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EXCHANGE RATE INSULATION PROPERTIES AND THE ROLE OF MACROPRUDENTIAL POLICY IN A SMALL OPEN ECONOMY

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Abstract

This paper studies the role of macroprudential policy in the insulation properties of flexible exchange rates. To this end, we build a small open economy New Keynesian DSGE model with a banking sector where, in the model economy, entrepreneurs may take foreign loans, and the exchange rate intervention is undertaken via a modified Taylor-rule. We also add a macroprudential measure, which limits the entrepreneurs' foreign to domestic loan ratio. From the analysis, three significant results emerge. First, the responses of aggregate output, consumption, investment, and inflation vary widely concerning the type of foreign shocks and the combinations of macroprudential policy and exchange rate intervention. Second, the flexible exchange rate's insulation properties seem to depend on the foreign shock hitting the economy. Under a foreign interest rate shock, a higher exchange rate intervention destabilizes output. Whereas under a risk premium shock, it stabilizes output. Finally, under the foreign shocks, tightening the macroprudential measure does not necessarily stabilize output in the economy.
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Chapter 1

Introduction

1.1 Background

The Mundell-Flemming framework has been the main reference for many countries in conducting their policy formulation. Based on this framework, a flexible exchange rate is optimal to stabilize the economy after domestic and external shock. Unfortunately, some of emerging countries might not fit the assumptions of the framework, because they are exposed to dominant currency pricing, imperfections in their financial market due to currency mismatch in their borrowing and very shallow foreign exchange market[1]. For these countries, to achieve its goal of macroeconomic stability, a central bank often deems it necessary to intervene in the foreign exchange market.

Obstfeld et al. (2019) argue that amid global financial volatility, countries with limited flexibility of exchange rate possess a higher risk of financial instability. Although to limit the instability, central banks could also deploy another type of policy, a macroprudential policy, to stabilize the domestic financial condition. Furthermore, Quint and Rabanal (2014) suggest that macroprudential rule could also reduce macroeconomic volatility and may somewhat substitute for the lack of national monetary policies.

In a closed economy, Turner (2016) mentions that macroprudential policies that regulate bank lending will affect the long-term interest rate in the country. Nevertheless, in an open economy, this will influence capital flow and exchange rate and subsequently, the effect on the exchange rate will feedback into domestic credit. Turner (2016), thus, argues that macroprudential policies regulating the domestic credit and foreign currency borrowing may be a preferred option for small EMEs facing risky credit expansion. Obstfeld et al. (2019), he suggests that a flexible exchange rate regime is not enough to insulate an economy from foreign financial shocks.

For these countries, to achieve its goal of macroeconomic stability, a central bank often deems

[1]This is one of the motivations of the development of integrated policy framework by the IMF (Gopinath, 2019)

it necessary to intervene in the foreign exchange market. A macroprudential rule can reduce macroeconomic volatility and may somewhat substitute for the lack of national monetary policies Quint and Rabanal (2014). Macroprudential policies regulating the domestic credit and foreign currency borrowing may be a preferred option for small EMEs facing risky credit expansion and a flexible exchange rate regime is not enough to insulate an economy from foreign financial shocks Turner (2016).

1.2 Motivation

The central bank has to keep its domestic macroeconomic stability; however, there are two competing central bank policies, i.e., foreign exchange rate policy, and macroprudential policy. However, hardly do we find the existing literature of both policies' impacts.

1.3 Research Gap

There are two alternative theorems of the central bank's policies. On the one hand, Obstfeld et al. (2019) said that the currency market intervention in the flexible exchange rate regime would dampen any global financial shock transmission, which is better than a fixed exchange rate. On the other hand, Quint and Rabanal (2014) favored using the central bank's macroprudential policy since it reduces macroeconomic volatility, improves welfare, and partially substitutes for the lack of national monetary policies. Likewise, in a small open economy, Turner (2016) said that when the global interest rates were low and risky domestic credit was expanding, and macroprudential policy is the best choice for the central bank.

1.4 Problem Formulation

Our paper studies the role of macroprudential policy in the insulation properties of the flexible exchange rate by:

1. examining the interaction between foreign exchange intervention policy and macroprudential policy,

2. evaluating the responses and the volatility of domestic macroeconomic variables under various shocks of total function productivity, the interest rate to exchange rate ratio, foreign to domestic loan ratio, foreign interest rate, and risk premium.

1.5 Research Goal

We aim to study the interaction between those policies and evaluate the responses and the volatility of domestic macroeconomic variables under various shocks. The model is similar to Gerali et al. (2010) with two extensions. First, the model is expanded into a small open economy model ala Adolfson et al. (2007). Then, we add foreign exchange intervention by the central bank into the model, which is conducted through a modified Taylor-rule monetary policy. Then, to obtain the impulse response function and the theoretical variance of aggregate output, consumption, investment, and inflation, we solve the model using a second-order approximation to the equilibrium conditions

1.6 Research Contribution

Under foreign shocks, a similar result is found. For instance, under risk premium shock, the nominal exchange rate is depreciated instantaneously, and the depreciation is higher when the central bank deploys a low level of intervention. When the fraction of foreign to domestic loans is high, the exchange rate is depreciated higher than when the ratio is low. This shock also causes a higher contraction on aggregate consumption and investment under a high fraction of foreign to domestic loans. Interestingly, when fixing the fraction of foreign to domestic loans to 60%, a higher exchange rate intervention stabilizes aggregate output but destabilizes consumption. When fixing the exchange rate intervention level, a higher ratio of foreign to domestic loans destabilizes output, consumption, investment, and inflation.

We also find that foreign shocks to domestic macroeconomic variables do vary concerning the type of shock. Under a risk premium shock, a baseline macroprudential and a high intervention stabilizes output. However, the same policy combination destabilizes output under foreign interest rate shock. Finally, we find that tightening a macroprudential policy measure of foreign to domestic loan ratio does not necessarily stabilize output amid foreign shocks.

Chapter 2

Literature Review

2.1 Exchange Rate Insulation and Macroprudential Policy

Our study is related to two strands of the literature. One strand of literature concerns the insulation properties of the flexible exchange rate regime. This property of flexible exchange rate regime has been heavily discussed in emerging markets and countries (EMEs) and the effectiveness of the flexible exchange rate highly depends on the type of shocks (e.g., real, nominal, or financial) and the degree of capital mobility. For example, Obstfeld et al. (2019) find that, amid global financial volatility, countries with fixed exchange rate regime has higher financial instability. They find that house price, domestic credit growth, and the bank leverage increases higher compared to countries with more degree of exchange rate flexibility. Furthermore, the transmission from global financial shock to the domestic financial market is amplified in a less flexible regime because monetary policy autonomy is declining and the sensitivity of capital flows to changes in global financial conditions is greater.

Eichengreen et al. (2018) performs extensive sensitivity checks on Obstfeld et al. (2019) and finds that, while flexible exchange rate regimes better insulate the EMEs market from external shocks, they find less robust evidence that a limited degree of flexibility can insulate EMEs from the shocks. Moreover, they suggest that limiting the degree of flexibility does not increase the likelihood of a domestic recession. Although Obstfeld et al. (2019) and Eichengreen et al. (2018) provide very robust evidence on the insulation properties of flexible exchange rate regimes, they do not show how limited flexibility might actually increase the impact of external shocks on domestic financial variables and what is the role of macroprudential policy in stabilizing the financial variables.

The second strand relates to macroprudential policies in an open economy model. It is a growing literature that includes financial frictions in a DSGE model and studies the optimal monetary and macroprudential policy. Some papers on that literature are Quint and Rabanal (2014), Chen and

Columba (2016), Angelini et al. (2014), Brzoza-Brzezina et al. (2015). In these papers, monetary policy is conducted by a central bank with an interest rate rule, but they do not conduct foreign exchange intervention.

Other papers in the macroprudential policy literature, such as Unsal (2013) and Medina and Roldos (2018), study how the policy affects a small open EME receiving large inflows of capital. In this literature, a simple operational macroprudential rule may lead to wrong policies because the optimal macroprudential policy is state dependent. For instance, when the shock is real, such as productivity shock, welfare could decrease if the policy reacts to a credit variable rather than to the effects of the shock. However, these papers do not explicitly model a bank as a financial intermediary. Thus, they cannot be used by a macroprudential authority to learn how banks would react to foreign shocks. By utilizing a model with an explicit banking sector, macroprudential policy and monetary policy that responds to the dynamics of the nominal exchange rate, we hope to fill the gap in the literature and provide insights for central banks in emerging countries in their policy mix formulation process.

2.2 The Economy Model

We will discuss the economi model of Gerali et al. (2010) which we develop in this study. The basic structure of the model is a new Keynesian model which consists of three interrelated blocks, i.e., a demand block, a supply block, and a monetary policy equation.

2.2.1 A Demand Block

A demand block contains patient household (H), impatient household (I), and entrepreneurs (E). Households consume and work, while entrapreneurs produce goods and hire labors. Those components have discount factor, β, which patient households get a higher discount factor than those of impation households and entrepreneurs. The components are as follow:

1. Patient Household

$$E_0 \sum_{t=0}^{\infty} \beta_P^t \left[\left(1-a^P\right) \varepsilon_t^{\zeta} log\left(c_t^P(i) - a^P c_{t-1}^P\right) + \varepsilon_t^h log\left(h_t^P(i)\right) - \frac{l_t^P(i)^{1+\phi}}{1+\phi} \right] \tag{2.1}$$

where c_t is consumption, h_t is housing price,ε_t is a shock variable, and l_t is working hour. A representative patient household always maximizes her utility function, Equation 2.1.

2. Impatient household

$$E_0 \sum_{t=0}^{\infty} \beta_I^t \left[\left(1-a^I\right) \varepsilon_t^{\zeta} log\left(c_t^I(i) - a^I c_{t-1}^I\right) + \varepsilon_t^h log\left(h_t^I(i)\right) - \frac{l_t^I(i)^{1+\phi}}{1+\phi} \right] \tag{2.2}$$

A representative impatient household usually maximizes his utility function of Equation 2.2.

3. Entrepreneurs

$$E_0 \sum_{t=0}^{\infty} \beta_E^t \, log\left(c_t^E(i) - a^E c_{t-1}^E\right) \tag{2.3}$$

where a is group habit variable, which an entrepreneur only care about its consumption deviation from his competitors. A representative entrepreneur always maximizes his utility function, Equation 2.3.

2.2.2 A Supply Block

1. Loan and Deposit Demand

$$\begin{aligned} b_t^I(j) &= \left(\frac{r_t^{bH}(j)}{r_t^{bH}}\right)^{-\varepsilon_t^{bH}} b_t^I \\ b_t^E(j) &= \left(\frac{r_t^{bE}(j)}{r_t^{bE}}\right)^{-\varepsilon_t^{bE}} b_t^E \end{aligned} \tag{2.4}$$

where r_t is a loan rate, b_t^I is the aggregate demand for bank loans from impatient household, and b_t^E is that of entrepreneurs.

2. The labor market

$$E_0 \sum_{t=0}^{\infty} \beta_s^t \left\{ U_{c_t^s(i,m)} \left[\frac{W_t^s(m)}{P_t} l_t^s(i,m) - \frac{\kappa_w}{2} \left(\frac{W_t^s(m)}{W_{t-1}^s(m)} - \pi_{t-1}^{l_w} \pi^{1-l_w} \right)^2 \frac{W_t^s}{P_t} \right] - \frac{l_t^s(i,m)^{1+\phi}}{1+\phi} \right\} \tag{2.5}$$

where W is a nominal wages, κ is a quadratic adjustment cost, l_w is the weighted average of lagged adjustment, and m represents a labor union. A representative labor always maximizes her utility function of Equation 2.5.

3. Banks

$$\pi_t K_t^b = \left(1-\delta^b\right) K_{t-1}^b + j_{t-1}^b$$
$$\max_{B_t, D_t} E_0 \sum_{t=0}^{\infty} \Lambda_{0,t}^P \left[\left(1+R_t^b\right) B_t - B_{t+1}\pi_{t+1} + D_{t+1}\pi_{t+1} - \left(1+R_t^d\right) D_t \right.$$
$$\left. + \left(K_{t+1}^b \pi_{t+1} - K_t^b\right) - \frac{\kappa_{K_b}}{2}\left(\frac{K_t^b}{B_t} - \nu^b\right)^2 K_t^b\right] \tag{2.6}$$

where K is bank capital, D is bank deposit, B, which equals to $D+K$, is the amount of wholesale loans, $1-\delta$ is a retained earning, π is a bank profit, j is a real profit, and R is a loan rate.

4. Capital and final goods producers

(a) Firms

$$\max_{\bar{x}_t, i_t} E_0 \sum_{t=0}^{\infty} \Lambda_{0,t}^E \left(q_t^k \Delta\bar{x}_t - i_t\right)$$
$$\text{subject to } \bar{x}_t = \bar{x}_{t-1} + \left[1 - \frac{\kappa_i}{2}\left(\frac{i_t \varepsilon_t^{q^k}}{i_{t-1}} - 1\right)^2\right] i_t \tag{2.7}$$

where $\Delta\bar{x}_t$ is firm's flow output, $\bar{x}_t$ is firm's effective capital, κ_i is the cost of adjusting investment, and q^k is the real price of capital.

(b) Retailers

$$\max_{\kappa_p} E_0 \sum_{t=0}^{\infty} \Lambda_{0,t}^P \left[P_t(j)\, y_t(j) - P_t^W y_t(j) \right.$$
$$\left. - \frac{\kappa_p}{2}\left(\frac{P_t(j)}{P_{t-1}(j)} - \pi_{t-1}^{i_p}\pi^{1-i_p}\right)^2 P_t\, y_t\right]$$
$$\text{subject to } y_t(j) = \left(\frac{P_t(j)}{P_t}\right)^{-\varepsilon_t^y} y_t \tag{2.8}$$

2.2.3 Monetary policy and market clearing

1. Policy rate

$$(1+r_t) = (1+r_t)^{(1-\phi_R)}(1+r_{t-1})^{\phi_R}\left(\frac{\pi_t}{\pi}\right)^{\phi_\pi(1-\phi_R)}\left(\frac{y_t}{y_{t-1}}\right)^{\phi_y(1-\phi_R)} \varepsilon_t^r \tag{2.9}$$

where r_t is central bank's policy rate, r is a steady-state interest rate, ϕ_π is the weight of assigned inflation, and ϕ_y is the weight of output growth, and ε_t^r is monetary policy shock.

2. Market clearing

$$y_t = c_t + q_t^k \left[k_t - (1-\delta) k_{t-1}\right] + k_{t-1} \psi(u_t) + \delta^b \frac{K_{t-1}^b}{\pi_t} + \mathrm{Adj}_t \tag{2.10}$$

where c_t is an aggregate consumption of impatient and patient households and entrepreneurs, k_t is aggregate physical capital, and K_t^b is an aggregate bank capital.

Chapter 3

Model

The model closely follows Gerali et al. (2010) with three main extensions: (1) the model is expanded into a small open economy model a la Adolfson et al. (2007), (2) we allow for entrepreneurs to borrow from foreign borrowers and we add a macroprudential measure which regulates the ratio of foreign to domestic loan ratio, and (3) we augment a foreign exchange depreciation in the central bank's Taylor rule as a measure of foreign exchange intervention.

There are two types of households (HH, henceforth), i.e., patient (P) and impatient (I), and entrepreneurs (E) with unit mass for each type. The difference among those types is how impatient each agent is–defined by the discount factor of patient HH (β_P), the discount factor of impatient HH (β_I), the discount factor of entrepreneurs (β_E). Households supply differentiated labor through a labor aggregator (or union), setting to maximize the HH' utility subject to adjustment costs.

Both patient and impatient HH work, consume, buy housing services (which supply is fixed). While entrepreneurs rent capital (bought from capital-goods producers) and hire labor to produces homogeneous intermediate goods. Aside from the entrepreneurs, there are two other types of firms in the model economy: retail firms that are monopolistically competitive and a capital-producing firm. Retailers purchase intermediate goods from entrepreneurs, which are then differentiated and priced subject to a nominal rigidity.

Banks supply two types of one-period financial instruments: deposits and loans. When impatient HH and entrepreneurs taking loans, they face a borrowing constraint that is related to the value of collateral in the future period. In this case, entrepreneurs may borrow against physical capital and impatient HH borrow against housing stock they own. Banks are monopolistically competitive–they set deposit and loan rates to maximize profits. Deposits and bank capital, accumulated through profits, are used to finance loans.

3.1 Households

3.1.1 Patient Households

In each period t, a patient HH $i \in [0, \mu]$ chooses consumption c_t^P, housing services h_t^P, real deposits to bank d_t^P, and real foreign bond holdings b_t^P to maximize

$$E_0 \sum_{t=0}^{\infty} \beta_P^t \Big(\ln(c_t^P(i)) + \ln(h_t^P(i)) - \frac{(l_t^P)^{1+\phi}}{1+\phi} \Big) \tag{3.1}$$

subject to the budget constraint

$$\begin{aligned} c_t^P(i) + q_t^H(h_t^P(i) - h_{t-1}^P(i)) + d_t^P(i) + s_t b_t^P(i) \leq \\ w_t^P l_t^P(i) + \frac{1+r_{t-1}^D}{\pi_t} d_{t-1}^P + \frac{\xi(\phi_t, \varepsilon_t^F)(1+r_{t-1}^F)}{\pi_t} s_t b_{t-1}^P + \tau_t^P(i), \end{aligned} \tag{3.2}$$

where π_t is gross inflation, $\xi(\phi_t, \varepsilon_t^F) = \exp^{(\phi_t, \varepsilon_t^F)}$ denotes risk premium on foreign bonds–where ϕ_t denotes debt premium and ε_t^F denotes risk premium shock, s_t denotes the nominal exchange rate, and t_t^P is the lump-sum transfer.

The first-order conditions are

$$\frac{1}{c_t^P} - \lambda_t^P = 0 \tag{3.3}$$

$$\frac{1}{h_t^P} - \lambda_t^P q_t^H + \beta_P E_t(\lambda_{t+1}^P q_{t+1}^H) = 0 \tag{3.4}$$

$$\beta_P E_t \Big(\lambda_{t+1}^P \Big(\frac{(1+r_t^D)}{\pi_{t+1}} \Big) \Big) - \lambda_t^P = 0 \tag{3.5}$$

$$\beta_P E_t \Big(\lambda_{t+1}^P \Big(\frac{\xi(\phi_t, \varepsilon_t^F)(1+r_t^F)}{\pi_{t+1}} s_{t+1} \Big) \Big) - \lambda_t^P s_t = 0 \tag{3.6}$$

Equation (3) describes the Lagrange multiplier λ_t as the marginal utility of consumption from an additional unit of income and implies that the benefit of an additional unit of consumption equals to the shadow price of wealth. Equation (4) equates the marginal utility of housing service consumption to the shadow value of real house price. While Equation (5) and (6) represent the Euler equations for deposits and foreign bonds–which imply that the utility cost of acquiring an additional unit of deposits and nominal bonds equals the discounted utility value of the assets next period after receiving nominal interest payment. Note that the exchange rate s_t is nominal exchange rate, depicted by foreign currency in domestic currency. To get the real exchange rate, we multiply the nominal exchange rate by the ratio of foreign to domestic prices, i.e., $S_t = \frac{s_t P_t^*}{P_t}$.

3.1.2 Impatient Households

In each period t, an impatient HH $i \in [1-\mu, 1]$ chooses consumption c_t^I, housing services h_t^I, real borrowings to bank b_t^I to maximize the expected lifetime discounted utility

$$\mathrm{E}_0 \sum_{t=0}^{\infty} \beta_I^t \Big(\ln(c_t^I(i)) + \ln(h_t^I(i)) - \frac{(l_t^I)^{1+\phi}}{1+\phi} \Big) \tag{3.7}$$

subject to the following constraint

$$c_t^I(i) + q_t^H(h_t^I(i) - h_{t-1}^I(i)) + \frac{1+r_{t-1}^{bH}}{\pi_t} b_{t-1}^I \leq w_t^I l_t^I(i) + b_t^I(i) + \tau_t^I(i) \tag{3.8}$$

$$(1+r_t^{bH}) b_t^I \leq m_t^I \mathrm{E}_t(q_{t+1}^H h_t^I(i) \pi_{t+1}). \tag{3.9}$$

where r_t^{bH} denotes the net interest rate of the real borrowings. Note that there is another constraint that impatient HH have to face, a borrowing constraint in (9). This constraint imply that the amount of debt (plus the interest) that the HH take should not exceed a fraction m_t^I of the expected value of their housing stock, where m_t^I denotes a stochastic loan-to-value (LTV) ratio for the borrowings. As mentioned by Gerali et al. (2010), for a given value of households' housing stock, this variable limit the credit which banks can lend to households at a macro level.

The first-order conditions are

$$\frac{1}{c_t^I} - \lambda_t^{I,1} = 0 \tag{3.10}$$

$$\frac{1}{h_t^I} - \lambda_t^{I,1} q_t^H + \beta_I \mathrm{E}_t(\lambda_{t+1}^{I,1} q_{t+1}^H + \lambda_t^{I,2} m_t^I q_{t+1}^H \pi_{t+1}) = 0 \tag{3.11}$$

$$\beta_I \mathrm{E}_t \Big(\lambda_{t+1}^{I,1} \Big(\frac{(1+r_t^{bH})}{\pi_{t+1}} \Big) \Big) - \lambda_t^{I,1} = 0 \tag{3.12}$$

Equation (10) gives the definition of the Lagrange multiplier $\lambda_t^{I,1}$ as the marginal utility of consumption. While Equation (11) and (12) describe the Euler equation for housing services and real borrowings, respectively.

3.2 Labor Market

We include wage rigidity to this model by assuming that each labor in household type $s \in \{P, I\}$ supplies a differentiated labor skill of type m. To aggregate the labor in the economy, there exists a labor aggregator (or a labor union) which transforms the differentiated skills into a single homogeneous labor service via a CES production function. An individual m in the family type s determines wages $W_t^s(m)$ which maximizes his/her expected discounted lifetime utility.

3.2.1 Demand for labor

The labor aggregator demands differentiated services from the workers (s,m) with $s \in \{P,I\}$ and $m \in [0,1]$. The aggregator maximizes

$$\max_{\{l_t^s(m)\}} l_t^s = \Big(\int_0^1 (l_t^s(m))^{\frac{\varepsilon^l-1}{\varepsilon^l}} \mathrm{d}m\Big)^{\frac{\varepsilon^l}{\varepsilon^l-1}} \text{ subject to } \int_0^1 W_t^s(m) l_t^s(m) \mathrm{d}m \le \bar{W}_t,$$

for a given level of payroll $\bar{W}_t$. The demand for each type of skill m is $l_t^s(m)$,

$$l_t^s(m) = \Big(\frac{W_t^s(m)}{W^s}\Big)^{-\varepsilon^l} l_t^s, \tag{3.13}$$

where $W_t^s = (\int_0^1 (W_t^s(m))^{1-\varepsilon^l} \mathrm{d}m)^{\frac{1}{1-\varepsilon^l}}$ is the aggregate wage in the economy.

3.2.2 Demand for wage

Each labor type (s,m) sets nominal wage $W_t^s(m)$ by maximizing their utility subject to the demand in (13) and a quadratic adjustment costs–with indexation to a weighted average of lagged and steady state inflation, l_w and $(1-l_w)$ respectively.

$$E_0 \sum_{t=0}^{\infty} \beta_s^t \Big(U_{c_t^s(i,m)} \Big(\frac{W_t^s(m)}{P_t} l_t^s(i,m) - \frac{\kappa_w}{2} \Big(\frac{W_t^s(m)}{W_{t-1}^s(m)} - \pi_{t-1}^{l_w} \pi^{1-l_w} \Big)^2 \frac{W_t^s}{P_t} \Big) - \dots \\ \frac{(l_t^s(i,m))^{1+\phi}}{1+\phi} \Big)$$

subject to (13). Assuming that each skills type m within the same type of households $\{P,I\}$ chooses the same wage level, the labor supply for a household of type s is given by

$$\kappa_w(\pi_t^{w_s} - \pi_{t-1}^{l_w}\pi^{1-l_w})\pi_t^{w_s} = \\ \beta_s \mathrm{E}_t \Big(\frac{\lambda_{t+1}^s}{\lambda_t^s} \kappa_w (\pi_{t+1}^{w_s} - \pi_{t-1}^{l_w}\pi^{1-l_w}) \frac{(\pi_{t+1}^{w_s})^2}{\pi_{t+1}} \Big) + (1-\varepsilon^l) l_t^s + \frac{\varepsilon^l (l_t^s)^{1+\phi}}{w_t^s l_t^s} \tag{3.14}$$

where

$$\pi_t^{w_s} = \frac{w_t^s}{w_{t+1}^s} \pi_t.$$

3.3 Entrepreneurs

An entrepreneur is in the interval $(0,1]$ maximizes the expected discounted lifetime utility,

$$\max_{\{c_t^E, l_t^{E,P}, l_t^{E,I}, k_t^E, u_t, b_t^E\}} \mathrm{E}_0 \sum_{t=0}^{\infty} \beta_E^t (\ln(c_t^E(i)). \tag{3.15}$$

subject to

$$c_t^E(i) + w_t^P l_t^{E,P}(i) + w_t^I l_t^{E,I}(i) + \frac{1+r_{t-1}^{bE}}{\pi_{t+1}} b_{t-1}^E(i) + \frac{\xi(\phi_t, \varepsilon_t^F)(1+r_{t-1}^F)}{\pi_{t+1}} s_t b_{t-1}^F(i) + q_t^K k_t^E(i) + \dots$$
$$\psi(u_t(i)) k_{t-1}^E(i) = \frac{y_t^E(i)}{x_t} + b_t^E(i) + s_t b_t^F(i) + q_t^K(1-\delta) k_{t-1}^E(i) \tag{3.16}$$

where c_t^E is consumption, k_t^E is physical capital, b_t^E denotes loans from banks, u_t is capital utilization rate, $l_t^{E,P}$ is labor input from patient HH, $l_t^{E,I}$ is labor input from impatient HH, $\psi(u_t) = \xi_1(u_t - 1) + \frac{\xi_2}{2}(u_t-1)^2$, $x_t = \frac{P_t}{P_t^w}$, b_t^F denotes foreign loans, $\xi(\phi_t, \varepsilon_t^F) = \exp^{(\phi_t, \varepsilon_t^F)}$ is the risk premium on foreign bonds, and s_t denotes the nominal exchange rate. P_t^w denotes the nominal price of wholesale good. The discount factor β_E is assumed to be strictly greater than β_P ($\beta_E > \beta_P$) which implies that entrepreneurs are net borrowers.

The production technology is given by

$$y_t^E(i) = a_t^E (k_{t-1}^E u_t(i))^{\alpha} (l_t^E(i))^{1-\alpha}.$$

The aggregate work combines input of patient and impatient HH

$$l_t^E = (l_t^{E,P})^{\mu} (l_t^{E,I})^{1-\mu}.$$

The borrowing of entrepreneurs is constrained by the amount of stock of physical capital

$$(1+r_t^{bE}) b_t^E(i) + \xi(\phi_t, \varepsilon_t^F)(1+r_t^{bF}) s_t b_t^F(i) \leq m_t^E (q_{t+1}^K \pi_{t+1} (1-\delta) k_t^E(i)). \tag{3.17}$$

where m_t^E denotes a stochastic LTV ratio of the entrepreneurs.

In our model economy, entrepreneurs can also borrow from abroad. When choosing so, they are constrained by a deterministic macroprudential policy measure m^F which are regulated by a macroprudential authority in the economy,

$$\xi(\phi_t, \varepsilon_t^F)(1+r_t^{bF}) s_t b_t^F(i) = m^F (1+r_t^{bE}) b_t^E(i).$$

3.4 Retailers

3.4.1 Domestic retailers

Retailers attach a brand to goods bought from the entrepreneurs to differentiate and sell it in the monopolistically competitive market. The retailers are subject to quadratic adjustment costs and the problem they face is

$$\max_{\{P_t(j)\}} \mathrm{E}_0 \sum_{t=0}^{\infty} \Delta_{0,t} \Big(P_t(j) y_t(j) - P_t^w y_t(j) - \frac{\kappa_P}{2} \Big(\frac{P_t(j)}{P_{t-1}(j)} - \pi_{t-1}^{\iota_p} \pi^{1-\iota_p} \Big)^2 P_t y_t \Big) \tag{3.18}$$

subject to demand for each type of good j,

$$y_t(j) = \Big(\frac{P_t(j)}{P_t} \Big)^{-\varepsilon^y} y_t. \tag{3.19}$$

In a symmetrical equilibrium, $P_t(j) = P_t(k) = P_t$, the first-order conditions imply a nonlinear Phillips curve

$$1 - \varepsilon^y + \frac{\varepsilon^y}{x_t} - \kappa_P(\pi_t - \pi_{t-1}^{\iota_p} \pi^{1-\iota_p}) \pi_t + \beta_P \mathrm{E}_t \Big(\frac{\lambda_{t+1}^P}{\lambda_t^P} \kappa_P (\pi_{t+1} - \pi_t^{\iota_p} \pi^{1-\iota_p}) \pi_{t+1} \frac{y_{t+1}}{y_t} \Big) = 0. \tag{3.20}$$

3.4.2 Importing retailers

Importing retailers attach a brand to goods bought from the foreign entrepreneurs to differentiate it and sell it in the monopolistically competitive market. Similar to the domestic retailers, the importing retailers are subject to quadratic adjustment costs and the problem they face is

$$\max_{\{P_t^F(j)\}} \mathrm{E}_0 \sum_{t=0}^{\infty} \Delta_{0,t} \Big(P_t^F(j) y_t^F(j) - s_t P_t^{w^F} y_t^F(j) - \frac{\kappa_P^F}{2} \Big(\frac{P_t^F(j)}{P_{t-1}^F(j)} - \pi_{t-1}^{F,\iota_p} \pi^{F,1-\iota_p} \Big)^2 P_t^F y_t^F \Big) \tag{3.21}$$

subject to

$$y_t^F(j) = \Big(\frac{P_t^F(j)}{P_t^F} \Big)^{-\varepsilon^{F,y}} y_t^F. \tag{3.22}$$

In a symmetrical equilibrium, $P_t(j) = P_t(k) = P_t$, the first-order conditions imply the following Phillips curve,

$$1 - \varepsilon^{F,y} + \frac{\varepsilon^{F,y}}{x_t^F} - \kappa_P^F(\pi_t^F - \pi_{t-1}^{F,\iota_p}\pi^{F,1-\iota_p})\pi_t^F + \dots$$

$$\beta_P \mathrm{E}_t\Big(\frac{\lambda_{t+1}^P}{\lambda_t^P}\kappa_P^F(\pi_{t+1}^F - \pi_t^{F,\iota_p}\pi^{F,1-\iota_p})\pi_{t+1}^F\frac{y_{t+1}^F}{y_t^F}\Big) = 0. \quad (3.23)$$

3.5 Capital goods producers

Capital good producers operate in a perfectly competitive market. These firms buy undepreciated capital stock from the entrepreneurs and i_t units of the final goods from final goods from retailers for P_t. The effective capital stock sold to entrepreneurs at P_t^K,

$$k_t = (1-\delta)k_{t-1} + \Big(1 - \frac{\kappa_I}{2}\Big(\frac{i_t}{i_{t-1}} - 1\Big)\Big)^2 i_t. \quad (3.24)$$

Let $q_t^K = \frac{P_t^K}{P_t}$, the problem of the capital producers is

$$\max \mathrm{E}_0 \sum_{t=0}^{\infty} \Delta_{0,t}^E\Big(q_t^K(k_t - (1-\delta)k_{t-1} - \Big(1 - \frac{\kappa_I}{2}\Big(\frac{i_t}{i_{t-1}} - 1\Big)\Big)^2 i_t)\Big), \quad (3.25)$$

subject to (24). The first-order conditions imply that q_t^K is given by

$$1 - q_t^K\Big(1 - \frac{\kappa_I}{2}\Big(\frac{i_t}{i_{t-1}} - 1\Big)^2 - \kappa_I\Big(\frac{i_t}{i_{t-1}} - 1\Big)\frac{i_t}{i_{t-1}}\Big) = \dots$$

$$\beta_E \mathrm{E}_t\Big(\frac{\Delta_{0,t+1}^E}{\Delta_{0,t}^E}q_{t+1}^K\kappa_I\Big(\frac{i_{t+1}}{i_t} - 1\Big)\Big(\frac{i_{t+1}}{i_t}\Big)^2\Big). \quad (3.26)$$

3.6 Deposits and Loans

3.6.1 Demand for loans

The demand for loans is coming from impatient HH and the entrepreneurs. Their problems are choosing a loan value by minimizing the amount of debt,

Impatient HH' demand for loans

$$\min_{\{b_t^I(i,j)\}} \int_0^1 r_t^{bH}(j) b_t^I(i,j)\mathrm{d}j, \text{ subject to } \Big(\int_0^1 b_t^I(i,j)^{\frac{\varepsilon^{bH}-1}{\varepsilon^{bH}}}\mathrm{d}j\Big)^{\frac{\varepsilon^{bH}}{\varepsilon^{bH}-1}} \leq b_t^I(i). \quad (3.27)$$

The aggregate demand for a loan j is

$$b_t^I(j) = \Big(\frac{r_t^{bH}(j)}{r_t^{bH}}\Big)^{-\varepsilon^{bH}} b_t^I. \tag{3.28}$$

where the average interest rate charge for each HH is

$$r_t^{bH} = \Big(\int_0^1 (r_t^{bH}(j))^{1-\varepsilon^{bH}} \mathrm{d}j\Big)^{\frac{1}{1-\varepsilon^{bH}}}. \tag{3.29}$$

Entrepreneurs' demand for loans

$$\min_{\{b_t^E(i,j)\}} \int_0^1 r_t^{bE}(j) b_t^E(i,j) \mathrm{d}j, \text{ subject to } \Big(\int_0^1 b_t^E(i,j)^{\frac{\varepsilon^{bE}-1}{\varepsilon^{bE}}} \mathrm{d}j\Big)^{\frac{\varepsilon^{bE}}{\varepsilon^{bE}-1}} \leq b_t^E(i). \tag{3.30}$$

The aggregate demand for a loan j is

$$b_t^E(j) = \Big(\frac{r_t^{bE}(j)}{r_t^{bE}}\Big)^{-\varepsilon^{bE}} b_t^E. \tag{3.31}$$

where the average interest rate charge for each entrepreneur is

$$r_t^{bE} = \Big(\int_0^1 (r_t^{bE}(j))^{1-\varepsilon^{bE}} \mathrm{d}j\Big)^{\frac{1}{1-\varepsilon^{bE}}}. \tag{3.32}$$

3.6.2 Patient HH' demand for deposits

$$\min_{\{d_t^P(i,j)\}} \int_0^1 r_t^D(j) d_t^P(i,j) \mathrm{d}j, \text{ subject to } \Big(\int_0^1 d_t^P(i,j)^{\frac{\varepsilon^d-1}{\varepsilon^d}} \mathrm{d}j\Big)^{\frac{\varepsilon^d}{\varepsilon^d-1}} \leq d_t^P(i). \tag{3.33}$$

The aggregate demand for a deposit j is

$$d_t^P(j) = \Big(\frac{r_t^D(j)}{r_t^D}\Big)^{-\varepsilon^D} d_t. \tag{3.34}$$

where the average interest rate charge for each HH is

$$r_t^D = \Big(\int_0^1 (r_t^D(j))^{1-\varepsilon^D} \mathrm{d}j\Big)^{\frac{1}{1-\varepsilon^D}}. \tag{3.35}$$

3.7 The Banks

3.7.1 Wholesale branch

Each wholesale branch operates under perfect competition market. They combine net worth, or bank capital, and wholesale deposits and issue wholesale loans. The capital accumulation equation is given by,

$$\pi_t K_t^B = (1-\delta^B)K_{t-1}^B(j) + J_{t-1}^B(j), \tag{3.36}$$

where J_t^B denotes overall real profits made by the three branches of each bank. Assuming that R_t^B and R_t^D are given, the profit maximization problem is to choose loans and deposits so to maximize the discounted sum of cash flows

$$\max_{\{b_t,d_t\}} \mathrm{E}_0 \sum_{t=0}^{\infty} \Delta_{0,t}^P \Big((1+R_t^B)B_t - B_{t+1}\pi_{t+1} + D_{t+1}\pi_{t+1} - (1+R_t^D)D_t + \dots$$
$$(K_t^B \pi_{t+1} - K_t^B) - \frac{K_B}{2}\left(\frac{K_t^B}{B_t} - \nu^B\right)^2 K_t^B \Big) \tag{3.37}$$

subject to

$$B_t = D_t + K_t^B. \tag{3.38}$$

The problem boils down to

$$\max_{\{b_t,d_t\}} R_t^B B_t - R_t^D D_t - \frac{K_B}{2}\left(\frac{K_t^B}{B_t} - \nu^B\right)^2 K_t^B. \tag{3.39}$$

The first-order conditions of the problem gives the relationship between loan and deposit rate is,

$$R_t^B = R_t^D - \kappa_B \left(\frac{K_t^B}{B_t} - \nu^B\right)\left(\frac{K_t^B}{B_t}\right)^2. \tag{3.40}$$

3.7.2 Retail branch

Loans

A banking branch j chooses r_t^{bH}, r_t^{bE} to maximize

$$\max_{\{r_t^{bH}, r_t^{bE}\}} \mathrm{E}_0 \sum_{t=0}^{\infty} \Delta_{0,t}^{P} \Big(r_t^{bH}(j) b_t^{I}(j) + r_t^{bE}(j) b_t^{E}(j) - R_t^B B_t - \dots$$
$$\frac{K_{BH}}{2} \Big(\frac{r_t^{bH}(j)}{r_{t-1}^{bH}(j)} - 1 \Big)^2 r_t^{bH} b_t^{I} - \frac{K_{BE}}{2} \Big(\frac{r_t^{bE}(j)}{r_{t-1}^{bE}(j)} - 1 \Big)^2 r_t^{bE} b_t^{E} \Big) \quad (3.41)$$

subject to (35), (38), and $B_t(j) = b_t(j) = b_t^I(j) + b_t^E(j)$. For $S \in \{H, E\}$, the FOC for the interest rate HH and entrepreneurs imply

$$1 - \varepsilon_t^{bS} + \varepsilon_t^{bS} \frac{R_t^{bS}}{r_t^{bS}} - \kappa_{BS} \Big(\frac{r_t^{bS}}{r_{t-1}^{bS}} - 1 \Big) \frac{r_t^{bS}}{r_{t-1}^{bS}} + \beta_S \mathrm{E}_t \Big(\frac{\lambda_{t+1}^{S}}{\lambda_t^{S}} \Big(\frac{r_{t+1}^{bS}}{r_t^{bS}} - 1 \Big) \Big(\frac{r_{t+1}^{bS}}{r_t^{bS}} \Big)^2 \frac{b_{t+1}^{S}}{b_t^{S}} \Big) = 0. \quad (3.42)$$

Deposits

A bank j receives deposits from patient HH and transfer it to wholesale bank which pays interest rate $r_t = R_t^D$. The problem for this branch is

$$\max_{\{r_t^D\}} \mathrm{E}_0 \sum_{t=0}^{\infty} \Delta_{0,t}^{P} \Big(r_t D_t(j) - r_t^D(j) d_t^P(j) - \frac{K_D}{2} \Big(\frac{r_t^D(j)}{r_{t-1}^D(j)} - 1 \Big)^2 r_t^D d_t \Big) \quad (3.43)$$

subject to (41) and $D_t(j) \equiv d_t^P(j)$. The first-order conditions for the deposit rate is given by

$$-1 + \varepsilon_t^D + \varepsilon_t^D \frac{r_t}{r_t^D} - \kappa_D \Big(\frac{r_t^D}{r_{t-1}^D} - 1 \Big) \frac{r_t^D}{r_{t-1}^D} + \beta_S \mathrm{E}_t \Big(\frac{\lambda_{t+1}^{P}}{\lambda_t^{P}} \Big(\frac{r_{t+1}^D}{r_t^D} - 1 \Big) \Big(\frac{r_{t+1}^D}{r_t^D} \Big)^2 \frac{d_{t+1}}{d_t} \Big) = 0. \quad (3.44)$$

3.8 Banks' profit

Profits of the banks are the sum of net gains for wholesale and retail branch,

$$J_t^B = r_t^{bH} b_t^I + r_t^{bE} b_t^E + r_t^D d_t - \frac{\kappa_{KB}}{2} \Big(\frac{K_t^B}{B_t} - \nu^B \Big)^2 - K_t^B - Adj_t^B. \quad (3.45)$$

3.9 Final Goods Producers

Final good firms combine domestically produced retail goods to produce final consumption, investment, and exported goods. For consumption good, the firms choose the production by maximizing profits subject to

$$c_t = \left(\omega_C^{\frac{1}{\eta_C}} (c_t^H)^{\frac{\eta_C - 1}{\eta_C}} + (1-\omega_C)^{\frac{1}{\eta_C}} (c_t^F)^{\frac{\eta_C - 1}{\eta_C}}\right)^{\frac{\eta_C}{\eta_C - 1}} \tag{3.46}$$

The optimal allocation for consumption and investment is given by

$$c_t^H = \omega_C \left(\frac{P_t^H}{P_t}\right)^{-\eta_C} c_t \tag{3.47}$$

$$c_t^F = (1-\omega_C)\left(\frac{P_t^F}{P_t}\right)^{-\eta_C} c_t. \tag{3.48}$$

The aggregate price level for consumption is

$$P_t = \left(\omega_C (P_t^H)^{1-\eta_C} + (1-\omega_C)(P_t^F)^{1-\eta_C}\right)^{\frac{1}{1-\eta_C}}. \tag{3.49}$$

For investment good, the firms chooses the production by maximizing profits subject to

$$i_t = \left(\omega_I^{\frac{1}{\eta_I}} (i_t^H)^{\frac{\eta_I - 1}{\eta_I}} + (1-\omega_I)^{\frac{1}{\eta_I}} (i_t^F)^{\frac{\eta_I - 1}{\eta_I}}\right)^{\frac{\eta_I}{\eta_I - 1}} \tag{3.50}$$

The optimal allocation for consumption and investment is given by

$$i_t^H = \omega_I \left(\frac{P_t^H}{P_t^I}\right)^{-\eta_I} i_t \tag{3.51}$$

$$i_t^F = (1-\omega_I)\left(\frac{P_t^F}{P_t^I}\right)^{-\eta_I} i_t. \tag{3.52}$$

The aggregate price level for consumption is

$$P_t^I = \left(\omega_I (P_t^H)^{1-\eta_I} + (1-\omega_I)(P_t^F)^{1-\eta_I}\right)^{\frac{1}{1-\eta_I}}. \tag{3.53}$$

3.10 Monetary Policy and Market Clearing

The central bank sets the interest rate r_t by responding to inflation, output, and nominal exchange rate using the following Taylor's rule formula

$$(1+r_t) = (1+r)^{1-\phi_R}(1+r_t)^{\phi_R}\left(\left(\frac{Y_t}{Y}\right)^{\phi_Y}\left(\frac{\pi_t}{\pi}\right)^{\phi_\pi}\left(\frac{s_t}{s}\right)^{\phi_s}\right)^{1-\phi_R}(1+\varepsilon_t^R) \tag{3.54}$$

and the market clearing conditions are the following,

$$y_t^E = y_t^H + y_t^{H^*}, \tag{3.55}$$

$$y_t = c_t^P + c_t^I + c_t^E + q_t^K (k_t - (1-\delta)k_{t-1}) + \dots$$
$$k_t \psi(u_t) + s_t y_t^{H^*} + s_t (c_{F,t} + i_{F,t}) \delta_{KB} \frac{K_{t-1}^B}{B_t} + Adj_t, \tag{3.56}$$

$$\bar{h} = h_t^P + h_t^I, \tag{3.57}$$

$$l_t^{E,P} + l_t^{E,I} = l_t^P + l_t^I, \tag{3.58}$$

$$B_t = b_t^E + b_t^I, \tag{3.59}$$

$$D_t = d_t^P, \tag{3.60}$$

$$s_t \frac{P_t^{H^*}}{P_t} y_t^{H^*} = s_t \frac{P_t^{F^*}}{P_t} y_t^F + \frac{\xi(\phi_t, \varepsilon_t^F)(1 + r_{t-1}^F)}{\pi_{t+1}} s_t b_{t-1}^F - \dots$$
$$s_t b_t^F + \frac{\xi(\phi_t, \varepsilon_t^F)(1 + r_{t-1}^F)}{\pi_{t+1}} s_t b_{t-1}^P - s_t b_t^P, \tag{3.61}$$

$$\phi_t = \exp\left(\rho_\phi \left(\frac{b_t^F}{y_t}\right) + \varepsilon_t^F\right), \tag{3.62}$$

where ε_t^F denotes a risk premium shock.

Chapter 4

Calibration and Qualitative Analysis

4.1 Model calibration

In this section, we report the results of numerical simulations on the model economy. To analyze the model's dynamics and to get the volatility of several macroeconomic variables, we compute the second-order approximation of the equilibrium conditions.

In many emerging economies, the banking sector is still a dominant source of financing. One of the factors affecting the dominant role of the banking sector is because access to the stock market is still limited to large corporations. In the period after the Global Financial Crisis, emerging economies have received large capital inflows that was mostly driven by the global excess liquidity caused by the accommodative monetary policy in the advanced economies. Relative to their size, the foreign loans to non-financial corporation in emerging economies are quite large, ranging from 5-30% of their GDP. For calibration purposes, instead of using generic values that may represent a broad range of countries, we choose to use values from Indonesia which possesses the general characteristics of emerging countries (dominant banking sector and relatively large foreign borrowing). Table 4.1 lists the parameter values used for the quantitative analysis of the model economy. The value of parameters are taken from Gerali et al. (2010) and papers which estimated DSGE models for Indonesia, such as Harmanta et al. (2014), Dutu (2016), and Setiastuti (2018). We loosely set the parameters and have not attempted to estimate the model and/or do moment-matching. However, for the purpose of this paper–which is to find out whether there is a role of macroprudential policy in the exchange rate insulation properties of the exchange rate, we consider the calibration to be sufficient.

Table 4.1: Model calibration.

Parameter	Description	Value	Source
$\beta_P = \beta_b$	Patient households and bank	0.967	Harmanta et al. (2014)
$\beta_I = \beta_E$	Impatient households and entrepreneurs	0.960	Harmanta et al. (2014)
ϕ	Inverse of elasticity of substitution work	1	Setiastuti (2018)
j	Weight of housing in the utility function	0.12	Harmanta et al. (2014)
α	Fraction of capital in production function	1/3	Setiastuti (2018)
δ	Depreciation rate of physical capital	0.025	Setiastuti (2018)
ξ_1	Parameter of adjustment cost for capacity utilization	0.0478	Gerali et al. (2010)
ξ_2	Parameter of adjustment cost for capacity utilization	0.00478	Gerali et al. (2010)
κ_I	Investment adjustment cost	10.03	Gerali et al. (2010)
ε^y	$\frac{\varepsilon^y}{\varepsilon^y - 1}$ is the markup in the goods market	6	Gerali et al. (2010)
ε^l	$\frac{\varepsilon^l}{\varepsilon^l - 1}$ is the markup in the labor market	5	Gerali et al. (2010)
ε^{bH}	$\frac{\varepsilon^{bH}}{\varepsilon^{bH} - 1}$ is the markup of rate loans to households	2.93	Gerali et al. (2010)
ε^{bE}	$\frac{\varepsilon^{bE}}{\varepsilon^{bE} - 1}$ is the markup of rate loans to firms	2.93	Gerali et al. (2010)
m^I	LTV ratio of households	0.75	Harmanta et al. (2014)
m^E	LTV ratio of entrepreneurs	0.35	Harmanta et al. (2014)
m_F	Foreign to deposit loans ratio	0.6	Indonesian data, Bank Indonesia
κ_{BH}	HH loan rate adjustment cost	8.04	Harmanta et al. (2014)
κ_{BE}	Entrepreneurs loan rate adjustment cost	3.48	Harmanta et al. (2014)
κ_D	Deposits rate adjustment cost	3.30	Harmanta et al. (2014)
κ_{KB}	Leverage adjustment cost	8.91	Harmanta et al. (2014)
δ^B	Cost for managing the bank's capital position	0.1049	Gerali et al. (2010)
κ_P	Price stickiness	33.77	Gerali et al. (2010)
κ_W	Wage stickiness	107.35	Gerali et al. (2010)
ι_P	Price indexation	0.1581	Gerali et al. (2010)
ι_P	Wage indexation	0.3	Gerali et al. (2010)
ϕ_B	Foreign bond adjustment	0.0045	Setiastuti (2018)
γ_C	Home bias in consumption goods	0.656	Setiastuti (2018)
γ_I	Home bias in investment goods	0.75	Setiastuti (2018)
η_C	Elasticity of subs. between domestic and imported consumption goods	1.7555	Setiastuti (2018)
η_{IF}	Elasticity of subs. between domestic and imported investment goods	1.6589	Setiastuti (2018)
η_{FF}	Elasticity of subs. between domestic and imported final goods	1.0952	Setiastuti (2018)
ϕ_R	Monetary policy: interest rate persistence	0.75	Harmanta et al. (2014)
ϕ_Y	Monetary policy: output response	2	Harmanta et al. (2014)
ϕ_π	Monetary policy: inflation response	0.25	Harmanta et al. (2014)
ϕ_S	Monetary policy: exchange rate response	0.1229	Dutu (2016)

Chapter 5

Results and Analysis

5.1 Responses of Variables to Domestic and External Shocks

Figures 5.1 and 5.2 present the responses of variables to a total factor productivity (TFP) shock under different combinations of exchange rate intervention and macroprudential policy. In Figure 5.1, we fix the respond of interest rate to exchange rate to $\phi_S = 0.1229$ and show the responses under several macroprudential measures $m_F = \{0.3, 0.5, 0.6, 0.8\}$. While in Figure 5.2, we fix the macroprudential measures $m_F = 0.6$ then show the responses under different responds of interest rate to nominal exchange rate $\phi_S = \{0.05, 0.1229, 1, 1.5\}$. We find that the responses of variables vary with respect to the the policy combinations. For example, in Figure 5.2, the higher response of interest rate to exchange rate depreciation, the bigger the responses of variables due to the TFP shock. Although, the shape of responses is fairly similar. This result shows that, given a macroprudential measure on limiting the foreign debt owns by entrepreneurs, a higher intervention on the foreign exchange rate amplifies the responses of variables to the TFP shock. Therefore, varying the macroprudential measure to limiting the responses of variables to the shock immediately seems more desirable.

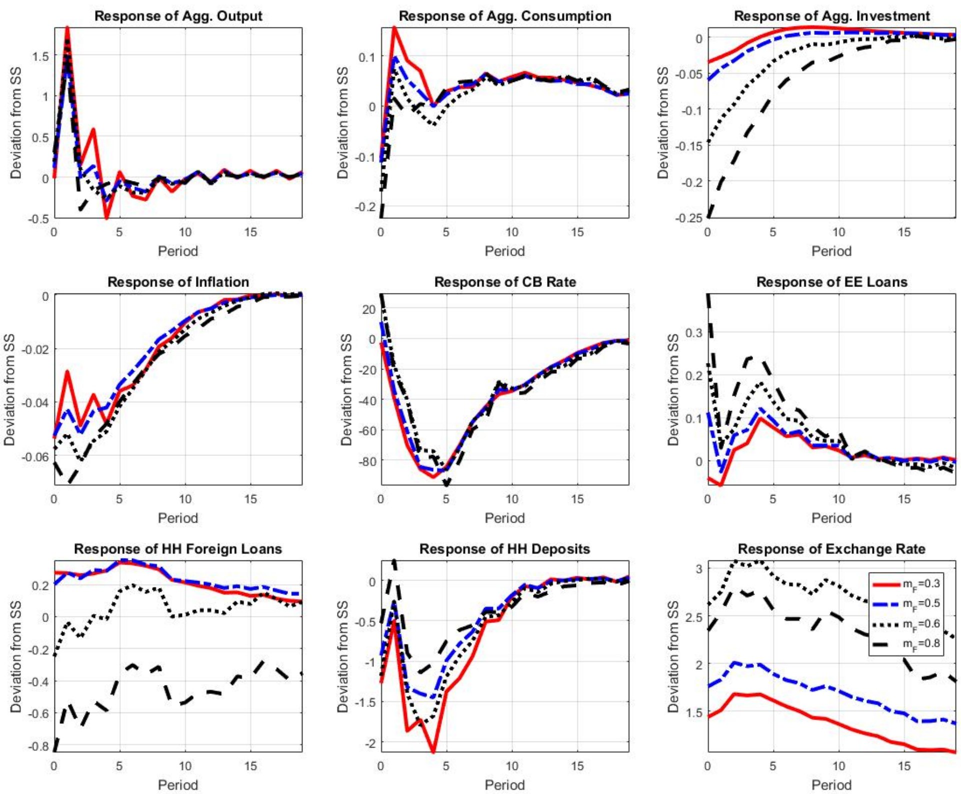

Figure 5.1: Responses of variables to TFP shock, $\phi_S = 0.1229$.

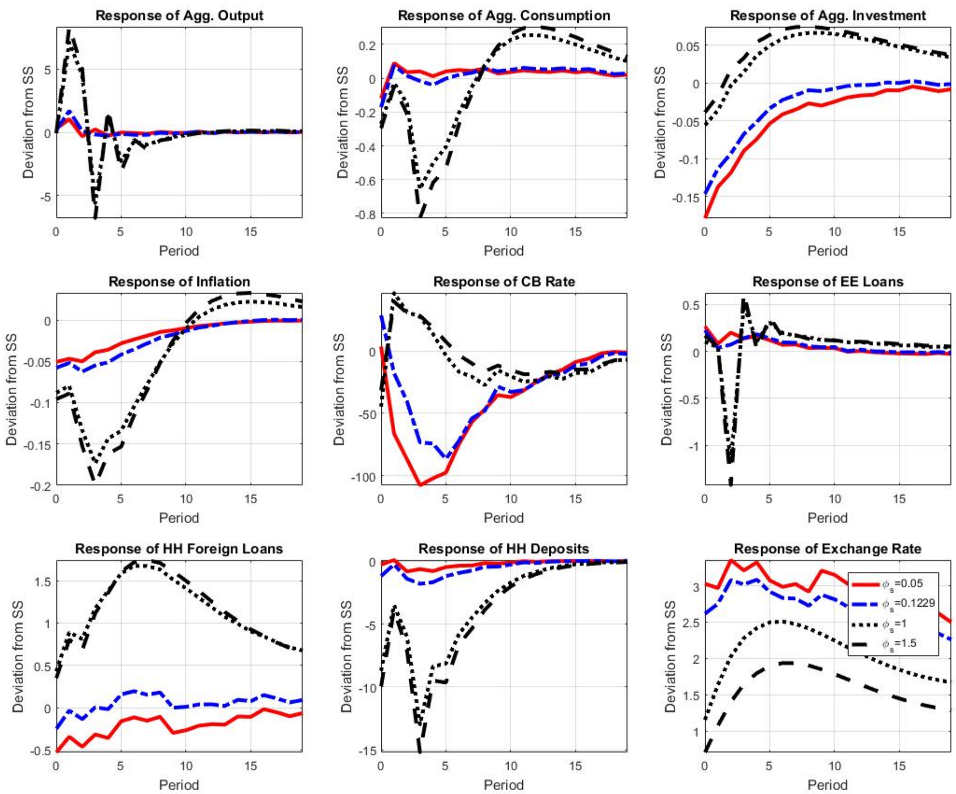

Figure 5.2: Responses of variables to TFP shock, $m_F = 0.6$.

In Figures 5.3, 5.4, 5.5, and 5.6, we illustrate the response or variables due to a foreign interest rate and a risk premium shock. Similar to the previous simulation we did using a TFP shock, the response of variables under the foreign shocks vary widely according to the policy combinations. For example, due to a foreign interest rate shock, HH foreign loans fall when central bank intervention on the exchange rate is smaller compared to when the intervention is relatively low, because the exchange rate does not depreciate as much. Interestingly, the effect of the foreign interest shock to aggregate output, consumption, and inflation is much lower when the degree of intervention is low. However, the contractionary effect on aggregate investment is much larger. Moreover, contrary to the previous simulation done using a TFP shock, the responses of variables under foreign interest rate shock do not weaken when the foreign intervention is lower. In this case, a relatively stringent macroprudential measure on foreign-to-domestic debt ratio should be administered to limit the responses of variables.

Figure 5.6 shows that the responses of aggregate output and investment due to risk premium shock does not vary much under different degree of exchange rate intervention. But, inflation and

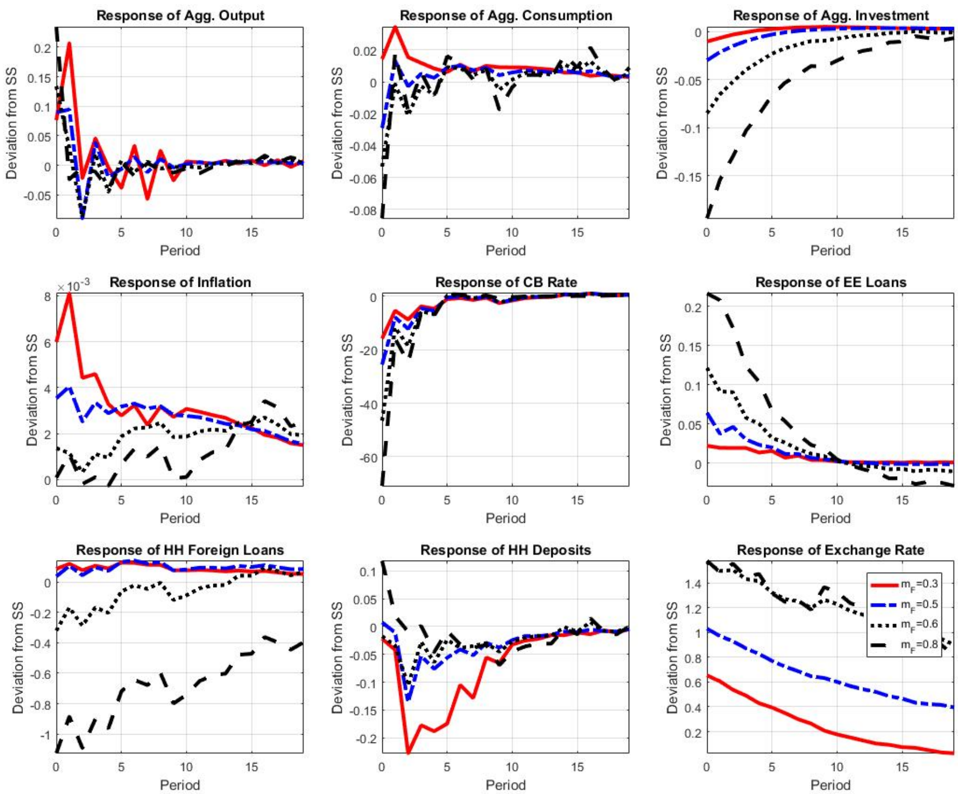

Figure 5.3: Responses of variables to foreign interest rate shock, $\phi_S = 0.1229$.

patient HH foreign loans are amplified. When changing the macroprudential measure, however, a low foreign to domestic loan ratio leads to a milder contraction on aggregate consumption and investment.

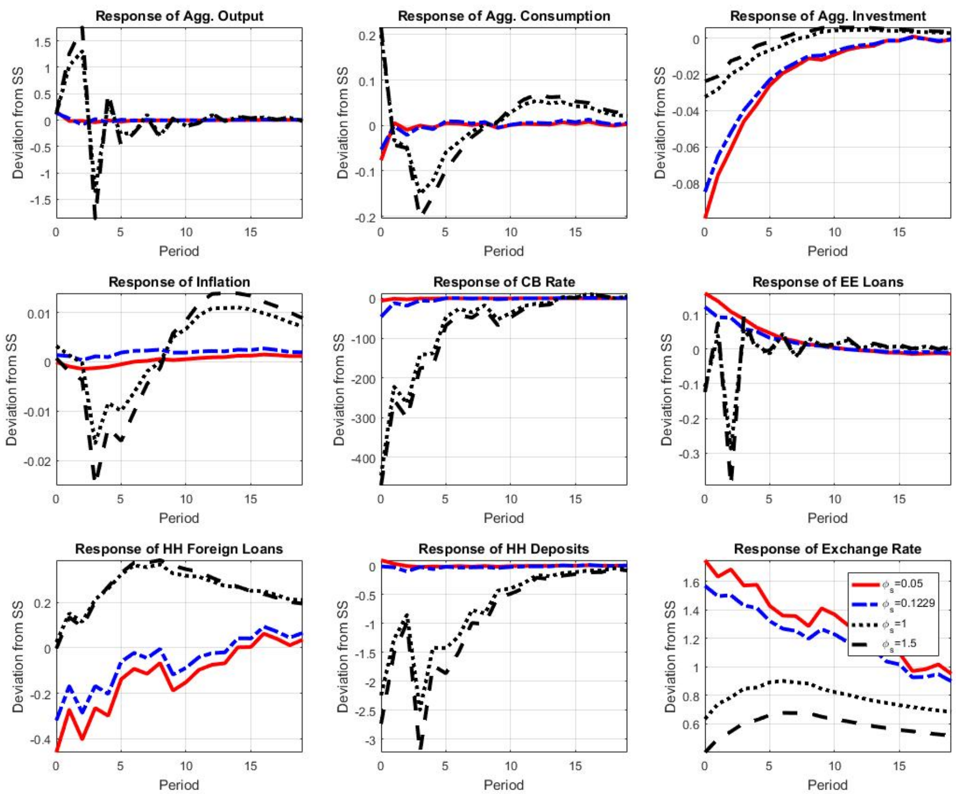

Figure 5.4: Responses of variables to foreign interest rate shock, $m_F = 0.6$.

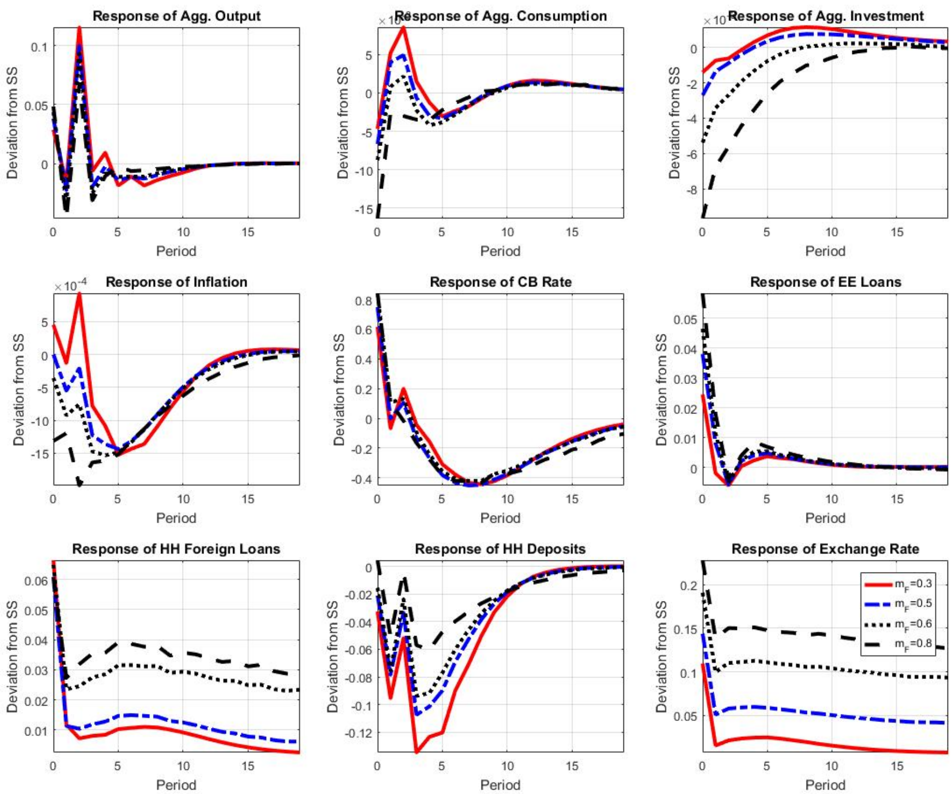

Figure 5.5: Responses of variables to risk premium shock, $\phi_S = 0.1229$.

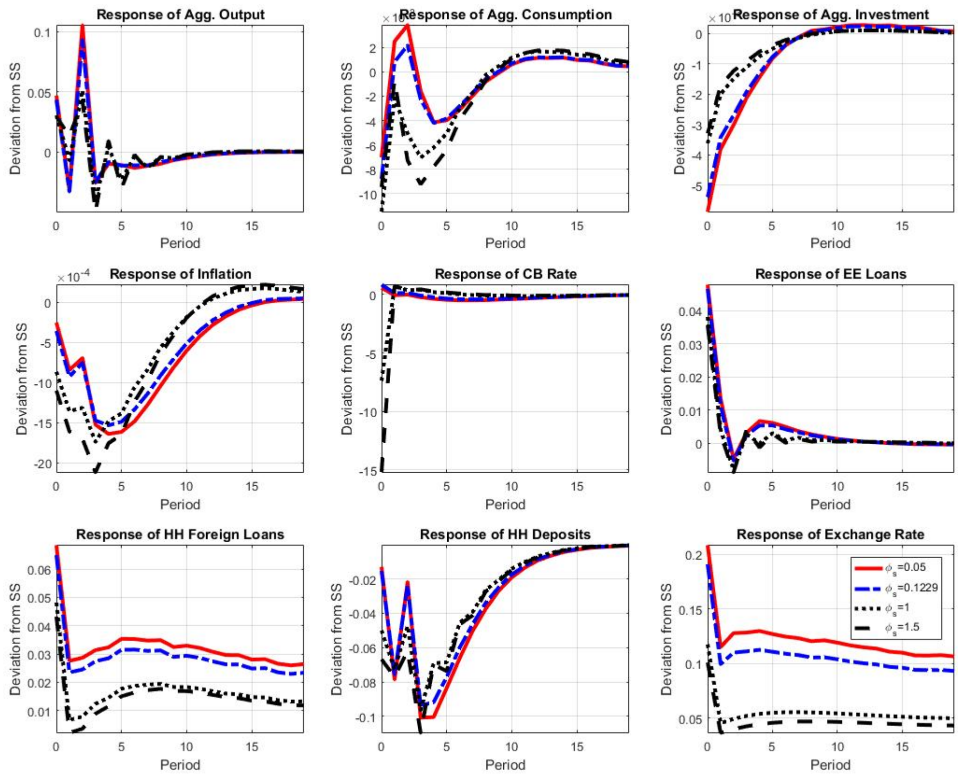

Figure 5.6: Responses of variables to risk premium shock, $m_F = 0.6$.

5.2 Volatility of Macroeconomic Variables under Policy Combinations

In this section, we compare the theoretical volatility of macroeconomic variables using different combinations of exchange rate intervention and macroprudential policies. Under a TFP shock, the top panel of Table 5.1 shows that a looser restriction on foreign to domestic loan ratio (i.e., $m_F = 0.8$), the more stable output. Although, the policy destabilizes consumption, investment and inflation. A more stable output under a TFP shock can be achieved by reducing the degree of exchange rate intervention. Nevertheless, the policy destabilizes investment.

Under foreign shocks, the exchange rate stabilization effort by the central bank yield a different pattern with respect to the type of shock. Due to a foreign interest rate shock, a higher degree of exchange rate intervention destabilizes output, while it stabilizes output when the shock is a risk premium shock. For both foreign shocks, a higher degree of intervention stabilizes investment. Nevertheless, it destabilizes aggregate consumption and inflation.

An intriguing result appear when we fix the degree of exchange rate intervention, the output stabilizing feature of macroprudential policy is not linear along the m_F space. The middle and bottom panel of Table 5.1 shows that given the baseline degree of intervention $\phi_s = 0.1229$, the ratio of foreign to the domestic loan that stabilizes the aggregate output the most is around $m_F = 0.5$. When the macroprudential policy is tightened, the output becomes more volatile. This suggests that tightening the macroprudential measure is necessarily beneficial for output stabilization effort under foreign shocks.

Table 5.1: Volatility of variables under various shocks.

	Y	C	I	π
TFP shock				
$\phi_S = 0.1229$				
$m_F = 0.3$	0.0894	0.0579	0.0004	0.0090
$m_F = 0.5$	0.0543	0.0558	0.0009	0.0083
$m_F = 0.6$	0.0570	0.0592	0.0044	0.0095
$m_F = 0.8$	0.0481	0.0689	0.0117	0.0108
$m_F = 0.6$				
$\phi_S = 0.05$	0.0321	0.0521	0.0054	0.0090
$\phi_S = 0.1229$	0.0570	0.0592	0.0044	0.0095
$\phi_S = 1$	0.2758	0.1308	0.0015	0.0116
$\phi_S = 1.5$	0.3110	0.1424	0.0012	0.0123
Foreign interest rate shock				
$\phi_S = 0.1229$				
$m_F = 0.3$	0.0060	0.0016	0.0014	0.00033
$m_F = 0.5$	0.0026	0.0024	0.0013	0.00021
$m_F = 0.6$	0.0031	0.0061	0.0023	0.00011
$m_F = 0.8$	0.0060	0.0183	0.0075	0.00008
$m_F = 0.6$				
$\phi_S = 0.05$	0.0056	0.0033	0.0029	0.0000
$\phi_S = 0.1229$	0.0031	0.0061	0.0023	0.0001
$\phi_S = 1$	0.0541	0.0396	0.0005	0.0018
$\phi_S = 1.5$	0.0690	0.0471	0.0004	0.0023
Risk premium shock				
$\phi_S = 0.1229$				
$m_F = 0.3$	0.0073	0.000012	0.000014	0.000008
$m_F = 0.5$	0.0068	0.000038	0.000022	0.000003
$m_F = 0.6$	0.0076	0.000079	0.000199	0.000009
$m_F = 0.8$	0.0077	0.000187	0.000811	0.000026
$m_F = 0.6$				
$\phi_S = 0.05$	0.0083	0.000046	0.000024	0.000004
$\phi_S = 0.1229$	0.0076	0.000079	0.000019	0.000009
$\phi_S = 1$	0.0040	0.000372	0.000007	0.000033
$\phi_S = 1.5$	0.0031	0.000470	0.000006	0.000036

Chapter 6

Conclusions

This paper investigates the role of macroprudential policy in the insulation properties of a flexible exchange rate. To this aim, we extend Gerali et al. (2010)'s model into a small open economy with a modified Taylor-rule to take account of the exchange rate intervention through monetary policy. We also add foreign loans by entrepreneurs which are regulated trough a macroprudential policy, via a foreign to domestic loan ratio.

Calibrating to the Indonesian economy, our numerical simulations highlights two main results. First, the responses of variables under the foreign shocks vary widely according to the type of shock and the policy combinations. Second, under a foreign interest rate shock, a higher degree of exchange rate intervention destabilizes aggregate output and consumption. However, under a risk premium shock, it stabilizes output and investment–while destabilizing consumption. Thus, the insulation properties of the flexible exchange rate seem to depend on the foreign shock hitting the economy.

Our findings carry an important empirical and policy implication. First, an attempt to find an empirical evidence of the insulation properties of the exchange rate in Indonesia should pay attention to the shock utilized in the research. An empirical investigation must also take account of macroprudential policy that might affect the financial system condition in general. Policy-wise, a monetary authority ought to focus on identifying the foreign shock driving the exchange rate depreciation. Aggressively responding to a foreign interest rate shock may actually destabilize output. Instead, an output stabilization effort can be carried out through moderately reducing the foreign to domestic loan ratio.

There are several caveats to take into considerations. Our calibration is loose, and to be taken seriously by policymakers, we will improve the next version of the paper by estimating parameters to match the moments of Indonesian data. Also, the exchange rate intervention measure will be improved by adding a direct intervention of the central bank to the foreign exchange market.

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