consumption shock
ε_I	0.1	0.0513	0.025	0.0786	invg	2	foreign investment shock
ε_{r^*}	0.1	0.0711	0.0251	0.1203	invg	2	foreign int rate shock
ε_{π^*}	0.1	0.0375	0.0302	0.0446	invg	2	foreign inflation shock
ε_{ϕ^*}	0.1	0.0148	0.0119	0.0172	invg	2	foreign risk premium shock
ε_{FX}	0.1	0.0836	0.0231	0.1537	invg	2	FX intervention shock
ε_{RR}	0.1	0.0173	0.0135	0.0207	invg	2	RR shock
$m\varepsilon_Y$	0.1	0.0192	0.0149	0.0235	invg	2	output measurement error
$m\varepsilon_C$	0.1	0.0148	0.0119	0.0172	invg	2	consumption measurement error
$m\varepsilon_I$	0.1	0.0184	0.0144	0.0223	invg	2	investment measurement error
$m\varepsilon_d$	0.1	0.0204	0.0155	0.025	invg	2	deposit measurement error
$m\varepsilon_L$	0.1	0.0212	0.0166	0.0257	invg	2	loan measurement error
$m\varepsilon_{ToT}$	0.1	0.0232	0.0179	0.0285	invg	2	terms of trade measurement error

The findings in Table 3 indicate that all of the parameter values are slightly lower than their priors. The inflation coefficient (ϕ_π) in the Taylor's rule equation is higher than its prior. We interpret this as the commitment of the central bank of Indonesia – as an ITF central bank – to assigning policy rates that focus more on price stability than defending the exchange rate. Therefore, in the context of Indonesia, we fail to agree with Federico et al. (2014), who argue that the policy rate is utilised to defend currency.

This interpretation is supported by the results for the standard deviations of the shocks in Table 4. Although slightly lower than the prior, the standard deviation of the FX intervention shock is relatively higher than the others. We interpret this as the central bank of Indonesia using this instrument

to stabilise the exchange rate. This can also be explained by the period of data we use, which is 2005-2018. During this period, the global environment put a great amount of pressure on emerging markets' exchange rates, particularly during the global financial crisis of 2007-2009 and in the aftermath of the crisis.

Another interesting finding in Table 3 is that the foreign loan risk premium parameter (θ_F) is higher than its prior. This indicates that the cost for a domestic bank of acquiring a foreign loan is higher than previously expected. By highlighting the existence of a cross-border bank portfolio channel, as suggested by Correa et al. (2018), domestic banks may expect an increase in the cost of foreign funding when a tighter monetary condition is applied in the source country, and the domestic banks might have to relocate their funding to other countries. This may increase the cost of their lending and, to some extent, cause a contraction in lending.

4.3.1. Impulse Response Analysis

We now turn to impulse response analysis in an attempt to explore the transmission mechanism in our model. We focus our discussion on describing the impacts of positive external shocks, particularly on foreign consumption, foreign interest rates and the risk premium. These shocks are portrayed in Figures 2 to 4.

Figure 2 Impulse Response to Foreign Consumption Shock

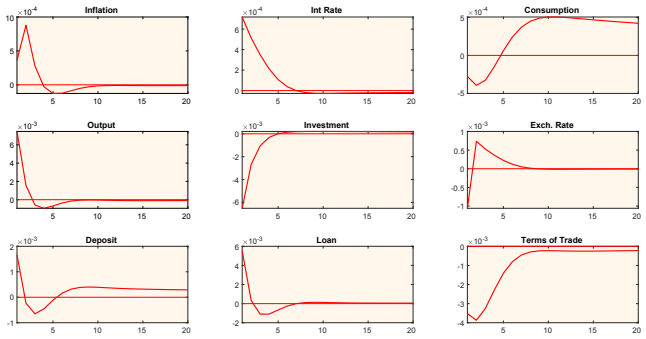


Figure 3 Impulse Response to Foreign Interest Rate Shock

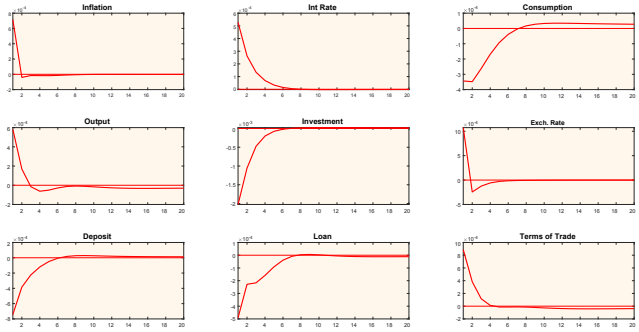
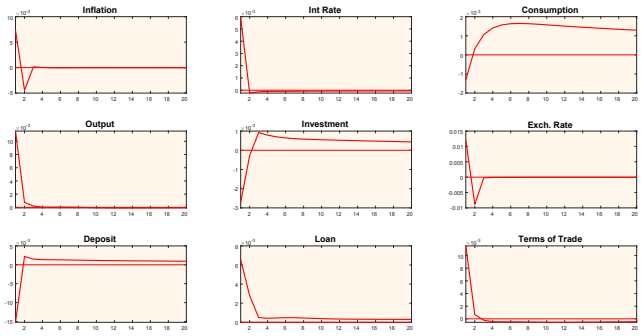


Figure 4 Impulse Response to Risk Appetite Shock



From Figure 2, we can observe that an increase in foreign consumption raises the demand for export, which in turn increases the domestic price. Bank loans also increase to facilitate production. The interest rate increases in response to inflation. As inflation and the interest rate increase, the incentive to consume declines, driving bank deposits up. The interest rate increasing then drives the exchange rate to appreciate and moves back the inflation to the initial point after 3 periods.

As we set working capital for firms to be funded by bank's loan an increase in output for export as the foreign demand increase, will be followed by an increase in loans. However, the investment will require imported goods, particularly in the emerging context. A surge in foreign consumption will increase foreign goods price and this is transmitted to the investment goods price. An increase in the investment goods price will decrease investment demand in the domestic firm. This is supported by many empirical studies in the emerging market context such as Salahuddin and Islam (2008) and Alfaro and Ahmed (2009).

As the foreign interest rate increase in Figure 3, we can expect that the foreign inflation rate is also increasing, which means the domestic goods become cheaper than foreign goods. The difference

in price drives an increase in output to be exported and leads the exchange rate to appreciate in the beginning. Meanwhile, the positive foreign interest rate shock drives the portfolio rebalancing, as highlighted by Correa et al. (2018), which in turn decreases the supply of loans. Inflation expectation rises because foreign goods become more expensive while the source of funding becomes limited. This prompts the interest rate to increase and the exchange rate to depreciate (Warjiyo, 2014).

Here, we model risk appetite as an addition to the risk premium. As explained by Cerutti et al. (2017), the interest rate is not the only factor that triggers portfolio rebalancing. There are other factors such as the stock market's expectation of volatility (VIX), and the TED spread, which account for the risk appetite of the market participants. The risk appetite shock has the most significant impact on investment growth. An increase in risk appetite drives the price up, which in turn decreases investment. However, capital outflows from the domestic market leads the price of the goods in the foreign market due to the excess liquidity. Foreign inflation drives the export which is responded by an increase in output.

4.3.2. Historical Shock Decomposition

We also examine the historical shock decomposition of the observed variables. The results are as presented in Figure 5 below.

Figure 5 Variance Decomposition

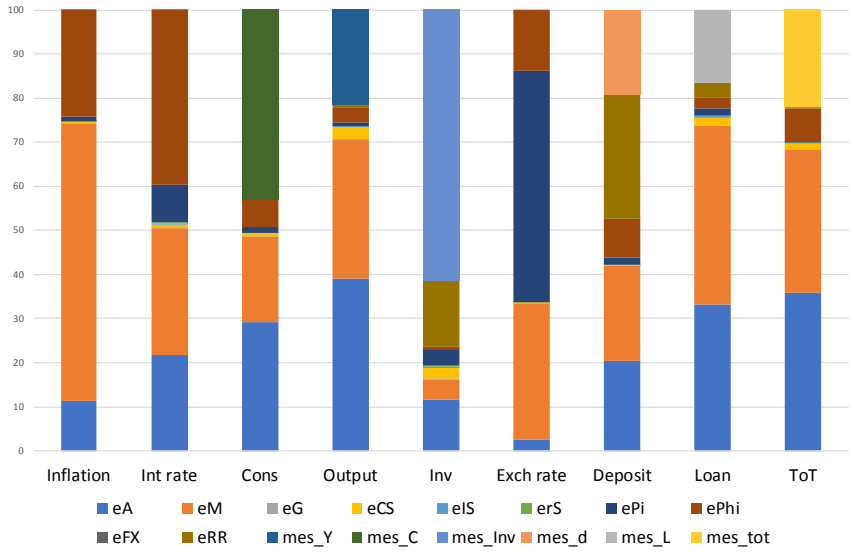


Figure 5 displays that the inflation, interest rate and exchange rate are relatively strongly affected by the risk appetite shock (ePhi). A positive shock to risk appetite, which we interpret as market

participants becoming more risk averse, and an increase in the cost of funds from abroad, drives the exchange rate to depreciate. This, in turn, will increase the inflation expectation due to the increasing price of imported goods. Therefore, the interest rate is responding to the increasing inflation expectation.

However, Figure 5 also indicates that the monetary policy affects almost all variables. Combined with the FX Intervention, monetary policy may balance the impact of the risk appetite shock on the exchange rate. We also observe that a shock to the countercyclical reserve requirement affects banks' deposits and loans. As we elaborate in detail in Appendix C.10, the reserve requirement consists of a 'fixed' reserve requirement and a countercyclical component which is adjusted according to the loan to deposit ratio of the bank. Increasing the 'secondary part' of the reserve requirement may due to the increase in the loan limit the ability of the bank to make the loan. Therefore, the bank will make deposits unattractive to the customer as the price drops, thus affecting the loan supply. With a higher premium on going abroad for funding, the contraction in deposits may then affect investment. In addition to Chawwa (2021), our findings confirm that countercyclical reserve requirement can be utilised as complementary to monetary policy so as to stabilise the credit growth in Indonesia in the presence of risk appetite shock.

4.4. Model Comparison

To illustrate the importance of the interaction between monetary and macroprudential policies using the countercyclical reserve requirement instrument, we compare our model to one without the presence of the macroprudential instrument. We develop two modified models based on the same model and perform an experiment. First, we only use the monetary policy, which only has the interest rule present, otherwise known as the full-fledged ITF. Second, we incorporate the FX intervention in the first model. We then take these two models and compare them to the FX intervention model. The impulse response analysis of some selected variables is presented in Figures 6, 7 and 8.

Figure 6 Impulse Response Comparison to Foreign Consumption Shock

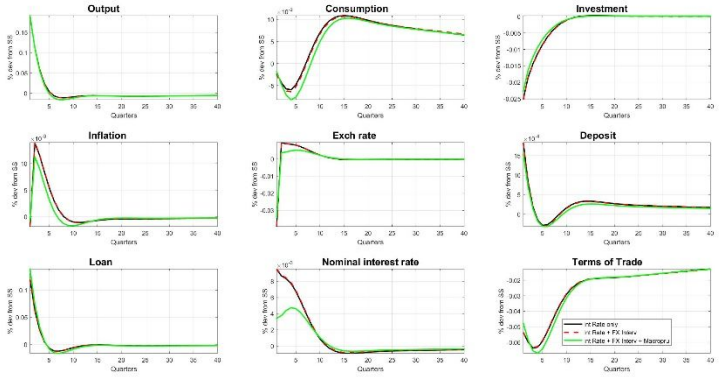


Figure 7 Impulse Response Comparison to Foreign Interest Rate Shock

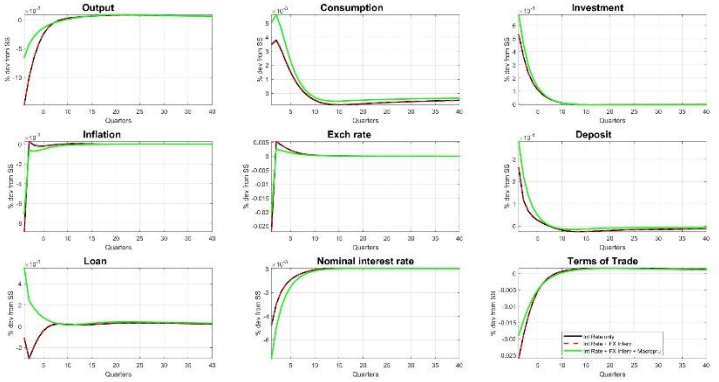


Figure 8 Impulse Response Comparison to Risk Appetite Shock

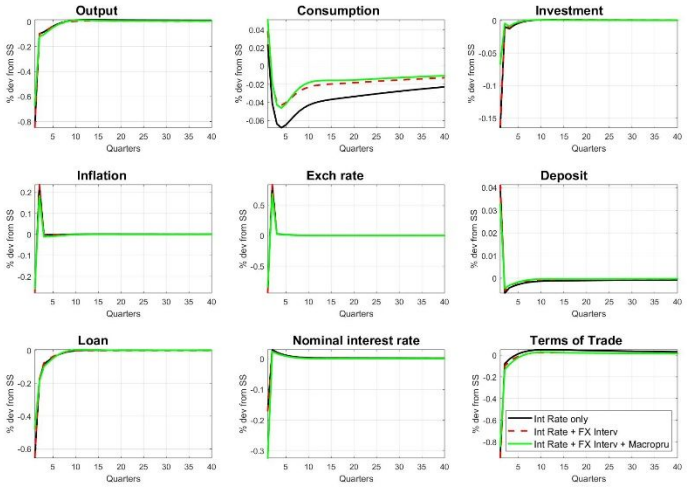


Figure 6 shows that the presence of the macroprudential instrument in the form of a countercyclical reserve requirement linked to the LDR helps reduce the degree to which the nominal interest rate increases during an expansion. An initial expansion in credit drives the reserve requirement

rate to respond, which in turn leads to a drop in deposits. Following the contraction in deposits, the central bank lending rate facility also decreases, and therefore the magnitude of the interest rate increase is limited compared to what would happen in the absence of a reserve requirement instrument. Under the foreign consumption shock, adding a reserve requirement to the FX intervention has a limited effect on output and inflation (Agénor *et al.*, 2018).

However, the countercyclical reserve requirement helps increase the consumption and output under a positive shock to the foreign interest rate, as presented in Figure 7. The foreign interest rate increase leads the exchange rate to appreciate and the terms of trade to fall. Subsequently, the import prices fall, the consumption increases and the investment returns. By reducing the reserve requirement, banks may gain an extra supply of loans, particularly if there is an expensive premium for borrowing from abroad. This additional supply of loans can be used to consume and increase output.

Under a positive risk appetite shock, the reserve requirement helps prevent consumption from falling too low as displayed in Figure 8. As the loans fall, the investment also decreases which in turn pushed down the output further. As the LDR decreases, cash expands more than when the reserve requirement is applied. Given the expectation that inflation will increase, household will have an incentive to consume. Unlike Loeffler (2015), we find that the ability of the reserve requirement to influence the exchange rate is limited during episodes of positive foreign interest rate and risk appetite shocks. Combining the reserve requirement with an interest rate policy and FX intervention may not have a significant impact.

4.5. Discussion and Policy Implications

Our findings, particularly during episodes of risk appetite shocks, may have several implications for the central bank. Our estimations suggest that, combined with FX intervention, a macroprudential policy that uses the reserve requirement as one of the instruments helps stabilise the macroeconomy. During a period of increasing risk appetite, funds will be withdrawn and reallocated from domestic financial markets to borrowers in safer countries, such as advanced economies or economies with an investment-grade sovereign rating (Correa *et al.*, 2018). As is commonly observed, in emerging markets, the financial markets are less developed and the ability of banks to access different sources of funding may

compel them to set up sophisticated liquidity management. During a period of pressure of this type, lowering the reserve requirements may be beneficial in providing additional liquidity.

In addition, the central bank needs to be cautious in trying to use the reserve requirement instrument to influence some variables. Our findings highlight that, under the risk appetite shock, the reserve requirement may be inadequate to influence the exchange rate. However, using FX intervention may be a way to perform this task. The presence of a reserve requirement may support the macroeconomy and financial stabilisation by isolating the money supply from the FX intervention operations (Agénor *et al.*, 2018). As previously discussed, managing reserve requirements during episodes of massive capital flows may affect liquidity and the credit supply (Montoro and Moreno, 2011).

5. Concluding remarks

This study provides a comprehensive analysis of the use of reserve requirements, by developing a small open-economy DSGE model with nominal rigidity in both wages and prices. We find that countercyclical reserve requirements influence banks' deposits and loans. In addition to that, banks encounter a higher premium when seeking funding from abroad. Therefore, a disruption on the deposit side may affect the loan supply.

We proceed by comparing the estimation results to a policy simulation based on two conditions: an interest rate policy that strictly follows the Taylor rule and an interest rate policy complemented by FX intervention. Our analysis indicates that the reserve requirement helps stabilise the economy by detaching the behaviour of the supply of money from FX operations. This instrument helps maintain consumption and output, particularly during a contraction period, by providing an additional supply of loans.

These findings may be beneficial to policymakers, particularly in emerging markets where reserve requirements are still widely implemented. These policymakers also face a strong challenge from external shocks when seeking to stabilise the economy. Our results suggest that the reserve requirement serves as a practical complement to interest rate policy and FX intervention when used to tackle these shocks. However, policymakers need to remain vigilant when implementing the reserve

requirement as a way to directly affect the exchange rate. Our results confirm that the use of this instrument, in addition to FX intervention, may not have any further impact on the exchange rate, compared to using the interest rate and FX intervention without the reserve requirement.

Although this study provides interesting findings, further research in this area is warranted. We assume that the working capital loan bears zero risk for the banks. It would be thought-provoking to examine whether this applies in practice and whether different classes of risk assets might affect the effectiveness of the reserve requirement and FX intervention instruments in emerging markets. Secondly, it would be stimulating to look at the impact of an active fiscal policy with the presence of both FX intervention and a reserve requirement. A distortionary tax applied to the economy may affect the behaviour of economic agents. In addition, many emerging markets are issuing government bonds in foreign currency denominations.

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