Essays on Macroeconomic Policy Mix for The Emerging Asian Economies - Post Global Financial Crisis

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Abstract

The emerging Asian economies have different financial system characteristics and exposure to shocks from the advanced economies, but the discussion regarding the role of monetary and macroprudential policies mainly revolve around the same issues. The first one is relating to the lack of understanding of macroprudential policy's transmission mechanism. The second one is about the role of monetary policy as a financial stabilisation instrument. The third one concerns the interaction between monetary and macroprudential policies as macroeconomic and financial stabilisation instruments. Due to the vulnerabilities of the emerging Asian economies to the volatility of capital inflows, the discussion also involves the role of the capital flow management policy as part of the stabilisation instruments. Utilising a small open economy model that has been designed and calibrated based on the emerging Asian economies characteristics, this research contributes to the discussion on the above issues by studying the transmission of monetary, macroprudential and capital flow management policies and their interactions in facing a certain dominant shock driving the disturbances in the economy, evaluating the macroeconomic and financial stabilisation performance of the policy strategies that combine different policy instruments, and examining how the welfare of economic agents are affected by the implementation of these policy strategies.

Model simulations show that not all countercyclical instruments can be used effectively in every shock. There are conditions in which the implementation of macroprudential policy can complement monetary policy to achieve macroeconomic and financial stability, but there are also conditions in which it may be preferable for the policymakers not to implement them. Understanding how a certain shock propagates in the economy and the nature of the interactions among the policy instruments in facing that particular shock are necessary for designing the optimal policy mix that can improve both macroeconomic and financial stability.

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Chapter 1: Introduction

1.1. Motivation

The financial system plays a critical role in an economy by providing intermediation between savings and productive investments in the real sector. A well-functioning financial system will support economic growth while the instability of the financial system can have some severe consequences for the economy. A strong linkage between monetary policy and the condition of the financial system is well acknowledged. Monetary policy transmission would benefit from an efficient financial system. On the other hand, monetary policy has a strong influence on financial system stability.

The global financial crisis in the late 2000s has highlighted the need to monitor and manage the stability of the financial system. The experiences from the crisis have made the central banks realise that monetary policy alone cannot achieve both price and financial system stability. Macroprudential instruments targeting specific imbalances in the financial system has been proposed to complement monetary policy as stabilisation tools.

There are significant differences between the experiences of the emerging Asian economies and the advanced economies during and after the global financial crisis. Many factors that contribute to the severity of the global financial crisis in the advanced economies, such as low capitalisation of banks, unregulated shadow banking system, heavy reliance on the wholesale funding and the lack of proper risk measurement of the innovative financial product are not part of emerging Asian economies' financial system characteristics. These differences were mainly due to the efforts to strengthen the financial system in most countries after the Asian financial crisis[1].

Another notable difference of the emerging Asian economies characteristics is their heavy reliance on the commercial bank financing for both corporate and households' sectors. In most emerging Asian economies, bank loans are still a very dominant source of financing. On average, the total size of bank's deposit is around 60 percent of GDP. Although the size of the bank loans to corporations is still dominating the assets of the banks, the share of the households' loans is increasing.

[1] Lim et al. (2013)

This results in high correlation among bank intermediation activities, property market development, and overall economic growth.

Regarding their exposure to shocks, these economies also more vulnerable to the occurrence of large and volatile capital inflows[2]. In the aftermath of the global financial crisis (GFC), the emerging Asian economies have received large capital inflows that were mostly driven by the global excess liquidity caused by the accommodative monetary policy in the advanced economies.

The recent surges of inflows to the emerging Asian economies were mostly dominated by portfolio investments that include equity and fixed income portfolio instruments. Due to their short-term nature, these types of inflows are very vulnerable to the changes in market sentiment that can lead to a sudden reversal and thus cause financial instability. The surges in capital inflows can also result in currency appreciation that may cause concerns of declining export competitiveness and the deterioration of the current account. Large portfolio inflows may also induce a significant boost in the asset prices. Pressures on both domestic currency and the asset prices will further intensify the risk of financial system instability.

Persistent foreign capital inflows can also significantly affect the efficiency of monetary policy. Under such conditions, the central bank cannot simply react to the mounting pressures of inflation, caused either by a domestic specific shock or by the increase in domestic liquidity, by raising the policy rate because it will induce even more capital inflows and will further increase domestic liquidity and inflation.

Rey (2015) argues that there is a global financial cycle that drives the dynamics of the capital flows, asset prices, and credit growth. This global financial cycle is caused by the monetary condition in the advanced economies and the changes in the risk aversion of the global investors. If a country has an open capital market, the global financial cycle constraints the domestic monetary policy regardless of the exchange rate regime. Grenville (2011) supported these arguments by showing that the dynamics of the capital flows in the emerging Asian economies are mainly caused by factors other than the interest rate differentials. These findings are in contrast to "the impossible trinity" doctrine that argues that a country can have an independent monetary policy and an open capital market only if it has a flexible exchange rate[3]. Rey (2015) propose that a country needs to manage its capital account either directly using capital flow management policy or indirectly using macroprudential policy.

[2] This applies to most emerging economies, not only Asia (Canuto and Ghosh, 2013).
[3] Obstfeld and Taylor (2004).

The experience of the emerging Asian economies if facing the surges of capital inflow after the global financial crisis seems to support the arguments of Rey (2015) and Grenville (2011). The complexities of the problems coming from the surges of capital inflows have encouraged policymakers to implement macroprudential policy and capital flow management policy that can be targeted to a specific source of financial system instability.

Although the emerging Asian economies have different financial system characteristics and exposure to shocks from the advanced economies, the discussion regarding the role of monetary and macroprudential policies mainly revolves around the same issues. The first one is regarding the lack of understanding of macroprudential policy's transmission mechanism. Since it employs a relatively new set of policy instruments and objectives, our knowledge about the transmission mechanism of macroprudential policy to the financial and the real sectors of the economy is not yet considered to be comprehensive and sufficient. The second one is about the role of monetary policy as a financial stabilisation instrument. Specifically, in exploring whether indicators of financial stability need to be included in the monetary policy reaction function. The third one concerns the interaction between monetary and macroprudential policies as macroeconomic and financial stabilisation instruments. Due to the vulnerabilities of emerging Asian economies to the volatility of capital inflow, the discussion also involves the role of capital inflow management tools as additional stabilisation instruments.

There are many papers in the literature that have studied the transmission of macroprudential policy and its interaction with other macroeconomic policies. Among them is Bakker et al. (2012) that empirically investigate the role of monetary, macroprudential and other policies in suppressing the credit growth. They found that, unlike monetary and fiscal policies, macroprudential policies can be effective in containing the credit growth. Utilising data from 18 emerging market economies, Fendoglu (2017) evaluate the effectiveness of macroprudential policies in facing volatile capital flows and found that borrower based instruments can effectively contain the credit growth. Baskaya et al. (2015) study the impact of capital flows on the loan growth in Turkey and found that macroprudential policies manage to reduce the sensitivity of domestic loan growth to capital flow cycle.

Schularick and Shim (2017) assess the effect of monetary and macroprudential policy on the various types of credit growth in Asia-Pacific countries. They found that both policies can significantly slow the credit growth. Using data from 13 Asian

economies, Zhang and Zoli (2014) found that macroprudential and capital flow policies can reduce house price growth, equity flows, credit growth and bank leverage. Bruno et al. (2015) assess the effectiveness of macroprudential and capital flow management policies in 12 Asia-Pacific economies and found that capital flow management policies are effective in slowing down capital inflows, while domestic macroprudential policies have insignificant effects on cross-border lending.

1.2. Research Objectives

The main objective of this research is to contribute to the discussion on the above issues by studying the transmission of monetary, macroprudential and capital flow management policies and their interactions as macroeconomic and financial stabilisation instruments. These are done by employing a small open economy DSGE (Dynamic Stochastic General Equilibrium) model that has been designed and calibrated based on the emerging Asian economies' characteristics.

The transmissions, interactions and overall effectiveness of monetary, macroprudential and capital flow management policies may also depend on the shock that propagates in the economy. The main contribution of this research is to study the potential differences in the nature of the transmissions and the interactions among these policies in facing four different shocks which include technology, domestic price, capital inflow and households' loan default shocks. This research also evaluates the macroeconomic and financial stabilisation performance of the policy strategies that combine different macroeconomic policy instruments. In addition, this study also examines how the welfare of agents are affected by the implementation of these policy strategies. The results of this research would hopefully give insightful inputs for the central bank or other policymakers in designing the optimal policy mix for a particular shock that dominates the disturbances in the economy.

1.3. Thesis Outline

This thesis is organised as follows. Chapter 2 describes the small open economy DSGE model for the emerging Asian economies, studies the transmission of monetary and macroprudential policies and examines the interactions of these policies in facing domestic supply shocks, specifically technology and domestic price shocks.

Chapter 3 describes an extension of the model to include capital flow management policy, studies the transmission of a capital inflow shock and capital flow management

policy and examines the interactions among monetary, macroprudential and capital flow management policy in facing a capital inflow shock.

Chapter 4 describes a second extension of the model to include the transmission of default shocks, studies the propagation of the household's loan default shock and examines the interaction of monetary and macroprudential policy in facing this particular shock.

Chapter 5 examines how the welfare of agents are affected by the policy of the central bank that has macroeconomic and financial stability mandate.

Chapter 6 concludes.

Chapter 2: DSGE Model of The Emerging Asian Economies

2.1. Introduction and Literature Review

According to BIS (2010), there are two objectives of macroprudential policy: (i) to strengthen the financial system's resilience against adverse shocks in the economy, and (ii) to limit the build-up of financial system risk. These two objectives implied that macroprudential policy has a countercyclical characteristic. In order to reduce the procyclicality of the financial system, macroprudential policy can be targeted to influence either banks or borrowers' balance sheet. This highlights the importance of including financial frictions and explicit balance sheets of borrowers and banks in an economic model for policy analysis.

One of the first papers to introduce financial frictions in a business cycle setting is Kiyotaki and Moore (1997). Financial frictions in this model are based on the idea that borrowers need to secure their loans by providing collateral in the form of durable assets. This type of financial frictions allows macroprudential policy to be introduced in the form of a loan to value (LTV) variable that determines the amount of loans available to borrowers based on the value of their collateral. Iacoviello (2005) utilised this type of financial frictions in a new Keynesian framework a la Bernanke et al. (1999) and extended it further by including the transmission of nominal debt.

Gerali et al. (2010) extended Iacoviello's model by including a banking sector which adds another type of financial friction arising from the supply side of the credit market. Based on Bayesian estimation results of the model using euro area data, they study the role of financial frictions and financial intermediation by banks in shaping business-cycle dynamics. Angelini et al. (2014) modified Gerali et al.'s model and utilised it to assess the interaction between macroprudential and monetary policy. They study the interaction in two different cases, cooperative and non-cooperative. In the first case, both policies are jointly and optimally chosen by the same policy-maker with two instruments (the interest rate and the capital ratio requirement). In the second, policies are implemented by two independent authorities. They found a significant benefit of cooperation between macroprudential and monetary policy in the face of financial shocks that affect the supply of loans.

The objectives of this chapter are the following: (1) to develop a DSGE model with emerging Asian economies characteristics that will include monetary and macroprudential policy measures, and to utilise the model to (2) study the

transmission of monetary and macroprudential policy and (3) examine the optimal policy mix among monetary and macroprudential policy measures in facing domestic supply shocks, specifically technology and domestic price shocks.

The model in this chapter is developed based on Iacoviello (2005) and Gerali et al. (2010). The innovation comes from extending the collateral constraint framework in a small open economy setting that will allow not only domestic source of financial instability but also the ones coming from foreign economies. A more detailed balance sheet of the commercial banks is also introduced to the reference model to match the characteristics of the emerging Asian economies' banking sector. In order to study the optimal policy mix, the reference model is extended to include macroeconomic policy measures that represent several options available to the policymakers for restraining financial instability. These measures include countercyclical loan to value (LTV) ratio requirements and a countercyclical leverage ratio requirement.

The remainder of the chapter is organised as follows. Section 2 summarises the financial sector characteristics of the emerging Asian economies. Section 3 describes the model in detail. Section 4 explains the calibration of the model. Section 5 studies the transmission of the different policy instruments. Section 6 examines the optimal policy mix for macroeconomic and financial stability, specifically in facing domestic supply shocks. Section 7 concludes.

2.2. Characteristics of The Emerging Asian Economies

The structural characteristics of the emerging Asian economies' financial sectors are quite diverse. Nevertheless, there are similarities that are shared by a majority of countries in this category especially in terms of the type of financial intermediaries dominating the economy and the composition of their assets.

In most emerging Asian economies, the bank loans are still a very dominant source of financing for both the corporate and the household's sectors[4]. On average, the total size of bank's deposit is around 60 percent of GDP[5], but there are quite significant variations among the countries. One of the factors affecting the dominant role of the banking sector is because access to the stock market is still limited to a very large corporation, while the bond markets are still mostly dominated by

[4] Ananchotikul and Seneviratne (2015)
[5] Burger et al. (2015)

government bond[6]. Other than in Hong Kong, Malaysia, and Singapore, corporate bond markets have been relatively underdeveloped[7].

Although the size of the bank loans to the corporations is still dominating the assets of the banks, the share of the households' loans is increasing. There are also significant shares of liquid asset in the banks' balance sheet in the form of government bonds or other public-sector securities[8]. The banking sector also has a high capital to asset ratio[9]. After the global financial crisis, a significant portion of the bank's capital accumulation is coming from the retained earnings[10].

In recent years, the emerging Asian 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. The recent surges of inflows were mostly dominated by portfolio investments that include equity and fixed income portfolio instruments. Due to their short-term nature, these types of inflows are very vulnerable to changes in market sentiment that can lead to a sudden reversal and thus cause financial instability.

The experiences of emerging Asian economies in facing capital inflows after the global financial crisis are quite diverse. Although many researchers agree that there is a pattern reversal in the form of shrinking banking flows and an increase in portfolio flows based on aggregate data, individual experiences may deviate from this pattern. The dominance of portfolio inflows in the current surges is especially noticeable in Indonesia, Malaysia, the Philippines, Thailand, Vietnam, and India. One of the important impacts of this development is the possibilities of asset price bubbles that may suddenly burst whenever there are changes in global market sentiment.

Another important development related to the increase in capital inflows to the emerging Asian economies is the effect that these flows had on the real estate market and credit growth. During the current episodes of capital inflows, residential house prices have increased in Indonesia, Malaysia, the Philippines, Singapore, and Thailand[11], which resulted in the accelerated growth in property loans distributed by the banks. Increasing domestic liquidity has also resulted in increasing domestic demand that has fuelled the increase in the banks' loan for consumption, specifically in China, Hong Kong, Malaysia, and Vietnam.

[6] Rigg and Schou-Zibell, 2009
[7] Mohanty and Turner (2010)
[8] Filardo et al. 2012
[9] Estrada et al. (2015)
[10] Cohen and Scatigna (2014
[11] Yiu and Sahminan (2015)

Some of the emerging Asian countries have implemented macroprudential and capital flow management measures to deal with the issues resulting from the increase in financial and macroeconomic vulnerabilities. There is significant diversity among the instruments implemented by these countries. Credit related instruments such as LTV policies were predominantly used in Indonesia, Korea, Singapore, and Thailand. Liquidity related instruments such as reserve requirement policies were mostly implemented in China, India and the Philippines. Indonesia, Thailand, and Korea have implemented capital flow management measures which include a minimum holding period policy for the central bank bill and withholding tax on the foreign purchases of government bonds. Capital-related macroprudential instruments were rarely used in these countries, except in India. Empirical evidence regarding the effectiveness of macroprudential policy in the emerging Asian economies shows that credit-related macroprudential instruments can manage to suppress the expansion in the total loans and the increase in the house prices while liquidity related instruments are effective in reducing leverage growth in the financial system[12].

2.3. Model Description

The model in this chapter is developed based on Iacoviello (2005) and Gerali et al. (2010) models. Iacoviello (2005) utilised a collateral constraint friction of Kiyotaki and Moore (1997) in a new Keynesian framework a la Bernanke et al. (1999) and extended it further by including the transmission of nominal debt. Gerali et al. (2010) extended Iacoviello's model by including a banking sector which adds another type of financial friction arising from the supply side of the credit market. The Gerali et al. (2010) model is used as the reference due to the possibility of including macroprudential instruments in both the borrowers and the financial intermediaries side of the credit market. The existence of the financial intermediaries' balance sheet also allows the model to be modified to match the characteristics of the emerging Asian economies banking sector.

I extend the Gerali et al. (2010) model to accommodate the small open economy assumption that will allow not only domestic source of financial instability but also the ones coming from foreign economies. The small open economy assumption requires the inclusion of access to the international trade and financial sector. I assume that the economy exports and imports intermediate goods in the international trade market. I follow the approach of Farhi and Werning (2014) and allows the agent that

[12] Lee at al. (2015)

have the role of savers in the economy to have access to the international financial market. I assume that the economy has an open capital market and a free-floating exchange rate. The monetary policy is governed by the Taylor rule that responds to the dynamic of output and inflation[13].

Rey (2015) argues that there is a global financial cycle that drives the dynamics of the capital flows, asset prices, and credit growth. This global financial cycle is caused by the monetary condition in the advanced economies (mainly the USA) and the changes in the risk aversion of the global investors. If a country has an open capital market, the global financial cycle constraints the domestic monetary policy regardless of the exchange rate regime. Grenville (2011) supported these arguments by showing that the dynamics of the capital flows in the emerging Asian economies are mainly caused by factors other than the interest rate differentials. In order to accommodate these arguments in the model, I extend the reference model by including a country's risk premium variable and allows that variable to be influenced by an exogenous shock. This shock is a proxy for the changes in the global investors' risk aversion towards the financial asset of the domestic economy.

I also add the assumption that savers in the model accumulate a portion of the capital assets that are being rented out to the producers of the intermediate goods[14]. These intermediate goods' producers are also one of the borrowers in the domestic economy. This assumption allows a direct linkage between international capital inflow and capital asset investments, in addition to the indirect linkage coming from the increase in domestic liquidity intermediated by the banking sector. The objective of this extension is to have an alternative source of capital asset financing other than from the bank lending. Despite this assumption, the model still assumes that financial intermediation is still dominated by the banking sector.

It is important to note that the model does not have different types of capital flows. Foreign capital flows in the model are assumed to be directed to economic agents that have the following role in the domestic economy: the savers and the owner of a fraction of housing and capital asset. This would mean that the type of flows being modeled is more consistent with the definition of portfolio flows.

Based on the above arguments, the model would be most suitable for emerging Asian countries that have the financial system that is dominated by the commercial banks with relatively underdeveloped bond and equity markets and have been

[13] For the baseline scenario
[14] Following Iacoviello (2014)

experiencing surges of capital inflows that are dominated by portfolio investments. These countries include Indonesia, Thailand, India, and the Philippines.

I also extend the model to add a more detail balance sheet of the banks that include bank's liquid asset in addition to the loans to the borrowers. In this model, changes in the banks' liquid asset can be considered as net liquidity absorption of the central bank.

In Gerali et al. (2010) model, the only source of the banks' capital accumulation is from retained earnings. This assumption is very relevant to the condition in most emerging Asian economies as discussed in the previous section.

In order to study the optimal policy mix, the reference model is extended to include macroeconomic policy measures that represent several options available to the policymakers for restraining financial instability. These measures include countercyclical loan to value (LTV) ratio requirements and a countercyclical leverage ratio requirement.

The model economy consists of two types of households (patient and impatient households), entrepreneurs, banks, three types of retailers (exporters, importers, and domestic retailers), three types of producers (capital, housing, and final goods' producers) and central bank. The households consume, acquire and accumulate housing assets and provide labour to entrepreneurs. The patient households also accumulate a portion of the capital assets that are being rented out to the entrepreneurs. Undifferentiated intermediate goods are produced by the entrepreneurs using labour, capital rented from the patient households, and their own accumulated capital.

The importers buy homogenous intermediate goods from the foreign market, differentiate them at no cost and then sell them to the final goods producers. The domestic retailers and exporters buy intermediate goods from the entrepreneurs, differentiate them and sell them to their respective markets. The final goods' producers combine differentiated intermediate goods from the domestic retailers and from the importers to be used by the agents in the domestic economy. Some of these final goods are then utilised to produce capital and housing assets.

The banks act as financial intermediaries for the domestic economy's agents. They collect deposits from the patient households and provide loans to the impatient households and the entrepreneurs. The borrowers need to comply with the borrowing constraints which determine the amount of loan they can get based on

the value of the collateral asset that they own. The patient households have access to the international financial market.

2.3.1. Patient Households

There is a continuum of patient households, indexed by $i \in (0.1)$ that maximise their utility function by choosing the level of consumption (C_t^p), the amount of time dedicated to providing labour to the entrepreneurs (L_t^p) and the amount of housing assets they acquired (H_t^p).

$$max \quad E_0 \sum_{t=0}^{\infty} \beta_P^t \left(ln\, C_t^p\,(i) + j\, lnH_t^p(i) - \frac{\left(L_t^p(i)\right)^{\eta}}{\eta} \right) \tag{1}$$

The patient households' income consists of labour income (w_t^p), interest income from the deposit (r_t^d), rental income from their accumulated capital assets ($R_t^K q_t^K K_{t-1}^P$) and transfer of dividends and subsidies (T_t) since they are the owners of the banks and the retailers. In addition, they also have access to the international financial market and can borrow money from foreign lenders (B_t^*). In each period, they spend their available funds for consumption, acquiring housing assets, accumulate capital assets and save the remaining in the form of deposit in the banking sector (D_t).

$$\begin{aligned} C_t^p(i) + q_t^K \left(K_t^p(i) - (1-\delta_K)K_{t-1}^p(i)\right) + q_t \left(H_t^p(i) - (1-\delta_H)H_{t-1}^p(i)\right) + D_t(i) \\ + e_t(1+\rho_{t-1})(1+r_{t-1}^*)\frac{B_{t-1}^*(i)}{\pi_t} \\ = w_t^P L_t^P(i) + (1+r_{t-1}^d)\frac{D_{t-1}(i)}{\pi_t} + R_t^K q_t^K K_{t-1}^P(i) + e_t B_t^*(i) \\ + T_t(i) \end{aligned} \tag{2}$$

The first order condition of the patient households' optimisation problem with respect to the deposit and the foreign borrowing will result in an equation describing the relation among the real interest rate differential, the country's risk premium (ρ_t) and the expectation of the real exchange rate (s_t) appreciation[15]:

$$E_t\left(\frac{s_{t+1}}{s_t}\right) = \frac{(1+r_t^d)}{(1+\rho_t)(1+r_t^*)} E_t\left(\frac{\pi_{t+1}^*}{\pi_{t+1}}\right) \tag{3}$$

[15] π_t is inflation, π_t^* is foreign inflation and $s_t = \frac{e_t P_t^*}{P_t}$

In accordance to Schmitt-Grohe and Uribe (2003), the country's risk premium is defined as a function of total foreign loans to output ratio.

$$(1+\rho_t) = exp\left(-\varphi \frac{e_t B_t^*}{Y_t^E}\right)\varepsilon_t^{\rho} \qquad (4)$$

2.3.2. Impatient Households

In the economy, there is also a continuum of impatient households, indexed by $i \in (0.1)$, that derive their utility from consumption, leisure (the amount of time they spend not working for the entrepreneurs) and the accumulation of their housing assets. The value of the discount for the impatient households is assumed to be higher than the patient households' which translates to lower β_I than β_P .

$$max \quad E_0 \sum_{t=0}^{\infty} \beta_I^t \left(ln\, C_t^I(i) + j\, lnH_t^I(i) - \frac{\left(L_t^I(i)\right)^{\eta}}{\eta} \right) \qquad (5)$$

The only source of income of the impatient households is from labour income ($w_t^I L_t^I$). In each period, they also borrow from the banks the amount of B_t^I and have an obligation to pay the previous period loans along with interest (r_{t-1}^I).

$$C_t^I(i) + q_t\left(H_t^I(i) - (1-\delta_H)H_{t-1}^I(i)\right) + (1+r_{t-1}^I)\frac{B_{t-1}^I(i)}{\pi_t} = B_t^I(i) + w_t^I L_t^I(i) \qquad (6)$$

The amount of loans they can get is determined by the value of the housing assets that they own and the loan to value (LTV) ratio requirement, m_t^I. The central bank decides on the value of m_t^I as part of its macroprudential measures.

$$E_t \frac{(1+r_t^I)}{\pi_{t+1}} B_t^I(i) \leq m_t^I E_t q_{t+1}(1-\delta_H)H_t^I(i) \qquad (7)$$

2.3.3. Entrepreneurs

There is also a continuum of entrepreneurs, indexed by $i \in (0.1)$ that derive their utility from consumption (C_t^E). As borrowers, similar to the impatient households, they also have a higher discount than the patient households.

$$max \quad E_0 \sum_{t=0}^{\infty} \beta_E^t \left(ln\, C_t^E\,(i) \right) \tag{8}$$

They produce undifferentiated intermediate goods (Y_t^E) with the following production function:

$$Y_t^E(i) = A_t \left[\left(K_{t-1}^E(i) \right)^{\sigma} \left(K_{t-1}^P(i) \right)^{(1-\sigma)} \right]^{\alpha} \left[\left(L_t^p(i) \right)^{\gamma} \left(L_t^I(i) \right)^{(1-\gamma)} \right]^{(1-\alpha)} \tag{9}$$

where A_t is the total factor productivity (TFP), and K_t^E is the stock of the capital asset owned by the entrepreneurs[16].

In each period, they receive revenues from selling their goods to retailers and acquire new loans (B_t^E) from the bank. They use the money for consumption, pay the labour costs, accumulate capital assets, pay the rental cost of the patient households' capital assets and pay the previous period loans along with interest. The following equation shows the entrepreneurs' budget constraint:

$$\begin{aligned} C_t^E(i) + q_t^K \left(K_t^E(i) - (1-\delta_K) K_{t-1}^E(i) \right) + w_t^p L_t^p(i) + w_t^I L_t^I(i) \\ + (1 + r_{t-1}^E) \frac{B_{t-1}^E(i)}{\pi_t} + R_t^K q_t^K K_{t-1}^P(i) = \frac{P_t^E}{P_t} Y_t^E(i) + B_t^E(i) \end{aligned} \tag{10}$$

where q_t^K is the price of the capital assets, P_t^E is the price of the intermediate goods and δ_k is the depreciation rate of the capital asset.

The amount of loans that the entrepreneurs can get are determined by the value of the capital assets that they own and the LTV ratio requirement (m_t^E)[17] :

$$E_t \frac{(1 + r_t^E)}{\pi_{t+1}} B_t^E(i) \leq m_t^E q_{t+1}^K E_t (1-\delta_K) K_t^E(i) \tag{11}$$

The assumption that production in the economy can utilise capital assets owned by two different agents allow us to have two different dynamics of capital asset accumulations. Capital asset accumulations by the entrepreneurs are financed by their incomes and the loans from the banking sector. In addition, the values of these capital assets also determine the amount of loans that the entrepreneurs' can get. This

[16] I normalise the steady state value of TFP to 1.
[17] Following Gerali et al. (2010) and Iacoviello (2005), I assume that shocks in the model are sufficiently small so that the variables are always around their steady state level allowing the model to be solved by assuming binding borrowing constraints.

highlight the fact that the changes made to influence the banking sector's loan distribution or their retail rates will directly affect the accumulation of capital asset by the entrepreneurs. On the other hand, the accumulation of capital asset by the patient households may not be directly determined by the changes made to restrict the banks' loans. Instead, they are affected by the changes made to the deposit rate which governs the opportunity cost of the patient households' capital asset accumulations. We can get the relationship between the real deposit rate and the rental rate of capital from the optimisation of the patient households' problem.

$$\frac{(1+r_t^d)}{\pi_{t+1}}\frac{q_t^K}{q_{t+1}^K} = (1-\delta_K) + R_{t+1}^K \qquad (12)$$

There are conditions in which we get the same responses from the households and the entrepreneurs regarding their capital accumulations. There are also conditions in which the responses are different. The possibilities of different accumulation responses would mean that any policy tools that try to restrict lending to the entrepreneurs but have the effect of increasing the capital accumulation by the patient households would be less efficient in this model compared to the ones without the accumulation of the capital by the households. This efficiency is partly determined by the parameter σ that governs the share of the capital asset owned by the entrepreneurs. We can argue that K_t^E represents the capital accumulation partly financed through the loans from the banking sector while K_t^P represents the capital accumulation financed by other financial systems which allow savers to fund investment projects without the assistance of the banks as the financial intermediaries. These may include issuance of stocks or private bonds by the entrepreneurs that are directly owned by the households (not part of bank's asset portfolio).

2.3.4. Banks

The banks perform as domestic financial intermediaries in the economy. I assume that there is a continuum of banks, indexed by $j \in (0.1)$ with the following balance sheet constraint:

$$B_t^E(j) + B_t^I(j) + B_t^{CB}(j) = D_t(j) + K_t^B(j) \qquad (13)$$

The assets consist of liquid assets (B_t^{CB}), loans to the households and loans to the entrepreneurs, while the liabilities include deposits and capital (K_t^B). In this model, the changes in the banks' liquid asset can be considered as the net liquidity absorption of the central bank. The cost of this absorption is transferred to the patient households as a lump sum tax.

The banks' capital accumulations are exogenous from the banks' point of view and determined by the previous level of capital stock and retained profits (Π_t^B):

$$K_t^B(j) = (1 - \delta_{KB})\frac{K_{t-1}^B(j)}{\pi_t} + \chi\frac{\Pi_{t-1}^B(j)}{\pi_t} \qquad (14)$$

The parameter χ govern the share of the retained earnings while the parameter δ_{KB} represents the cost of managing the banks' capital.

In each period, the banks' profits are determined by the difference between the interest income from their productive assets (r_t^E, r_t^I and r_t) and their costs, which include interest on deposits (r_t^d) and an additional cost they incurred when they deviate from their target leverage ratio (Ψ_t). I assume that the dynamics of this target leverage ratio is determined by the leverage ratio requirement (Ψ_t^{reg})[18].

$$\Psi_t = \left(\frac{\Psi}{\Psi^{reg}}\right)\Psi_t^{reg} \qquad (15)$$

The leverage ratio requirement or the inverse of capital to asset ratio requirement is a macroprudential measure which value is determined by the central bank.

In addition, to study the implication of imperfect pass-through of the policy rate to banks' retail rates, it is assumed that banks are subjected to quadratic adjustment costs (governed by the parameters κ_d, κ_E and κ_I) in setting the deposit and the loan rates.

$$\begin{aligned}\Pi_t^B(j) = {} & \left(r_t^E(j)\right)B_t^E(j) + \left(r_t^I(j)\right)B_t^I(j) + \left(r_t\ \right)B_t^{CB}(j) - \left(r_t^d(j)\right)D_t(j) \\ & - \frac{\kappa_L}{2}\left(\frac{B_t^E(j) + B_t^I(j)}{K_t^B(j)} - \Psi_t\right)^2 K_t^B(j) - \frac{\kappa_d}{2}\left(\frac{r_t^d(j)}{r_{t-1}^d(j)} - 1\right)^2 r_t^d D_t \\ & - \frac{\kappa_E}{2}\left(\frac{r_t^E(j)}{r_{t-1}^E(j)} - 1\right)^2 r_t^E B_t^E - \frac{\kappa_I}{2}\left(\frac{r_t^I(j)}{r_{t-1}^I(j)} - 1\right)^2 r_t^I B_t^I\end{aligned} \qquad (16)$$

[18]The parameter Ψ is the steady state value of the banks' leverage target while the parameter Ψ^{reg} is the steady state value of the leverage ratio requirement.

Banks have monopolistic power in the deposit and the loan markets. The degree of market power is determined by the interest rate elasticity of loan supply/deposit demand. The supply/demand functions of loan/deposit are the following:

$$D_t(j) = \left(\frac{r_t^d(j)}{r_t^d}\right)^{-\varepsilon^d} D_t \qquad (17)$$

$$B_t^I(j) = \left(\frac{r_t^I(j)}{r_t^I}\right)^{-\varepsilon^{bi}} B_t^I \qquad (18)$$

$$B_t^E(j) = \left(\frac{r_t^E(j)}{r_t^E}\right)^{-\varepsilon^{be}} B_t^E \qquad (19)$$

where ε^d, ε^{bi} and ε^{be} are the elasticities of substitution among the deposit, the households' loan and the entrepreneurs' loan contracts offered by different banks.

Banks maximise their profits (Π_t^B) subject to the balance sheet constraint, supply function for deposit and demand functions for both types of loans[19]:

$$max \quad E_0 \sum_{t=0}^{\infty} \Lambda_{0,t}^P \, \Pi_t^B(j) \qquad (20)$$

Based on profit maximisation, the optimal retail rates of the banking sector are the following[20]:

$$1 + \frac{\varepsilon^{bi}}{r_t^I}\left(r_t \; + \kappa_L\left(\frac{B_t^E + B_t^I}{K_t^B} - \Psi_t\right)\right) + \beta_P \, \frac{C_t^p}{C_{t+1}^p}\left(\kappa_I\left(\frac{r_{t+1}^I}{r_t^I} - 1\right)\frac{B_{t+1}^I}{B_t^I}\left(\frac{r_{t+1}^I}{r_t^I}\right)^2\right) = \varepsilon^{bi} + \kappa_I\left(\frac{r_t^I}{r_{t-1}^I} - 1\right)\frac{r_t^I}{r_{t-1}^I} \qquad (21)$$

$$1 + \frac{\varepsilon^{be}}{r_t^E}\left(r_t \; + \kappa_L\left(\frac{B_t^E + B_t^I}{K_t^B} - \Psi_t\right)\right) + \beta_P \, \frac{C_t^p}{C_{t+1}^p}\left(\kappa_E\left(\frac{r_{t+1}^E}{r_t^E} - 1\right)\frac{B_{t+1}^E}{B_t^E}\left(\frac{r_{t+1}^E}{r_t^E}\right)^2\right) = \varepsilon^{be} + \kappa_E\left(\frac{r_t^E}{r_{t-1}^E} - 1\right)\frac{r_t^E}{r_{t-1}^E} \qquad (22)$$

[19] $\Lambda_{0,t}^P$ is the patient households' stochastic discount factor.
[20] Aggregate version after imposing symmetric equilibrium

$$\varepsilon^d + \beta_P \frac{C_t^p}{C_{t+1}^p}\kappa_d\left(\frac{r_{t+1}^d}{r_t^d}-1\right)\frac{D_{t+1}}{D_t}\left(\frac{r_{t+1}^d}{r_t^d}\right)^2 = 1+\frac{r_t}{r_t^d}(\varepsilon^d)+\kappa_d\left(\frac{r_t^d}{r_{t-1}^d}-1\right)\frac{r_t^d}{r_{t-1}^d} \qquad (23)$$

The above equations relate the banks' optimal retail rates with the policy rate, their steady state markup or markdown[21] and the adjustment cost parameters. For the case of the loan rates, the determinants also include the deviation of the leverage from the targeted level.

2.3.5. Housing and Capital Producers

The housing and capital producers operate in perfectly competitive markets and use the final goods to produce housing (H_t) and capital (K_t) assets, respectively. Both are produced from the un-depreciated previous stocks and the transformation of the final goods (I_t^H and I_t^K) with the following production functions[22]:

$$H_t = (1-\delta_H)H_{t-1} + \varepsilon_t^H\left(1-\frac{1}{2}\kappa_H\left(\frac{I_t^H}{I_{t-1}^H}-1\right)^2\right)I_t^H \qquad (24)$$

$$K_t = (1-\delta_K)K_{t-1} + \varepsilon_t^K\left(1-\frac{1}{2}\kappa_K\left(\frac{I_t^K}{I_{t-1}^K}-1\right)^2\right)I_t^K \qquad (25)$$

2.3.6. Retailers

All retailers (domestic retailers, exporters, and importers) operate in monopolistic competitive markets with Calvo price setting behaviour. In each period, with probability $(1-\theta_H)$ [23] the domestic retailers can re-optimise their price. For the ones that are not re-optimising, will set the price according to the following function: $P_t^H = P_{t-1}^H \pi_{t-1}^H$. This will result in the following aggregate price[24]:

$$P_t^H = \left(\theta_H (P_{t-1}^H \pi_{t-1}^H)^{1-\varepsilon_H} + (1-\theta_H)\left(P_{t-1}^H(i)\right)^{1-\varepsilon_H}\right)^{\frac{1}{1-\varepsilon_H}} \qquad (26)$$

Similar arrangements for the importers will result in the following aggregate price:

[21] $\frac{\varepsilon^{bl}}{\varepsilon^{bl}-1}$ and $\frac{\varepsilon^{be}}{\varepsilon^{be}-1}$ are the steady state markups for the loan rates while $\frac{\varepsilon^d}{\varepsilon^d-1}$ is the steady state markdown for the deposit rate.
[22] ε_t^H and ε_t^K are shocks with normal distribution and standard deviation $\sigma_{\varepsilon h}$ and $\sigma_{\varepsilon k}$, respectively.
[23] $\theta_H \in [0,1]$
[24] $\frac{\varepsilon_H}{\varepsilon_H-1}$ is the steady state markup.

$$P_t^F = \left(\theta_F (P_{t-1}^F \pi_{t-1}^F)^{1-\varepsilon_F} + (1-\theta_F)\left(P_t^F(i)\right)^{1-\varepsilon_F}\right)^{\frac{1}{1-\varepsilon_F}} \quad (27)$$

The exporters sell their differentiated intermediated goods to the foreign market with price $P_t^{H^*}(i)$, expressed in the foreign currency. The demand equation for the export goods is the following:

$$y_t^{H^*}(i) = \left(\frac{P_t^{H^*}(i)}{P_t^{H^*}}\right)^{\frac{-(1+\mu_{H^*})}{\mu_{H^*}}} y_t^{H^*} \quad (28)$$

where $y_t^{H^*}$ is the aggregate volume of exports:

$$y_t^{H^*} = \left(\int_0^1 \left(y_t^{H^*}(i)\right)^{\frac{1}{1+\mu_{H^*}}} di\right)^{1+\mu_{H^*}} \quad (29)$$

and $P_{H,t}^*$ is the aggregate price of exports:

$$P_t^{H^*} = \left(\int_0^1 \left(P_{H,t}^*(i)\right)^{\frac{-1}{\mu_{H^*}}} di\right)^{-\mu_{H^*}} \quad (30)$$

The foreign demand for the country's exports is determined by the aggregate export price, the world price of the export goods (P_t^{x*}) and the world demand (y_t^*):

$$y_t^{H^*} = (1-\eta^*)\left(\frac{P_t^{H^*}}{P_t^{x*}}\right)^{\frac{-(1+\mu_{H^*})}{\mu_{H^*}}} y_t^* \quad (31)$$

With similar Calvo price setting as the other retailers, the aggregate price of the export goods is:

$$P_t^{H^*} = \left(\theta_{H^*}\left(P_{t-1}^{H^*}\pi_{t-1}^{H^*}\right)^{1-\varepsilon_{H^*}} + (1-\theta_{H^*})\left(P_t^{H^*}(i)\right)^{1-\varepsilon_{H^*}}\right)^{\frac{1}{1-\varepsilon_{H^*}}} \quad (32)$$

2.3.7. Final Goods' Producers

The final goods' producers combine differentiated intermediate goods from the domestic retailers (y_t^H) and the importing retailers (y_t^F) and sell them in a perfectly

competitive market. The following equation describes the production function of the final goods:

$$y_t = \left[\xi^{\frac{\mu}{1+\mu}}(y_t^H)^{\frac{1}{1+\mu}} + (1-\xi)^{\frac{\mu}{1+\mu}}(y_t^F)^{\frac{1}{1+\mu}}\right]^{1+\mu} \quad (33)$$

where ξ is the home bias parameter, and μ is the parameter that determines the elasticity of substitution between domestic and foreign goods.

2.3.8. Central Bank

In the baseline model, it is assumed that the central bank follows a Taylor rule based equation in setting the policy rate:

$$(1+r_t) = (1+r\ \ )^{1-\phi_R}(1+r_{t-1})^{\phi_R}\left(\left(\frac{\pi_t}{\pi}\right)^{\phi_\pi}\left(\frac{Y_t^E}{Y^E}\right)^{\phi_y}\right)^{1-\phi_R}\varepsilon_t^r \quad (34)$$

where ϕ_π and ϕ_y are weights for inflation and output stabilisation. While ε_t^r is the shock to monetary policy[25].

2.3.9. Market Clearings

The following are market clearing equations for all the goods produced by the final goods' producers, the intermediate goods produced by the entrepreneurs, the housing asset market and the capital asset market:

$$y_t = C_t^p + C_t^I + C_t^E + I_t^K + I_t^H + \delta_{KB}\frac{K_{t-1}^B}{\pi_t} \quad (35)$$

$$y_t^E = y_t^H + y_t^{H^*} \quad (36)$$

$$H_t = H_t^p + H_t^I \quad (37)$$

$$K_t = K_t^p + K_t^E \quad (38)$$

Combining all agents' balance sheet constraints will result in the following balance of payment equation[26]:

[25] i.i.d shock with normal distribution and standard deviation $\sigma_{\varepsilon r}$

[26] $\tilde{B}_t^* = \frac{B_t^*}{P_t^*}$; $\tilde{p}_t^{F^*} = \frac{P_t^{F^*}}{P_t^*}$ and $\tilde{p}_t^{H^*} = \frac{P_t^{H^*}}{P_t^*}$

$$s_t \tilde{p}_t^{F^*} y_t^F + s_t(1+\rho_{t-1})(1+r_{t-1}^*)\frac{\tilde{B}_{t-1}^*}{\pi_t^*} = s_t \tilde{p}_t^{H^*} y_t^{H^*} + s_t \tilde{B}_t^* \quad (39)$$

2.4. Model Calibration - The Case for Indonesia

For calibration purposes, instead of using generic values that may represent a broad range of countries, I choose to use values from one of the country in emerging Asia that possesses the characteristics mentioned in the previous section. Diversity among the countries and complexity of the model which demands a significant number of parameter calibrations are the main drivers for choosing this strategy.

The model is calibrated based on Indonesian data and characteristics. For the steady state values of output components and banks' balance sheet, I use the information from similar DSGE models of the Indonesian economy as the main guide, and I adjust them based on the assumptions of the model[27].

Table 1: Steady State Values

Variables	Values
Components of Output	
Consumption to Output Ratio	0.67
Housing Investment to Output Ratio	0.07
Capital Investment to Output Ratio	0.15
Export to Output Ratio	0.44
Import to Output Ratio	0.34
Banks' Balance Sheet Variables	
Deposit to total asset ratio	0.88
Bank's capital to total asset ratio	0.12
Loan to total asset ratio	0.70
Liquid Asset to total asset ratio	0.3
Households' loan to total asset ratio	0.20
Entrepreneurs' loan to total asset ratio	0.50
Leverage target	5.83
Leverage requirement	12.50
Deposit to output ratio	1.28

Both excess reserves and excess capital buffers are observed in the Indonesian banking sector. These characteristics also exist in many other emerging Asian economies. The steady state values of excess reserves are included in banks' liquid

[27] Most of the calibrations are similar with Harmanta et al. (2014).

assets, together with their aggregate holdings of central bank bills and government bonds. The leverage ratio target is set based on the steady state level of the leverage, while the leverage ratio requirement is based on the capital ratio requirement determined by Bank Indonesia.

I use 0.005 as the value of κ_L (parameter for the leverage deviation cost), based on the existence of excess capital buffer in the banking sector[28]. The steady state of the entrepreneurs' loan rate is set at 0.114 (annual value) while the value of the households' loan rate is set at 0.135. The value for β_P is 0.99, consistent with the steady state of the deposit rates (0.04). I set 0.96 as the value for β_I and β_E which ensures binding collateral constraints. The values for the markup and markdown parameters for the deposit and the loan rates are calculated based on the steady state of the domestic policy rate (0.0575) and each retail rates. The steady state for the banks' profit is set to match the steady state of the balance sheet components and their interest rates. The value for the banking sector retained profit parameter (χ) is set at 0.5, consistent with Indonesian data. The parameter for the cost of managing banks' capital (δ_{KB}) is set at 0.07 to match the steady state of the bank's capital and profit. The values for κ_d is set at 3.3, κ_E is set at 3.48 while κ_I is set at 8.04. These values are chosen to match the policy rate pass-through of each retail rate.

I set the depreciation rate for the capital asset (δ_K) at 0.025 and the housing asset (δ_H) at 0.0125, consistent with the values used in the literature. I use 0.54 for the capital share in the production function parameter (α), based on the similar model used in Bank Indonesia. For the parameter j (the weight of housing in the utility function), I use 0.28 to match the steady state of the housing investments. The LTV ratio for the household loans (m^I) is set at 0.75, generally similar to the LTV ratio in Indonesia. The calibration on j, m^I and the households' loan to output ratio determine the value for the impatient households' wage share ($1-\gamma$) which is set at 0.28. I use 0.84 for the parameter σ (the share of capital asset owned by the entrepreneurs) to match the capital investment to output ratio and the stock market capitalisation (a proxy for the share of the capital assets owned by the patient households). The entrepreneurs' LTV ratio is based on the steady state level of the entrepreneurs' loan to output ratio. I set parameter κ_H (the adjustment parameter for the housing investments) at 3.65 and parameter κ_K (the adjustment parameter for the capital investments) at 0.98[29].

[28] This parameter determines the speed of adjustment of the banks' leverage to the changes in the leverage ratio requirement
[29] Based on the estimation of Harmanta et al. (2014)

The value of the home bias parameter is set at 0.622. The parameter that governs the elasticity of substitution between domestic and foreign goods (μ) is set at 0.435 while the elasticity of substitution for export goods (μ_{H^*}) is set at 0.37[30]. The Calvo parameter for the domestic retailers (θ_H) is set at 0.6, for the importers (θ_F) at 0.5 and for the exporters (θ_{H^*}) at 0.4.

Due to the size, the model does not have an analytical solution and need to be solved numerically. I apply the perturbation methods framework developed by Schmitt-Grohe and Uribe (2004) to solve the model using the software Dynare[31].

2.5. Transmission Mechanism of The Policy Instruments

To gain insights on the possible interactions among the policy instruments that exist in the model, I will start by analysing the transmission mechanism of each instrument to the changes in the balance sheet composition of the banking sector and the real sectors.

2.5.1. Transmission of The Policy Rate

Figure 1 describes the transmission mechanism of the policy rate in the model. For this simulation, I use the following values for the Taylor rule parameters: $\phi_R = 0.75$; $\phi_\pi = 2$; $\phi_y = 0.25$ [32].

An increase in the policy rate will be transmitted by the banks through the changes in the deposit and the loan rates. The model allows for different rates of the pass-through of the policy rate to the different banks' retail rates. These rates of pass-through are determined by parameter κ_d for the deposit rate, κ_I for the households' loan rate and κ_E for the entrepreneurs' loan rate[33]. The differences in pass-through can be influenced by the maturity structure of the deposits and the loans in the banks' balance sheet. The longer the maturities, the slower the pass-throughs. Based on the calibration, the values for κ_d and κ_E are significantly lower than κ_I which reflects a longer maturity of the households' loans which consist mostly of mortgage loans. There are two different plots in each impulse response in Figure 1 that allow us to compare the different transmission of the policy rate with the different pass-throughs. The impulse responses are based on a 1% shock to the policy rate.

An increase in the policy rate will result in lower deposit collection, lower loan distribution and an increase in the banks' liquid assets. The dynamics of the various

[30] These values are based on the estimation done by Zhang and Verikios (2006).
[31] Adjemian et al. (2011)
[32] Based on Harmanta et al. (2014)
[33] See equation (16)

variables of the banks' balance sheet will translate to decreases in the loan to deposit ratio and the banks' leverage. The effects on the financial variables will be transmitted to the real sectors in the form of lower output (GDP), lower inflation, lower asset prices and the appreciation of the real exchange rates[34].

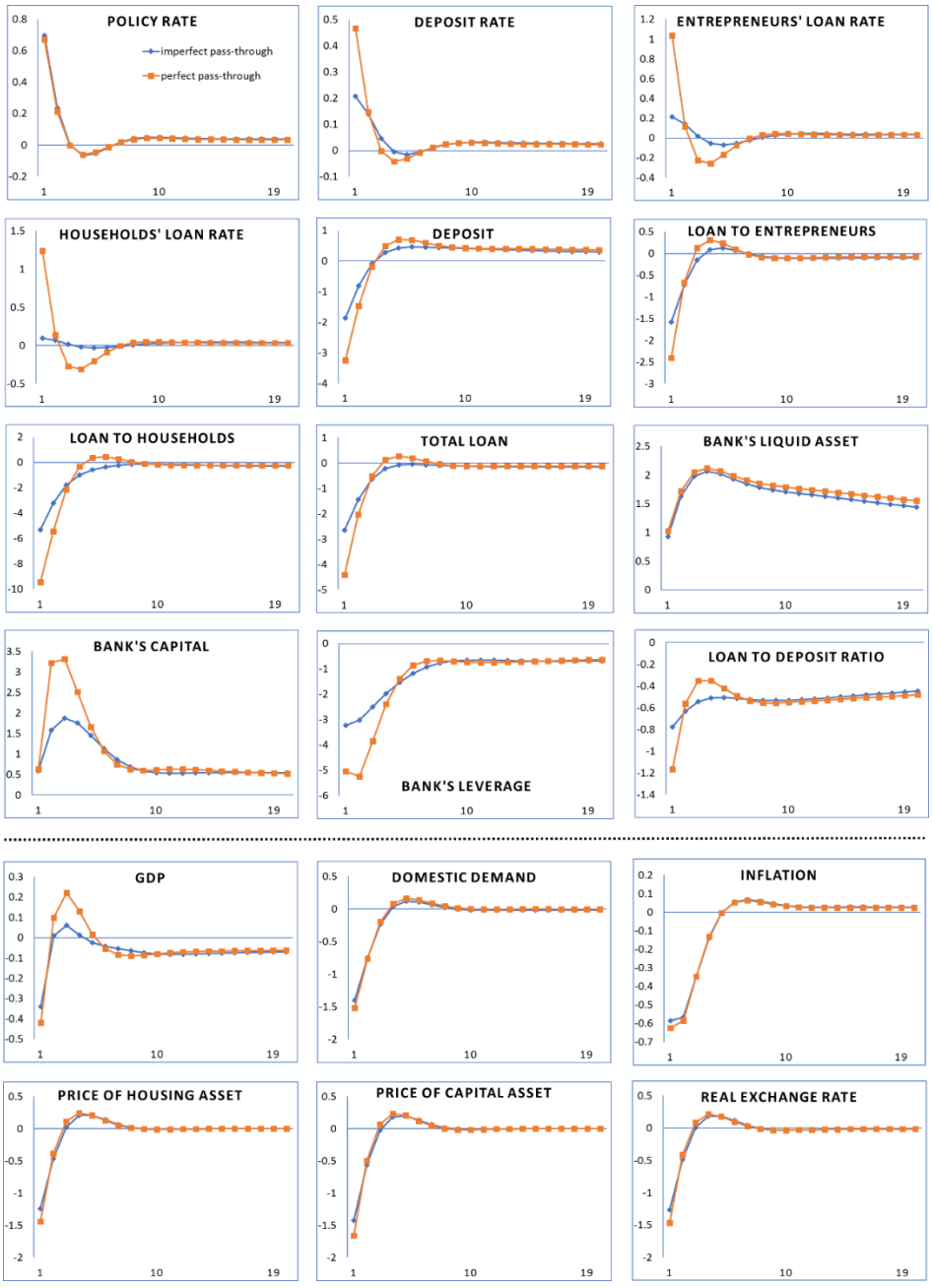


Figure 1: Comparison of impulse responses to monetary policy shock between perfect and imperfect pass-through

Notes: The figure reports the impulse responses to a one percent positive shock to the policy rate. For interest rate variables, the figure shows absolute deviations from the steady state in percentage points. For other variables, it shows percent deviations from the steady state.

[34] A decrease in the value of variable s_t means a domestic currency's appreciation.

The differences in pass-through translate to the differences in the impact of the policy rate changes on the various financial sector variables. The changes in the deposit collection and the loan distribution are significantly less in the case of imperfect pass-through. Since the pass-through to the loan rates on average are slower than to the deposit rate, the total loan distribution will be significantly higher than the deposit collection. This translates to a higher loan to deposit ratio (LDR) on impact, compared to the case of the perfect pass-throughs. The higher loan distribution in the case of the imperfect pass-through will also result in a higher leverage.

Significant differences in the composition of the banks' balance sheet components between different pass-through may influence how monetary policy interacts with macroprudential policy measures, especially when they are aiming at a specific balance sheet condition, such as leverage or loan to deposit ratio. This warrant the need of a periodical inspection of monetary policy transmission through banks' balance sheet, not only for monetary policy purpose but also for the benefit of macroprudential policy arrangements.

2.5.2. Transmission of The Leverage Ratio Requirement

To study the transmission of the changes in the leverage ratio requirement (Ψ_t^{reg}), I define the following equation:

$$\Psi_t^{reg} = \rho_\Psi \Psi_{t-1}^{reg} + (1-\rho_\Psi)\Psi^{reg} + \varepsilon_t^\Psi \qquad (40)$$

where ρ_Ψ is the persistence parameter, and ε_t^Ψ is an i.i.d shock with normal distribution and standard deviation equal to $\sigma_{\varepsilon\Psi}$. For the simulation, I use the following value for the persistence parameter: $\rho_\Psi = 0.9$.

In responding to the changes in the leverage ratio requirement, the banks can use two different strategies. The first one is to restrict lending and increase their liquid assets. The second one is to increase profitability by widening the interest rate spread (the difference between the loan rates and the deposit rate)[35]. The adjustment made by the banks due to the changes in the leverage ratio requirement depends on the parameter that determines the cost of deviation from the banks' leverage target (κ_L), the retained earnings' ratio (χ), the retail rates' adjustment cost parameters (κ_d, κ_E,

[35] There are other strategies that the banks can pursue to meet the leverage ratio requirement, such as issuing new equities or increasing the rate of the retained earnings. These strategies are not supported by the model due to the assumptions made on the banks' capital accumulation in equation (14)

κ_I) and the markup/markdown parameters (ε^d, ε^{bi} and ε^{be}). The higher the retained earnings' ratio, the higher the markups and the lower the adjustment costs, the more likely for the banks to pursue the second strategy. However, this still depends on the level of the excess capital buffer that they choose to hold.

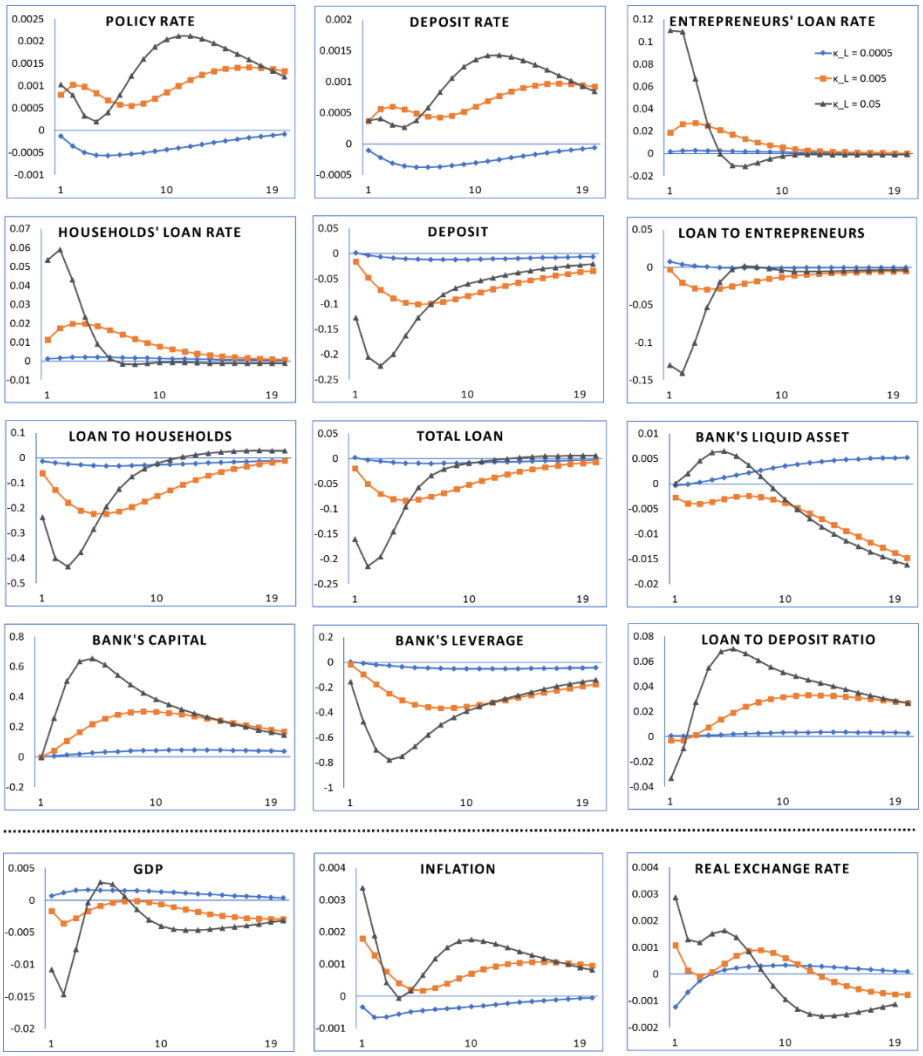


Figure 2: Impulse Responses to Leverage Ratio Requirement Shock with Various Values of Parameter κ_L

Notes: The figure reports the impulse responses to a one percent negative shock to the leverage ratio requirement (the inverse of capital ratio requirement)). For interest rate variables, the figure shows absolute deviations from the steady state in percentage points. For other variables, it shows percent deviations from the steady state.

The parameter κ_L determines the speed of adjustment of the bank's leverage to the changes in the leverage ratio requirement due to the assumptions made in equation (15). Figure 2 shows the transmission of a 1% negative shock to the leverage ratio requirement rate. For the simulation, I use three different values for the parameter κ_L that represent the different levels of the excess capital buffer. When the

banks have a very high buffer (κ_L=0.0005), they respond very slowly to the changes in the leverage ratio requirement, while when they have a very low buffer (κ_L=0.05), they respond very quickly. When they have less buffer, changes in the leverage ratio requirement will be responded mostly by pursuing the first strategy because it is the faster alternative to achieve the new leverage ratio requirement. The different strategy taken by the banks for the different levels of the excess capital buffer can be directly observed by looking at the changes in the banks' liquid asset. When they are less restricted (κ_L=0.005), they can dominantly pursue the second strategy and even can decrease the size of their liquid asset. While in the more restricted case, they dominantly pursue the first strategy by increasing their liquid assets in order to deleverage.

The dominant strategy taken by the banks will determine the size of the impact of a change in the leverage ratio requirement to the real sectors. The impact on output, if the banks dominantly pursue the first strategy, will be more pronounced due to the more restricted lending.

2.5.3. Transmission of The LTV Ratio Requirements

To study the transmissions of the changes in the LTV ratio requirements, I define the following equations:

$$m_t^I = \rho_{mi} m_{t-1}^I + (1-\rho_{mi}) m^I + \varepsilon_t^{mi} \qquad (41)$$

$$m_t^E = \rho_{me} m_{t-1}^E + (1-\rho_{me}) m^E + \varepsilon_t^{me} \qquad (42)$$

where ρ_{mi} and ρ_{me} are the persistence parameters, while ε_t^{mi} and ε_t^{me} are i.i.d. shocks with normal distribution and standard deviation equal to $\sigma_{\varepsilon mi}$ and $\sigma_{\varepsilon me}$, respectively. In the simulations, I use the following value for the persistence parameters: $\rho_{mi} = \rho_{me} = 0.9$.

Figure 3 shows the impulse responses to 1% negative shocks to the LTV ratio requirements. I simulate three different shocks: a shock only to m_t^I (the LTV ratio for the households' loans), a shock only to m_t^E (the LTV ratio for the entrepreneurs' loans) and shocks to m_t^I and m_t^E simultaneously. A negative shock to m_t^I will result in a decrease in the households' loans, a decrease in the total loans and a decrease in the housing asset prices. On the other hand, a negative shock to m_t^E will result in a decrease in the entrepreneurs' loans, a decrease in the total loans and a decrease in the capital asset prices. The objectives of countercyclically reacting to an increase in a

certain type of loans and reducing the collateral asset prices related to that loans can potentially be achieved by implementing the LTV ratio requirement rules.

In the case of an individual shock, there is a diversion of loan distribution from the more restricted sector to the less restricted one. A negative shock to m_t^I will increase the loans to the entrepreneurs, while a negative shock to m_t^E will increase the loans to the households[36]. This will lead to a different impact of the two shocks to the real sectors. Diversion from the households' loans to the entrepreneurs' will increase the capital asset prices, while diversion from the entrepreneurs' loans to the households' will increase the housing asset prices. In the case of a shock to m_t^I, the model simulation shows an increase in output. This is the results of an increase in the domestic demand fuelled by the capital asset investments.

[36] Appendix 2 - **Error! Main Document Only.** shows Impulse responses for Individual negative shock to m_t^I

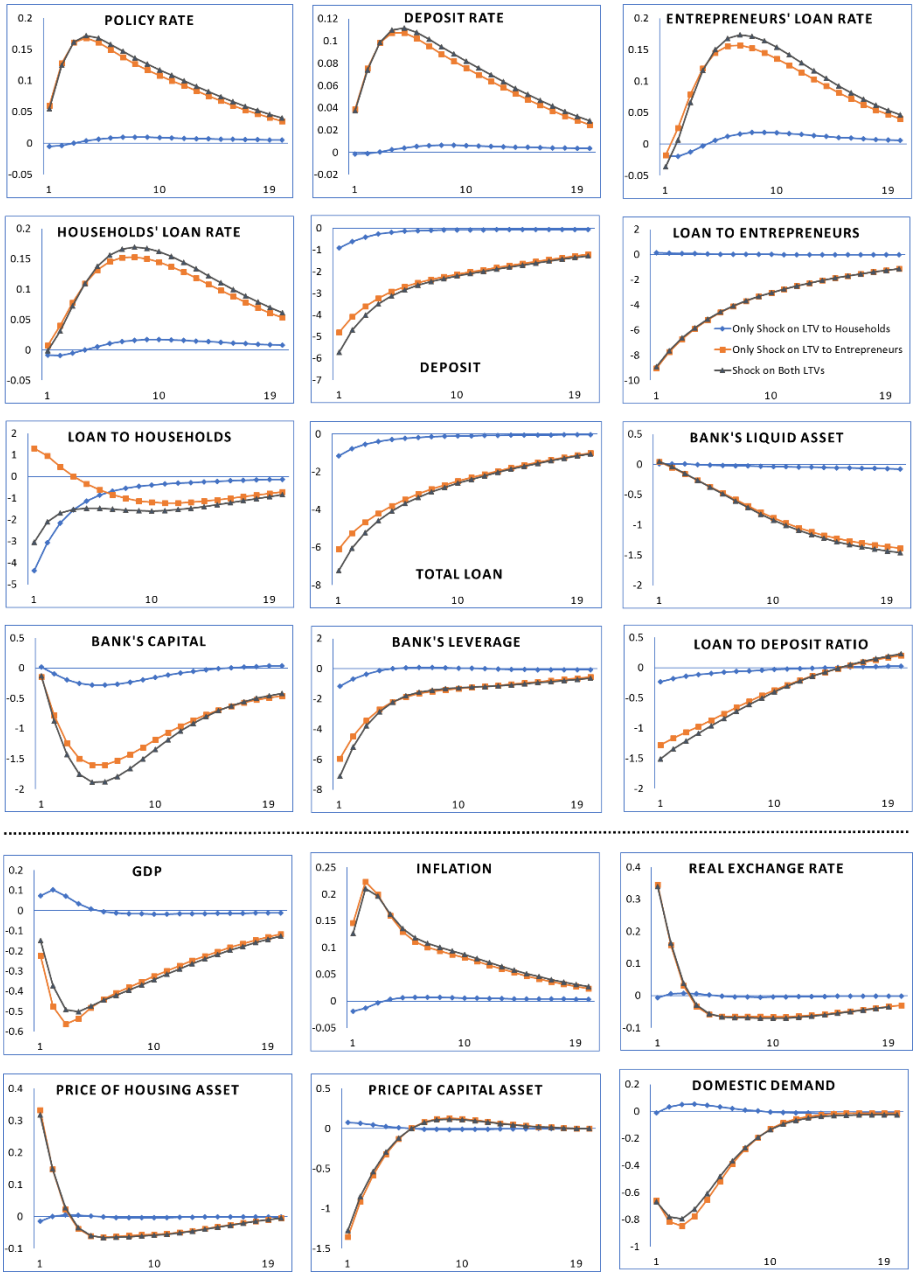


Figure 3: Impulse Responses to Loan to Value Ratio Requirement Shocks

Notes: The figure reports the impulse responses to one percent negative shock to LTV Ratio Requirements. For interest rate variables, the figure shows absolute deviations from the steady state in percentage points. For other variables, it shows percent deviations from the steady state.

The central bank needs to consider the impact of the diversion of the loan distributions between the two types of loans in designing its countercyclical LTV ratio policies. If the goal is for countercyclically react to an increase in output due to a certain shock, the most effective way is to use LTV policy on both types of loans at the same time so that we do not have diversions that may increase the procyclicality of the banking sector.

2.6. The Optimal Policy Mix of Monetary and Macroprudential Policy

For the purpose of choosing the optimal policy mix, I assume that the central bank is the only policymaker responsible for macroeconomic and financial stability. This assumption is relevant for the central banks in the emerging Asian economies because they either have both mandates or they work closely with other policymakers that have been assigned the financial stability mandate[37].

According to Borio (2011), macroprudential policy has two dimensions: a time dimension and a cross-sectional dimension. The latter involves the increase in financial vulnerabilities due to the interconnections among the financial institutions. The focus of the model in this and the following chapters is in the time dimension of macroprudential policy in which the source of the financial vulnerabilities is the procyclicality of the financial system. Recent literature on macroprudential policy has been trying to find the measures that can be used as indicators for the increasing vulnerabilities in the financial sector that may lead to a crisis. Based on empirical evidence[38], the deviation from the long run trend of the loan to output ratio is considered to be an excellent indicator and can be used in guiding the stance of macroprudential policy.

I define macroeconomic stability as the weighted sum of the variances[39] of inflation and output, and financial stability as the variance of the loan to output ratio[40]. In order to achieve macroeconomic and financial stability, the central bank can utilise three different policy tools in the form of the policy rate, the countercyclical loan to value (LTV) ratio requirement rates and the countercyclical leverage ratio requirement rate[41].

In determining the loan to value ratio requirement rates, the central bank uses the following equations:

$$m_t^I = (m_{t-1}^I)^{\rho_{mi}} \left(m^I \left(\frac{\frac{B_t^I}{Y_t^E}}{\frac{B^I}{Y^E}} \right)^{-\phi_{mi}} \right)^{1-\rho_{mi}} \qquad (43)$$

[37] Lim et al. (2013) and Kim and Mehrotra (2016)
[38] Borio and Drehmann (2009), Demirguc-Kunt and Detragiache (2005) and Drehman and Tsatsaronis (2014)
[39] Asymptotic (unconditional) variances
[40] Following the approach of Agenor et al. (2013)
[41] In the model, since I do not assign weight on the different types of the bank's assets based on their level of risk, the leverage ratio is equal to the inverse of the capital to asset ratio. I will use the two terms interchangeably in this and the following chapters.

$$m_t^E = (m_{t-1}^E)^{\rho_{me}} \left(m^E \left(\frac{\frac{B_t^E}{Y_t^E}}{\frac{B^E}{Y^E}} \right)^{-\phi_{me}} \right)^{1-\rho_{me}} \quad (44)$$

where ρ_{mi} and ρ_{me} are the smoothing parameters for the policy variables while ϕ_{mi} and ϕ_{me} are parameters that determine the countercyclical reaction of the rules. I choose the deviation of each sector's loan to output ratio from its steady state as the variable that triggers the reaction from the rule.

With the same arrangement, the following equation determines the leverage ratio requirement:

$$\Psi_t^{reg} = \left(\Psi_{t-1}^{reg}\right)^{\rho_\Psi} \left(\Psi^{reg} \left(\frac{\frac{B_t}{Y_t^E}}{\frac{B}{Y^E}} \right)^{-\phi_\Psi} \right)^{1-\rho_\Psi} \quad (45)$$

where ρ_Ψ is the persistence parameter and ϕ_Ψ the parameter that determines the response of the leverage ratio requirement to changes in the gap of the loan to output ratio. [42].

Given the definition of macroeconomic and financial stability and the assumption that the central bank is also concerned with the variability of the policy instruments ($\sigma^2_{\Delta r}$,$\sigma^2_{\Delta m^I}$, $\sigma^2_{\Delta m^E}$ and $\sigma^2_{\Delta \psi^{reg}}$), the loss function of the central bank would be[43]:

$$L = \sigma_\pi^2 + \varsigma_{Y^E}\sigma^2_{Y^E} + \varsigma_{B/Y^E}\sigma^2_{B/Y^E} + \varsigma_r\sigma^2_{\Delta r} + \varsigma_{m^I}\sigma^2_{\Delta m^I} + \varsigma_{m^E}\sigma^2_{\Delta m^E} + \varsigma_{\Psi^{reg}}\sigma^2_{\Delta \Psi^{reg}} \quad (46)$$

where ς_{Y^E} and ς_{B/Y^E} reflect the central bank subjective weight on output stability and financial stability relative to price stability while ς_r, ς_{m^I}, ς_{m^E} and $\varsigma_{\Psi^{\mathrm{reg}}}$ reflect the central bank preference on the variability of its policy tools. I set ς_{Y^E} at 0.5, ς_{B/Y^E} at 1 and the weight for instrument variability at 0.1[44]

Given the loss function, the central bank has the option to utilise some or all the policy tools available, to deal with any disturbances that may cause macroeconomic

[42] BCBS (2010).
[43] The choice of using ad-hoc loss function is based on the arguments of Blanchard (2009) and Svensson (2008).
[44] Angelini et al. (2014)

and financial instabilities. I will consider two scenarios: the first one is where the central bank only uses the policy rate and the second one is where the central bank utilises the policy rate and the other countercyclical instruments[45].

For the first scenario, the only stabilisation policy that exists in the model is monetary policy. In addition to the model where monetary policy is governed by the Taylor rule as in equation (34), I also consider three augmented Taylor rules with additional countercyclical reactions to the real exchange rate appreciation, growth of loan to output ratio and growth of asset prices.

$$(1+r_t) = (1+r\ )^{1-\phi_R}(1+r_{t-1})^{\phi_R}\left(\left(\frac{\pi_t}{\pi}\right)^{\phi_\pi}\left(\frac{Y_t^E}{Y^E}\right)^{\phi_y}\left(\frac{s_t}{s_{t-1}}\right)^{\phi_s}\right)^{1-\phi_R}\varepsilon_t^r \qquad (47)$$

$$(1+r_t) = (1+r\ )^{1-\phi_R}(1+r_{t-1})^{\phi_R}\left(\left(\frac{\pi_t}{\pi}\right)^{\phi_\pi}\left(\frac{Y_t^E}{Y^E}\right)^{\phi_y}\left(\frac{\frac{B_t}{Y_t^E}}{\frac{B_{t-1}}{Y_{t-1}^E}}\right)^{\phi_{B/Y}}\right)^{1-\phi_R}\varepsilon_t^r \qquad (48)$$

$$(1+r_t) = (1+r\ )^{1-\phi_R}(1+r_{t-1})^{\phi_R}\left(\left(\frac{\pi_t}{\pi}\right)^{\phi_\pi}\left(\frac{Y_t^E}{Y^E}\right)^{\phi_y}\left(\left(\frac{q_t^k}{q_{t-1}^k}\right)^{\phi_{ap1}}\left(\frac{q_t}{q_{t-1}}\right)^{1-\phi_{ap1}}\right)^{\phi_{ap2}}\right)^{1-\phi_R}\varepsilon_t^r \qquad (49)$$

As a baseline to assess macroeconomic and financial stabilisation performance of each policy strategy, I use the case in which the central bank has only macroeconomic stability mandate and utilises the policy rate as the instrument for stabilisation. In this baseline scenario, the central bank loss function is:

$$L = \sigma_\pi^2 + \varsigma_{Y^E}\sigma_{Y^E}^2 + \varsigma_r\sigma_{\Delta r}^2 \qquad (50)$$

In addition, I also consider other variables that may have an impact on macroeconomic and financial stability which include the exchange rates, the foreign loan to output ratio, the housing asset prices and the capital asset prices. These variables are not directly included in the loss function, but their dynamics is an important source of macroeconomic and financial instabilities, especially in the emerging Asian economies[46].

[45] All parameters in the rules are optimised, except for ϕ_R that is set at 0.75 and the persistence parameters for the countercyclical rules that is set at 0.9.
[46] Agenor et al. (2014) use some of these variables as alternative measures of financial stability. Drehman and Tsatsaronis (2014) point out the fact that other indicators of financial vulnerabilities need to be considered and not solely use gap of loan to output ratio.

2.6.1. Technology Shock

I begin by studying the performance of the different policy strategies in facing a total factor productivity shock (A_t)[47]. I assume that the TFP follows an autoregressive process:

$$ln(A_t) = \rho_A ln(A_{t-1}) + \epsilon_t^A \qquad (51)$$

where ρ_A is the persistence parameter, and ϵ_t^A is a normal distribution shock with standard deviation equal to σ_A[48].

A positive technology shock will increase the output produced by the entrepreneurs and reduce the cost of producing them. For the domestic economy, these will lead to an increase in GDP and a decrease in inflation. Responding to the dynamics of GDP and inflation, the central bank responds by lowering the policy rate. In the baseline scenario in which the central bank loss function only includes macroeconomic stability, the policy rate is mostly responding to the dynamic of inflation and not to output, as evident by a very low optimised value of parameter ϕ_Y (Table 3). A decrease in the policy rate is followed by decreases in the banks' retail rates. A combination of reductions in the policy rate and inflation results in a decline in the domestic real interest rate and lead to the depreciation of the exchange rates. In the first periods after the shock, the total loan distribution decreases which mostly caused by the reduction in the loans to the entrepreneurs. A lower loan rate is not an adequate incentive for the entrepreneurs to borrow more from the banks due to the increase in their income. On the other hand, a lower loan rate encourages the impatient households to borrow more from the banks which will lead to an increase in the housing investments and the house prices.

In the first scenario, compared to the condition in which the central bank only concerns about macroeconomic stability and utilises the standard Taylor rule, all policy strategies result in lower financial instability. However, it comes at the cost of higher macroeconomic instability, especially inflation. Besides its impact on inflation, lowering financial instability also has a significant adverse effect on the variance of the capital asset prices, which increases by more than 400%. This is because implementing the policy strategies result in higher loan distribution towards entrepreneurs that encourages the demand for the capital assets. The increase in

[47] Angelini et al. (2014) considered this shock as a normal cyclical fluctuation shock.
[48] For the simulation, I use the following value for the persistence parameter: $\rho_A = 0.7$.

capital investment while the economy is facing a positive technology shock will result in an even higher output and lower inflation. Implementing all strategies in this scenario may not be preferable for the central bank that has a higher preference towards price stability over financial stability. In addition, the central bank may also need to consider the possibility of greater financial vulnerabilities coming from a higher variance of the capital asset prices.

In the second scenario, the central bank has additional policy instruments in the form of the countercyclical leverage ratio rule and the countercyclical LTV ratio rules.

The performance of implementing the policy strategy that combines the leverage ratio rule and the Taylor rule is very similar to the one that utilises only the Taylor rule. The reason for this is because the incentive to encourage lending by increasing the leverage ratio requirement is limited. It is interesting to examine the limitation of this incentive in detail by comparing the impulse responses (blue lines in Figure 6) with the policy strategy that utilises the loan to output ratio augmented Taylor rule (red lines in Figure 4). Both strategies influence the distribution of loans by reducing the loan rates with two different mechanisms. The augmented Taylor rule reduces the loan rates by lowering the policy rate which also results in a decrease in the deposit rate. On the other hand, the reduction in the loan rates from implementing the leverage ratio rules is achieved by increasing the leverage ratio requirement which does not have a direct impact on the deposit rate. The effectiveness of both policies is restricted by the condition of the economy or the banks' balance sheet after technology shock. In the case of implementing the loan to output ratio augmented Taylor rule, the reduction in the loan rates results in lower financial instability compared to the other policy strategies in the first scenario due to the limited demands for the loans that are caused by the lower collateral asset prices. In the case of implementing the leverage ratio rule, the incentive to reduce the loan rates is limited by the fact that the loan rates are already low and further reduction in the loan rates may result in a lower profit that has a direct impact on the banks' leverage. This explains a low optimised countercyclical response of the leverage ratio rule (Table 6) that results in a similar performance of this strategy with the one that implements only the standard Taylor rule.

To study the effect of the speed of the banks' leverage adjustment on the effectiveness of the policy strategy that utilises the leverage ratio rule, I use different calibration values for the parameter κ_l and compare the stabilisation performance of

the policy strategy to the other strategies[49]. Figure 7 shows that the changes in the parameter value do not have a significant effect on the stabilisation performance of the policy strategy that utilises the leverage ratio rule. In all parameter values considered, the stabilisation performance of the strategy is slightly above the performance of the one that utilises only the Taylor rule. This shows that the effectiveness of utilising the leverage ratio rule when the economy is facing a technology shock does not depend on the speed of the banks' leverage adjustment.

A significantly better performance in financial stability can be achieved by implementing the policy strategy that combines the LTV ratio rules and the Taylor rule. This is because the LTV ratio rules can directly influence the volume of loans without the need to influence the loan rates. Since the impact of the shock on the entrepreneurs' loan distribution is higher than on the impatient households', the countercyclical LTV ratio rule for the entrepreneurs is more responsive than the one for the households. Both types of loans increase to match the increase in output, resulting in lower financial instability. Unfortunately, implementing this strategy results in significantly higher capital asset prices' instability, for the same reason as in the other strategies. The decision on implementing this policy strategy depends on the central bank assessment on the trade-off between potentially lower financial/macroeconomic vulnerabilities resulting from the higher financial stability and the potentially higher vulnerabilities caused by the significantly lower stability of the capital asset prices.

[49] For ease of comparison and to better demonstrate if the changes in the value of the parameter are also causing the changes in the policy rank, I only show the policy strategy that has the highest total stability from the first scenario. Since the stabilisation performance of this strategy is very close to the one that combines the Taylor rule and the leverage ratio rule, I also include the policy strategy that utilises the loan to output ratio augmented Taylor rule.

Table 2: Macroeconomic and Financial Stabilisation Performance of Model with Only Monetary Policy in Facing Technology Shock

	Variances of		Macroeconomic Instability	Financial Instability	Total Instability
	Inflation	Output			
Optimised for Macroeconomic Stability					
Standard Taylor Rule	0.02	2.15	1.1	2.82	3.92
Optimised for Macroeconomic and Financial Stability					
Standard Taylor Rule	0.03 (53.8)	2.37 (10.2)	1.22 (11)	2.18 (-23)	3.39 (-13.5)
Taylor Rule Augmented with Exchange Rate Growth	0.03 (50.23)	2.37 (10.3)	1.22 (11)	2.19 (-22.5)	3.4 (-13.14)
Taylor Rule Augmented with Loan to Output Growth	0.06 (158.7)	2.32 (8.2)	1.22 (11)	2.29 (-19)	3.5 (-10.4)
Taylor Rule Augmented with Asset Price Growth	0.03 (41.4)	2.37 (10.3)	1.22 (11)	2.2 (-22)	3.42 (-12.73)

Note: The variances, macroeconomic instability, financial instability, and total instability are expressed as the ratio to the variance of the exogeneous shock. The values in the bracket show percentage difference of the variance/instability with the one acquired from the model with the Taylor rule that has been optimised for only macroeconomic stability. The values in red indicate an increase in the instability while the values in blue indicate a decrease in the instability.

Table 3: Parameter Values (Technology Shock)

	ϕ_π	ϕ_Y	ϕ_s	$\phi_{B/Y}$	ϕ_{ap1}	ϕ_{ap2}
Optimised for Macroeconomic Stability						
Standard Taylor Rule	2.089	0.03				
Optimised for Macroeconomic and Financial Stability						
Standard Taylor Rule	2.061	0.066				
Taylor Rule Augmented with Exchange Rate Growth	2.062	0.064	0.248			
Taylor Rule Augmented with Loan to Output Growth	2.057	0.086		0.5		
Taylor Rule Augmented with Asset Price Growth	2.063	0.059			0.5	0.5

Note: ϕ_π. Is the parameter governing the response of the policy rate to inflation; ϕ_Y is the parameter governing the response of the policy rate to output; ϕ_s is the parameter governing the response of the policy rate to the exchange rate growth; $\phi_{B/Y}$ is the parameter governing the response of the policy rate to the growth in loan to output ratio; $\phi_{ap1}$is the parameter governing the response of the policy rate to capital asset price growth relative to housing asset price growth; $\phi_{ap2}$is the parameter governing the response of the policy rate to asset (capital and housing) prices' growth.

Table 4: Instabilities of other Variables of Interest (Technology Shock)

	Variances of			
	Real Exchange Rate	House Price	Capital Asset Price	Foreign Loan to Output Ratio
Optimised for Macroeconomic Stability				
Standard Taylor Rule	0.07	0.12	0.01	4.89
Optimised for Macroeconomic and Financial Stability				
Standard Taylor Rule	0.05 (-30.81)	0.09 (-18.84)	0.03 (426.9)	5.74 (17.31)
Taylor Rule Augmented with Exchange Rate Growth	0.05 (-30.34)	0.09 (-18.57)	0.03 (433.8)	5.73 (17.24)
Taylor Rule Augmented with Loan to Output Growth	0.04 (-43.6)	0.08 (-30.33)	0.02 (220.8)	5.9 (20.52)
Taylor Rule Augmented with Asset Price Growth	0.05 (-28.6)	0.1 (-17.16)	0.03 (448.1)	5.71 (16.76)

Note: The variances are expressed as the ratio to the variance of the exogeneous shock. The values in the bracket show percentage difference of the variance with the one acquired from the model with the Taylor rule that has been optimised for only macroeconomic stability. The values in red indicate an increase in the instability while the values in blue indicate a decrease in the instability.

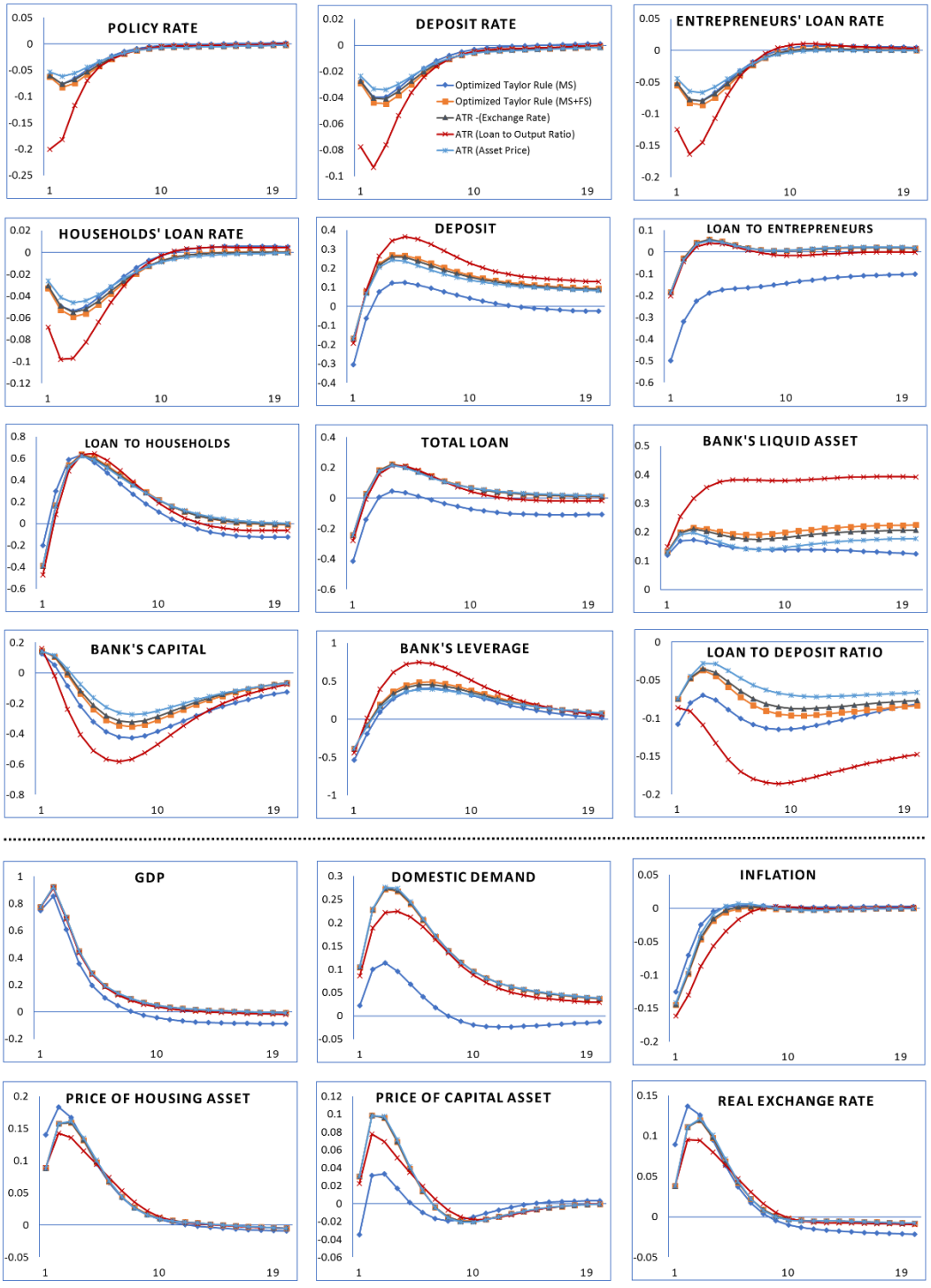


Figure 4: Impulse Responses of Model with Only Policy Rate – Technology Shock

Notes: The figure reports the impulse responses to a one percent positive technology shock. For interest rate variables, the figure shows absolute deviations from the steady state in percentage points. For other variables, it shows percent deviations from the steady state. ATR is Augmented Taylor Rule. MS is Macroeconomic Stability and FS is Financial Stability.

Given the performance of the countercyclical LTV ratio rules in reducing financial instability, I experiment with an alternative scenario where the responses of the trigger parameters of the LTV rules are significantly lower. In this scenario, the countercyclical

LTV parameters are not optimised and set to certain values[50], while the Taylor rule parameters are optimised. I use different values for the pair of parameters $[\phi_{mi}, \phi_{me}]$ to simulate different target reduction of financial instability. There are two policy strategies in this scenario which have two different ways of optimising the Taylor rule parameters: (1) only for macroeconomic stability or (2) for macroeconomic and financial stability. The objective of the experiment is to find the condition in which we get higher financial stability with less cost on macroeconomic stability or other measures of financial stability that are not included in the loss function.

Figure 5 shows the performance of the two policy strategies relative to the baseline scenario. Policy strategy in which the Taylor rule is optimised for macroeconomic and financial stability results in lower financial instability and higher macroeconomic instability than the policy strategy in which the Taylor rule is optimised for only macroeconomic stability. Based on the performance in terms of total instability (Table 8), this policy strategy seems to be the better option for the central bank. Unfortunately, implementing this policy strategy results in the same adverse effect as the other strategies in the previous scenarios, which is a significantly higher capital asset price instability that may signal an increase in financial/macroeconomic vulnerabilities (Table 9). The instability of the capital asset price is even higher than the policy strategy that jointly optimised the Taylor rule and the LTV ratio rules. The implementation of the policy strategy that combines the non-optimised LTV ratio rules and the Taylor rule that is optimised for macroeconomic stability results in a significantly lower instability of the capital asset price. This policy strategy may be the better option for the central bank that concerns about rising financial/macroeconomic vulnerabilities from the significantly higher instability of the capital asset price from implementing the other strategies.

[50] The values of the parameters ϕ_{mi} and ϕ_{me} are kept in the same proportion as the optimised values from the policy strategy that combines the Taylor rule and the LTV ratio rules.

Table 5: Macroeconomic and Financial Stabilisation Performance of Model with Monetary and Macroprudential Policy in Facing Technology Shock

	Variances of		Macroeconomic Instability	Financial Instability	Total Instability
	Inflation	Output			
Optimised for Macroeconomic and Financial Stability					
Standard Taylor Rule	0.03 (53.8)	2.37 (10.2)	1.22 (11)	2.18 (-23)	3.39 (-13.5)
Taylor Rule and Leverage Ratio Policy	0.03 (53.4)	2.37 (10.16)	1.22 (11.02)	2.17 (-23.16)	3.39 (-13.61)
Taylor Rule and LTV Ratio Policy	0.02 (3.8)	2.46 (14.42)	1.25 (14.21)	0.001 (-99.95)	1.25 (-68.06)

Note: The variances, macroeconomic instability, financial instability, and total instability are expressed as the ratio to the variance of the exogeneous shock. The values in the bracket show percentage difference of the variance/instability with the one acquired from the model with the Taylor rule that has been optimised for only macroeconomic stability. The values in red indicate an increase in the instability while the values in blue indicate a decrease in the instability.

Table 6: Parameter Values-2 (Technology Shock)

	ϕ_π	ϕ_Y	ϕ_{mi}	ϕ_{me}	ϕ_ψ
Optimised for Macroeconomic and Financial Stability					
Standard Taylor Rule	2.061	0.066			
Taylor Rule and Leverage Ratio Policy	2.061	0.065			0.102
Taylor Rule and LTV Ratio Policy	2.084	0.03	97.44	260	

Note: ϕ_π. is the parameter governing the response of the policy rate to inflation; ϕ_Y is the parameter governing the response of the policy rate to output; ϕ_{mi} is the parameter governing the response of the households' LTV ratio requirement to the changes in the gap of households' loan to output ratio; ϕ_{me} is the parameter governing the response of the entrepreneurs' LTV ratio requirement to the changes in the gap of entrepreneurs' loan to output ratio; ϕ_ψ is the parameter governing the response of the leverage ratio requirement to the changes in the gap of loan to output ratio;

Table 7: Instabilities of other Variables of Interest-2 (Technology Shock)

	Variances of			
	Real Exchange Rate	House Price	Capital Asset Price	Foreign Loan to Output Ratio
Optimised for Macroeconomic and Financial Stability				
Standard Taylor Rule	0.05 (-30.81)	0.09 (-18.84)	0.03 (426.9)	5.74 (17.31)
Taylor Rule and Leverage Ratio Policy	0.05 (-30.72)	0.09 (-18.7)	0.03 (426.4)	5.74 (17.29)
Taylor Rule and LTV Ratio Policy	0.08 (10.67)	0.13 (10.6)	0.02 (203)	5.46 (11.6)

Note: The variances are expressed as the ratio to the variance of the exogeneous shock. Values in the bracket shows percentage difference of the variance with the one acquired from the model with Taylor rule that has been optimised for only macroeconomic stability. Values in red indicate an increase in instability while values in blue indicate a decrease in instability.

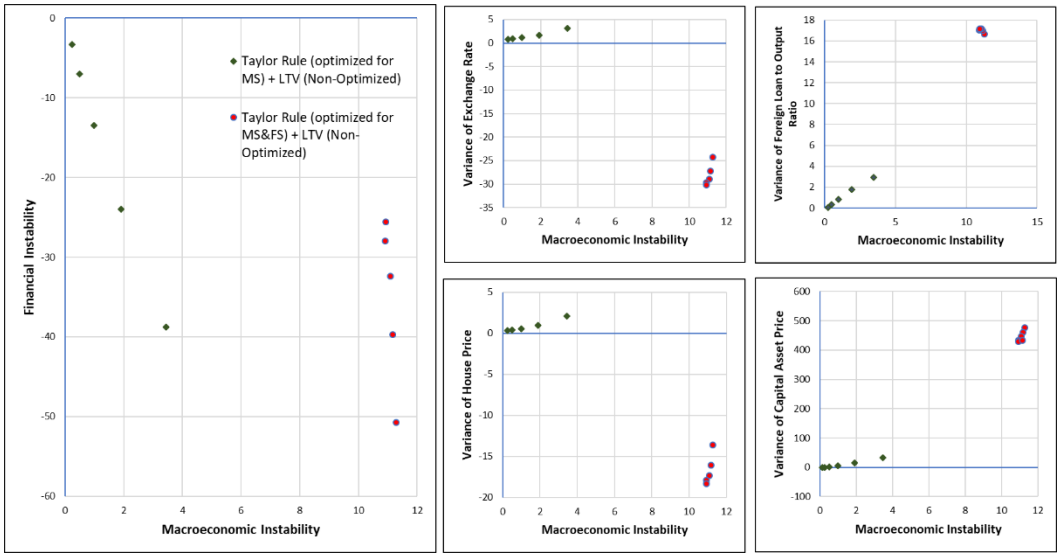


Figure 5: Stabilisation Performance of Models in Alternative Scenario (Technology Shock)

Notes: Variances, Macroeconomic Instability and Financial Instability are expressed as percentage difference of the instability/variance with the one acquired from the model with the Taylor rule that has been optimised for only macroeconomic stability. Positive values indicate an increase in the instability/variance while negative values indicate a decrease in the instability. MS is Macroeconomic Stability. FS is Financial Stability. The values of ϕ_{mi} and ϕ_{me} used for the figure are: $[\phi_{mi} = 0.5, \phi_{me} = 1.3]$, $[\phi_{mi} = 0.25, \phi_{me} = 0.625]$, $[\phi_{mi} = 0.125, \phi_{me} = 0.3125]$, $[\phi_{mi} = 0.0625, \phi_{me} = 0.15625]$ *and* $[\phi_{mi} = 0.03125, \phi_{me} = 0.078125]$.

Table 8: Macroeconomic and Financial Stabilisation Performance of Model with Monetary and Macroprudential in Facing Technology Shock (Alternative Scenario)

	Variances of		Macroeconomic Instability	Financial Instability	Total Instability
	Inflation	Output			
Alternative Scenario					
Standard Taylor Rule (MS) + Non-optimised LTV $[\phi_{mi} = 0.5, \phi_{me} = 1.3]$	0.02 (-2.34)	2.22 (3.57)	1.13 (3.5)	1.73 (-38.8)	2.86 (-27)
Standard Taylor Rule (MS+FS) + Non-optimised LTV $[\phi_{mi} = 0.5, \phi_{me} = 1.3]$	0.03 (33.22)	2.38 (10.84)	1.22 (11.3)	1.39 (-50.7)	2.61 (-33.4)

Note: The variances, macroeconomic instability, financial instability and total instability are expressed as the ratio to the variance of the exogeneous shock. The values in the bracket show percentage difference of the variance/instability with the one acquired from the model with the Taylor rule that has been optimised for only macroeconomic stability. The values in red indicate an increase in the instability while the values in blue indicate a decrease in the instability.

Table 9: Instabilities of other Variables of Interest-Alternative Scenario (Technology Shock)

	Variances of			
	Real Exchange Rate	House Price	Capital Asset Price	Foreign Loan to Output Ratio
Alternative Scenario				
Standard Taylor Rule (MS) + Non-optimised LTV $[\phi_{mi} = 0.5, \phi_{me} = 1.3]$	0.08 (3.1)	0.12 (2.1)	0.01 (33)	5.04 (3)
Standard Taylor Rule (MS+FS) + Non-optimised LTV $[\phi_{mi} = 0.5, \phi_{me} = 1.3]$	0.06 (-24.29)	0.1 (-13.63)	0.03 (477)	5.71 (16.67)

Note: The variances are expressed as the ratio to the variance of the exogeneous shock. The values in the bracket show percentage difference of the variance with the one acquired from the model with the Taylor rule that has been optimised for only macroeconomic stability. The values in red indicate an increase in the instability while the values in blue indicate a decrease in the instability.

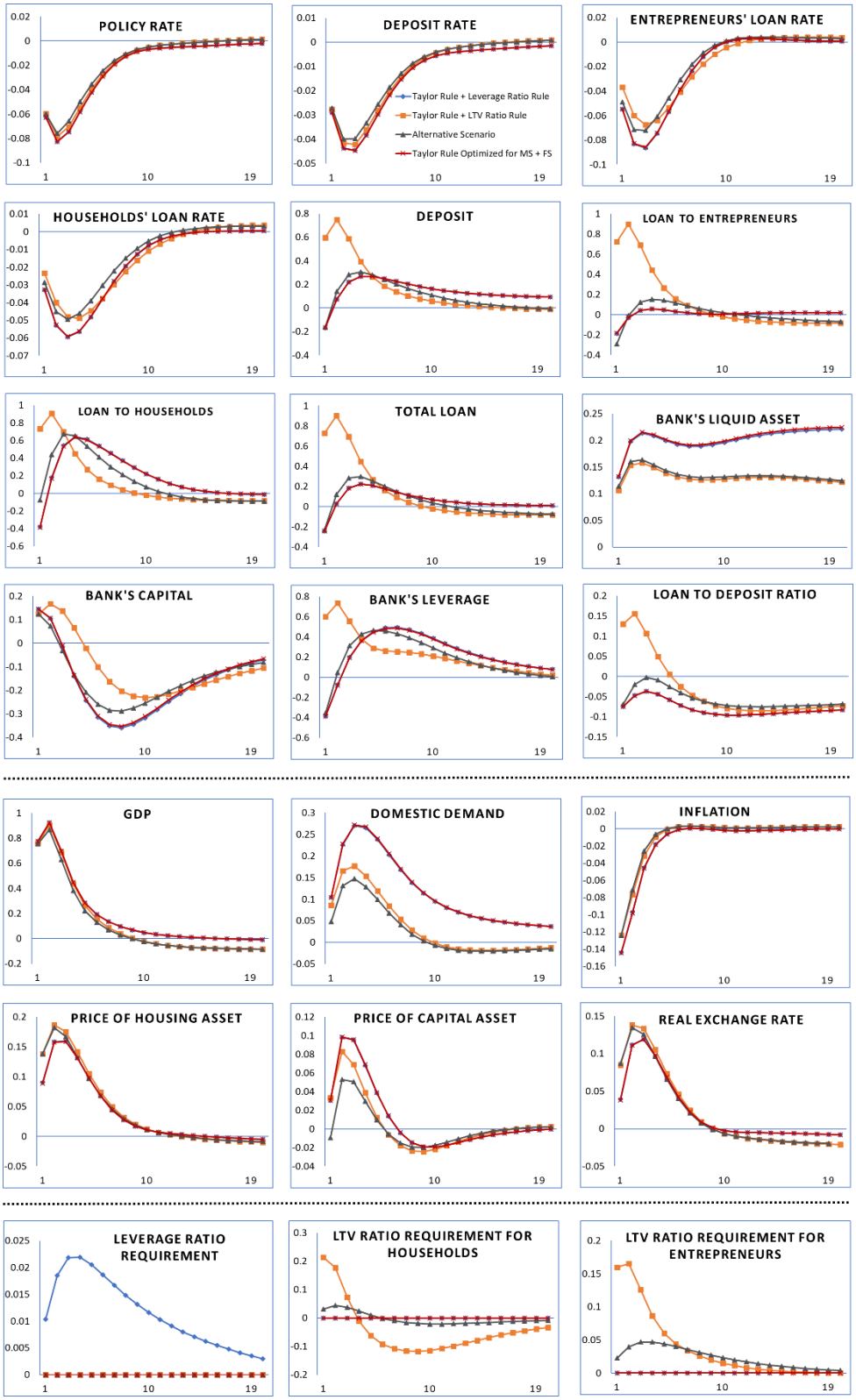


Figure 6: Impulse Responses of Model with Policy Rate, LTV Ratio Requirement and Leverage Ratio Requirement (Technology Shock)

Notes: The figure reports the impulse responses to a one percent positive technology shock. For interest rate variables and LTV ratio requirements, the figure shows absolute deviations from the steady state in percentage points. For other variables, it shows percent deviations from the steady state. MS is Macroeconomic Stability, and FS is Financial Stability. Impulse responses of the alternative scenario are for the one in which the Taylor rule is optimised for macroeconomic stability, and the values of the LTV rules' countercyclical parameters are: $[\phi_{mi} = 0.5, \phi_{me} = 1.3]$.

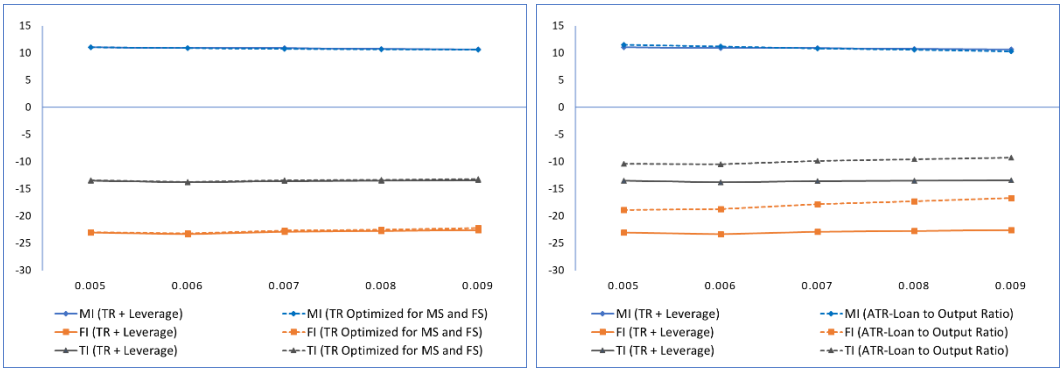


Figure 7: Stabilisation Performance of Models with Different Speed of Banks' Leverage Adjustment (Technology Shock)

Notes: The horizontal axis shows the values of κ_t (the parameter that governs the speed of adjustment of bank's leverage to changes in the leverage target/requirement). The vertical axis shows the percentage difference of macroeconomic, financial and total instability values with the one acquired from the model with the Taylor rule that has been optimised for only macroeconomic stability. MI is Macroeconomic Instability. FI is Financial Instability. TI is Total Instability. TR is Taylor Rule. ATR is Augmented Taylor Rule.

2.6.2. Domestic Price Shock

A domestic price shock is defined as a shock to the domestic retailers' markup (ε_t^{xh}), as described in equation (A 33). It represents a shock coming from the domestic input of the consumption goods' prices[51]. I assume that the shock is normally distributed with standard deviation σ_A.

A positive domestic price shock will directly increase inflation and lead to decreases in domestic demand and GDP. In the baseline scenario, in which the central bank is only optimizing for macroeconomic stability, the policy rate increase since the Taylor rule is mostly responding to the dynamic of inflation. As in the case of a technology shock, the parameter of the Taylor rule that responds to the dynamic of output has a very low value (Table 11). A decrease in the policy rate is followed by decreases in the banks' retail rates. Unfortunately, the total loan distribution declines which mostly due to the pressures on the budget and borrowing constraints of the borrowers from the increase in inflation. Reductions in the loan distribution lead to decreases in the investments for both house and capital assets which will cause the declines in the prices of those assets. The lower collateral asset prices will further reduce the loan distribution to the borrowers.

[51] As opposed to imported input. The source of this shock can be one of the followings: changes in government subsidies, disruption on domestic distribution channel, etc.

Table 10: Macroeconomic and Financial Stabilisation Performance of Model with Only Monetary Policy in Facing Domestic Price Shock

	Variances of		Macroeconomic Instability	Financial Instability	Total Instability
	Inflation	Output			
Optimised for Macroeconomic Stability					
Standard Taylor Rule	0.0061	0.0061	0.0091	0.0061	0.0152
Optimised for Macroeconomic and Financial Stability					
Standard Taylor Rule	0.0062 (2.56)	0.0060 (-1.46)	0.0092 (1.22)	0.0061 (-0.08)	0.0153 (0.69)
Taylor Rule Augmented with Exchange Rate Growth	0.0061 (0.36)	0.0066 (8.68)	0.0094 (3.14)	0.0054 (-11.58)	0.0148 (-2.78)
Taylor Rule Augmented with Loan to Output Growth	0.0062 (2.63)	0.0061 (-0.18)	0.0093 (1.69)	0.0051 (-16)	0.0144 (-5.42)
Taylor Rule Augmented with Asset Price Growth	0.0064 (5.8)	0.0061 (1.03)	0.0095 (4.21)	0.0064 (5.19)	0.0159 (4.61)

Note: The variances, macroeconomic instability, financial instability and total instability are expressed as the ratio to the variance of the exogeneous shock. The values in the bracket show percentage difference of the variance/instability with the one acquired from the model with the Taylor rule that has been optimised for only macroeconomic stability. The values in red indicate an increase in the instability while the values in blue indicate a decrease in the instability.

Table 11: Parameter Values (Domestic Price Shock)

	ϕ_π	ϕ_Y	ϕ_s	$\phi_{B/Y}$	ϕ_{ap1}	ϕ_{ap2}
Optimised for Macroeconomic Stability						
Standard Taylor Rule	2.08	0.064				
Optimised for Macroeconomic and Financial Stability						
Standard Taylor Rule	2.002	0.081				
Taylor Rule Augmented with Exchange Rate Growth	2.043	0.022	0.264			
Taylor Rule Augmented with Loan to Output Growth	2.038	0.04		0.526		
Taylor Rule Augmented with Asset Price Growth	2.04	0.127			0.489	0.503

Note: ϕ_π. Is the parameter governing the response of the policy rate to inflation; ϕ_Y is the parameter governing the response of the policy rate to output; ϕ_s is the parameter governing the response of the policy rate to the exchange rate growth; $\phi_{B/Y}$ is the parameter governing the response of the policy rate to the growth in loan to output ratio; $\phi_{ap1}$is the parameter governing the response of the policy rate to the capital asset price growth relative to the housing asset price growth; $\phi_{ap2}$is the parameter governing the response of the policy rate to the asset (capital and housing) prices' growth.

Table 12: Instabilities of other Variables of Interest (Domestic Price Shocks)

	Variances of			
	Real Exchange Rate	House Price	Capital Asset Price	Foreign Loan to Output Ratio
Optimised for Macroeconomic Stability				
Standard Taylor Rule	0.0156	0.0144	0.0085	0.0049
Optimised for Macroeconomic and Financial Stability				
Standard Taylor Rule	0.0152 (-3.04)	0.014 (-3.2)	0.0085 (0.46)	0.0045 (-8.97)
Taylor Rule Augmented with Exchange Rate Growth	0.0160 (2.2)	0.0148 (2.44)	0.0077 (-10)	0.0057 (17.08)
Taylor Rule Augmented with Loan to Output Growth	0.0155 (-1.16)	0.0142 (-1.25)	0.008 (-6.16)	0.005 (2.26)
Taylor Rule Augmented with Asset Price Growth	0.015 (-4.12)	0.0138 (-4.35)	0.0091 (6.7)	0.0042 (-13.63)

Note: The variances are expressed as the ratio to the variance of the exogeneous shock. The values in the bracket show percentage difference of the variance with the one acquired from model with the Taylor rule that has been optimised for only macroeconomic stability. The values in red indicate an increase in the instability while the values in blue indicate a decrease in the instability.

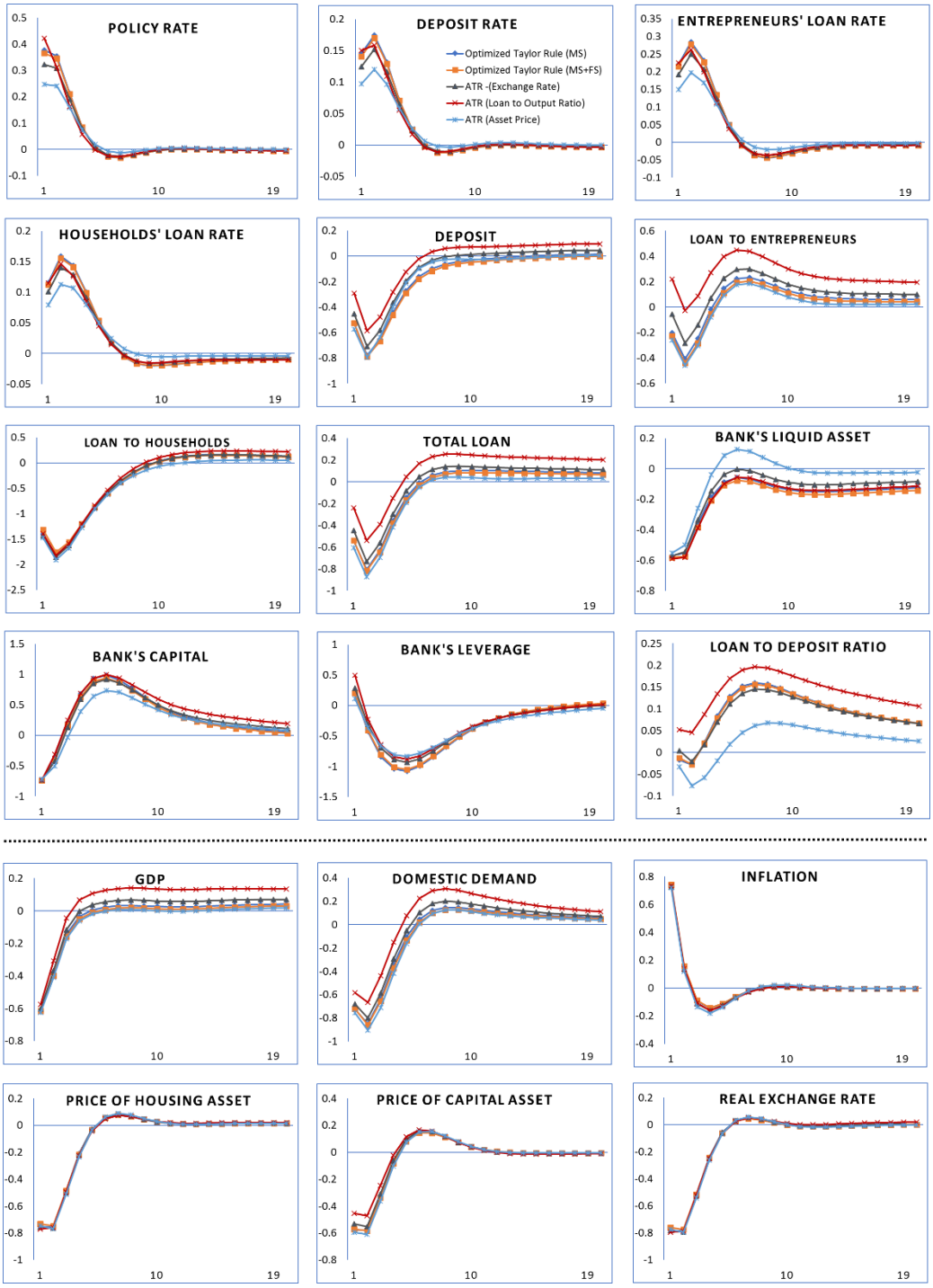


Figure 8: Impulse Responses of Model with Only Policy Rate – Domestic Price Shock

Notes: The figure reports the impulse responses to a positive domestic price shock resulting in 0.75% increase in inflation. For interest rate variables, the figure shows absolute deviations from the steady state in percentage points. For other variables, it shows percent deviations from the steady state. ATR is Augmented Taylor Rule. MS is Macroeconomic Stability and FS is Financial Stability.

As in the case of a technology shock, first I will consider the scenario in which the central bank has only one policy tool in the form of the Taylor rule. Table 10 shows that the performance of the various types of Taylor rules, relative to the baseline scenario, are quite diverse. The diversity in the performance is not only for the variables that are included in the central bank loss function but also for other financial stability measures that are not included in the loss function. These are partly due to the difference in the responses of the Taylor rules' parameters towards output and inflation. Based on the total stability performance, the best policy strategy is the one that utilises the loan to output ratio augmented Taylor rule.

In the second scenario, the central bank can utilise two additional policy measures in the form of a countercyclical leverage ratio rule and countercyclical LTV ratio rules.

When the central bank implements the leverage ratio rule along with the Taylor rule, it can manage to increase both financial and total stability. However, it comes at the cost of lower output stability. The reason for this is partly because the parameter in the Taylor rule that responds towards output is smaller. Financial stability can be improved by increasing the loan distribution, especially towards entrepreneurs. The impact of the shocks towards the house prices is bigger than toward the capital asset prices resulting in less loan distribution towards households, even after the incentive of a lower loan rate due to a higher leverage requirement. The higher loan distribution to entrepreneurs, along with the lower loan rates can reduce the overall costs for the entrepreneurs, which results in a better price stability.

To study the effect of the speed of the banks' leverage adjustment on the effectiveness of the policy strategy that utilises the leverage ratio rule, I use different calibration values for the parameter κ_l and compare the stabilisation performance of the policy strategy to the other strategies[52]. Figure 11 shows that the changes in the parameter value do not have a significant effect on the stabilisation performance of the policy strategy that utilises the leverage ratio rule, relative to the performance of the best strategy in the first scenario. In all parameter values considered, the stabilisation performance of the strategy is constantly below the performance of the one that utilises the loan to output ratio augmented Taylor rule.

A significantly better financial stability performance can be achieved by implementing the policy strategy that combines the LTV ratio rules and the Taylor rule. The reason for this is because this strategy can directly influence the volume of loans

[52] For ease of comparison and to better demonstrate if the changes in the value of the parameter also cause the changes in the policy rank, I only show the policy strategy that has the highest total stability from the first scenario.

by changing the borrowing constraints. The total loan distribution is significantly higher than the other policy strategies. Since the impact of the shock is greater on the house prices than on the capital asset prices, the trigger parameter in the households LTV ratio rule is also bigger. This will result in a higher loan distribution to the impatient households. Unfortunately, a lower loan distribution to the entrepreneurs will lead to lower capital asset investments and output.

Given the performance of the countercyclical LTV rule in reducing financial instability, I experiment with an alternative scenario where the responses of the trigger parameters of the LTV ratio rules are significantly lower. In this scenario, the countercyclical LTV parameters are not optimised and set to certain values, while the Taylor rule parameters are optimised. I use different values for the pair of parameters $[\phi_{mi}, \phi_{me}]$ to simulate different target level of financial stability. There are two policy strategies in this scenario which have two different ways of optimising the Taylor rule parameters: (1) only for macroeconomic stability or (2) for macroeconomic and financial stability. The objective of the experiment is to find the condition in which we get higher financial stability with less cost on macroeconomic stability or other measures of financial stability that are not included in the loss function. Figure 9 shows the performance of the two policy strategies in the alternative scenario. The figure shows that the performance of the policy strategy that optimised the Taylor rule for only macroeconomic stability is slightly better than the one in which the Taylor is optimised for both macroeconomic and financial stability.

In facing a domestic price shock, the central bank would benefit from implementing the policy strategies that combine the LTV ratio rules with the Taylor rule to increase financial stability. There is a cost to macroeconomic stability in implementing these strategies. The trade-off between macroeconomic and financial stability is better if the central bank implements the strategy that combines the non-optimised LTV ratio rules and the Taylor rule that has been optimised for only macroeconomic stability. The cost to macroeconomic stability can be reduced by adjusting the responses of the LTV ratio rules based on the central bank assessment on the acceptable level of financial/macroeconomic vulnerabilities caused by the increase in macroeconomic instability and the variances of the other variables of interest.

Table 13: Macroeconomic and Financial Stabilisation Performance of Model with Monetary and Macroprudential Policy in Facing Domestic Price Shock

	Variances of		Macroeconomic Instability	Financial Instability	Total Instability
	Inflation	Output			
Optimised for Macroeconomic and Financial Stability					
Standard Taylor Rule	0.0062 (2.56)	0.0060 (-1.46)	0.0092 (1.22)	0.0061 (-0.08)	0.0153 (0.69)
Taylor Rule and Leverage Ratio Policy	0.0061 (-0.2)	0.0064 (5.62)	0.0093 (1.74)	0.0058 (-6.01)	0.0150 (-1.37)
Taylor Rule and LTV Ratio Policy	0.0062 (2.56)	0.0073 (20.34)	0.0099 (8.49)	0.00001 (-99.88)	0.0099 (-35.06)

Note: The variances, macroeconomic instability, financial instability and total instability are expressed as the ratio to the variance of the exogeneous shock. The values in the bracket show percentage difference of the variance/instability with the one acquired from the model with the Taylor rule that has been optimised for only macroeconomic stability. The values in red indicate an increase in the instability while the values in blue indicate a decrease in the instability.

Table 14: Parameter Values-2 (Domestic Price Shock)

	ϕ_π	ϕ_Y	ϕ_{mi}	ϕ_{me}	ϕ_ψ
Optimised for Macroeconomic and Financial Stability					
Standard Taylor Rule	2.002	0.081			
Taylor Rule and Leverage Ratio Policy	2.051	0.042			0.134
Taylor Rule and LTV Ratio Policy	2.077	0.066	785	113	

Note: ϕ_π. is the parameter governing the response of the policy rate to inflation; ϕ_Y is the parameter governing the response of the policy rate to output; ϕ_{mi} is the parameter governing the response of the households' LTV ratio requirement to the changes in the gap of households' loan to output ratio; ϕ_{me} is the parameter governing the response of the entrepreneurs' LTV ratio requirement to the changes in the gap of entrepreneurs' loan to output ratio; ϕ_ψ is the parameter governing the response of the leverage ratio requirement to the changes in the gap of loan to output ratio;

Table 15: Instabilities of other Variables of Interest-2 (Domestic Price Shock)

	Variances of			
	Real Exchange Rate	House Price	Capital Asset Price	Foreign Loan to Output Ratio
Optimised for Macroeconomic and Financial Stability				
Standard Taylor Rule	0.0152 (-3.04)	0.0140 (-3.2)	0.0085 (0.46)	0.0045 (-8.97)
Taylor Rule and Leverage Ratio Policy	0.0158 (1.09)	0.0146 (1.24)	0.0079 (-7.02)	0.0054 (9.55)
Taylor Rule and LTV Ratio Policy	0.0159 (1.36)	0.0145 (0.85)	0.0094 (10.23)	0.0037 (-24.39)

Note: The variances are expressed as the ratio to the variance of the exogeneous shock. The values in the bracket show percentage difference of the variance with the one acquired from the model with the Taylor rule that has been optimised for only macroeconomic stability. The values in red indicate an increase in the instability while the values in blue indicate a decrease in the instability.

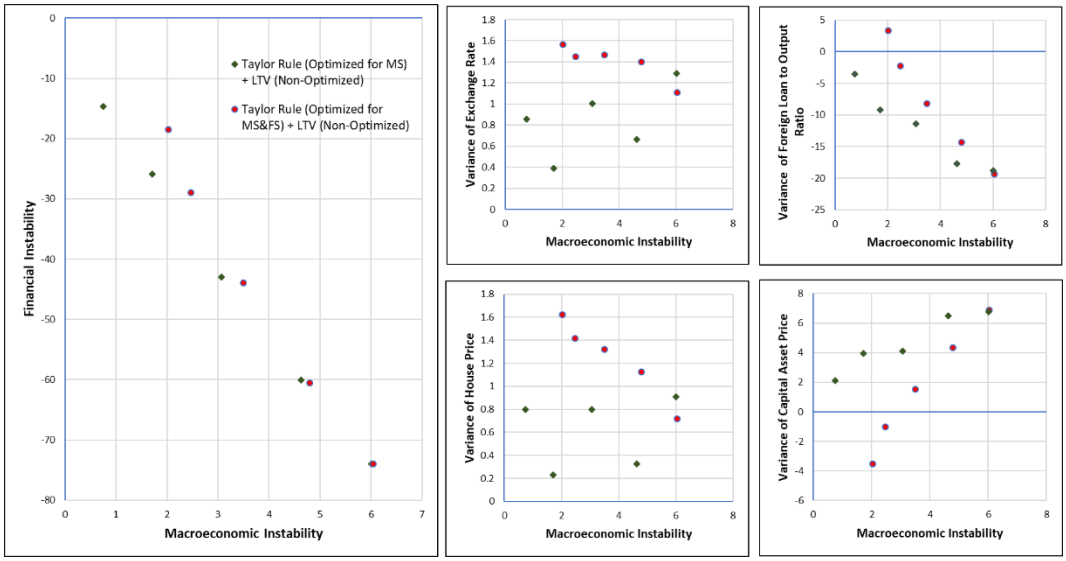


Figure 9: Stabilisation Performance of Models in Alternative Scenario (Domestic Price Shock)

Notes: Variances, Macroeconomic Instability and Financial Instability are expressed as percentage difference of the instability/variance with the one acquired from model with the Taylor rule that has been optimised for only macroeconomic stability. Positive values indicate an increase in the instability/variance while negative values indicate a decrease in the instability. MS is Macroeconomic Instability. FS is Financial Instability. The values of ϕ_{mi} and ϕ_{me} used for the figure are : $[\phi_{mi} = 3.5, \phi_{me} = 0.5]$, $[\phi_{mi} = 1.75, \phi_{me} = 0.25]$, $[\phi_{mi} = 0.875, \phi_{me} = 0.125]$, $[\phi_{mi} = 0.4375, \phi_{me} = 0.0625]$ and $[\phi_{mi} = 0.21875, \phi_{me} = 0.03125]$.

Table 16: Macroeconomic and Financial Stabilisation Performance of Model with Monetary and Macroprudential in Facing Domestic Price Shock (Alternative Scenario)

	Variances of		Macroeconomic Instability	Financial Instability	Total Instability
	Inflation	Output			
Alternative Scenario					
Standard Taylor Rule (MS) + Non-optimised LTV $[\phi_{mi} = 3.5, \phi_{me} = 0.5]$	0.0062 (1.6)	0.0070 (14.83)	0.0097 (6.01)	0.0016 (-73.95)	0.0112 (-26.13)
Standard Taylor Rule (MS+FS) + Non-optimised LTV $[\phi_{mi} = 3.5, \phi_{me} = 0.5]$	0.0062 (1.74)	0.0070 (14.64)	0.0097 (6.04)	0.0016 (-73.95)	0.0112 (-26.11)

Note: The variances, macroeconomic instability, financial instability and total instability are expressed as the ratio to the variance of the exogeneous shock. The values in the bracket show percentage difference of the variance/instability with the one acquired from the model with the Taylor rule that has been optimised for only macroeconomic stability. The values in red indicate an increase in the instability while the values in blue indicate a decrease in the instability.

Table 17: Instabilities of other Variables of Interest- Alternative Scenario (Domestic Price Shock)

	Variances of			
	Real Exchange Rate	House Price	Capital Asset Price	Foreign Loan to Output Ratio
Alternative Scenario				
Standard Taylor Rule (MS) + Non-optimised LTV $[\phi_{mi} = 3.5, \phi_{me} = 0.5]$	0.0158 (1.29)	0.0146 (0.91)	0.0091 (6.76)	0.0040 (-18.82)
Standard Taylor Rule (MS+FS) + Non-optimised LTV $[[\phi_{mi} = 3.5, \phi_{me} = 0.5]]$	0.0158 (1.11)	0.0145 (0.72)	0.0091 (6.88)	0.0040 (-19.35)

Note: The variances are expressed as the ratio to the variance of the exogeneous shock. The values in the bracket show percentage difference of the variance with the one acquired from the model with the Taylor rule that has been optimised for only macroeconomic stability. The values in red indicate an increase in the instability while the values in blue indicate a decrease in the instability.

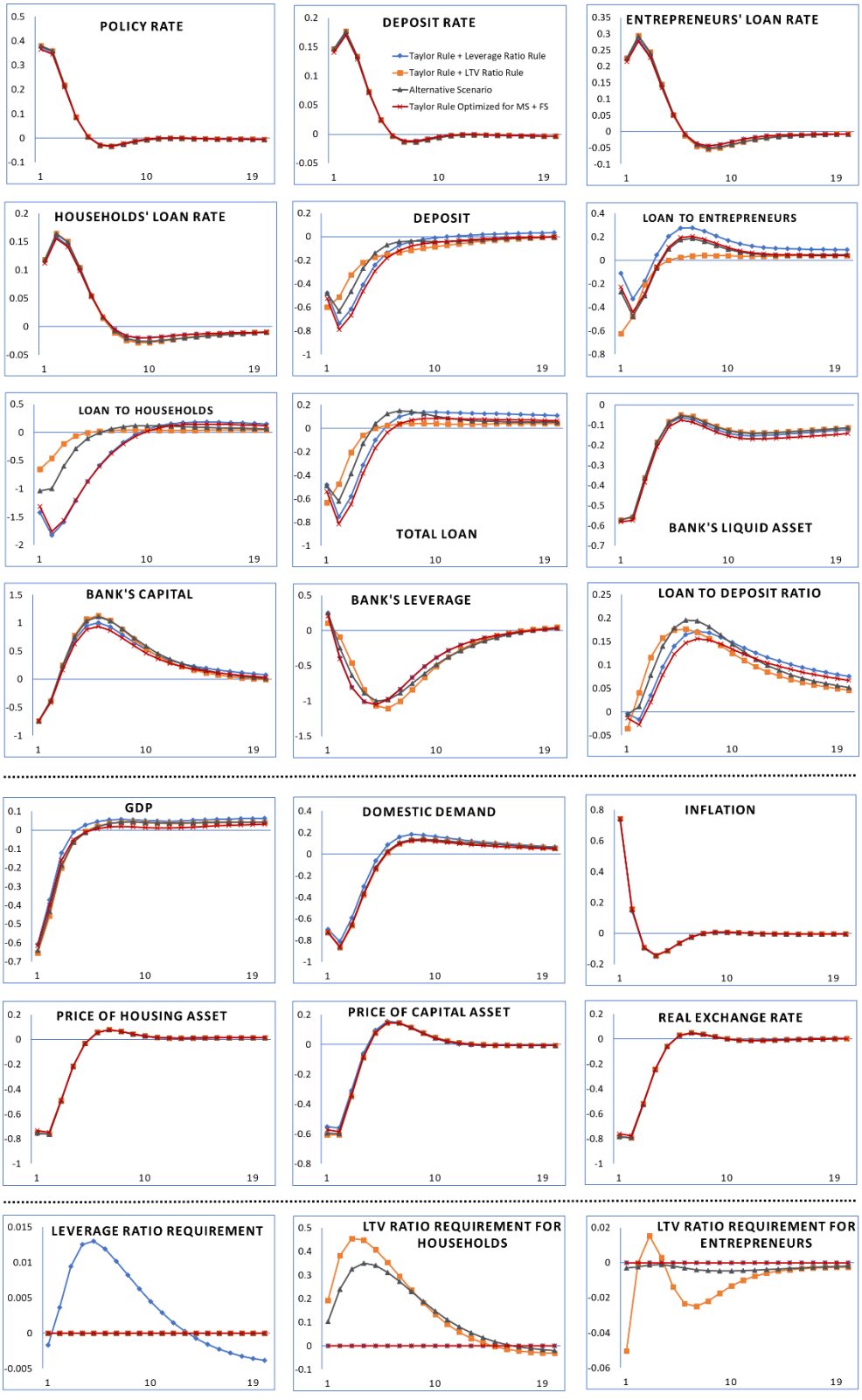


Figure 10: Impulse Responses of Model with Policy Rate, LTV Ratio Requirement and Leverage Ratio Requirement (Domestic Price Shock)

Notes: The figure reports the impulse responses to a positive domestic price shock resulting in 0.75% increase in inflation. For interest rate variables and LTV ratio requirements, the figure shows absolute deviations from the steady state in percentage points. For other variables, it shows percent deviations from the steady state. MS is Macroeconomic Stability, and FS is Financial Stability. Impulse responses of the alternative scenario are for the one in which the Taylor rule is optimised for macroeconomic stability, and the values of LTV rules' countercyclical parameters are: $[\phi_{mi} = 3.5, \phi_{me} = 0.5]$.

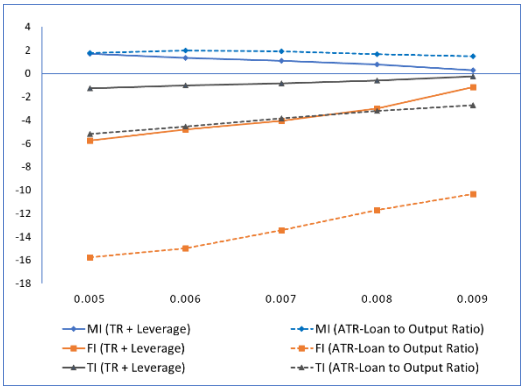


Figure 11: Stabilisation Performance of Models with Different Speed of Banks' Leverage Adjustment (Domestic Price Shock)

Notes: The horizontal axis shows the values of κ_l (the parameter that governs the speed of adjustment of bank's leverage to changes in the leverage target/requirement). The vertical axis shows the percentage difference of macroeconomic, financial and total instability values with the one acquired from the model with the Taylor rule that has been optimised for only macroeconomic stability. MI is Macroeconomic Instability. FI is Financial Instability. TI is Total Instability. TR is Taylor Rule. ATR is Augmented Taylor Rule.

2.7. Conclusion

In this chapter, I develop a small open economy DSGE model that has been designed and calibrated based on the emerging Asian economies' characteristics. The model includes a monetary policy instrument (the policy rate) and two macroprudential policy instruments (the leverage ratio requirement rate and the LTV ratio requirement rates) that can be utilised for the purpose of macroeconomic and financial stabilisation.

Based on the model simulations, each policy instrument has the potential to propagate shocks in the manner that can be considered as countercyclical. They have the ability to suppress lending from the bank and will result in a decrease in output.

Model simulations show significant differences in the composition of the banks' balance sheet components after a monetary policy shock between the different pass-through of the policy rate to the retail bank's rate. This may influence how the policy rate interacts with macroprudential policy measures, especially when the macroprudential policies are aiming at a specific balance sheet condition, such as leverage or loan to deposit ratio. Periodical inspection of monetary policy transmission through the banks' balance sheets would be beneficial, not only for monetary policy purposes but also for macroprudential policy arrangements.

The central bank needs to consider the size of excess capital buffers in the banking sector in designing a countercyclical leverage ratio policy. The size of the excess capital buffer determines the dominant strategy taken by the banks to meet the new leverage ratio requirement. The model includes two different strategies: (1) restricting lending or (2) widening the interest rate spread. The dominant strategy taken by the banks

will determine the size of the impact of a change in the leverage ratio requirement to the real sectors. The impact of pursuing the first strategy on output would be more pronounced.

Restricting the LTV ratio requirement in a certain sector involves diversion of loan distribution to the other unrestricted sectors. The central bank needs to consider the impact of these diversions in designing their countercyclical LTV ratio policies. If the goal is to countercyclically react to the increasing output due to a certain shock, the most effective way is to use both instruments at the same time so that we do not have diversions that may increase procyclicality.

I utilise the model to study the optimal policy mix for macroeconomic and financial stabilisation in facing two different domestic supply shocks: technology and domestic price shocks. The results are as follows:

1. In facing a technology shock, it may be best for the central bank not to use the policy rate as the instrument for financial stabilisation, because it results in a significant adverse effect on the price and output stability. In addition, utilising the policy rate for this purpose may also create another source of financial vulnerabilities due to a significant increase in the instability of the capital asset prices. By focusing the policy rate only for macroeconomic stabilisation, the central bank can utilise the non-optimised countercyclical LTV ratio policies for financial stabilisation purposes. Implementing this policy also involves adverse effects on price, output and capital asset price stabilities. However, it is possible for the central bank to adjust its financial stability reduction target based on its assessment of the acceptable level of financial/macroeconomic vulnerabilities that are caused by the increase in the instability of price, output and the capital asset prices.
2. For the purpose of macroeconomic and financial stabilisation in facing a domestic price shock, without additional countercyclical macroprudential tools, the central bank may benefit from implementing the augmented Taylor rule with a reaction to the growth of loan to output ratio. This policy strategy is the best choice for the central bank that has constraints in implementing countercyclical macroprudential tools either due to conflicting microprudential concerns, the unavailability of policy infrastructure or political pressures. When other countercyclical instruments are available, the central bank will benefit from implementing the non-optimised LTV ratio rules for financial stabilisation, while the Taylor rule can be targeted solely for

macroeconomic stabilisation. There is a cost to macroeconomic stability in implementing this strategy which can be reduced by adjusting the response of the LTV ratio rules, based on the central bank assessment on the acceptable level of financial/macroeconomic vulnerabilities caused by the increase in macroeconomic instability and the variances of the other variables of interest.

Model simulations show that the financial stability performance of combining the Taylor rule and the LTV ratio rules or the leverage ratio rule and jointly optimised them for macroeconomic and financial stability is higher than the baseline scenario. The financial stabilisation performance of implementing the LTV ratio rules is significantly higher than the leverage ratio rule. The performance of implementing the leverage ratio rule is very similar or below the performance of only utilising the standard or augmented Taylor rule that is optimised for both macroeconomic and financial stability.

For both shocks considered in this chapter, combining the Taylor rule and the LTV ratio rules results in a better overall stabilization performance than any policy strategy that utilises only the standard or augmented Taylor rule. This result supports the use of additional countercyclical macroprudential rules instead of using only the Taylor rule for minimizing the central bank loss function that includes both macroeconomic and financial stability. Using the agents' welfare as the objective function of the policymaker, Carrillo et al. (2017) also find evidence that supports the use of two separate monetary and macroprudential rules when the economy is facing a risk shock which is a shock to the variance of the entrepreneur's investment project.

Chapter 3: Capital Flow and Macroeconomic Fragility

3.1. Introduction

In the aftermath of the global financial crisis (GFC), emerging Asian economies have received large capital inflows. This upward trend in capital inflows was mostly driven by the global excess liquidity caused by the accommodative monetary policy in the advanced economies. Unlike the experience before the Asian financial crisis, the recent surges of inflows were mostly dominated by portfolio investments that include equity and fixed income portfolio instruments such as central bank bills and government bonds.This portfolio investment dominated inflows were most prevalent in the emerging Asian economies that were associated with the Asian financial crisis[53]. Due to their short-term nature, these types of inflows are very vulnerable to changes in market sentiment that can lead to a sudden reversal and thus cause financial instability.

These surges in capital inflows also exert pressure on the domestic currency, and then the appreciation may cause concerns of declining export competitiveness and deterioration of the current account. These concerns will further exacerbate the risk of sudden reversals due to the procyclical nature of these types of inflows. The "Taper Tantrum" episode in 2013, which began when the Fed chairman announced the potential unwinding of quantitative easing (QE), demonstrates the existence of this risk. Indonesia and India, which at the time had a current account deficit, suffered a significant decline in their currencies' values due to sudden capital outflows triggered by pessimistic investors[54].

Large portfolio inflows may also induce a significant boost in asset prices coming from the increase in initial demand of these assets and a subsequent amplification of the demand, due to the increase in domestic liquidity[55]. Pressures on both domestic currency and asset prices will further intensify the risk of financial system instability.

Persistent foreign capital inflows can also significantly affect the efficiency of monetary policy. Under such conditions, the central bank cannot simply react to the mounting pressures of inflation, caused either by a domestic specific shock or by the increase in domestic liquidity from capital inflows, by raising the policy rate because

[53] See Balakrishnan et al. (2013) for details on types of capital inflows coming into emerging Asian economies.
[54] ADB (2013) provide a detail description of the "taper tantrum" episode along with other episodes of capital flows in Asia.
[55] See Tillman (2013) and Yiu and Sahminan (2015) for empirical evidence on the effect of capital flow to housing prices in emerging Asian economies. Park et al. (2014) documents the effect of capital flow on equity prices in six emerging Asian economies.

it will induce even more capital inflows and will further increase domestic liquidity and inflation.

The complexities of the problems coming from the surges of capital inflows have encouraged the policymakers to implement macroprudential policies that can be targeted to a specific source of financial system instability. Another set of tools that are popular among the policymakers is the capital flow management measures (CFM). These measures have been formally sanctioned by the IMF, especially in the case of surges in the capital inflow that can have a drastic impact on financial or macroeconomic stability (IMF, 2012). However, as pointed out by many researchers[56], there are still many issues regarding the implementation of both macroprudential and CFM policies that still need to be addressed. The two most important issues are the lack of understanding of the policies' transmission mechanism and their interaction with other macroeconomic policies.

The objective of this chapter is to study the optimal policy mix, which includes monetary, macroprudential and capital flow management policies in stabilising the economy, specifically in responding to shocks that lead to surges in capital inflows. For this purpose, I utilise the small open economy DSGE model, explained in the previous chapter, and extend it to include a capital flow management measure.

Unsal (2013) studied the interaction between monetary and macroprudential policy when facing a sudden surge of capital inflows, that is caused by two different shocks: the perception of investors on borrowers' productivity and a technology shock. Based on model simulations, macroprudential policy can significantly complement monetary policy in stabilising the economy in the first case but not in the second case. The macroprudential measure used in this model is defined as an additional premium on the loan's interest rate which increases, as the growth rate of loans increases. As mentioned in the paper, this approach does not allow for the analysis of a particular type of macroprudential policy and the results of the study will benefit from the inclusion of a fully optimised banking sector.

Focusing on capital inflows caused by shocks to the world interest rate, Medina and Roldos (2013) found that the use of a countercyclical reserve requirement, in addition to Taylor rule based monetary policy, significantly improves welfare compared to the use of only monetary policy. This result persists even if it is compared

[56] see Blanchard et al. 2010 and 2013.

to the case when the policy only implements a Taylor rule that has been augmented to include countercyclical reactions to loan fluctuations.

Agenor et al. (2014) examined macroeconomic and financial stabilisation role of countercyclical capital regulation in facing sudden increases in capital inflows, specifically the one that is directly intermediated by the banking sector. They found that countercyclical capital regulation is an effective stabilisation tool but may need to be complemented by other instruments.

The small open economy model I use in this chapter has an explicit linkage between capital flows and financial fragility. This linkage exists through the effects of capital inflows on domestic excess liquidity, bank's intermediation activities and asset prices. In terms of capital inflow shocks, the analysis is focused on the shocks that are recently responsible for the increase in capital inflows to emerging Asian economies, which are shocks to the country's risk premium and global interest rate[57]. In order to do this, I extend the model used in the previous chapter by adding capital flow management policy so that the central bank would have four different policy tools that they can utilise to stabilise the economy in facing capital inflow shocks.

The remainder of the chapter is organised as follows. Section 2 describes the experiences of emerging Asian economies in facing capital flows after the global financial crisis. Section 3 describes the extension of the model to include capital flow management policy. Section 4 and 5 present transmission of capital inflow and capital flow management policy. Section 6 examines the optimal policy mix for macroeconomic and financial stability. Section 7 concludes.

3.2. Capital Flows to Emerging Asian Economies – Post GFC

The experiences of emerging Asian economies in facing capital inflows after the global financial crisis are quite diverse. Although many researchers agree that there is a pattern reversal in the form of shrinking banking flows and an increase in portfolio flows[58] based on aggregate data, individual experiences may deviate from this pattern. The dominance of portfolio inflows in the current surges is especially noticeable in Indonesia, Malaysia, the Philippines, Thailand, Vietnam, and India[59]. A large share of portfolio inflows coming into these economies have resulted in an increase in foreign ownership of the sovereign bonds. This is especially true for Indonesia, Korea, Malaysia, and Thailand. This development may suggest an increase

[57] See Ahmed and Zlate (2014), Balakrishnan et al. (2013), Canuto and Ghosh (2013) and Filardo et al. (2014), among others.
[58] See Park and Shin (2014) and ADB (2013), among others.
[59] Balakrishnan et al. ,2013

in financial vulnerabilities, especially for Indonesia where the size of the capital inflows is relatively large compared to the size of the financial market. One of the important impacts of this development is the possibilities of asset price bubbles that may suddenly burst whenever there are changes in global market sentiment.

Figure 12 shows episodes of capital inflow surges and sudden stops or sudden reversals in Indonesia post the global financial crisis. Although domestic factors may influence this capital flow dynamics, the dominant factors driving these episodes are external factors, which include changes in global market sentiment resulting from development in advanced economies' condition. Most of the surges in capital inflows are mainly associated with the quantitative easing being implemented by the advanced economies. While the episodes of sudden stops or sudden reversals are mainly the result of changes in market sentiments caused by certain external events, such as the Greek crisis in mid-2010, the European sovereign debt crisis at the end of 2011 and the "Taper Tantrum" episode in 2013.

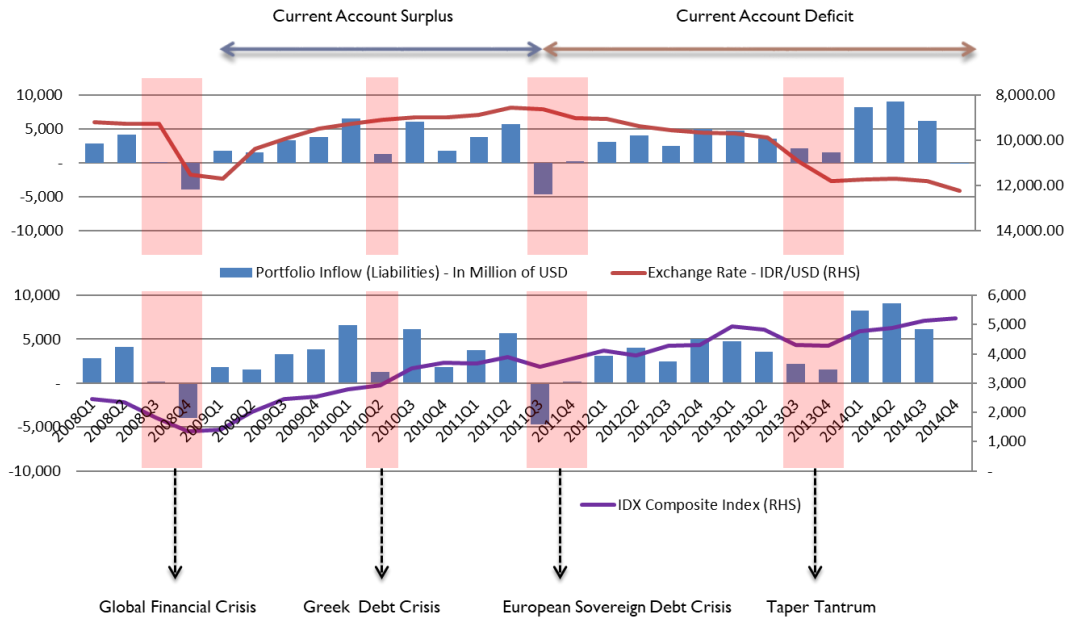


Figure 12: Capital Inflows to Indonesia After the Global Financial Crisis

Source: Bank Indonesia

Another important development related to the increase in capital inflows to emerging Asian economies is the effect that these flows had on the real estate market and credit growth. During the current episodes of capital inflows, residential house prices have increased in Indonesia, Malaysia, the Philippines, Singapore, and

Thailand[60], which resulted in the accelerated growth in property loans distributed by the banks. Increasing domestic liquidity has also resulted in increasing domestic demand that has fuelled the increase in banks' loan for consumption, specifically in China, Hong Kong, Malaysia, and Vietnam.

Some of the emerging Asian countries have implemented macroprudential and capital flow management measures to deal with the issues resulting from the increase in capital inflows. In dealing with the high share of foreign ownership in the central bank bills, Indonesia has implemented a holding period policy and introduced longer tenors for the bills. While in Thailand and Korea, to limit inflows to local bond market, they implemented withholding tax on foreign purchases of state bonds. In dealing with the accelerated increases in the residential property market, more restricted lending criteria has been implemented in China, Hong Kong, India, Korea, Malaysia, Singapore, and Thailand[61].

3.3. Model Description: Addition of Capital Inflow Tax

In the analysis of this chapter, I utilise the small open economy model, explained in Chapter 2, and extend it to include a capital flow management policy. Specifically, I introduce a capital flow management measure in the form of a tax on capital inflows (τ_t^*). This addition will change patient households' budget constraint into the following[62]:

$$\begin{aligned} C_t^p + q_t^K\left(K_t^p - (1-\delta_K)K_{t-1}^p\right) + q_t\left(H_t^p - (1-\delta_H)H_{t-1}^p\right) + D_t \\ + e_t(1+\rho_{t-1})(1+r_{t-1}^*)(1+\tau_{t-1}^*)\frac{B_{t-1}^*}{\pi_t} \\ = w_t^P L_t^P + (1+r_{t-1}^d)\frac{D_{t-1}}{\pi_t} + R_t^K q_t^K K_{t-1}^P + e_t B_t^* + T_t \end{aligned} \qquad (52)$$

I also change definition of T_t to include the following expression[63]:

$$s_t(1+\rho_{t-1})(1+r_{t-1}^*)\tau_{t-1}^*\frac{\tilde{B}_{t-1}^*}{\pi_t^*} \qquad (53)$$

which is a lump sum transfer from the proceeds of the capital inflow tax.

[60] Yiu and Sahminan (2015)
[61] Balakrishnan et al. (2013)
[62] Aggregate version
[63] π_t^* is foreign inflation, $\tilde{B}_t^* = \frac{B_t^*}{P_t^*}$ and $s_t = \frac{e_t P_t^*}{P_t}$

The first order condition of the patient household optimisation problem with respect to deposits and foreign borrowings will result in an equation that links the capital inflow tax and the expectation of real exchange rate (s_t) appreciation:

$$E_t\left(\frac{s_{t+1}}{s_t}\right) = \frac{(1+r_t^d)}{(1+\rho_t)(1+r_t^*)(1+\tau_t^*)} E_t\left(\frac{\pi_{t+1}^*}{\pi_{t+1}}\right) \qquad (54)$$

From equation (54), we can see that the country's risk premium and the capital inflow tax can influence the exchange rates' dynamics and the patient household's preference towards foreign borrowing. Both variables determine the total cost paid by the patient households for borrowing from the international financial market. However, the overall effect of the shocks on these two variables will not be the same because of the difference in the way they influence the patient household's budget constraint. The cost related to the value of the country's risk premium is being paid to the foreign lenders, while the cost related to the value of the capital inflow tax is being paid to the government and will be transferred back to the patient households[64].

Given the changes in equation (52) and the additional term in the definition of transfers to patient households, the combination of all agents' budget constraint will result in the same balance of payments equation:

$$s_t \tilde{p}_t^{F^*} y_t^F + s_t(1+\rho_{t-1})(1+r_{t-1}^*)\frac{\tilde{B}_{t-1}^*}{\pi_t^*} = s_t \tilde{p}_t^{H^*} y_t^{H^*} + s_t \tilde{B}_t^* \qquad (55)$$

I also use the same definition for the country's risk premium (ρ_t) as in the previous chapter, which is a function of the total foreign loans to output ratio.

$$(1+\rho_t) = exp\left(-\varphi \frac{e_t B_t^*}{Y_t^E}\right)\varepsilon_t^\rho \qquad (56)$$

It is important to note that the model does not have different types of capital flows. Although, we can infer that these flows are not in the form of banking flows or those directly intermediated by the banking sector. We also can assume that they are not foreign direct investment flows or the ones directed towards entrepreneur's investment decisions. Foreign capital flows in the model are assumed to be directed to economic agents that have the following role in the domestic economy: savers

[64] Similar arrangements also used by Farhi and Werning (2014)

and the owner of a fraction of housing and capital asset. This would mean that the type of flows being modeled is more consistent with the definition of portfolio flows. Because of this, the model would be most suitable for emerging Asian countries that have experience surges of capital inflows that are dominated by portfolio investment.

3.4. Transmission of Capital Inflow

This chapter will focus on shocks that are recently responsible for the increase in capital inflows to emerging Asian economies, which are shocks to the country's risk premium and the global interest rate. In the model, shocks to both variables will result in similar transmission mechanisms and responses of various policy measures. Shocks to both variables, which enter in the same manner in equation (52) and (53) will initiate the transmission to the rest of the equations in the model. The effect of monetary policy (through its effect on r_t^d) and capital inflow tax also coming from equation (52) which explain the similar response of both measures to these different shocks. This allows us to only use one of the variables as a source of capital inflow shocks in the analysis.

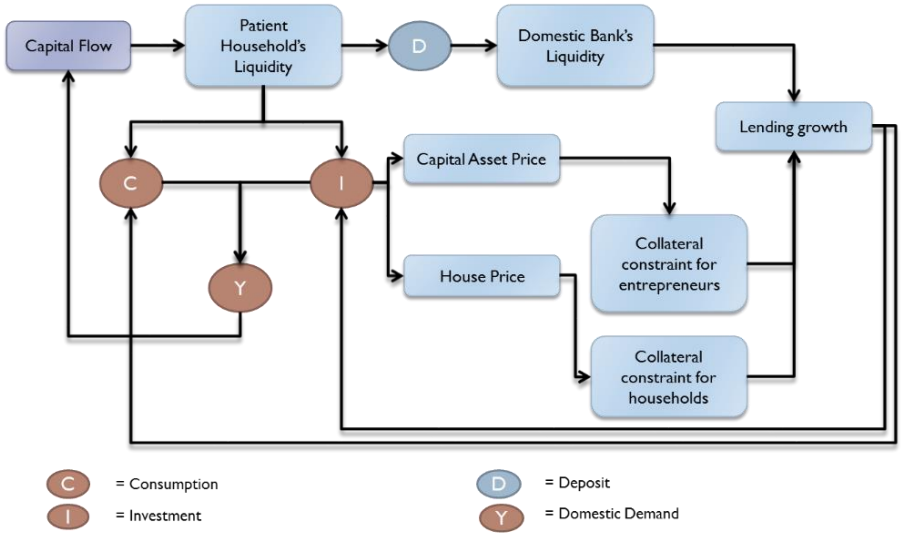


Figure 13: Transmission of Capital Inflow Shocks

For the purpose of this and the following sections, the capital inflow shocks are defined as the shocks to the country's risk premium. These shocks can be caused by either domestic or external factor. Following the global financial crisis, the external factors in the form of changes in global investors' risk aversion are the primary driver

of changes in the emerging Asian economies' risk premium[65]. A decrease in global investors' risk aversion, which is represented by a negative shock to the country's risk premium, will encourage more foreign capital into the domestic economy and raise patient households' liquidity. This will allow them to do some or all of the following actions: (1) increase their consumption, (2) increase their investment in capital assets, (3) increase their housing assets and (4) increase their savings in domestic banks[66]. This transmission will allow the link between capital inflow and domestic financial fragility through its effect on the aggregate demand (by increasing consumption and investment), asset prices (by increasing demand for housing and capital assets), and domestic bank's liquidity (which may later induce an increase in lending growth and subsequent additional increases in the aggregate demand). Figure 13 describes the transmission of a capital inflow shock in the model and Figure 14 shows the simulation results based on the baseline calibration of the Taylor rule parameters[67].

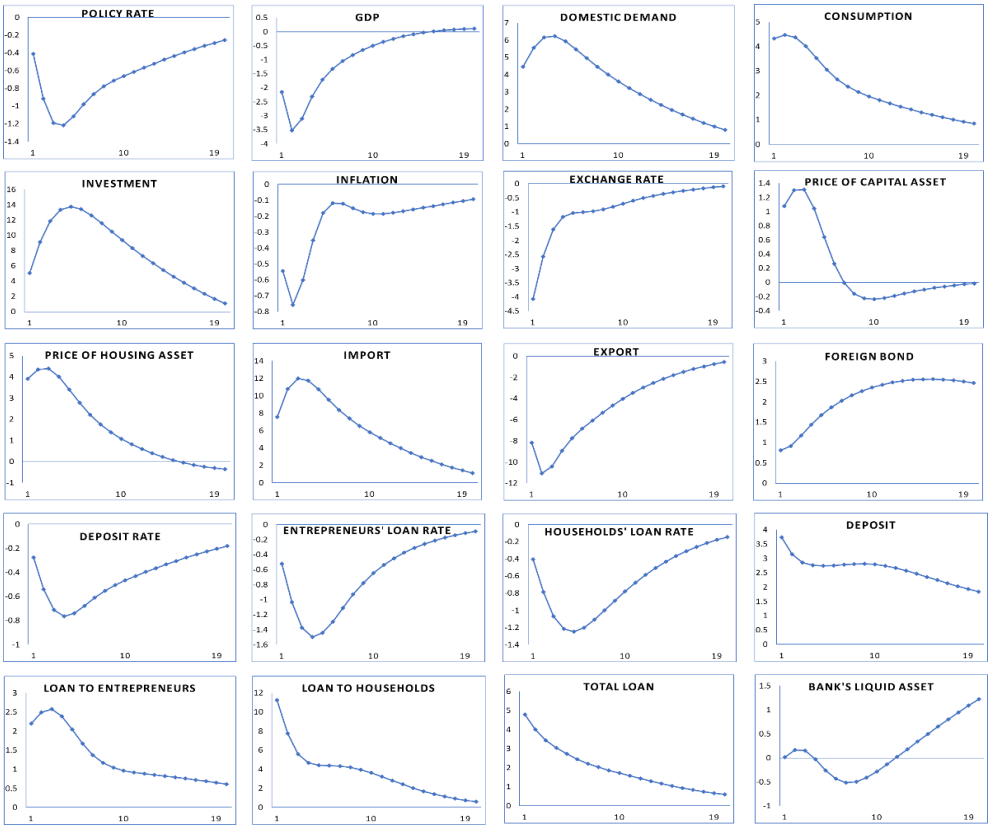


Figure 14: Model Impulse Responses to Capital Inflow Shock

Notes: The figure reports the impulse responses to a one percent negative shock to the country's risk premium for the model with only a monetary policy with baseline calibration of the Taylor rule's parameters. For interest rate variables, the figure shows absolute deviations from the steady state in percentage points. For other variables, it shows percent deviations from the steady state

[65] Cho and Rhee (2013) and Caceres and Unsal (2011).
[66] The same effect will occur in the case of a negative shock to the global interest rate.
[67] $\phi_R = 0.75$; $\phi_\pi = 2$; $\phi_y = 0.25$

As shown in Figure 14, capital inflow shock will boost consumption, investment, banks' lending and asset prices. An increase in domestic liquidity triggers an increase in deposit by patient households, which will allow banks to distribute more loans to both impatient households and entrepreneurs. The increases in the loan distribution are then accelerated by the increase in the value of collateralised assets. The increases in the value of these assets owned by both impatient households and entrepreneurs will increase the amount of borrowing by those agents, which will further boost the prices of the assets.

In the baseline model, the policy rate mainly reacts to stabilise inflation and output. The pressure to decrease the policy rate is the result of a decline in inflation, mainly from the pass-through effect of exchange rate appreciation. The transmission of the policy rate through the banking sector will increase the acceleration of the capital inflow shocks by decreasing the loan rates both for households and entrepreneurs. From the model's impulse responses, we find that although domestic demand increases after capital inflow shock, the overall output of the economy is declining due to currency appreciation that reduces demand for exporters' goods. This is in accordance with the experiences of some of emerging Asian economies where a sustained increase in capital inflows has led to a decline in their current account positions.

3.5. Transmission of Capital Inflow Tax

To study the impact of the capital inflow tax on the economy, I define the following equation:

$$\tau_t^* = \rho_\tau \tau_{t-1}^* + (1-\rho_\tau)\tau^* + \varepsilon_t^\tau \qquad (57)$$

where ρ_τ is the persistence parameter and ε_t^τ is an i.i.d shock with normal distribution and standard deviation equal to $\sigma_{\varepsilon\tau}$. For the simulation, I use 0.9 as the value of the persistence parameter.

Figure 15 shows that the capital inflow tax can have the potential to counteract the increase in foreign borrowing that happens after the shock to the country's risk premium. However, the implementation of the capital inflow tax can also have an adverse effect in the form of increasing volatility of output through its effect on the net exports. The increase in output will be transmitted into an increase in total domestic loans distribution by the banking sector. The effect of the shock to the

capital inflow tax on the loan to output ratio is even greater than the effect of the shock to the country's risk premium, in medium to long term period. The transmission shows that, without the objective of trying to reduce capital inflows, the implementation of the capital inflow tax may have negative effects on macroeconomic and financial stability.

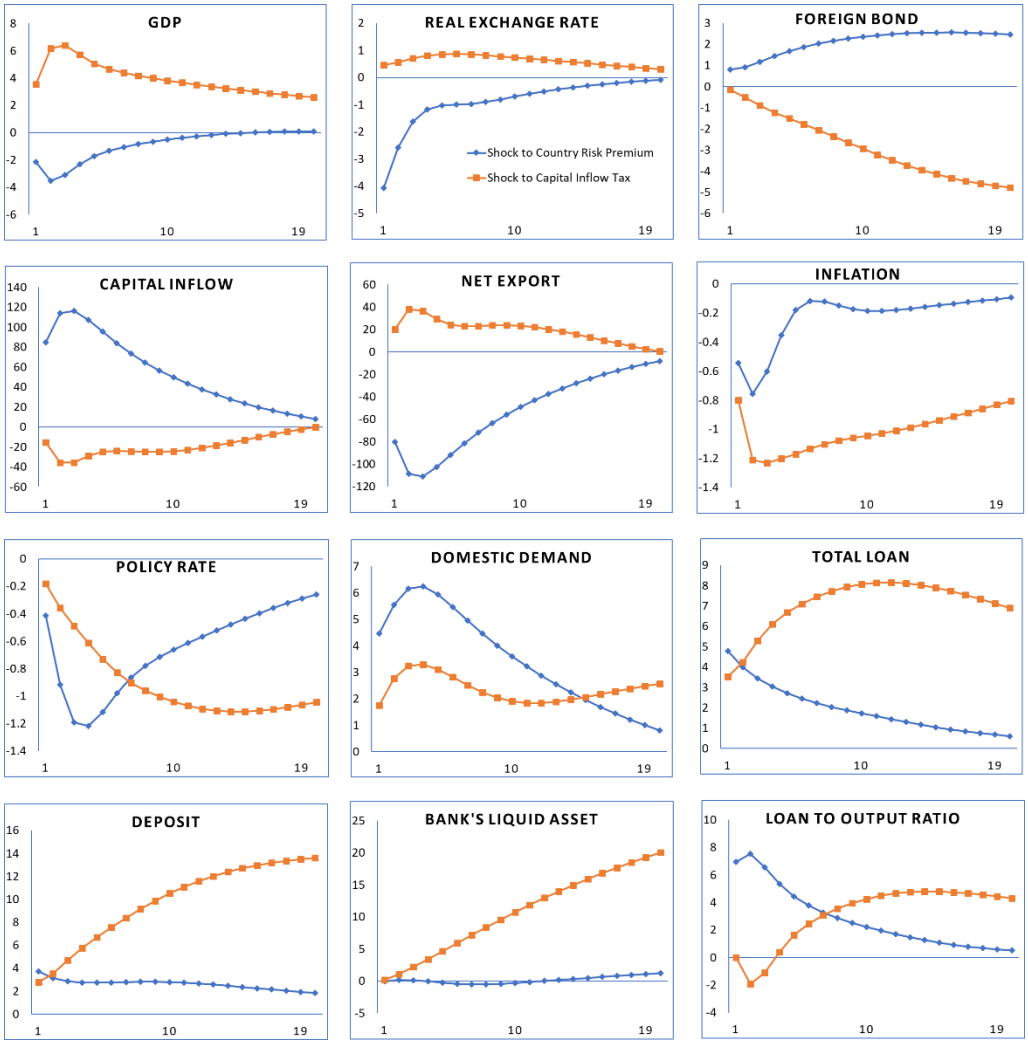


Figure 15: Impulse Responses to Country Risk Premium (Capital Inflow) Shock and Capital Inflow Tax (Capital Flow Management) Shock

Notes: The figure reports the impulse responses to a one percent negative shock to the country's risk premium and a one percent positive shock to the capital inflow tax. For interest rate variables, the figure shows absolute deviations from the steady state in percentage points. For other variables, it shows percent deviations from the steady state.

Shocks to the capital inflow tax and the country's risk premium have the same effect on total loan and domestic demand but have the opposite effect on capital inflows and output. The increase in total loan and domestic demand after the shock to the country's risk premium is coming from the increase in domestic liquidity due to foreign borrowing. In the case of the shock to the capital inflow tax, the main driver

of the increase in domestic demand and the total loan is the increase in output (due to rising net-export).

3.6. Optimal Policy Mix

As in the previous chapter, I assume that the central bank has the mandate for macroeconomic and financial stability. The central bank can utilise four different instruments to achieve its objective. In addition to previously defined policy rules, the central bank can also implement a capital flow management policy in the form of the following countercyclical rule:

$$\tau_t^* = (\tau_{t-1}^*)^{\rho_\tau} \left(\tau^* \left(\frac{\frac{s_t \tilde{B}_t^*}{Y_t^E}}{\frac{s \quad \tilde{B}^*}{Y^E}} \right)^{-\phi_\tau} \right)^{1-\rho_\tau} \tag{58}$$

where ρ_τ is the persistence parameter and ϕ_τ is the parameter that determines the response of the capital inflow tax to the changes in the foreign loan to output gap (measures in domestic currency). By adding this new policy instrument, the loss function of the central bank is modified into the following:

$$L = \sigma_\pi^2 + \varsigma_{Y^E}\sigma_{Y^E}^2 + \varsigma_{B/Y^E}\sigma_{B/Y^E}^2 + \varsigma_r\sigma_{\Delta r}^2 + \varsigma_{m^I}\sigma_{\Delta m^I}^2 + \varsigma_{m^E}\sigma_{\Delta m^E}^2 + \varsigma_{\Psi^{reg}}\sigma_{\Delta\Psi^{reg}}^2 + \varsigma_{\tau^*}\sigma_{\Delta\tau^*}^2 \tag{59}$$

where ς_{τ^*} reflects the central bank preference on the variability of the capital inflow tax ($\sigma_{\Delta\tau^*}^2$)[68]. Similar to other policy instruments, I set the value for ς_{τ^*} equal to 0.1 and the persistence parameter ρ_τ equal to 0.9[69].

I divide the analysis into two scenarios. The first one is when the only instrument available for macroeconomic and financial stabilisation is the policy rate, either the standard version or the augmented ones as described in equation (47), (48) and (49). In the second scenario, the central bank can utilise the other three countercyclical policy rules along with the Taylor rule.

In order to assess the performance of each policy scenario in macroeconomic and financial stabilisation, I will also consider the case in which the central bank is only given the mandate of macroeconomic stability (where the loss function does not

[68] Asymptotic variance of changes in capital inflow tax
[69] The values are chosen based on Angelini et al. (2014). In their experiment, the value of for persistence parameter are optimised.

include financial stability measures) and only use the Taylor rule as the policy instrument. In addition, the analysis will also include the impact of each policy strategy to alternative measures of financial stability that may be of interest for central banks in emerging Asian economies.

3.6.1. The Role of The Policy Rate

Including a financial stability measure in the loss function and only using the Taylor rule as a policy instrument will result in a lower financial instability and higher macroeconomic instability. On average, to get a 70% lower financial stability, inflation instability needs to be 60% higher, and output stability needs to be 160% higher. The instability of house prices, capital asset prices and the foreign loan to output ratio are also significantly lower for all types of the Taylor rule. Only the real exchange rate instability is shown to be higher. Based on total stability, the best option is to implement the Taylor rule that has been augmented with the reaction to the growth of loan to output ratio.

In order to achieve better performance in financial stability, the policy rate need to respond less to output dynamics, which is reflected by the smaller value of parameter ϕ_Y . This will result in a higher decline in output and inflation, which contributes to changes in the composition of loans distributed by the banks. With a much lower deposit collection, caused by lower output, banks need to maximise their profit by distributing loans to the more profitable sector (the one with a higher interest rate spread), which is households' loans. This will lead to a lower loans distribution to entrepreneurs. Total loan intermediation is restricted in this scenario, shown by a decline in the loan to deposit ratio and an increase in banks' liquid asset. All types of Taylor rules can counteract the procyclicality of the banking sector in fuelling the growth of domestic demand due to the capital inflow shock. However, since output is already declining from decreasing net export, a lower domestic demand will result in an even lower output. In addition, changes in the composition of loans distributed by the banks also contribute to the lower output by decreasing capital investments.

Table 18: Macroeconomic and Financial Stabilisation Performance of Model with Only Monetary Policy in Facing Capital Inflow Shock

	Variances of		Macroeconomic Instability	Financial Instability	Total Instability
	Inflation	Output			
Optimised for Macroeconomic Stability					
Standard Taylor Rule	2.01	42.01	23.02	256.97	279.98
Optimised for Macroeconomic and Financial Stability					
Standard Taylor Rule	3.17 (57.75)	114.03 (171.43)	60.19 (161.50)	88.15 (-65.7)	148.34 (-47.02)
Taylor Rule Augmented with Exchange Rate Growth	3.21 (59.85)	116.73 (177.86)	61.58 (167.56)	90.76 (-64.68)	152.34 (-45.59)
Taylor Rule Augmented with Loan to Output Growth	3.26 (62.03)	102.92 (144.97)	54.71 (137.73)	71.11 (-72.33)	125.82 (-55.06)
Taylor Rule Augmented with Asset Price Growth	3.32 (65.13)	105.58 (151.30)	56.11 (143.78)	74.92 (-70.85)	131.02 (-53.20)

Note: The variances, macroeconomic instability, financial instability and total instability are expressed as the ratio to the variance of the exogeneous shock. The values in the bracket show percentage difference of the variance/instability with the one acquired from the model with the Taylor rule that has been optimised for only macroeconomic stability. The values in red indicate an increase in the instability while the values in blue indicate a decrease in the instability.

Table 19: Parameter Values (Capital Inflow Shock)

	ϕ_π	ϕ_Y	ϕ_s	$\phi_{B/Y}$	ϕ_{ap1}	ϕ_{ap2}
Optimised for Macroeconomic Stability						
Standard Taylor Rule	2.012	0.368				
Optimised for Macroeconomic and Financial Stability						
Standard Taylor Rule	2.018	0.074				
Taylor Rule Augmented with Exchange Rate Growth	2.018	0.077	0.243			
Taylor Rule Augmented with Loan to Output Growth	2.012	0.069		0.517		
Taylor Rule Augmented with Asset Price Growth	2.015	0.072			0.494	0.511

Note: ϕ_π. Is the parameter governing the response of the policy rate to inflation; ϕ_Y is the parameter governing the response of the policy rate to output; ϕ_s is the parameter governing the response of the policy rate to the exchange rate growth; $\phi_{B/Y}$ is the parameter governing the response the of the policy rate to the growth in the loan to output ratio; ϕ_{ap1} is the parameter governing the response of the policy rate to capital asset price growth relative to housing asset price growth; ϕ_{ap2} is the parameter governing the response of the policy rate to asset (capital and housing) prices' growth.

Table 20: Instabilities of other Variables of Interest (Capital Inflow Shock)

	Variances of			
	Real Exchange Rate	House Price	Capital Asset Price	Foreign Loan to Output Ratio
Optimised for Macroeconomic Stability				
Standard Taylor Rule	30.22	105.93	8.18	181.37
Optimised for Macroeconomic and Financial Stability				
Standard Taylor Rule	41.21 (36.35)	97.63 (-7.84)	3.64 (-55.47)	172.18 (-5.07)
Taylor Rule Augmented with Exchange Rate Growth	40.42 (33.73)	97.99 (-7.50)	3.32 (-59.41)	172.98 (-4.63)
Taylor Rule Augmented with Loan to Output Growth	44.55 (47.39)	95.95 (-9.42)	4.83 (-40.96)	168.13 (-7.30)
Taylor Rule Augmented with Asset Price Growth	43.56 (44.13)	96.17 (-9.22)	4.37 (-46.50)	168.65 (-7.02)

Note: The variances are expressed as the ratio to the variance of the exogeneous shock. The values in the bracket show percentage differences of the variance with the one acquired from the model with Taylor rule that has been optimised for only macroeconomic stability. The values in red indicate an increase in the instability while the values in blue indicate a decrease in the instability.

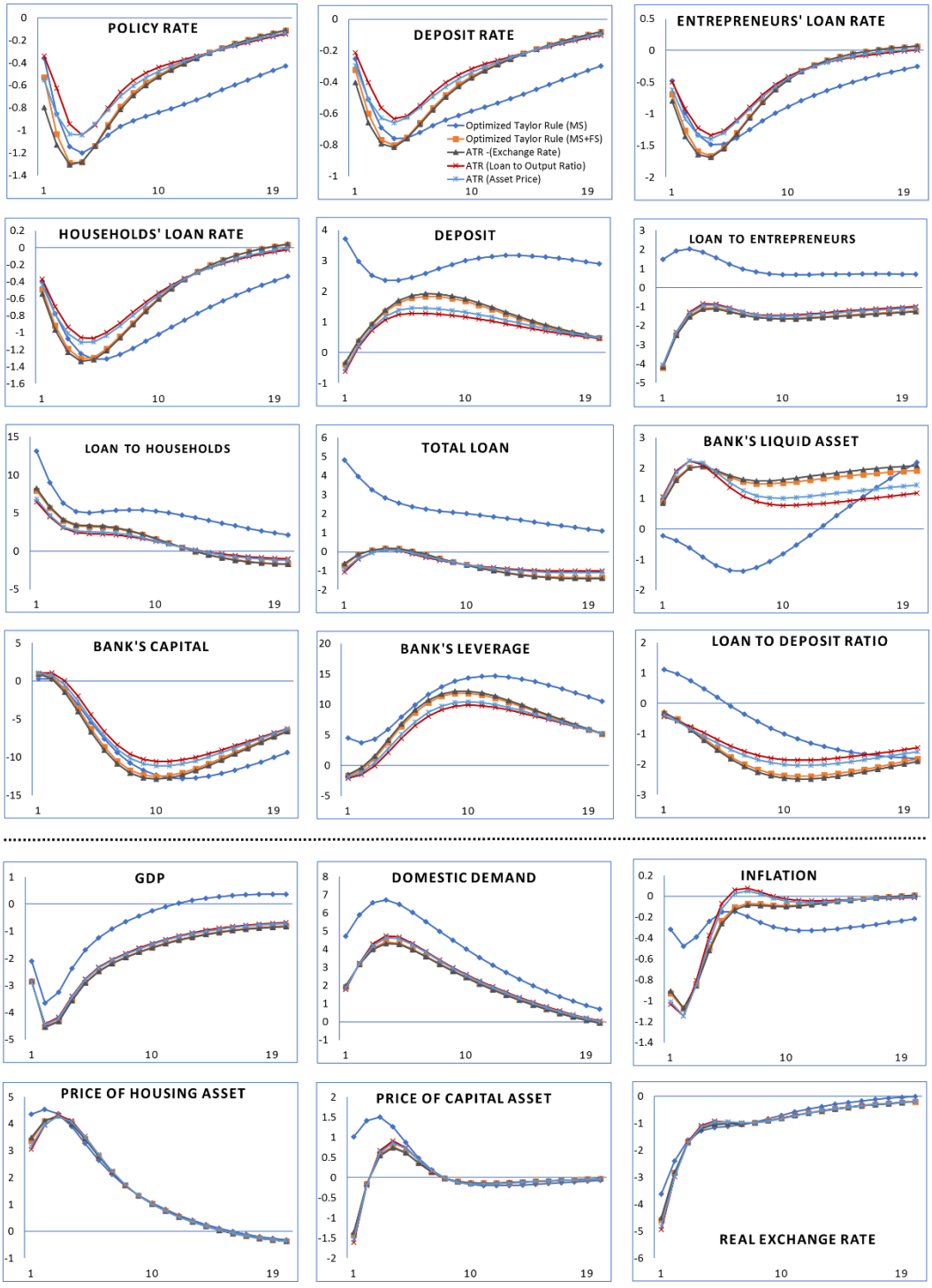


Figure 16: Impulse Responses of Model with Only Policy Rate – Capital Inflow Shock

Notes: The figure reports the impulse responses to a one percent negative shock to the country's risk premium. For interest rate variables, the figure shows absolute deviations from the steady state in percentage points. For other variables, it shows percent deviations from the steady state. ATR is Augmented Taylor Rule. MS is Macroeconomic Stability and FS is Financial Stability.

3.6.2. The Role of Macroprudential and Capital Flow Management Policies

In this scenario, the central bank can utilise one or more countercyclical rules along with the Taylor rule to achieve its objective of minimising the loss function.

The stabilisation performance of implementing the countercyclical leverage ratio policy is very similar to the results from the previous scenario. In order to increase its capital (achieved by accumulating profit) to meet the new leverage requirement, banks decide to divert loan distribution to the more profitable sector which is households' loans. This will result in an increase in the house prices and a decrease in the capital asset prices. In addition, fewer loans distribution to entrepreneurs will lead to a lower capital investment that will contribute to lowering output. The mechanism in which the banks change their balance sheet composition is almost the same as in the previous scenario, which explains the similar results. In terms of total stability, the performance of implementing countercyclical leverage ratio rule is still lower than when the central bank implements the Taylor rule augmented with the growth of loan to output ratio.

To study the effect of the speed of the banks' leverage adjustment on the effectiveness of the policy strategy that utilises the leverage ratio rule, I use different calibration values for the parameter κ_l and compare the stabilisation performance of the policy strategy to the one that implements the loan to output ratio augmented Taylor rule. Figure 19 shows that the changes in the parameter value do not have a significant effect on the stabilisation performance of the policy strategy that utilises the leverage ratio rule. In all parameter values considered, the stabilisation performance of the strategy is below the performance of the one that utilises the loan to output ratio augmented Taylor rule. This shows that the effectiveness of utilising the leverage ratio rule when the economy is facing a capital inflow shock does not depend on the speed of the banks' leverage adjustment.

A significantly better performance is given by implementing the countercyclical LTV ratio rules along with the Taylor rule. Both macroeconomic and financial instability are lower than in the case of only utilises the Taylor rule optimised for macroeconomic stability. This performance is achieved by very aggressive responses of the LTV rules to their trigger variables (each sector's loan to output gap). In contrast with the results from the previous scenario, implementing these rules results in a higher instability of house price, capital asset price and the foreign loan to output ratio. On the other hand, the instability of the real exchange rate is lower. Impulse responses in Figure 18 show us that the objective is achieved by restricting lending, both to households' and

entrepreneurs. Although the loan to deposit ratio is declining, but banks' liquid asset is also declining, which indicates fewer deposits collection. The reason for this is because patient households choose to increase their accumulation of housing and capital assets which drive up their prices. The increase in asset prices will force the LTV rules to respond even more to restrict lending to borrowers. Although it has better performance in terms of total instability, these rules fail to address the source of the initial problem, which is an increase in foreign borrowing. They are effective in reducing the pro-cyclicality of the banking sector, but in doing so, they divert the liquidity into fuelling the increase in asset prices.

When the central bank implements the capital inflow tax rule, it manages to suppress foreign borrowing and significantly reduce the amount of liquidity coming into the economy. This is reflected in a much lower instability in all variables of interest except for output. The reason for this is that the rule is not designed to specifically deal with the imbalances in the banking sector. In this case, the imbalances are coming from changes in the composition of loans that cause a lower output.

Significantly better results, in terms of lowering all instability of the variables of interest, can be achieved by combining the Taylor rule, the LTV ratio rules, and the capital inflow tax rule. Although total instability only slightly increases, these combinations can manage to avoid the diversion problems that happen when the central bank only combines one of the two countercyclical rules. The capital inflow tax rule can manage to decrease foreign borrowing coming into the economy, while the LTV ratio rules can deal with the imbalances in the financial sector. Implementing two additional countercyclical rules also allows the Taylor rule to be more responsive toward the changes in inflation. The optimised Taylor rule parameter is greater for the inflation response and smaller for the output response, compared to the baseline scenario.

The same results cannot be achieved by combining the Taylor rule, the leverage ratio rule and the capital inflow tax rule. The overall performance of this strategy is very similar to the case of combining the Taylor rule and the capital inflow tax rule.

From all policy strategies in the first and second scenario, the ones that include the capital flow management policy can significantly suppress the appreciation of the exchange rates caused by the reduction in the country's risk premium. The effect on the exchange rates translates into a different effect on the profit of exporters and

importers[70]. The appreciation of the exchange rates will increase the demand for import, while at the same time, decrease the demand for exports. The effect on these agents' profit is also caused by the existence of price rigidities in both the export and import markets. Exchange rates appreciation reduces the cost for importers and, without the same reduction in the price of imported goods paid by the domestic consumers, will increase importers' profit. While for exporters, exchange rate appreciation reduces their income in the domestic currency value due to the slow price adjustment in the export market. Implementing the capital inflow tax, either combined only with the Taylor rule or also with another countercyclical macroprudential policy, can significantly reduce the variances of the exchange rates which resulted in significant reductions in the variances of importers and exporters' profits.

Given the performance of the countercyclical LTV rule in reducing financial instability, I experiment with an alternative scenario where the values of the trigger parameters of the LTV rules are significantly smaller. In this scenario, the countercyclical LTV parameters are not optimised and set to certain values[71], while the parameters for the Taylor rule and another countercyclical rule are optimised. I use different values for the pair of parameters $[\phi_{mi}, \phi_{me}]$ to simulate different target level of financial stability. There are three policy strategies in this scenario. The first one is a combination of non-optimised LTV rules with the Taylor rule and the capital inflow tax rule. The last two rules are jointly optimised for macroeconomic and financial stability. The other two strategies are combinations of the non-optimised LTV rules and the Taylor rule. The difference between the two strategies is in the way of optimising the Taylor rule parameters: (1) only for macroeconomic stability or (2) for macroeconomic and financial stability. The objective of the experiment is to find the condition in which we get higher financial stability with less cost on macroeconomic stability or other measures of financial stability that are not included in the loss function.

[70] Additional impulse responses for the first and second scenario which include the effect of capital inflow shock on foreign borrowing, import, export, profit of importers, profit of exporters and profit of domestic retailers are in Appendix 2 - 5.
[71] The values of the parameters ϕ_{mi} and ϕ_{me} are kept in the same proportion as the optimised values from the policy strategy that combines the Taylor rule and the LTV ratio rules.

Table 21: Macroeconomic and Financial Stabilisation Performance of Model with Monetary, Macroprudential and Capital Flow Management Policy in Facing Capital Inflow Shock

	Variances of		Macroeconomic Instability	Financial Instability	Total Instability
	Inflation	Output			
Optimised for Macroeconomic and Financial Stability					
Taylor Rule and Leverage Ratio Policy	2.85 (42.05)	115.53 (175)	60.62 (163.4)	84 (-67.31)	144.62 (-48.35)
Taylor Rule and LTV Ratio Policy	0.94 (-53.13)	36.87 (-12.24)	19.38 (-15.81)	0.01 (-100)	19.39 (-93.1)
Taylor Rule and CFM Policy	0.53 (-73.75)	54.27 (29.17)	27.66 (20.2)	55.92 (-78.24)	83.59 (-70.15)
Taylor Rule, LTV Ratio and CFM Policy	0.66 (-67.13)	18.25 (-56.56)	9.78 (-57.5)	9.31 (-96.4)	19.10 (-93.2)
Taylor Rule, Leverage Ratio and CFM Policy	0.53 (-73.81)	53.29 (26.84)	27.17 (18.05)	53.08 (-79.35)	80.25 (-71.34)

Note: The variances, macroeconomic instability, financial instability and total instability are expressed as the ratio to the variance of the exogeneous shock. The values in the bracket show percentage difference of the variance/instability with the one acquired from the model with the Taylor rule that has been optimised for only macroeconomic stability. The values in red indicate an increase in the instability while the values in blue indicate a decrease in the instability.

Table 22: Parameter Values-2 (Capital Inflow Shock)

	ϕ_π	ϕ_Y	ϕ_{mi}	ϕ_{me}	ϕ_ψ	ϕ_τ
Optimised for Macroeconomic and Financial Stability						
Taylor Rule and Leverage Ratio Policy	2.085	0.075			0.521	
Taylor Rule and LTV Ratio Policy	2.003	0.483	425.4	380.9		
Taylor Rule and CFM Policy	2.108	0.070				1.197
Taylor Rule, LTV Ratio and CFM Policy	2.135	0.140	5.009	5.021		1.194
Taylor Rule, Leverage Ratio, and CFM Policy	2.105	0.071			0.524	1.197

Note: ϕ_π. is the parameter governing the response of the policy rate to inflation; ϕ_Y is the parameter governing the response of the policy rate to output; ϕ_{mi} is the parameter governing the response of the households' LTV ratio requirement to changes in the gap of households' loan to output ratio; ϕ_{me} is the parameter governing the response of the entrepreneurs' LTV ratio requirement to changes in the gap of entrepreneurs' loan to output ratio; ϕ_ψ is the parameter governing the response of the leverage ratio requirement to changes in the gap of loan to output ratio; ϕ_ψ is the parameter governing the response of the capital inflow tax to changes in the gap of foreign loan to output ratio

Table 23: Instabilities of other Variables of Interest-2 (Capital Inflow Shock)

	Variances of			
	Real Exchange Rate	House Price	Capital Asset Price	Foreign Loan to Output Ratio
Optimised for Macroeconomic and Financial Stability				
Taylor Rule and Leverage Ratio Policy	40.23 (33.11)	98.19 (-7.31)	3.36 (-58.94)	174.96 (-3.54)
Taylor Rule and LTV Ratio Policy	25.34 (-16.15)	111.63 (5.38)	9.53 (16.59)	205.54 (13.33)
Taylor Rule and CFM Policy	14.20 (-53.01)	34.32 (-67.61)	2.20 (-73.06)	2.88 (-98.41)
Taylor Rule, LTV Ratio and CFM Policy	21.46 (-29)	37.78 (-64.34)	2.02 (-75.28)	4.95 (-97.27)
Taylor Rule, Leverage Ratio and CFM Policy	14.25 (-52.85)	34.24 (-67.68)	2.06 (-74.84)	2.87 (-98.42)

Note: The variances are expressed as the ratio to the variance of the exogeneous shock. The values in the bracket show percentage differences of the variance with the one acquired from the model with the Taylor rule that has been optimised for only macroeconomic stability. The values in red indicate an increase in the instability while the values in blue indicate a decrease in the instability.

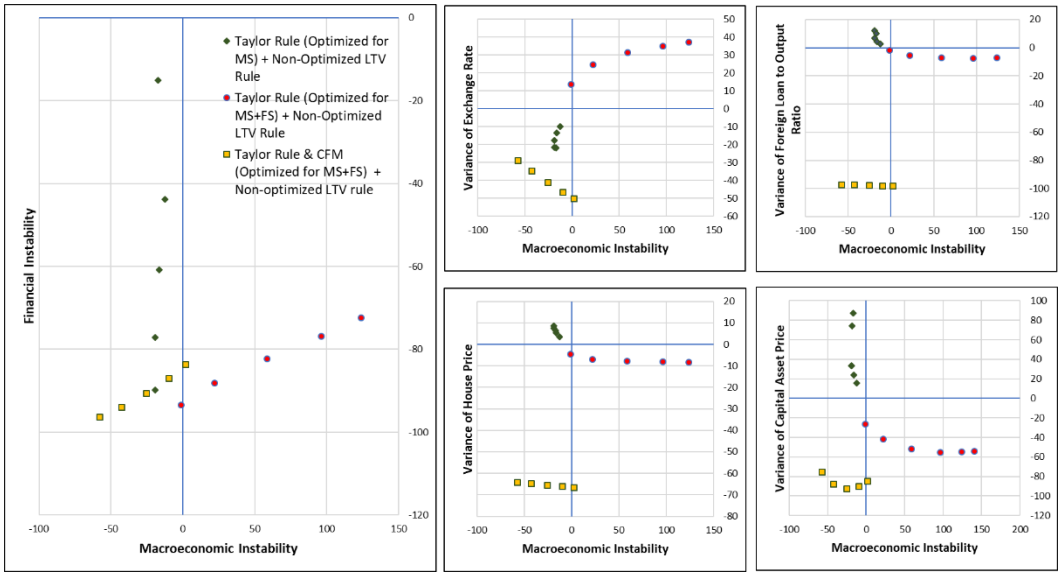


Figure 17: Stabilisation Performance of Models in Alternative Scenario (Capital Inflow Shock)

Notes: Variances, Macroeconomic Instability, and Financial Instability are expressed as percentage differences of the instability/variance with the one acquired from the model with the Taylor rule that has been optimised for only macroeconomic stability. Positive values indicate an increase in the instability/variance while negative values indicate a decrease in the instability. MS is Macroeconomic Stability. FS is Financial Stability. The values of ϕ_{mi} and ϕ_{me} used for the figure are : $[\phi_{mi} = 5, \phi_{me} = 5]$, $[\phi_{mi} = 2.5, \phi_{me} = 2.5]$, $[\phi_{mi} = 1.25, \phi_{me} = 1.25]$, $[\phi_{mi} = 0.625, \phi_{me} = 0.625]$ and $[\phi_{mi} = 0.3125, \phi_{me} = 0.3125]$.

Table 24: Macroeconomic and Financial Stabilisation Performance of Model with Monetary, Macroprudential and Capital Flow Management Policy in Facing Capital Inflow Shock (Alternative Scenario)

	Variances of		Macroeconomic Instability	Financial Instability	Total Instability
	Inflation	Output			
Alternative Scenario					
Standard Taylor Rule (MS) + Non-optimised LTV $[\boldsymbol{\phi_{mi} = 5, \phi_{me} = 5}]$	1.31 (-34.87)	34.62 (-17.59)	18.62 (-19.1)	26.3 (-89.77)	44.92 (-83.96)
Standard Taylor Rule (MS+FS) + Non-optimised LTV $[\boldsymbol{\phi_{mi} = 5, \phi_{me} = 5}]$	1.81 (-9.98)	41.79 (-0.52)	22.7 (-1.35)	16.92 (-93.41)	39.63 (-85.85)
Standard Taylor Rule & CFM (MS+FS) + Non-optimised LTV $[\boldsymbol{\phi_{mi} = 5, \phi_{me} = 5}]$	0.66 (-67.23)	18.23 (-56.61)	9.77 (-57.54)	9.36 (-96.36)	19.13 (-93.17)

Note: The variances, macroeconomic instability, financial instability and total instability are expressed as the ratio to the variance of the exogeneous shock. The values in the bracket show percentage difference of the variance/instability with the one acquired from themodel with the Taylor rule that has been optimised for only macroeconomic stability. The values in red indicatean increase in the instability while the values in blue indicatea decrease in the instability.

Table 25: Instabilities of other Variables of Interest-Alternative Scenario (Capital Inflow Shock)

	Variances of			
	Real Exchange Rate	House Price	Capital Asset Price	Foreign Loan to Output Ratio
Alternative Scenario				
Standard Taylor Rule (MS) + Non-optimised LTV $[\boldsymbol{\phi_{mi} = 5, \phi_{me} = 5}]$	23.75 (-21.42)	115.08 (8.63)	10.91 (33.5)	203.08 (11.97)
Standard Taylor Rule (MS+FS) + Non-optimised LTV $[\boldsymbol{\phi_{mi} = 5, \phi_{me} = 5}]$	34.30 (13.50)	100.98 (-4.68)	6.01 (-26.48)	178.41 (-1.63)
Standard Taylor Rule & CFM (MS+FS) + Non-optimised LTV $[\boldsymbol{\phi_{mi} = 5, \phi_{me} = 5}]$	21.44 (-29.07)	37.78 (-64.34)	2.02 (-75.25)	4.94 (-97.28)

Note: The variances are expressed as the ratio to the variance of the exogeneous shock. The values in the bracket show percentage difference of the variance with the one acquired from the model with the Taylor rule that has been optimised for only macroeconomic stability. The values in red indicate an increase in the instability while the values in blue indicate a decrease in the instability.

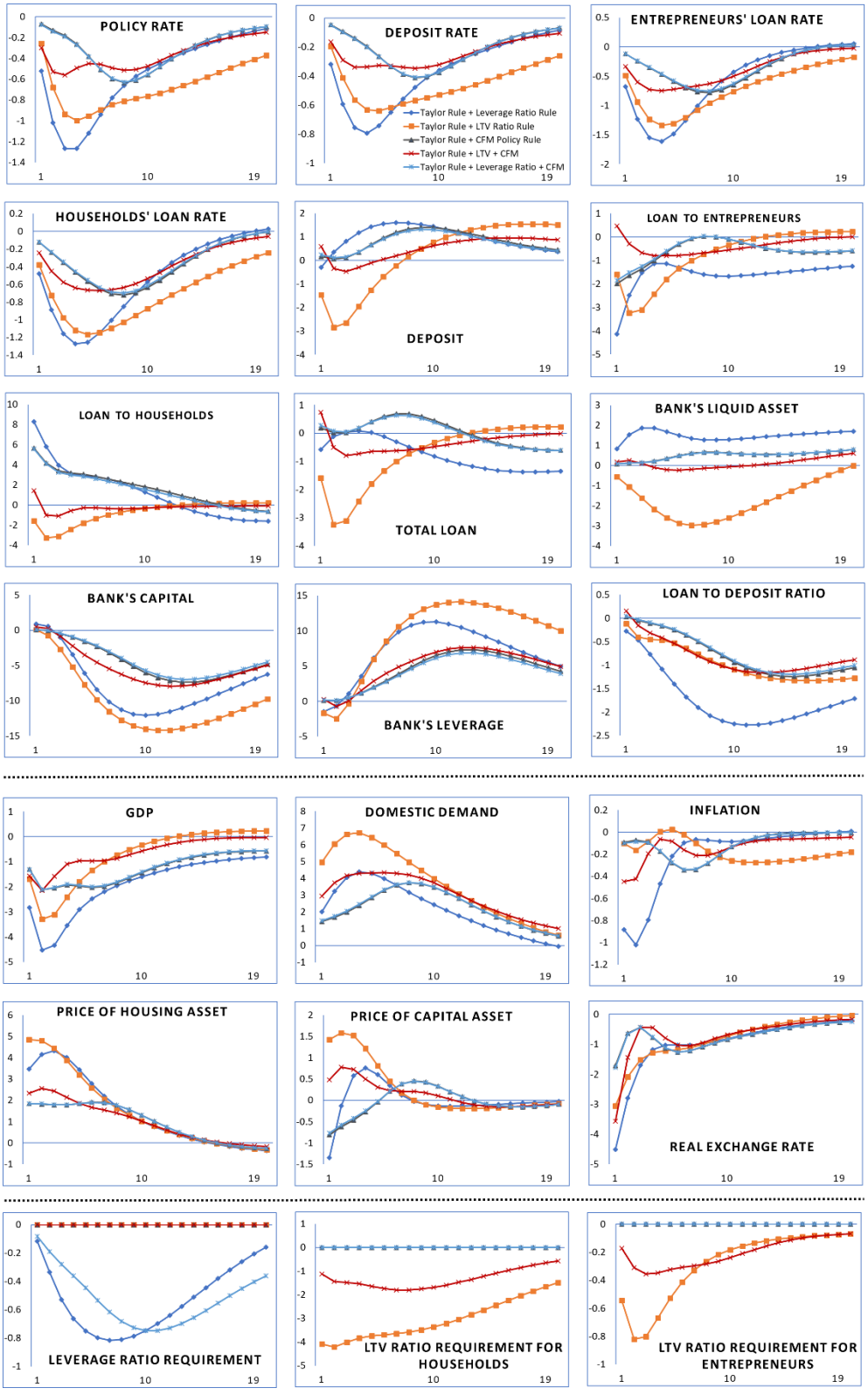


Figure 18: Impulse Responses of Model with Policy Rate, LTV Ratio Requirement, Leverage Ratio Requirement and Capital Flow Management – Capital Inflow Shock

Notes: The figure reports the impulse responses to a one percent negative shock to the country's risk premium. For interest rate variables and LTV ratio requirements, the figure shows absolute deviations from the steady state in percentage points. For other variables, it shows percent deviations from the steady state. MS is Macroeconomic Stability, and FS is Financial Stability.

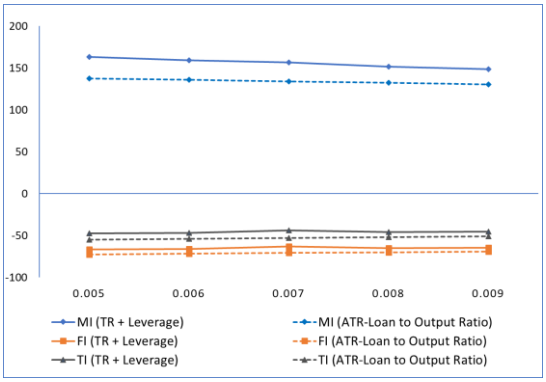


Figure 19: Stabilisation Performance of Models with Different Speed of Banks' Leverage Adjustment (Capital Inflow Shock)

Notes: The horizontal axis shows the values of κ_L (the parameter that governs the speed of adjustment of bank's leverage to changes in the leverage target/requirement). The vertical axis shows the percentage difference of macroeconomic, financial and total instability values with the one acquired from the model with the Taylor rule that has been optimised for only macroeconomic stability. MI is Macroeconomic Instability. FI is Financial Instability. TI is Total Instability. TR is Taylor Rule. ATR is Augmented Taylor Rule.

Figure 17 shows the performance of the three policy strategies in the alternative scenario. The implementation of the policy strategy that combines the Taylor rule, the capital inflow tax rule and the non-optimised LTV rules result in the best overall performance, compared to the other two strategies. The stronger the response of the LTV rules' parameters to changes in the trigger variables, the better the performance of the strategy. This particular strategy can be implemented by the central bank as an alternative for the one in the second scenario that combines the Taylor rule, the LTV rules, and the capital inflow tax rule that are jointly optimised for macroeconomic and financial stability. Especially, if the central bank decides to have a certain target reduction in the loan to output ratio, instead of the optimal reduction[72].

The second policy strategy in the alternative scenario is the one in which the Taylor rule is optimised for only macroeconomic stability. This strategy shows a similar performance with the one in the second scenario that jointly optimised the Taylor rule and the LTV rules for macroeconomic and financial stability. These two strategies managed to increase both macroeconomic and financial stability but at the cost of reductions in the stability of asset prices. The similarities between the two strategies may be counterintuitive at first, but it can be explained by the similarities of how the Taylor rule parameters are (effectively) optimised. When the central bank implements the policy strategy that jointly optimised the Taylor rule and the LTV rules for macroeconomic and financial stability, due to the significant effect of the (very responsive) LTV rules on financial stability, the optimised Taylor rule parameters are

[72] It may be caused by conflicting microprudential concerns, political pressures or other reasons.

effectively optimised for only macroeconomic stability. The last policy strategy in the alternative scenario is the one in which the central bank combines the non-optimised LTV rules and the Taylor rule that has been optimised for macroeconomic and financial stability. For a relatively stronger response of the LTV rules[73], this policy strategy can increase both macroeconomic and financial stability at the cost of a reduction in the stability of the exchange rates. When the capital flow management policy cannot be implemented by the central bank[74], it can choose to implement the last two strategies in the alternative scenario for a certain target reduction in financial instability. These policy strategies may be the better option than the one in the second scenario in which the central bank jointly optimised the Taylor rule and the LTV rules for macroeconomic and financial stability. The decision in choosing the two strategies is based on:

1. The trade-off between the reduction in financial instability (measured as the variance of the loan to output ratio) and the increase in instability of the other variables of interest.
2. The central bank assessment on the level of financial vulnerabilities related to the trade-off.

3.7. Conclusion

The objective of this chapter is to study the interaction of monetary, macroprudential and capital flows management policies in stabilising the economy when facing shocks that lead to surges of capital inflows. I extend the small open economy model that features the characteristics of the emerging Asian economies to include a capital flow management measure.

The model simulation shows that a capital inflow tax can have the potential to counteract the increase in foreign borrowing that happens after the shock to the country's risk premium. Without the objective of trying to reduce capital inflow, the implementation of a capital inflow tax may have a negative effect on macroeconomic and financial stability.

Without the addition of macroprudential or capital flow management measures, financial stability in the economy will benefit from a monetary policy that leans against the growth of loan to output ratio. The inclusion of macroprudential policy in the form of a countercyclical loan to value (LTV) ratio rule can significantly dampen the

[73] $[\phi_{mi} \geq 5, \phi_{me} \geq 5]$
[74] Due to the unavailability of the policy infrastructures or other reasons.

effect of the shocks by reducing the procyclicality of the domestic financial sector. Unfortunately, it has the adverse effect of diverting liquidity into fuelling growth in the asset prices. Instead of implementing this strategy, the central bank may be better of implementing one of the two policy strategies that combine the non-optimised LTV ratio rules and the optimised Taylor rule (either only for macroeconomic stability or also for financial stability). A significantly better macroeconomic and financial stabilisation is achieved by combining the Taylor rule, the LTV ratio rules, and the capital flow management rule.

Chapter 4: Households' Loans and Financial Stability

4.1. Introduction

Crises in the banking sector often started in the real estate sector[75]. As the experiences from the global financial crisis have shown, an increase in the housing sector's default rate is not only the result of an economic downturn but can also be the source[76].

Households' loans, which mostly consist of mortgage/property loans have been growing rapidly in emerging Asian economies in the recent times[77]. The increasing share of households' loans in the banking sector's balance sheet warrants the need for the policymakers to assess the possibility of financial imbalances that may arise from the sudden increase in the default rate of the households' loans.

In the previous chapters, I utilise a small open economy DSGE model with financial frictions in the form of collateral constraints and an explicit banking sector to study the interaction of monetary and macroprudential policies. As many of the variants of the Iacoviello (2005) model, this model does not include an endogenous default mechanism which excludes it from being used to study the transmission of the borrowers' default shocks and the role of monetary and macroprudential policies in mitigating the effect of the shocks.

One of the ways to approach this limitation is by defining the default shock as a shock that has a negative impact on the level of the banks' capital. This approach is utilised by Gerali et al. (2010) and Angelini et al. (2014). They found that the shock has a significant negative impact on output and inflation since it forces banks to deleverage, increase the loan rates, and restrict lending. Based on their simulations, monetary policy is not a sufficient tool for macroeconomic stabilisation and adding a countercyclical capital requirement can increase output stability.

Focusing on the redistribution of wealth that occurs in the event of default, Iacoviello (2014) defines the default shock as a simultaneous shock that affects the borrowers and the financial intermediaries in the opposite manner: a negative shock to the financial intermediaries and a positive shock to the borrowers. Model simulations show that the shock has a long-lasting negative effect on business activities.

[75] Bordo and Jeanne (2002), Reinhart and Rogoff (2009) and Gerlach (2012)
[76] Forlati and Lambertini (2011)
[77] Mohanty and Turner (2010), Morgan and Zhang (2015) and Schularick and Shim (2017)

One of the important contributing factors of the global financial crisis is the financial sector's failure in assessing the risk and the cost of default. Among the reasons for this is the assumption of constant recovery rates of the defaulting loans. Empirical evidence suggests that the recovery rates are correlated with the financial cycle[78]. Based on this, Choi and Cook (2012) extends the financial accelerator model[79] to allow the recovery rates to be negatively correlated with the default rates so that the bank can suffer a loss from selling the collateral assets at fire sale prices. They study the role of government liquidity subsidy in reducing the liquidity spiral caused by a default shock.

The objective of this Chapter is to study the propagation process of households' loan default shocks to the overall economy and the role of monetary and macroprudential policies to stabilise the economy after the occurrence of the shock. I extend the small open economy DSGE model from Chapter 2 with a more comprehensive transmission of the borrowers' default shocks through changes in both the borrowers and the financial intermediaries' balance sheets. The model features costly liquidation services that cause negative correlations between the recovery rates and the default rates which triggers losses to the financial intermediaries in the occurrence of defaults. It is important to note that the extension made to the model is not to add an endogenous default with a feedback mechanism with other endogenous variables. The focus is on the transmission of loan defaults and not on the trigger mechanism. The lack of endogenous feedback mechanism of loan defaults will understandably result in a less pronounced effect of defaults in this model compared to the ones that include endogenous defaults.

The remainder of the chapter is organised as follows. Section 2 describes the extension of the model to include the transmission of loan default. Section 3 describes the model calibration. Section 4 studies the propagation of the shock to the default rate of households' loan. Section 5 examines the optimal policy mix for macroeconomic and financial stability. Section 6 concludes.

4.2. Model Description: Addition of Loan Default Transmission

The model includes all the agents as in the previous chapters, which are patient households, who are the savers in the domestic economy, impatient households and the entrepreneurs who are the borrowers, and banks as the financial intermediaries.

[78] Bruche and Gonzalez-Aguado (2010)
[79] Bernanke et al. (1999)

Bank lending to borrowers are non-recourse and are backed by collateral, which includes housing assets for the impatient households and capital assets for the entrepreneurs. For each type of borrowers, the amount of the loans is linked to the expected value of the collateral assets they own multiplied by the Loan to Value (LTV) ratio requirement which is assumed to be determined by the central bank as one of the macroprudential policy measures.

The main difference with the models in the previous chapters is the assumption that, in each period, a fraction of borrowers decides to default on their loans and must suffer the consequences of losing their collateral assets. Since the focus of this chapter is mainly on the transmission after the event of default, I take an agnostic approach and do not explicitly model the reason behind defaulting decision of the borrowers.

There are steady state loan default rates for each type of loans. The evolution of the realised loan default rates in each period is assumed to be exogenous, both from the borrowers and banks' point of view. Let ζ_t^I and ζ_t^E defined as the realised default rate for loans to impatient households and entrepreneurs, respectively. The evolutions of these rates are the following:

$$\zeta_t^I = \rho^{\zeta i}\zeta_{t-1}^I + \left(1-\rho^{\zeta i}\right)\zeta^I + \varepsilon_t^{\zeta i} \tag{60}$$

$$\zeta_t^E = \rho^{\zeta e}\zeta_{t-1}^E + \left(1-\rho^{\zeta e}\right)\zeta^E + \varepsilon_t^{\zeta e} \tag{61}$$

Both $\varepsilon_t^{\zeta i}$ and $\varepsilon_t^{\zeta e}$ are stochastic shocks with variance $\sigma^{\zeta i}$ and $\sigma^{\zeta e}$. The parameter $\rho^{\zeta i}$and $\rho^{\zeta e}$ govern the persistence of the realised loan default rates.

To accommodate aggregation, I assume that there are perfect insurances among each type of borrowers that allow them to consume and accumulate housing or capital asset equally across all members in each period after the realisation of default. Modification to impatient households' and entrepreneurs' budget constraints are necessary to include the realised default rate variables. The new (aggregate) budget constraints for both borrowers are the following:

$$C_t^I + q_t(H_t^I - (1-\delta_H)(1-\zeta_t^I)H_{t-1}^I) + (1+r_{t-1}^I)(1-\zeta_t^I)\frac{B_{t-1}^I}{\pi_t} = B_t^I + w_t^I L_t^I \tag{62}$$

$$C_t^E + q_t^K(K_t^E - (1-\delta_K)(1-\zeta_t^E)K_{t-1}^E) + w_t^P L_t^P + w_t^I L_t^I + (1+r_{t-1}^E)(1-\zeta_t^E)\frac{B_{t-1}^E}{\pi_t} + R_t^K K_{t-1}^P = \frac{P_t^E}{P_t} Y_t^E + B_t^E \quad (63)$$

Defaults only occur for the borrowers and not for the banks. The banks will suffer the consequences of the borrowers' default in the form of a decrease in profit due to the deviation between the expected and realised loss given default rates. To accommodate this mechanism, a modification is made to the banks' profit function. The new function will include a loss of income due to the defaults on some of the previous period loans and an additional income coming from the sale of acquired collateral from defaulted borrowers. It is assumed that the bank can only sell the acquired collaterals, not with the current market prices (q_t and q_t^K) but with the fire sale prices which are a fraction of γ_t^H and γ_t^K. The banks' current period profit[80] based on the previous loan distribution and deposit collection is:

$$\begin{aligned}\frac{\Pi_{t-1}^B}{\pi_t} = {} & (r_{t-1}^E)\frac{B_{t-1}^E}{\pi_t} + \left(r_t^I(j)\right)\frac{B_{t-1}^I}{\pi_t} + \left(r_t\ \right)\frac{B_{t-1}^{CB}}{\pi_t} - \left(r_t^d(j)\right)\frac{D_{t-1}}{\pi_t} \\ & - \frac{\kappa_L}{2}\left(\frac{B_{t-1}^E + B_{t-1}^I}{K_{t-1}^B} - \Psi_{t-1}\right)^2 \frac{K_{t-1}^B}{\pi_t} - \frac{\kappa_d}{2}\left(\frac{r_{t-1}^d}{r_{t-2}^d} - 1\right)^2 r_{t-1}^d \frac{D_{t-1}}{\pi_t} \\ & - \frac{\kappa_E}{2}\left(\frac{r_{t-1}^E}{r_{t-2}^E} - 1\right)^2 r_{t-1}^E \frac{B_{t-1}^E}{\pi_t} - \frac{\kappa_I}{2}\left(\frac{r_{t-1}^I}{r_{t-2}^I} - 1\right)^2 r_{t-1}^I \frac{B_{t-1}^I}{\pi_t} \\ & - \zeta_t^E(1+r_{t-1}^E)\frac{B_{t-1}^E}{\pi_t} - \zeta_t^I(1+r_{t-1}^I)\frac{B_{t-1}^I}{\pi_t} \\ & + q_t\ \gamma_t^H(1-\delta_H)(\zeta_t^I)H_{t-1}^I + q_t^K\gamma_t^K(1-\delta_K)(\zeta_t^E)K_{t-1}^E\end{aligned} \quad (64)$$

In determining the loan rates, the banks maximise their profit based on their expectation of the default rates and the fire sale rates.

Combining equation (64)[81] with the borrowing constraint for each type of borrowers (equation (7) and (11)) would result in the equation of the bank's expected profit[82]:

$$\begin{aligned}\Pi_t^B = {} & (r_t^E)B_t^E + (r_t^I)B_t^I + \left(r_t\ \right)B_t^{CB} - (r_t^d)D_t - \frac{\kappa_L}{2}\left(\frac{B_t^E + B_t^I}{K_t^B} - \Psi_t\right)^2 K_t^B \\ & - \frac{\kappa_d}{2}\left(\frac{r_t^d}{r_{t-1}^d} - 1\right)^2 r_t^d D_t - \frac{\kappa_E}{2}\left(\frac{r_t^E}{r_{t-1}^E} - 1\right)^2 r_t^E B_t^E \\ & - \frac{\kappa_I}{2}\left(\frac{r_t^I}{r_{t-1}^I} - 1\right)^2 r_t^I B_t^I - loss_t^E(1+r_t^E)B_t^E - loss_t^I(1+r_t^I)B_t^I\end{aligned} \quad (65)$$

[80] Aggregate version, after imposing symmetric equilibrium
[81] Moving it forward to the current period (t)
[82] Imposing binding collateral constraints

where the bank's expected losses given default (LGD) rate for each type of loans are defined as:

$$loss_t^I = E_t\left(\zeta_{t+1}^I\left(1-\frac{\gamma_{t+1}^H}{m_t^I}\right)\right) \tag{66}$$

$$loss_t^E = E_t\left(\zeta_{t+1}^E\left(1-\frac{\gamma_{t+1}^K}{m_t^E}\right)\right) \tag{67}$$

Based on the optimisation of equation (65), the optimal loan rates for each type of borrower are the following:

$$\begin{aligned} 1-\varepsilon^{bI}+\varepsilon^{bI}loss_t^I-loss_t^I+\frac{\varepsilon^{bI}}{r_t^I}r_t \;&+\kappa_L\frac{\varepsilon^{bI}}{r_t^I}\frac{B_t^E}{K_t^B}+\kappa_L\frac{\varepsilon^{bI}}{r_t^I}\frac{B_t^I}{K_t^B}-\kappa_L\frac{\varepsilon^{bI}}{r_t^I}\Psi_t+\frac{\varepsilon^{bI}}{r_t^I}loss_t^I \\ &=\kappa_I\left(\frac{r_t^I}{r_{t-1}^I}-1\right)\frac{r_t^I}{r_{t-1}^I}-\beta_P\,\frac{C_t^P}{C_{t+1}^P}\left(\kappa_I\left(\frac{r_{t+1}^I}{r_t^I}-1\right)\frac{B_{t+1}^I}{B_t^I}\left(\frac{r_{t+1}^I}{r_t^I}\right)^2\right) \end{aligned} \tag{68}$$

$$\begin{aligned} 1-\varepsilon^{bE}+\varepsilon^{bE}loss_{t+1}^E-loss_{t+1}^E+\frac{\varepsilon^{bE}}{r_t^E}r_t \;&+\kappa_L\frac{\varepsilon^{bE}}{r_t^E}\frac{B_t^E}{K_t^B}+\kappa_L\frac{\varepsilon^{bE}}{r_t^E}\frac{B_t^I}{K_t^B}-\kappa_L\frac{\varepsilon^{bE}}{r_t^E}\Psi_t \\ &+\frac{\varepsilon^{bE}}{r_t^E}loss_{t+1}^E \\ &=\kappa_E\left(\frac{r_t^E}{r_{t-1}^E}-1\right)\frac{r_t^E}{r_{t-1}^E}-\beta_P\,\frac{C_t^P}{C_{t+1}^P}\left(\kappa_I\left(\frac{r_{t+1}^E}{r_t^E}-1\right)\frac{B_{t+1}^E}{B_t^E}\left(\frac{r_{t+1}^E}{r_t^E}\right)^2\right) \end{aligned} \tag{69}$$

The above equations relate the banks' current optimal loan rates with the expected loss given default rates for each type of loans. With positive values of the steady state loss given default rates, the markup parameters (ε^{bI} and ε^{bE}) will be higher than when the steady state loss given default rates are zero. This translates to lower markups of the loan rates, given the same steady state values of the loan rates and the policy rate.

To accommodate the fire sale mechanism, I add two auxiliary agents which are the housing asset liquidators and the capital asset liquidators. They provide liquidation services and buy acquired collateral from the banks at the fire sale prices. The liquidators can sell the acquired collateral to the housing and capital producers at full prices (q_t and q_t^k). In order to do this, liquidators need to use a v^h and v^k quantity of liquidation service (LS_t^H and LS_t^K) per quantity of acquired collateral.

$$LS_t^H = v^h\zeta_t^I(1-\delta_H)H_{t-1}^I \tag{70}$$

$$LS_t^K = v^k \zeta_t^E (1 - \delta_K) K_{t-1}^E \quad (71)$$

Producing liquidation services require the utilisation of final goods (LQ_t^H and LQ_t^K) with the following production functions:

$$LS_t^H = Z^H (LQ_t^H)^{(1-\iota h)} \quad (72)$$

$$LS_t^K = Z^K (LQ_t^K)^{(1-\iota k)} \quad (73)$$

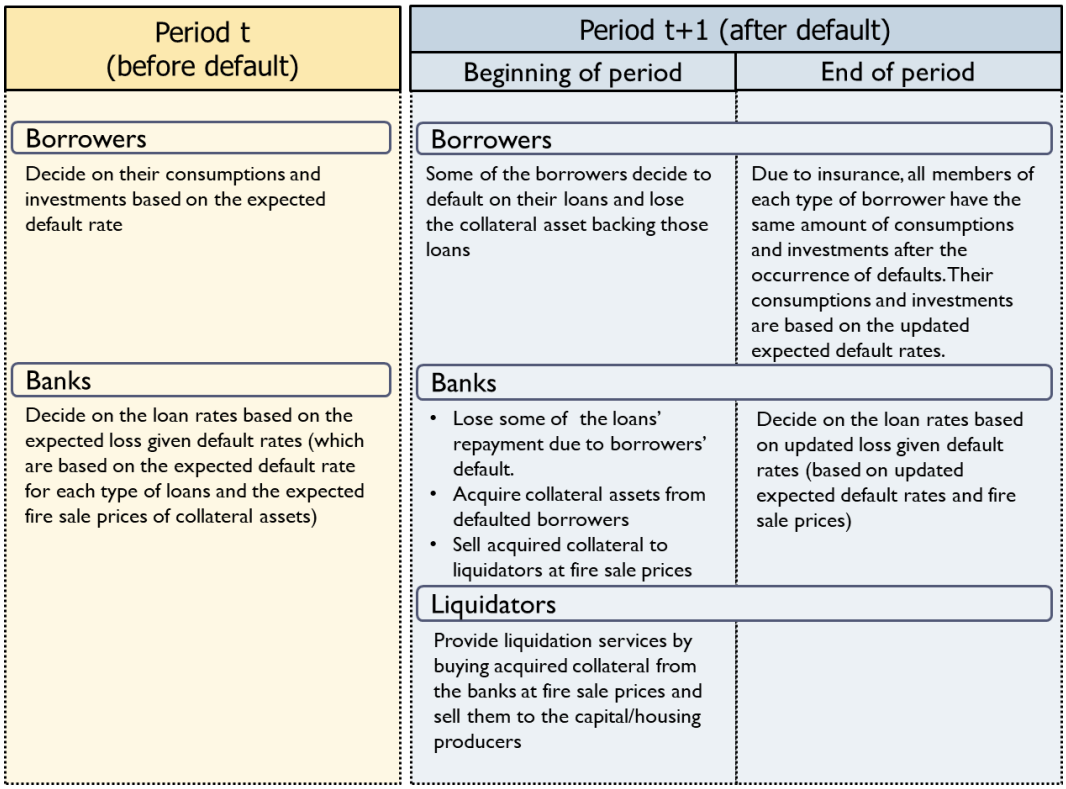


Figure 20 : Timeline of Defaults

I assume that liquidators operate in a competitive market which implies:

$$\gamma_t^H = \left(1 - \frac{p_t^{LH}(1 - \iota h)v^h}{q_t}\right) \quad (74)$$

$$\gamma_t^H = \left(1 - \frac{p_t^{LK}(1 - \iota k)v^k}{q_t^K}\right) \quad (75)$$

where p_t^{LH} and p_t^{LK} are the marginal costs of the liquidation services. These relationships will ensure a decrease in the fire sale rates when there is an increase in

the demand for liquidation services. In the realisation of a positive default shock, the bank's expected fire sale rates will be higher than the realised rates, resulting in a deviation between their expected and realised profit. In determining the current loan rates, the bank will use the information regarding the occurrence of defaults (and the changes in the fire sales rates) and will adjust their loan rates accordingly. This will result in an increase in the loan rates for the type of borrowers that are currently experiencing default.

The simple design of the loan default transmission and the short-term nature of the liquidation process in this extension are more applicable for studying the transmission of the shock to the default rate of households' loans. The relatively longer liquidation process of the entrepreneur's loans cannot be appropriately modeled using this framework. In addition, some of the emerging Asian economies still have issues regarding their default resolution[83] that may also prolong the process of liquidation which deviate significantly with the model's assumptions. Nevertheless, we can still gain insights from the application of this model to study the transmission of the households' loan default, which arguably plays a significant role during the global financial crisis[84].

4.3. Model Calibration

Most of the parameters and the steady state values of the variables are the same as the model in the previous chapters. I use 0.02 as the annual value of the default rate for entrepreneurs' loans that is in accordance with the default rate for investment loan in Indonesia. For the default rate of the households' loans, I use an annual value of 0.05 which is based on the default rate of Indonesia's property loans. The steady state values for the default rates are based on Indonesia data after the global financial crisis. These values are largely similar with the values of other emerging Asian economies (especially Thailand, The Philippines, and India) which have shown a significant decrease in the non-performing loan rates relative to the period after the Asian financial crisis[85].

The fire sale rate for the entrepreneur's loans is calibrated based on an 82% recovery rate[86] , while the fire sale rate for the households' loans is based on a 30%

[83] See IMF (2012) for an example.
[84] Iacoviello and Neri (2010)
[85] See BIS (2016), Estrada et al. (2015), IMF (2016), and Morgan and Yan (2015).
[86] $\left(\frac{\gamma^K}{m^E}\right)$

loss given default rate[87]. Following Choi and Cook (2012), I use the same values for both parameter ι_h and ι_k which is 0.27 to match the volatility of the recovery rate. I normalised Z^H and Z^K so that the steady state p_t^{LH} and p_t^{LK} are equal to 1. The value of $\rho^{\zeta i}$and $\rho^{\zeta e}$ is set at 0.9 to simulate persistence in the default rates and to compensate for the fact that there is no endogenous default mechanism in the model[88].

4.4. Transmission of Household's Loan Default Shock

Figure 22 shows that an unanticipated shock to the households' loan default rate will result in a decrease in banks' profit that will reduce their capital and restrict their ability to provide loans to all borrowers.

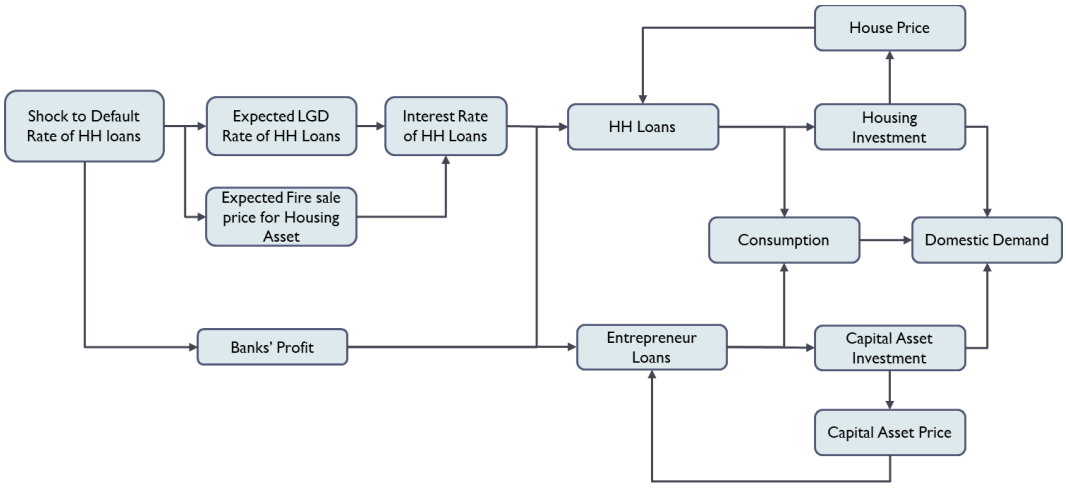


Figure 21: Transmission of Shock to the Default Rate of Households' Loans

The realisation of default will change the bank's loss given default value for the household's loans which is reflected by the increase in the loan rate to the households. This increase is quite significant, especially if we compare it with the dynamics of loan rates to entrepreneurs and the policy rate. Although we see a divergence between the two loan rates, we do not observe any diversion of the loan distribution towards entrepreneurs. The reason for this is because the loss of banks' profit forces them to deleverage and decrease their loan to deposit ratio.

A reduction in the loan distribution to both borrowers will have a negative impact on their ability to consume and accumulate housing or capital asset. This will result in a decrease in the price of both assets that will further decrease loans distribution to

[87] Qi and Yang (2008).
[88] Iacoviello (2014)

the borrowers. The decrease in consumption and investment will result in a reduction of output.

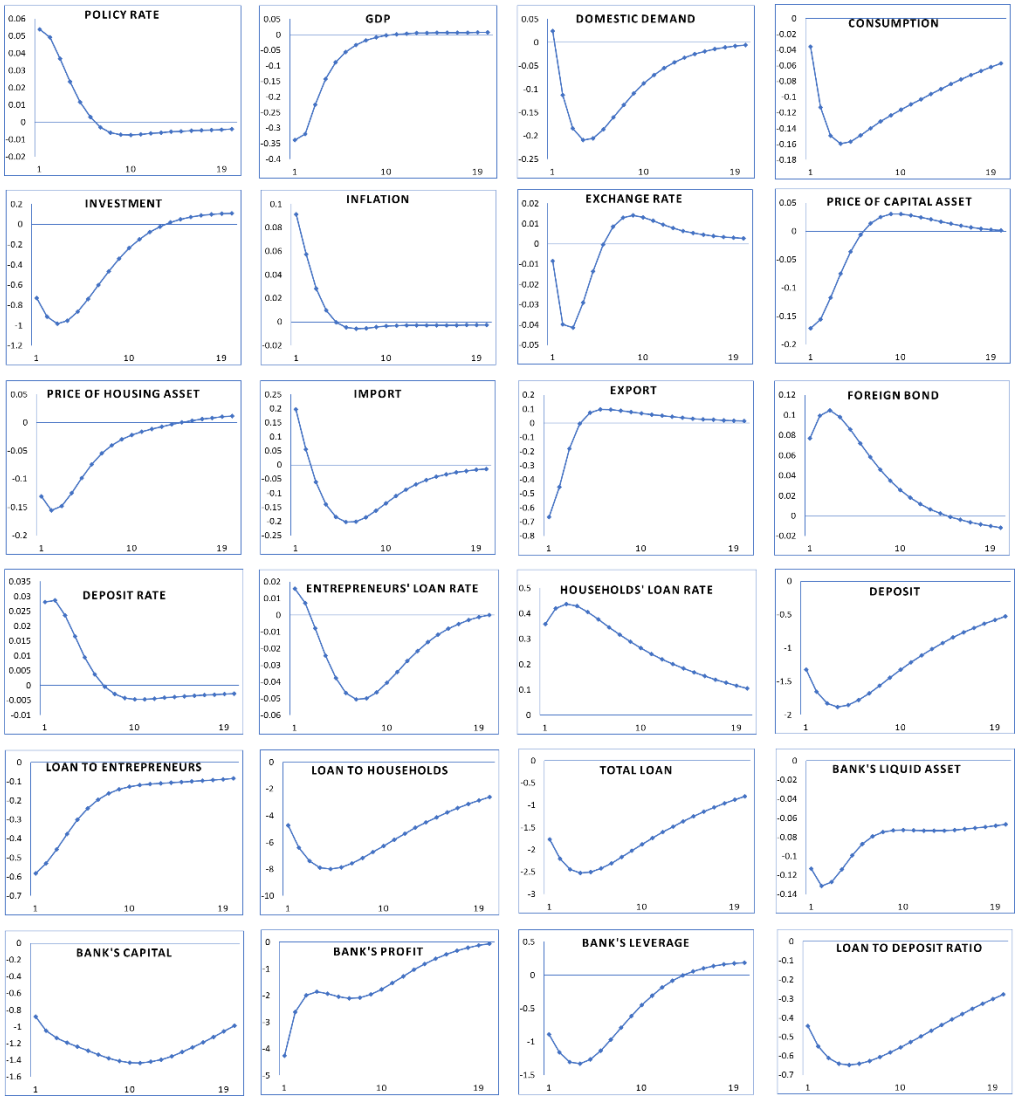


Figure 22: Transmission of Households' Loan Default Shock

Notes: The figure reports the impulse responses to a one percent positive shock to the households' loan default rate for model with only monetary policy with baseline calibration of the Taylor rule's parameters. For interest rate variables, the figure shows absolute deviations from the steady state in percentage points. For other variables, it shows percent deviations from the steady state

4.5. Optimal Policy Mix

I use the same method as in the previous chapters to study the macroeconomic and financial stabilisation performance of the policy mix in facing a shock to households' loan default rate. I divide the analysis into two scenarios. In the first scenario, the central bank only uses the Taylor rule, either the standard version or the

augmented ones[89], to minimise the loss function defined in equation (46). In the second scenario, the central bank has the option to utilise other macroprudential instruments to achieve macroeconomic and financial stability. These additional instruments are countercyclical LTV ratio rules and a countercyclical leverage ratio rule. The analysis will also include the impact of each policy strategy to alternative measures of financial stability that may be of interest for central banks in emerging Asian economies.

4.5.1. The Role of The Policy Rate

Table 26 shows that adding a financial stability measure in the loss function result in lower financial instability and higher macroeconomic instability. This trade-off is quite significant since, for most rules, a decrease of around 1% in financial instability is followed by an increase of around 11% in macroeconomic instability. The performance of the standard, exchange rate augmented, and asset price augmented rules are quite comparable. The implementation of this rule will decrease total instability of around 1% relative to the standard Taylor rule that has been optimised only for macroeconomic stabilisation.

A notable difference in performance is shown by the implementation of the loan to output ratio augmented rule, which results in a decrease in financial instability of around 11%, followed by an increase of around 273% in macroeconomic instability. If we only look at the performance in terms of total instability, we will find that the best policy is to implement the loan to output ratio augmented Taylor rule. However, if we look closely to the instability of the other variables, this choice may not be as conclusive. The instability of inflation is more than 3000% higher if the central bank implements this strategy, which may not be preferable if it has price stability as the main mandate.

In order to increase financial stability, a higher response from the Taylor rule to output dynamics is necessary (Table 27). This is expected since loan to output ratio will decline significantly after the shock. Unfortunately, this results in a significantly higher policy rate that will induce changes in the composition of the banks' balance sheet. Changes in the composition of the banks' asset are mainly caused by the increase in the policy rate. Both loan rates increase, but since households' loan rates have a significantly lower pass-through and already higher due to changes in loss given default expectation of the banks, the deviation is not as large as in the case of

[89] in which the trigger variables such as growth of real exchange rate, loan to output ratio or asset prices have been added to the rule

the entrepreneurs' loan rate. This result in significantly lower loan demand from the entrepreneurs, relative to households. In addition, banks also reduce the size of their liquid asset to increase the total loan distribution, which mostly distributed to the households. The overall impact on the real sector is even lower output and significantly higher inflation due to higher production cost coming from higher interest on loans. The increase in inflation instability will also cause instability in the real exchange rate and the foreign loan to output ratio. In addition, instability of asset prices is also significantly higher. If the adverse effect of implementing this policy strategy (higher instability of inflation, real exchange rate, foreign borrowing and asset prices) results in higher financial/macroeconomic vulnerabilities relative to the baseline scenario, it may not be preferable for the central bank to implement this strategy.

If we examine closely the other three rules that have comparable performance in terms of total instability, we find that they have a similar transmission with the loan to output ratio augmented Taylor rule, only with significantly less pronounced responses. The main difference is in their effect on the instability of asset prices which mainly due to the lower increase in the instability of inflation. Still, the cost of increasing financial stability in the form of higher instability in inflation, the real exchange rates, and the foreign loan is quite high and warrants more considerations from the central bank.

Table 26: Macroeconomic and Financial Stabilisation Performance of Model with Only Monetary Policy in Facing Shock to Households' Loan Default Rate

	Variances of		Macroeconomic Instability	Financial Instability	Total Instability
	Inflation	Output			
Optimised for Macroeconomic Stability					
Standard Taylor Rule	0.012	0.326	0.175	66.05	66.22
Optimised for Macroeconomic and Financial Stability					
Standard Taylor Rule	0.030 (150.92)	0.327 (0.183)	0.193 (10.44)	65.45 (-0.91)	65.64 (-0.88)
Taylor Rule Augmented with Exchange Rate Growth	0.030 (155.15)	0.327 (0.132)	0.194 (10.69)	65.43 (-0.93)	65.63 (-0.90)
Taylor Rule Augmented with Loan to Output Growth	0.386 (3136.52)	0.534 (63.64)	0.653 (272.82)	58.59 (-11.29)	59.24 (-10.54)
Taylor Rule Augmented with Asset Price Growth	0.035 (192.38)	0.331 (1.53)	0.200 (14.52)	65.33 (-1.09)	65.53 (-1.05)

Note: The variances, macroeconomic instability, financial instability and total instability are expressed as the ratio to the variance of the exogeneous shock. The values in the bracket show percentage difference of the variance/instability with the one acquired from the model with the Taylor rule that has been optimised for only macroeconomic stability. The values in red indicate an increase in the instability while the values in blue indicate a decrease in the instability.

Table 27: Parameter Values (Households' Loan Default Shock)

	ϕ_π	ϕ_Y	ϕ_s	$\phi_{B/Y}$	ϕ_{ap1}	ϕ_{ap2}
Optimised for Macroeconomic Stability						
Standard Taylor Rule	2.025	0.156				
Optimised for Macroeconomic and Financial Stability						
Standard Taylor Rule	2.001	0.311				
Taylor Rule Augmented with Exchange Rate Growth	2.002	0.312	0.251			
Taylor Rule Augmented with Loan to Output Growth	1.993	0.523		0.542		
Taylor Rule Augmented with Asset Price Growth	1.997	0.347			0.487	0.506

Note: ϕ_π. Is the parameter governing the response of the policy rate to inflation; ϕ_Y is the parameter governing the response of the policy rate to output; ϕ_s is the parameter governing the response of the policy rate to the exchange rate growth; $\phi_{B/Y}$ is the parameter governing the response of the policy rate to the growth in the loan to output ratio; $\phi_{ap1}$is the parameter governing the response of the policy rate to the capital asset price growth relative to the housing asset price growth; $\phi_{ap2}$is the parameter governing the response of the policy rate to asset (capital and housing) prices' growth.

Table 28: Instabilities of other Variables of Interest (Households' Loan Default Shock)

	Variances of			
	Real Exchange Rate	House Price	Capital Asset Price	Foreign Loan to Output Ratio
Optimised for Macroeconomic Stability				
Standard Taylor Rule	0.007	0.114	0.122	0.523
Optimised for Macroeconomic and Financial Stability				
Standard Taylor Rule	0.014 (112.64)	0.104 (-9.18)	0.095 (-21.66)	0.622 (18.79)
Taylor Rule Augmented with Exchange Rate Growth	0.015 (117.02)	0.104 (-9.31)	0.095 (-22.32)	0.625 (19.36)
Taylor Rule Augmented with Loan to Output Growth	0.365 (5343.3)	0.317 (177.71)	0.173 (41.80)	1.967 (275.92)
Taylor Rule Augmented with Asset Price Growth	0.022 (225.39)	0.106 (-7.59)	0.089 (-26.62)	0.662 (25.51)

Note: The variances are expressed as the ratio to the variance of the exogeneous shock. The values in the bracket show percentage difference of the variance with the one acquired from the model with the Taylor rule that has been optimised for only macroeconomic stability. The values in red indicate an increase in the instability while the values in blue indicate a decrease in the instability.

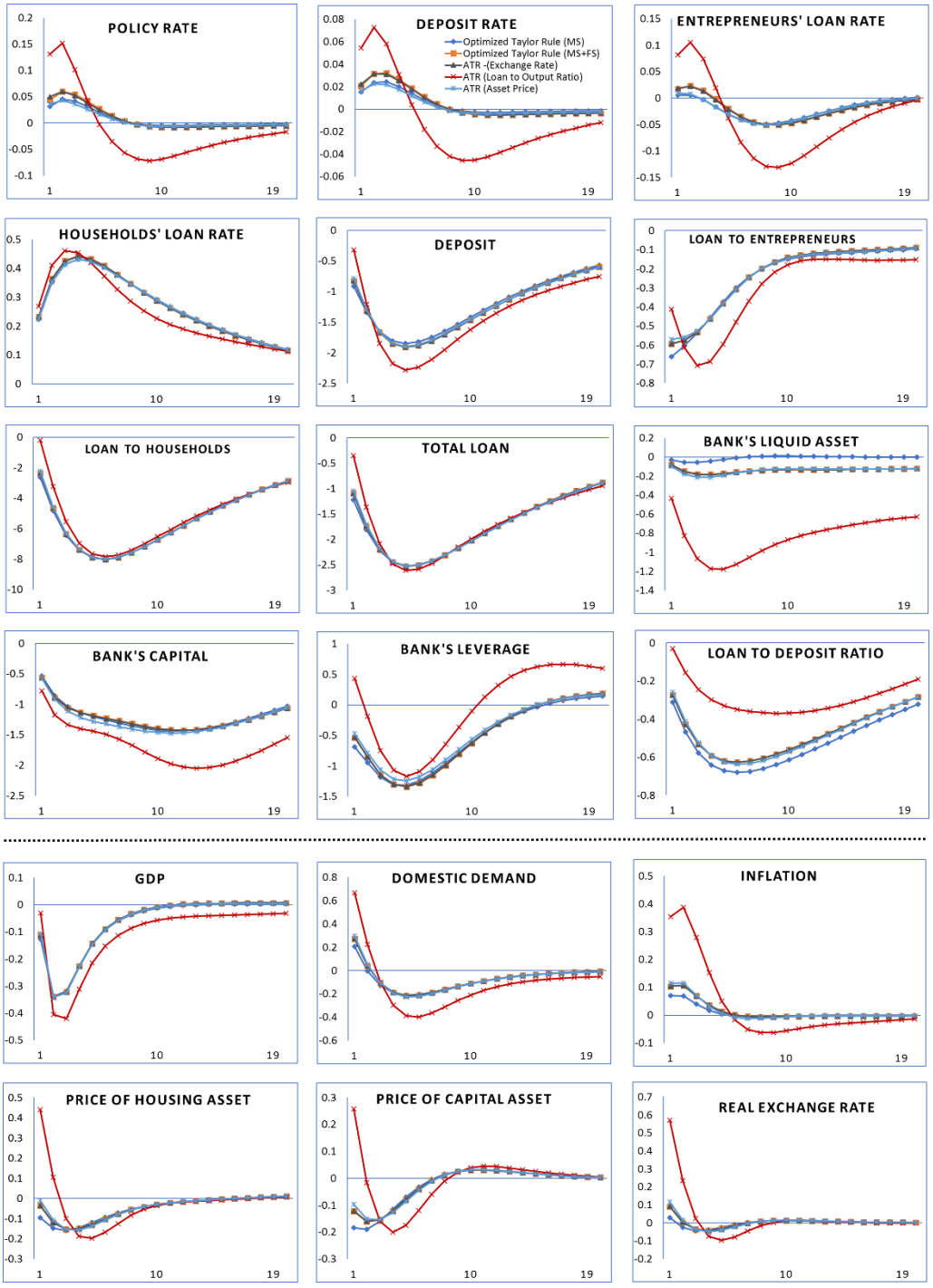


Figure 23: Impulse Responses of Model with Only Policy Rate – Shock to Households' Loan Default

Notes: The figure reports the impulse responses to a one percent negative shock to the households' loan default rate. For interest rate variables, the figure shows absolute deviations from the steady state in percentage points. For other variables, it shows percent deviations from the steady state. ATR is Augmented Taylor Rule. MS is Macroeconomic Stability and FS is Financial Stability.

4.5.2. The Role of Macroprudential Policy

Compared to the performance of implementing the standard Taylor rule, combining the leverage ratio rule and the standard Taylor rule results in a lower financial instability. Unfortunately, it also results in a higher macroeconomic instability. The higher macroeconomic instability is caused by the higher output instability while inflation instability is actually lower. This is because the Taylor rule parameter that responds to inflation is higher. This shows that adding another instrument that can better target financial stability will enable the policy rate to be more targeted towards inflation stability. The higher performance in inflation stability translates to higher stability in the real exchange rates. The performance in the stability of foreign borrowing is slightly lower, due to lower output stability. It also has a positive impact on the stability of the house prices but not on the stability of the capital asset prices. For a central bank that has more preference toward price stability, adding a countercyclical leverage ratio policy may be the better option than any policy strategies in the first scenario. It can give better performance, both in financial and price stability, at the cost of a lower performance in output stability. The transmission of this policy is almost the same as the policy strategies in the previous scenario. The main difference is on the less impact of the policy rate increase on the changes in the loan rates. This is due to the incentive to increase the leverage given by this rule that allows the loan rates to have different dynamics with the deposit rate.

The financial stability performance of combining the Taylor rule and the leverage ratio rule is lower than when the central bank implements the loan to output ratio augmented Taylor rule. One of the reason is the high excess capital buffer in Indonesian banking sector that affecting the speed of the banks' leverage adjustment. Figure 26 shows the stabilisation performance of the two policy strategies for different calibration values of the parameter κ_l which govern the speed of the banks' leverage adjustment. As we increase the parameter values, the impact of implementing policy strategy that combines the Taylor rule and the leverage ratio rule on financial stability increases and even surpasses the financial stabilisation performance of implementing the loan to output ratio augmented Taylor rule. This experiment shows that the effectiveness of utilising the leverage ratio rule, when the economy is facing a shock to the households' loan default rate, depends on the speed of adjustment of banks' leverage. For emerging Asian economies that have a large excess capital buffer in their banking sector, the impact of implementing the leverage ratio rule on financial stability may not be substantial. As the banking sector increase their leverage

adjustment's speed, either due to the rise in competition or other conditions that reduce their profitability and ability to accumulate capital buffer, the impact of implementing the leverage ratio rule on financial stability will increase.

A significantly better performance in financial stability can be achieved by implementing the policy strategy that combines the countercyclical LTV ratio rules and the Taylor rule. With very aggressive responses from the countercyclical parameters of the LTV ratio rules (Table 30), financial instability is significantly reduced. The optimised values of the parameters show that the response to the households' loans is more than four times the response to the entrepreneurs' loans. This is expected since the source of the shock has a direct impact on the growth of the households' loans. Unfortunately, implementing this strategy results in a significantly higher macroeconomic instability. Inflation instability is almost 700% higher while output instability is around 1300% higher. Other measures of financial stability that are not included in the loss function also have significantly higher instability (Table 31).

Studying the impulse responses will help us understand the reason for the significant divergence between macroeconomic and financial stability if the central bank implements this policy strategy. The implementation of the strategy increases financial stability by lowering the reduction in the total loans. The composition of the loans also changes, as also happen in the other strategies, in which we have less reduction in the loans to households and more reduction in the loans to entrepreneurs. However, in this strategy, the changes in the composition of loans is achieved by directly affecting the quantity of the loans through changes in the borrowing constraints. This results in significantly more loans distributed to the households and fewer loans distributed to the entrepreneurs, compared to the other strategies. By implementing this policy strategy, the central bank gives a direct incentive for the banks to deviate from its optimal choice of reducing loan distribution to households towards reducing loan distribution to entrepreneurs. These incentives will result in significantly higher macroeconomic instability. The decision on implementing this policy strategy depends on the central bank assessment on the trade-off between potentially lower financial/macroeconomic risks resulting from higher financial stability and the potentially higher financial/macroeconomic risks resulting from the lower stability of output, inflation, exchange rate, foreign loan to output ratio and asset prices. If the central bank concern about the potentially higher financial/macroeconomic vulnerabilities caused by the lower stability of these

variables, it may be better off choosing the two strategies in the alternative scenario that combines the non-optimised LTV ratio rules with the optimised Taylor rule.

In the alternative scenario, the countercyclical parameters of the LTV rules can be chosen by the central bank based on a certain target reduction in financial instability[90]. There are two policy strategies in this scenario which have two different ways of optimising the Taylor rule parameters: (1) only for macroeconomic stability or (2) for macroeconomic and financial stability. Figure 24 shows the stabilisation performance of the two strategies. Based on the figure, the macroeconomic and financial stabilisation performance of the two strategies are quite similar. The implementation of the policy strategy that utilises the Taylor rule that has been optimised for macroeconomic stability results in higher asset prices' instability and lower foreign loan to output ratio and exchange rate's instability. The decision on choosing which strategy to be implemented for a certain target reduction in financial instability are based on:

1. the trade-off between the reduction in financial instability and the increase in the instability of the other variables and
2. the central banks' assessment of financial/macroeconomic vulnerabilities related to the trade-off.

[90] The values of the parameters ϕ_{mi} and ϕ_{me} are kept in the same proportion as the optimised values from the policy strategy that combines the Taylor rule and the LTV ratio rules.

Table 29: Macroeconomic and Financial Stabilisation Performance of Model with Monetary and Macroprudential Policy in Facing Households' Loan Default Shock

	Variances of		Macroeconomic Instability	Financial Instability	Total Instability
	Inflation	Output			
Optimised for Macroeconomic Stability					
Standard Taylor Rule	0.012	0.326	0.175	66.05	66.22
Optimised for Macroeconomic and Financial Stability					
Standard Taylor Rule	0.030 (150.92)	0.327 (0.183)	0.193 (10.44)	65.45 (-0.91)	65.64 (-0.88)
Taylor Rule and Leverage Ratio Policy	0.025 (113.51)	0.40 (21.96)	0.224 (28.19)	60.54 (-8.34)	60.76 (-8.25)
Taylor Rule and LTV Ratio Policy	0.094 (692.7)	4.58 (1302)	2.383 (1261.2)	0.002 (-99.99)	2.39 (-96.4)

Note: The variances, macroeconomic instability, financial instability and total instability are expressed as the ratio to the variance of the exogeneous shock. The values in the bracket show percentage difference of the variance/instability with the one acquired from the model with the Taylor rule that has been optimised for only macroeconomic stability. The values in red indicate an increase in the instability while the values in blue indicate a decrease in the instability.

Table 30: Parameter Values-2 (Households' Loan Default)

	ϕ_π	ϕ_Y	ϕ_{mi}	ϕ_{me}	ϕ_ψ
Optimised for Macroeconomic Stability					
Standard Taylor Rule	2.025	0.156			
Optimised for Macroeconomic and Financial Stability					
Standard Taylor Rule	2.001	0.311			
Taylor Rule and Leverage Ratio Policy	2.306	0.296			0.752
Taylor Rule and LTV Ratio Policy	2.044	0.107	893.62	179.54	

Note: ϕ_π. is the parameter governing the response of the policy rate to inflation; ϕ_Y is the parameter governing the response of the policy rate to output; ϕ_{mi} is the parameter governing the response of the households' LTV ratio requirement to changes in the gap of households' loan to output ratio; ϕ_{me} is the parameter governing the response of the entrepreneurs' LTV ratio requirement to the changes in the gap of entrepreneurs' loan to output ratio; ϕ_ψ is the parameter governing the response of the leverage ratio requirement to the changes in gap of loan to output ratio;

Table 31: Instabilities of other Variables of Interest-2 (Households' Loan Default Shock)

	Variances of			
	Real Exchange Rate	House Price	Capital Asset Price	Foreign Loan to Output Ratio
Optimised for Macroeconomic Stability				
Standard Taylor Rule	0.007	0.114	0.122	0.523
Optimised for Macroeconomic and Financial Stability				
Standard Taylor Rule	0.014 (112.64)	0.104 (-9.18)	0.095 (-21.66)	0.622 (18.79)
Taylor Rule and Leverage Ratio Policy	0.01 (54.1)	0.098 (-14.25)	0.136 (11.3)	0.635 (21.24)
Taylor Rule and LTV Ratio Policy	0.07 (935)	0.222 (94)	0.85 (596.3)	5.6 (968.7)

Note: The variances are expressed as the ratio to the variance of the exogeneous shock. The values in the bracket show percentage difference of the variance with the one acquired from the model with the Taylor rule that has been optimised for only macroeconomic stability. The values in red indicate an increase in the instability while the values in blue indicate a decrease in the instability.

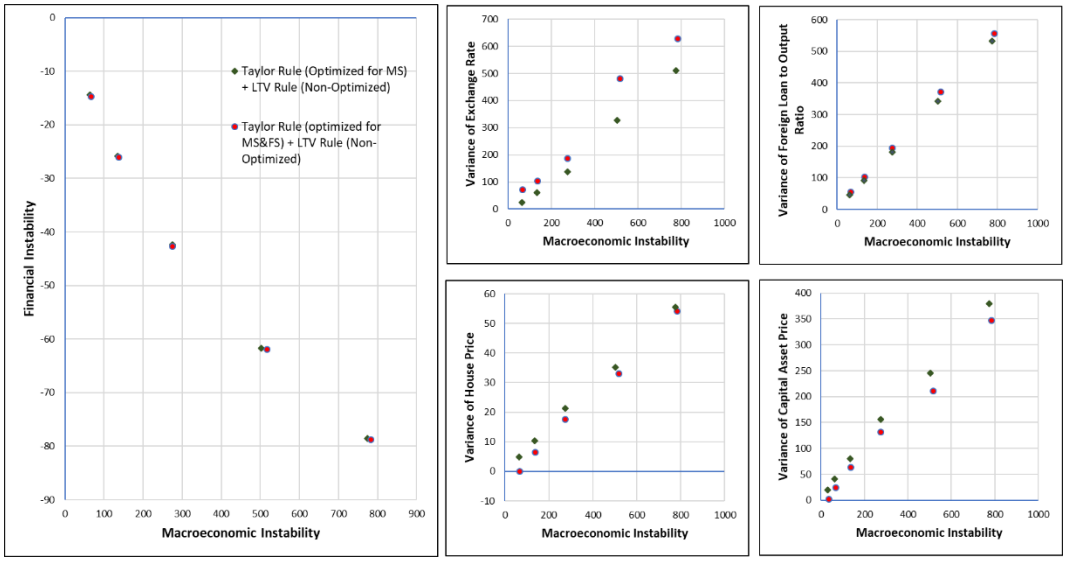


Figure 24: Stabilisation Performance of Models in Alternative Scenario (Households' Loan Default Shock)

Notes: Variances, Macroeconomic Instability and Financial Instability are expressed as percentage differences of the instability/variance with the one acquired from the model with the Taylor rule that has been optimised for only macroeconomic stability. Positive values indicate an increase in the instability/variance while negative values indicate a decrease in the instability. MS is Macroeconomic Stability. FS is Financial Stability. The values of ϕ_{mi} and ϕ_{me} used for the figure are : $[\phi_{mi} = 2.25, \phi_{me} = 0.5]$, $[\phi_{mi} = 1.125, \phi_{me} = 0.25]$, $[\phi_{mi} = 0.5625, \phi_{me} = 0.125]$, $[\phi_{mi} = 0.28125, \phi_{me} = 0.0625]$ *and* $[\phi_{mi} = 0.140625, \phi_{me} = 0.03125]$.

Table 32: Macroeconomic and Financial Stabilisation Performance of Model with Monetary and Macroprudential in Facing Households' Loan Default Shock (Alternative Scenario)

	Variances of		Macroeconomic Instability	Financial Instability	Total Instability
	Inflation	Output			
Alternative Scenario					
Standard Taylor Rule (MS) + Non-optimised LTV $[\phi_{mi} = 2.25, \phi_{me} = 0.5]$	0.06 (403.4)	2.94 (801.8)	1.53 (774.6)	14.16 (-78.56)	15.69 (-76.3)
Standard Taylor Rule (MS+FS) + Non-optimised LTV $[\phi_{mi} = 2.25, \phi_{me} = 0.5]$	0.085 (612.6)	2.92 (796.1)	1.55 (783.65)	14.05 (-78.73)	15.6 (-76.45)

Note: The variances, macroeconomic instability, financial instability and total instability are expressed as the ratio to the variance of the exogeneous shock. The values in the bracket show percentage differences of the variance/instability with the one acquired from the model with the Taylor rule that has been optimised for only macroeconomic stability. The values in red indicate an increase in the instability while the values in blue indicate a decrease in the instability.

Table 33: Instabilities of other Variables of Interest- Alternative Scenario (Households' Loan Default)

	Variances of			
	Real Exchange Rate	House Price	Capital Asset Price	Foreign Loan to Output Ratio
Alternative Scenario				
Standard Taylor Rule (MS) + Non-optimised LTV $[\phi_{mi} = 2.25, \phi_{me} = 0.5]$	0.041 (510.6)	0.178 (55.54)	0.585 (379.6)	3.311 (532.65)
Standard Taylor Rule (MS+FS) + Non-optimised LTV $[[\phi_{mi} = 2.25, \phi_{me} = 0.5]]$	0.049 (628.17)	0.176 (54.14)	0.544 (346.7)	3.437 (556.72)

Note: The variances are expressed as the ratio to the variance of the exogeneous shock. The values in the bracket show percentage differences of the variance with the one acquired from the model with the Taylor rule that has been optimised for only macroeconomic stability. The values in red indicate an increase in the instability while the values in blue indicate a decrease in the instability.

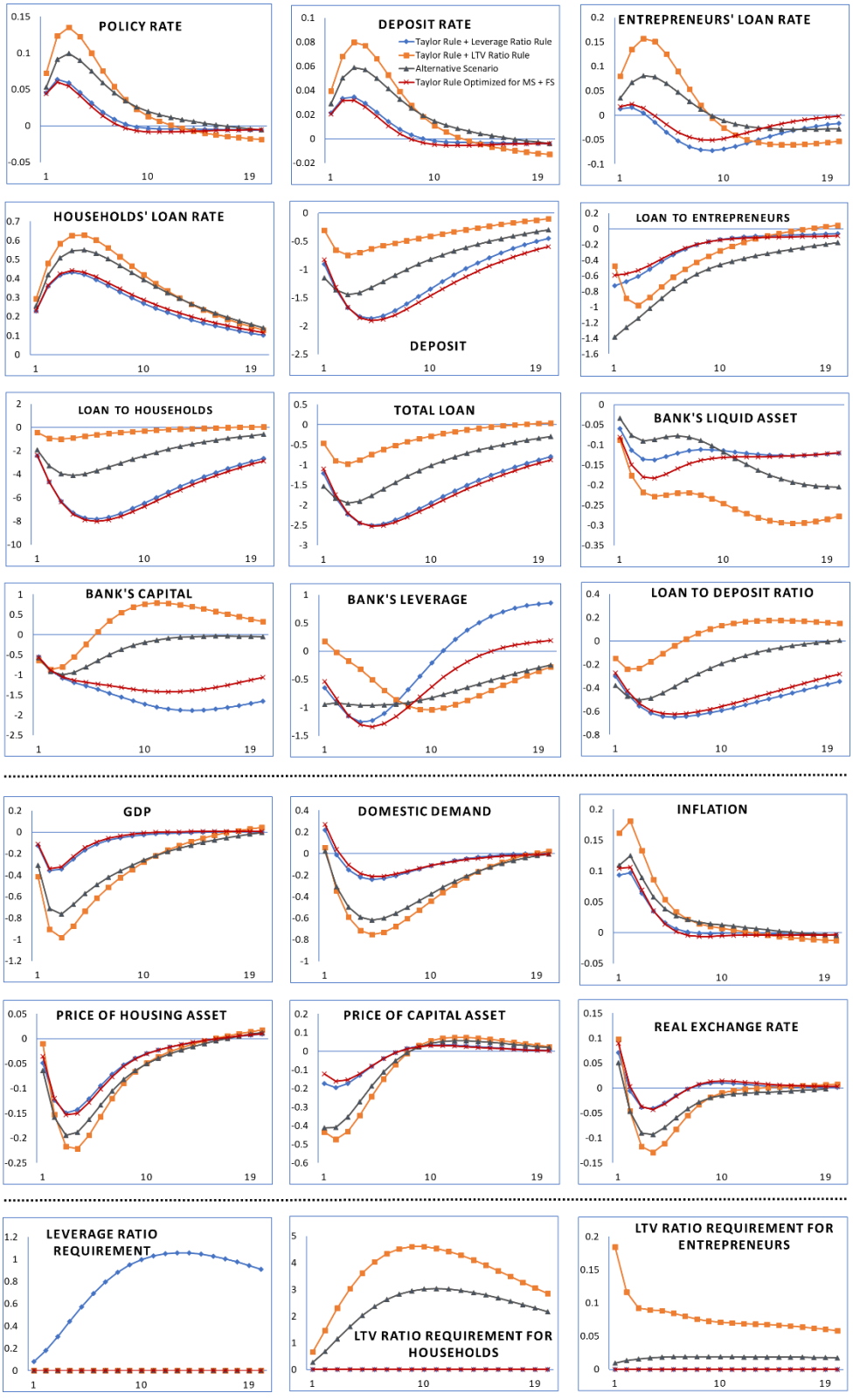


Figure 25: Impulse Responses of Model with Policy Rate, LTV Ratio Requirement and Leverage Ratio Requirement (Shock to Households' Loan Default Rate)

Notes: The figure reports the impulse responses to a one percent negative shock to the households' loan default rate. For interest rate variables and LTV ratio requirements, the figure shows absolute deviations from the steady state in percentage points. For other variables, it shows percent deviations from the steady state. MS is Macroeconomic Stability, and FS is Financial Stability. Impulse responses of the alternative scenario are for the one in which the Taylor rule is optimised for macroeconomic stability, and the values of LTV rules' countercyclical parameters are: $[\phi_{mt} = 2.25, \phi_{me} = 0.5]$.

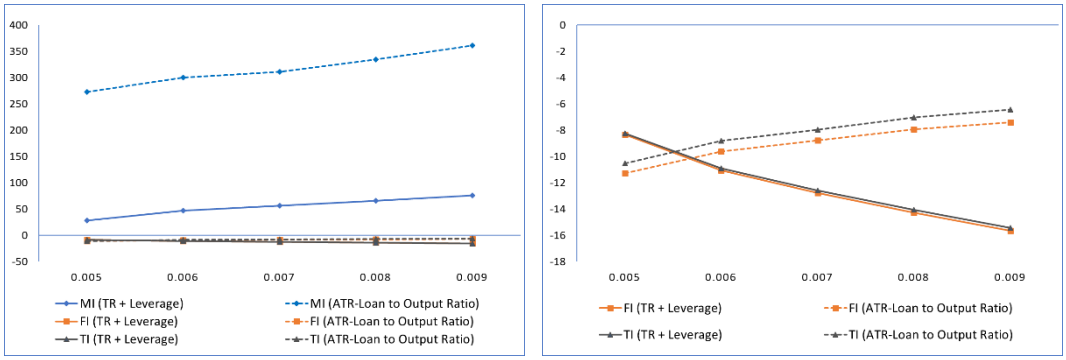


Figure 26: Stabilisation Performance of Models with Different Speed of Banks' Leverage Adjustment (Households' Loan Default Shock)

Notes: The horizontal axis shows the values of κ_l (the parameter that governs the speed of adjustment of bank's leverage to changes in the leverage target/requirement). The vertical axis shows the percentage difference of macroeconomic, financial and total instability values with the one acquired from the model with the Taylor rule that has been optimised for only macroeconomic stability. MI is Macroeconomic Instability. FI is Financial Instability. TI is Total Instability. TR is Taylor Rule. ATR is Augmented Taylor Rule.

4.5.3. Discussion

In the case of a shock to the households' loan default rate, the choice of the best policy mix is not as easy as choosing the one that can minimise the central bank loss function. Divergence in the stability of variables that enter the loss function is significantly large. There is also a divergence between the variance of financial stability measure that enters the loss function with the ones that are not in the loss function. These complicate the problems faced by the central bank that tries to achieve both macroeconomic and financial stability.

Given a choice, it would be preferable for the central bank to minimise the initial impact of the shock by implementing other types of policy. From the model simulations, we learned that the channel of transmission started from the deviation between the banks expected and realised loss given default rates. The policy implemented towards minimising the initial impact of the shock would be to minimise this deviation. As we learned from the global financial crisis, over optimism of the financial intermediaries may result in an unrealistically low expected value of the loss given default rates. A better measurement of the probability of default and the loss given default rates by the banks would significantly lower the initial impact of the shock.

4.6. Conclusion

I extend the small open economy DSGE model, developed for emerging Asian economies, to include the transmission of shocks to the loan default rates. I use the extended model to study the propagation process of the shock to the households'

loan default rate and the interaction of monetary and macroprudential policies in stabilising the economy after the shock.

The model simulation shows that an unanticipated shock to the households' loan default rate can be the source of macroeconomic and financial instability due to its effect on the financial intermediaries' balance sheet. The main channel of transmission is from the deviation between the expected and the realised loss given default rates of the banks.

All policy strategies, implemented to minimise the central bank loss function that includes financial stability measures, result in a higher financial stability but with a cost of a significantly lower macroeconomic stability. The implementation of the policy strategy that combines and jointly optimised the Taylor rule and the LTV ratio rules results in the highest increase in the total stability. Unfortunately, the cost of implementing this strategy also includes a significant decline in the stability of other measures of financial stability that are not included in the loss function. If the central bank concern about the increase in financial/macroeconomic vulnerabilities caused by the reduction in the stability of these variables, it may be better off choosing the strategies that combine the non-optimised LTV ratio rules with the optimised Taylor rule. The countercyclical parameters of the LTV ratio rules can be chosen by the central bank based on a certain target reduction in financial instability. The decision on implementing these policy strategies depend on the central bank assessment on the trade-off between potentially lower financial/macroeconomic risks resulting from the higher financial stability and the potentially higher financial/macroeconomic risks resulting from the lower stability of output, inflation, exchange rate, foreign loan to output ratio and asset prices.

It may be best for the central bank to consider implementing policies that can minimise the initial impact of the shock to the households' loan default rate. These policies may include any incentives that can encourage the banks to properly measure the probability of defaults and the loss given default rates.

Chapter 5: The Central Bank Loss Function and Welfare

5.1. Introduction

In the previous chapters, the optimal policy mix for different types of shocks is studied based on an ad-hoc loss function of the central bank. The loss function is based on the interpretation of the central bank mandate which includes macroeconomic and financial stability. The alternative way to define the loss function is by deriving it from the quadratic approximations of the households' and the entrepreneurs' utility functions. Svensson (2008) argues that the welfare of agents may not be an appropriate proxy of an operational central bank objective and the loss functions derived from them are depended on the distortions assumed in each model. This last argument also backed by Blanchard (2008) which emphasises the role of assumptions used in DSGE models that are based on the effort to match model dynamics with the data which may not have theoretical or empirical supports. Based on this, Blanchard (2016) also prefers the conclusion of the optimal policy based on an ad-hoc loss function, while still acknowledges that the loss function based on agents' welfare may have useful information.

The inclusion of a financial stability measure in the central bank loss function is based on the empirical evidence[91] showing that the gap of the loan to output ratio is an excellent indicator of the increasing level of financial vulnerabilities. Since the model in this research does not include the possibility of a crisis, the welfare effect of avoiding a crisis due to higher financial stability cannot be measured[92]. This would mean that the best policy strategy for the central bank that tries to minimise its loss function may not be the same as the one that results in the largest welfare gain for all agents. Nevertheless, studying the impact of the central bank policy on the welfare of agents can still give useful insights for the central banks. Especially, in understanding the possible trade-off between financial stability and the agents' welfare.

The objective of this chapter is to examine how the welfare of agents are affected by the policy of the central bank that has macroeconomic and financial stability mandate. Welfare is defined for each type of agent (patient households, impatient

[91] Borio and Drehmann (2009), Demirguc-Kunt and Detragiache (2005) and Drehman and Tsatsaronis (2014)
[92] Woodford (2012) argues for the inclusion of a financial stability measure in the central bank loss function based on a regime switching model which includes the possibility of crisis.

households, and entrepreneurs) based on their utility functions. In addition, I also define a social welfare measure as a weighted sum of these agents' welfare values

The chapter is organised as follows. Section 2 describes the detail of the welfare measurements, presents the welfare values of each policy strategy for the different type of shocks and discusses the results in relation to the performance of the policy strategies in minimising the central bank loss function and its impact on the alternative measures of financial stability[93]. Section 3 concludes.

5.2. Central Bank Loss Function and Welfare

Welfare for the patient households (WF_t^P), the impatient households (WF_t^I) and the entrepreneurs (WF_t^E) are defined as follows[94]:

$$WF_t^P = E_t \sum_{t=0}^{\infty} \beta_P^t \left(ln\, C_t^p + j\, lnH_t^p - \frac{(L_t^p)^\eta}{\eta} \right) \tag{76}$$

$$WF_t^I = E_t \sum_{t=0}^{\infty} \beta_I^t \left(ln\, C_t^I + j\, lnH_t^I - \frac{(L_t^I)^\eta}{\eta} \right) \tag{77}$$

$$WF_t^E = E_t \sum_{t=0}^{\infty} \beta_E^t \left(ln\, C_t^E \right) \tag{78}$$

I also define the social welfare as a weighted sum of the three agents' welfare values. The weights are the discount factor of each agent so that all types of agents receive the same level of utility from a constant consumption stream[95].

$$WF_t = (1 - \beta_P) WF_t^P + (1 - \beta_I) WF_t^I + (1 - \beta_E) WF_t^E \tag{79}$$

Comparison of the welfare impact of the policy strategies is based on the difference of the welfare values of each strategy with the ones from the baseline scenario, in which the central bank only concern about macroeconomic stability and utilises the standard Taylor rule as a stabilisation instrument. I present the results in consumption equivalent measure which is defined as the fraction of consumption

[93] Which includes the variance of the real exchange rates, the foreign loan to output ratio, the house prices, and the capital asset prices.
[94] I use Dynare to solve the model using a second order approximation and evaluate the welfare using this approximate solution, as in Schmitt-Grohe and Uribe (2004).
[95] Following Rubio and Carrasco-Gallego (2014) and Mendicino and Punzi (2014) which are based on Mendicino and Pescatori (2007).

needed to equate the welfare under the policy strategies to the welfare under the baseline scenario:

$$CE^P = exp\left[\left(1-\beta_P\right)\left(WF_t^P - WF_t^{PB}\right)\right] - 1 \quad (80)$$

$$CE^I = exp\left[\left(1-\beta_I\right)\left(WF_t^I - WF_t^{IB}\right)\right] - 1 \quad (81)$$

$$CE^E = exp\left[\left(1-\beta_E\right)\left(WF_t^E - WF_t^{EB}\right)\right] - 1 \quad (82)$$

$$CE \quad = exp\left[WF_t - WF_t^B\right] - 1 \quad (83)$$

where CE^P, CE^P, CE^P and, CE are the consumption equivalent values for the patient households', the impatient households, the entrepreneurs and the social welfare. The variable WF^{PB}, WF^{IB}, WF^{EB}, WF^B are the welfare values for the baseline scenario[96].

In the analysis, I will compare the welfare and the stabilisation performance of each policy strategy relative to the baseline scenario. In order to study the effect of including a financial stability measure in the central bank loss function to agents' welfare, I experiment with different weights of financial stability in the loss function for each policy strategy, except for the policy strategies that include the LTV ratio rules.

Due to their substantial effect on reducing financial instability that dominates the changes in total instability, all policy strategies that include the LTV ratio rules show very similar macroeconomic and financial instability values for various weights of financial stability in the central bank loss function. Based on this, I will focus on the policy strategies that include the non-optimised LTV ratio rules. As in the case of the alternative scenario in the previous chapters, I simulate different values of the countercyclical parameters of the LTV ratio rules as proxies for different target reductions in financial stability. The other rules included in the policy strategies are optimised in two different ways: for only macroeconomic stability or both macroeconomic and financial stabilities.

[96] Ascari and Ropele (2012)

5.2.1. Technology Shock

Table 34 shows the welfare gain of each policy strategy relative to the baseline scenario for the case of a technology shock. Positive values indicate welfare improvements while negative values indicate welfare reductions.

Table 34: Welfare Gain (Technology Shock)

Policy Strategies	Welfare			
	Patient HH	Impatient HH	Entrepreneurs	Total
Scenario 1				
Standard Taylor Rule	-0.0126	0.0471	0.0484	0.0831
ATR - Exchange Rate	-0.0126	0.0472	0.0489	0.0836
ATR - Loan to Output ratio	-0.0105	0.0202	0.0372	0.0470
ATR - Asset Price	-0.0127	0.0479	0.0497	0.0850
Scenario 2				
Standard Taylor Rule + Leverage Ratio Rule	-0.0127	0.0470	0.0483	0.0827
Standard Taylor Rule + LTV Ratio Rule	0.0003	0.0437	0.0368	0.0809
Alternative Scenario				
Standard Taylor Rule (Optimised for MS) + Non-optimised LTV Ratio Rule $[\phi_{mi} = 0.5, \phi_{me} = 1.3]$	0.0029	-0.0042	0.0053	0.0040
Standard Taylor Rule (Optimised for MS and FS) + Non-optimised LTV Ratio Rule $[\phi_{mi} = 0.5, \phi_{me} = 1.3]$	-0.0129	0.0542	0.0492	0.0905

Notes: The table shows the welfare gain of each policy strategy relative to the baseline scenario. ATR is Augmented Taylor Rule. LTV is Loan to Value. MS is Macroeconomic Stability. FS is Financial Stability.

When the economy is facing a technology shock, the implementation of all policy strategies results in an improvement in the social welfare. The impacts of the strategies on each type of agents' welfare are varied. If the central bank implements any strategy in the first scenario, the welfare of the savers will be lower while the welfare of the borrowers will be higher. The same outcomes also occur when the central bank implements the policy strategy that combines the Taylor rule and the leverage ratio rule. This is because these policy strategies rely on influencing the loan rates to achieve the objective of minimising the loss function and have similar transmission mechanism. The upper panel of Figure 27 shows the stabilisation performance of these policy strategies with different weights of financial stability in the central bank loss function. Among these five policy strategies, the combination of the Taylor rule and the leverage ratio rule results in a better trade-off between financial and macroeconomic stability than the other strategies. This is consistent with the results of the stabilisation performances of these strategies in chapter 2.

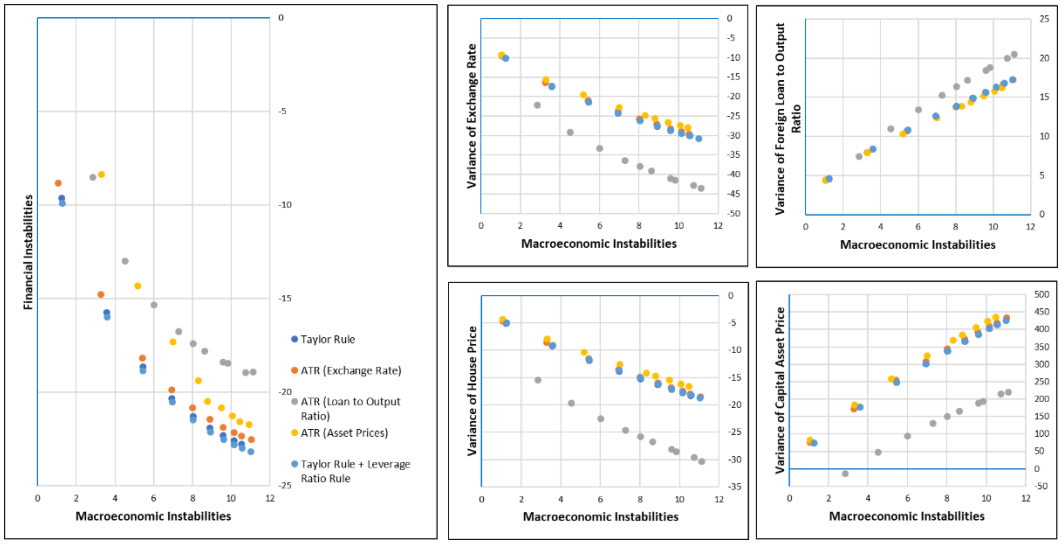
The welfare performances of the five policy strategies are quite comparable with their performances in minimising the central bank loss function. The implementation

of the policy strategy that utilises the loan to output ratio augmented Taylor rule results in the smallest welfare gains and the lowest stabilisation performances. The welfare gains and the stabilisation performances of the other four strategies are relatively similar. As the weight of financial stability in the loss function decreases, the welfare gain of the borrowers decreases, while the welfare gain of the savers increases (the welfare loss decreases). These will result in a decrease in the social welfare gain as the central bank reduces the weight of financial stability in the loss function.

If the central bank implements the policy strategy that combines and jointly optimised the Taylor rule and the LTV ratio rules, all agents' welfares are improved. This policy strategy also results in the highest increase in total stability[97]. These would mean that, in the case of a technology shock, the best policy strategy for the central bank that tries to minimise its loss function is also the one that can improve the welfare of all the agents in the economy.

In Chapter 2, we learned that all policy strategies could improve financial stability with the cost of reducing macroeconomic stability. In addition, we also found a significantly high instability of the capital asset prices except for the implementation of the policy strategy that combines the non-optimised LTV ratio rules with the Taylor rule that is optimised for macroeconomic stability[98]. If the central bank concerns about the possibility of higher financial/macroeconomic vulnerabilities coming from the higher instability of the capital asset prices, this alternative strategy may be the better choice. The implementation of this policy strategy results in an improvement in the welfare of the patient households and the entrepreneurs, and a reduction in the welfare of the impatient households (Table 34). Both the entrepreneurs and the patient households' welfare gains increase as the LTV ratio rules are calibrated to be more responsive (Figure 28). On the other hand, the more responsive the LTV ratio rules, the larger welfare loss suffered by the impatient households. The adverse effect of the increasing responses of the LTV ratio rules on the impatient households' welfare is mainly caused by the higher variance of the housing asset prices (Figure 28). Unfortunately, the probability of a crisis happening due to a significantly higher capital asset prices' instability and the potential welfare loss from the realisation of the crisis cannot be measured using this model. This would mean that we cannot compare the potential welfare gains of avoiding the crisis from implementing this policy strategy instead of the other ones.

[97] The best performance in terms of minimising the central bank loss function
[98] This strategy also increases the instability of the capital asset prices, but the value is significantly lower than the other strategies



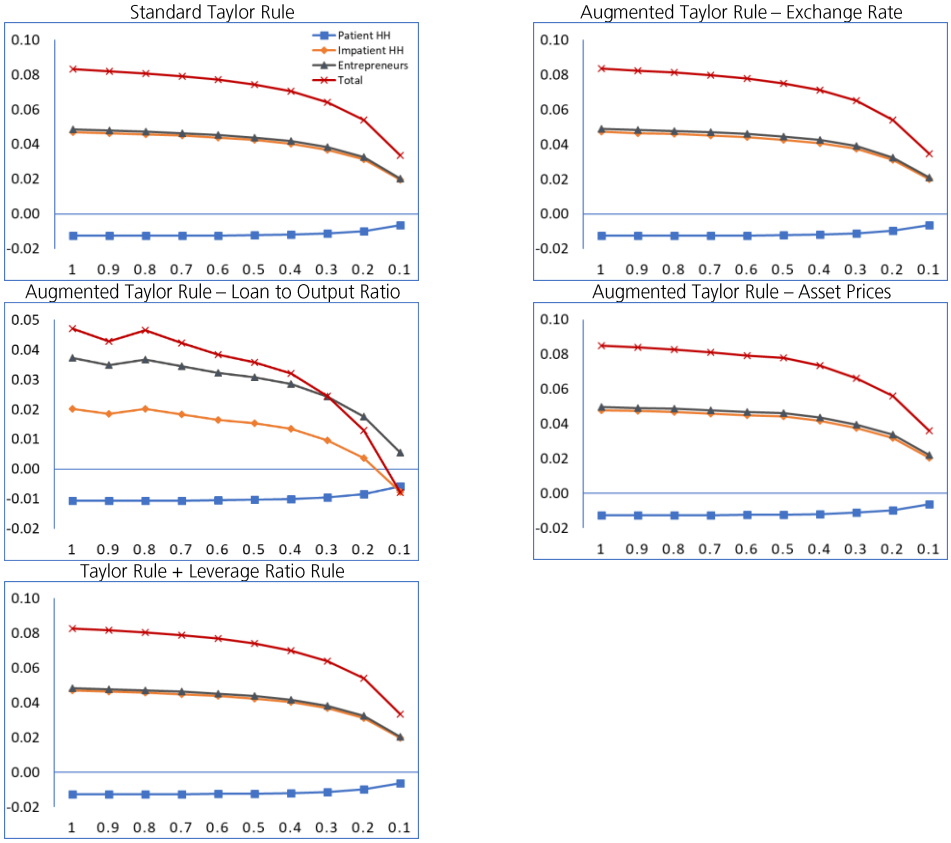


Figure 27: Stabilisation Performances and Welfare Gains of Models with Different Weights of Financial Stability in The Loss Function (Technology Shock)

Notes: The upper panel shows the models' stabilisation performances. Variances, macroeconomic instability, and financial instability are expressed as percentage difference of the instability/variance with the one acquired from the model with the Taylor rule that has been optimised for only macroeconomic stability. Positive values indicate an increase in instability/variance while negative values indicate a decrease in instability/variance. ATR is Augmented Taylor Rule. The lower panel shows the welfare gains. The horizontal axis shows the value of financial stability weight in the central bank's loss function. The vertical axis shows the welfare gains relative to the model with Taylor rule optimised for only macroeconomic stability.

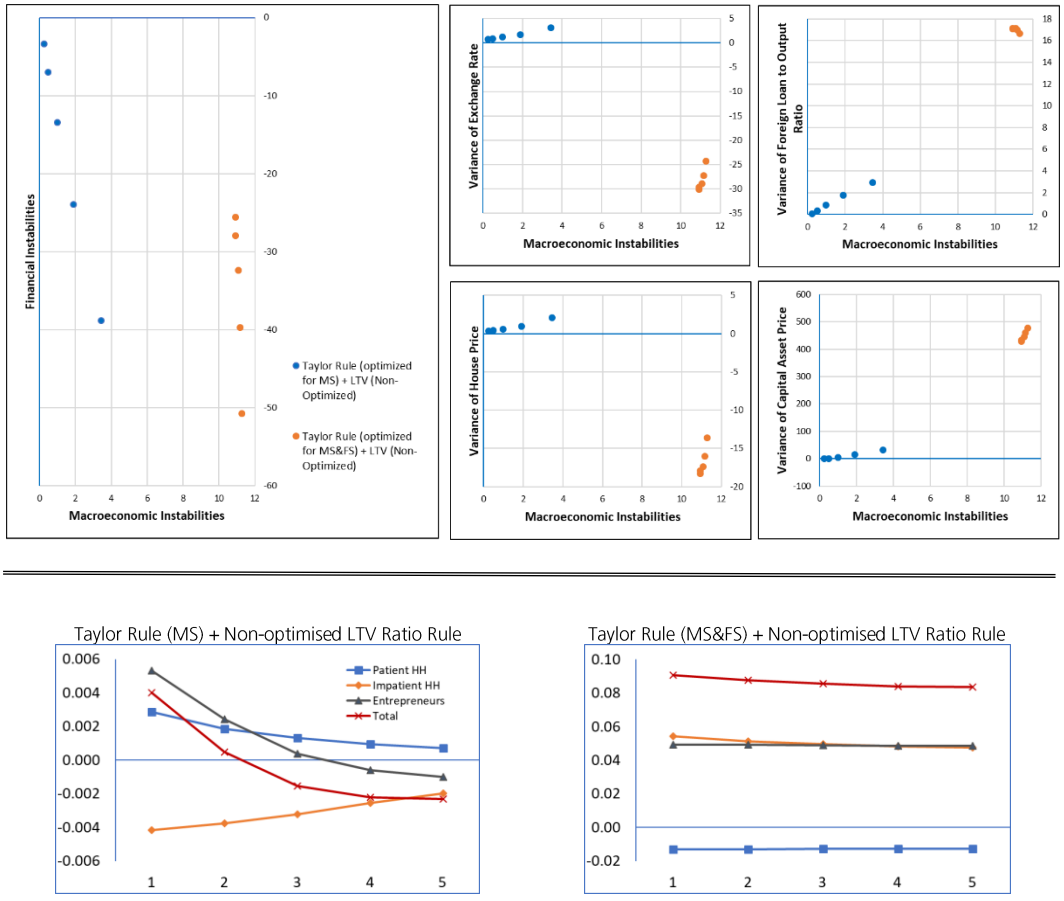


Figure 28: Stabilisation Performances and Welfare Gains of Models in Alternative Scenario (Technology Shock)

Notes: The upper panel shows the models' stabilisation performances. Variances, macroeconomic instability, and financial instability are expressed as percentage difference of the instability/variance with the one acquired from the model with the Taylor rule that has been optimised for only macroeconomic stability. Positive values indicate an increase in instability/variance while negative values indicate a decrease in instability/variance. MS is Macroeconomic Stability. FS is Financial Stability. LTV is Loan to Value ratio. The lower panel shows the welfare gains. The horizontal axis shows different calibration of parameter ϕ_{mi} and ϕ_{me} with 1 represents $[\phi_{mi} = 0.5, \phi_{me} = 1.3]$, 2 represents $[\phi_{mi} = 0.25, \phi_{me} = 0.625]$, 3 represents $[\phi_{mi} = 0.125, \phi_{me} = 0.3125]$, 4 represents $[\phi_{mi} = 0.0625, \phi_{me} = 0.15625]$, 5 represents $[\phi_{mi} = 0.03125, \phi_{me} = 0.078125]$. The vertical axis shows the welfare gains relative to the model with Taylor rule optimised for only macroeconomic stability.

5.2.2. Domestic Price Shock

Table 35 shows the welfare gains of each policy strategy, relative to the baseline scenario, for the case of a domestic price shock. The largest social welfare gain from all the policy strategies is given by the one that combines and jointly optimised the Taylor rule and the countercyclical LTV ratio rules. This social welfare gain is mostly due to a significant increase in the borrowers' welfare, especially for impatient households. The borrowers' welfare gains are mostly the result of the increase in the stability of loans, especially for households' loans. The patient households suffer welfare loss that partly caused by the increase in the instability of inflation and output. Based on this table and the results of Chapter 2 we can conclude that, in the case of

domestic price shock, policy strategy that has the highest stabilisation performance also the one that has the largest social welfare gain.

Table 35: Welfare Gain (Domestic Price Shock)

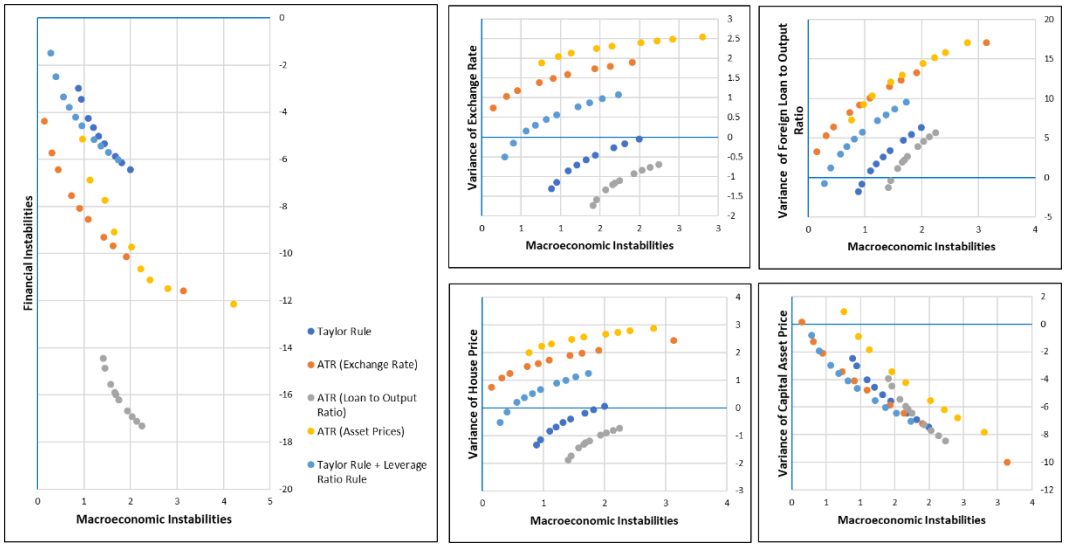
Policy Strategies	Welfare			
	Patient HH	Impatient HH	Entrepreneurs	Total
Scenario 1				
Standard Taylor Rule	-0.0052	0.0057	0.0089	0.0095
ATR - Exchange Rate	0.0085	-0.0427	-0.0386	-0.0728
ATR - Loan to Output ratio	0.0014	-0.0316	-0.0154	-0.0457
ATR - Asset Price	-0.0147	0.0174	0.0299	0.0327
Scenario 2				
Standard Taylor Rule + Leverage Ratio Rule	0.0035	-0.0253	-0.0260	-0.0479
Standard Taylor Rule + LTV Ratio Rule	-0.1621	0.9555	0.1048	0.8991
Alternative Scenario				
Standard Taylor Rule (Optimised for MS) + Non-optimised LTV Ratio Rule $[\phi_{mi} = 3.5, \phi_{me} = 0.5]$	-0.1221	0.7752	0.0579	0.7117
Standard Taylor Rule (Optimised for MS and FS) + Non-optimised LTV ratio Rule $[\phi_{mi} = 3.5, \phi_{me} = 0.5]$	-0.1226	0.7769	0.0588	0.7138

Notes: The table shows the welfare gain of each policy strategy relative to the baseline scenario. ATR is Augmented Taylor Rule. LTV is Loan to Value. MS is Macroeconomic Stability. FS is Financial Stability.

Figure 30 shows the stabilisation and the welfare performances of the alternative scenario for various values of the non-optimised LTV ratio rule's parameters. From the figure, we can see that the stabilisation performance of the two policy strategies are very similar and they also have a similar welfare performance. The implementation of the two strategies results in a higher welfare for the borrowers and a lower welfare for the patient households. As we increase the parameter values, the welfare gains of the borrowers and the welfare loss of the patient households also increases.

Due to their similar transmission mechanism, the four policy strategies in the first scenario and the policy strategy that combines the Taylor rule and the leverage ratio rule also have similar stabilisation and welfare performances. Based on the upper panel of Figure 29, we find that the best stabilisation performance is given by the policy strategy that utilises the loan to output ratio augmented Taylor rule. For various values of financial stability weight in the central bank loss function, the overall stabilisation performance rank of the five policy strategies are broadly consistent. The welfare performances of the five policy strategies are also quite comparable, except when the weight of financial stability in the central bank loss function is equal to one. Except for this case, the five policy strategies result in a welfare loss for the borrowers and a welfare gain for the patient households. As the weight of financial stability

increases, the welfare loss of the borrowers and the welfare gain of the patient households also increases.



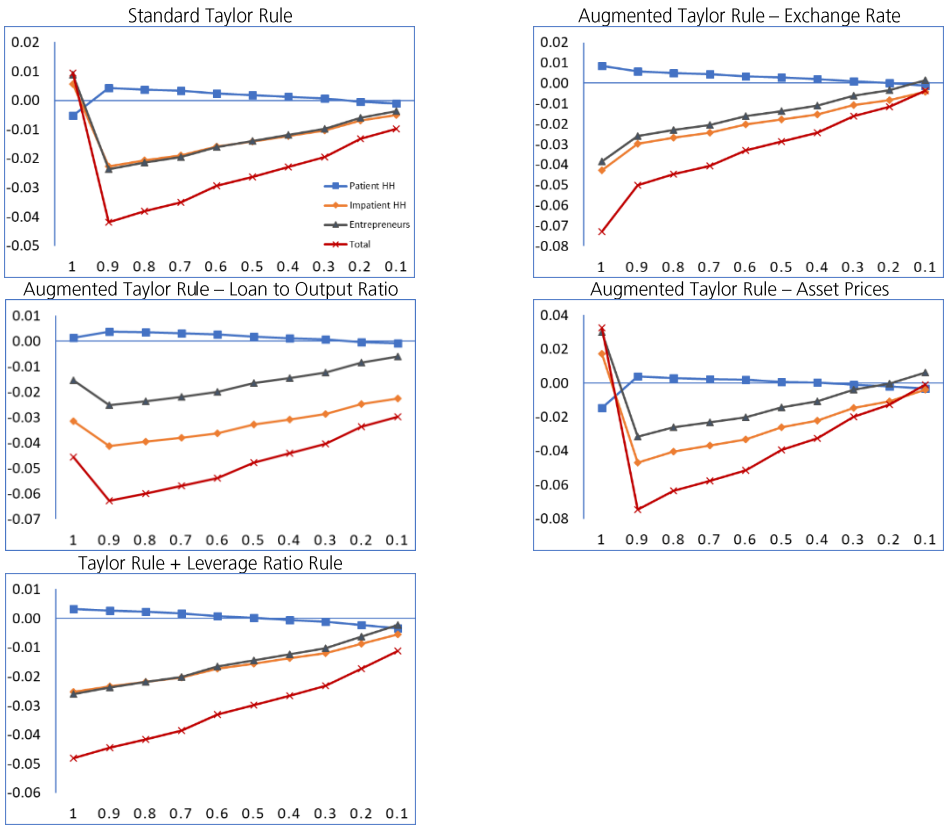


Figure 29: Stabilisation Performances and Welfare Gains of Models with Different Weights of Financial Stability in The Loss Function (Domestic Price Shock)

Notes: The upper panel shows the models' stabilisation performances. Variances, macroeconomic instability, and financial instability are expressed as percentage difference of the instability/variance with the one acquired from the model with the Taylor rule that has been optimised for only macroeconomic stability. Positive values indicate an increase in instability/variance while negative values indicate a decrease in instability/variance. ATR is Augmented Taylor Rule. The lower panel shows the welfare gains. The horizontal axis shows the value of financial stability weight in central bank's loss function. The vertical axis shows the welfare gains relative to the model with the Taylor rule optimised for only macroeconomic stability.

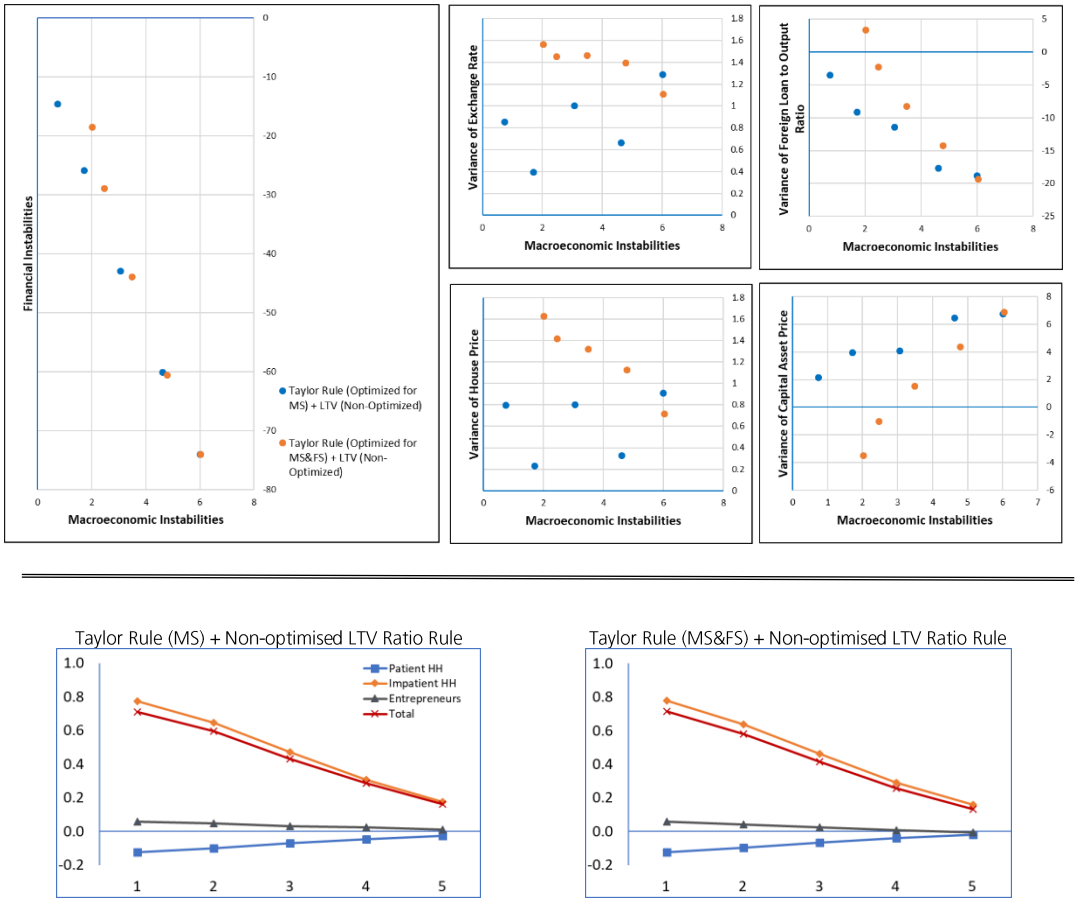


Figure 30: Stabilisation Performances and Welfare Gains of Models in Alternative Scenario (Domestic Price Shock)

Notes: The upper panel shows the models' stabilisation performances. Variances, macroeconomic instability, and financial instability are expressed as percentage difference of the instability/variance with the one acquired from the model with Taylor rule that has been optimised for only macroeconomic stability. Positive values indicate an increase in instability/variance while negative values indicate a decrease in instability/variance. MS is Macroeconomic Stability. FS is Financial Stability. LTV is Loan to Value ratio. The lower panel shows the welfare gains. The horizontal axis shows different calibration of parameter ϕ_{mi} *and* ϕ_{me} *with 1 represents* $[\phi_{mi} = 3.5, \phi_{me} = 0.5]$, *2 represents* $[\phi_{mi} = 1.75, \phi_{me} = 0.25]$, *3 represents* $[\phi_{mi} = 0.875, \phi_{me} = 0.125]$, *4 represents* $[\phi_{mi} = 0.4375, \phi_{me} = 0.0625]$, *5 represents* $[\phi_{mi} = 0.21875, \phi_{me} = 0.03125]$. *The vertical axis shows the welfare gains relative to the model with the Taylor rule optimised for only macroeconomic stability.*

5.2.3. Capital Inflow Shock

In the case of a capital inflow shock, relative to the baseline scenario, all policy strategies improve the welfare of all agents, except for two policy strategies. These policy strategies are: (1) the one that combines and jointly optimised (for macroeconomic and financial stability) the Taylor rule and the LTV ratio rules and (2) the one that combines the non-optimised LTV ratio rules and the Taylor rule that has been optimised for macroeconomic stability. One of the reasons for the welfare loss is because although macroeconomic and financial instabilities are reduced, the instability of the asset prices and the foreign loan to output ratio are increased. A combination of a lower variance of the (domestic) loans with a higher variance of the collateral asset prices when the economy is facing a capital inflow shock is not optimal for the welfare of the borrowers due to its effect on the borrowers' budget constraints. While an increase in the variance of the foreign loan also results in a lower welfare for the patient households, also due to its effect on their budget constraints. Figure 32 shows the welfare gains and the stabilisation performances of the alternative scenario with different values of the parameters that govern the countercyclical response of the LTV ratio rules. Implementation of the policy strategy that combines the non-optimised LTV ratio rules with the Taylor rule that has been optimised for macroeconomic and financial stability results in a larger welfare gain than the one that combines the non-optimised LTV ratio rules with the Taylor rule that has been optimised for only macroeconomic stability. The reason for this is because the former strategy performs better in stabilising the collateral asset prices and the foreign loan to output ratio.

Figure 31 shows the welfare gains and the stabilisation performances of all policy strategies that do not include LTV ratio rules for a different relative weight of financial stability in the central bank loss function. From the figure, we found that the stabilisation performances of the policy strategies that include the capital flow management rule are significantly better than the other strategies, but they have lower welfare gains relative to the other strategies[99]. From Figure 32 we also found that implementing an additional capital flow management policy reduces the welfare gain if the LTV ratio rules are calibrated to have a relatively low response to the dynamic of the loan to output ratio. The addition of CFM policy results in a lower welfare gain due to its effect in changing the composition of output that especially

[99] A comparison between two pairs of policy which are (1) the one that utilises only the Taylor rule and the one that combines the Taylor rule and CFM rule and (2) the one that combines the Taylor rule and leverage rule and the one that combines the Taylor rule, leverage rule and CFM rule, shows as that the addition of CFM rule reduces the welfare gains.

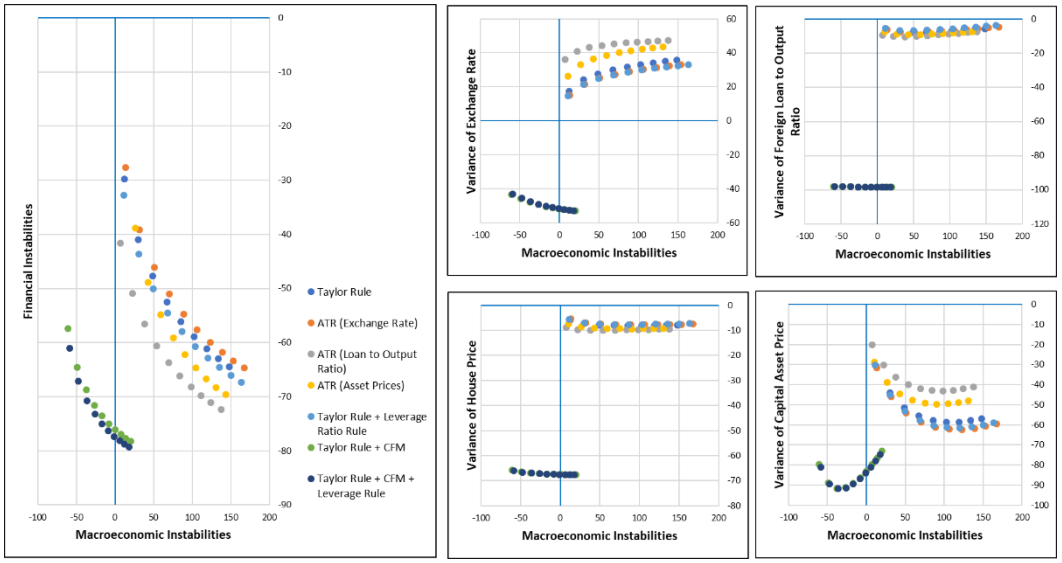
disadvantaging the patient and the impatient households. If the countercyclical parameters of the LTV ratio rule are calibrated to be more responsive, the implementation of an additional CFM policy will increase the welfare gain. The reason for this is because the addition of CFM policy increases the stability of the asset prices which is an important factor for the welfare of agents, especially the borrowers.

Table 36: Welfare Gain (Capital Inflow Shock)

Policy Strategies	Welfare			
	Patient HH	Impatient HH	Entrepreneurs	Total
Scenario 1				
Standard Taylor Rule	9.00	10.67	0.87	21.57
ATR - Exchange Rate	8.34	10.05	0.39	19.60
ATR - Loan to Output ratio	11.11	12.79	2.28	28.05
ATR - Asset Price	10.38	11.98	1.74	25.64
Scenario 2				
Standard Taylor Rule + Leverage Ratio Rule	8.38	10.49	0.93	20.76
Standard Taylor Rule + LTV Ratio Rule	-0.52	-20.90	-3.45	-24.02
Standard Taylor Rule + CFM Rule	4.33	5.55	2.03	12.31
Standard Taylor Rule + CFM Rule + Leverage Ratio Rule	4.37	5.56	2.09	12.43
Standard Taylor Rule + CFM Rule + LTV Ratio Rule	5.39	2.03	1.61	9.21
Alternative Scenario				
Standard Taylor Rule (Optimised for MS) + Non-optimised LTV Ratio Rule $[\phi_{mi} = 5, \phi_{me} = 5]$	-2.22	-20.64	-3.90	-25.41
Standard Taylor Rule (Optimised for MS and FS) + Non-optimised LTV Ratio Rule $[\phi_{mi} = 5, \phi_{me} = 5]$	4.56	-2.66	0.96	2.71
Standard Taylor Rule and CFM Rule (Optimised for MS and FS) + Non-optimised LTV Ratio Rule $[\phi_{mi} = 5, \phi_{me} = 5]$	5.39	2.04	1.62	9.22

Notes: The table shows the welfare gain of each policy strategy relative to the baseline scenario. ATR is Augmented Taylor Rule. LTV is Loan to Value. CFM is Capital Flow Management. MS is Macroeconomic Stability. FS is Financial Stability.

Based on the overall stabilisation performances, the best policy strategy when the economy is facing a capital inflow shock is the one that combines the Taylor rule, the LTV ratio rules, and the CFM rule. The implementation of this policy strategy improves the welfare of all agents in the economy. The implementation of the other policy strategies may result in larger welfare gains but their stabilisation performances may not be preferable for the central bank that tries to reduce the risk of financial and macroeconomic vulnerabilities caused by a capital inflow shock.



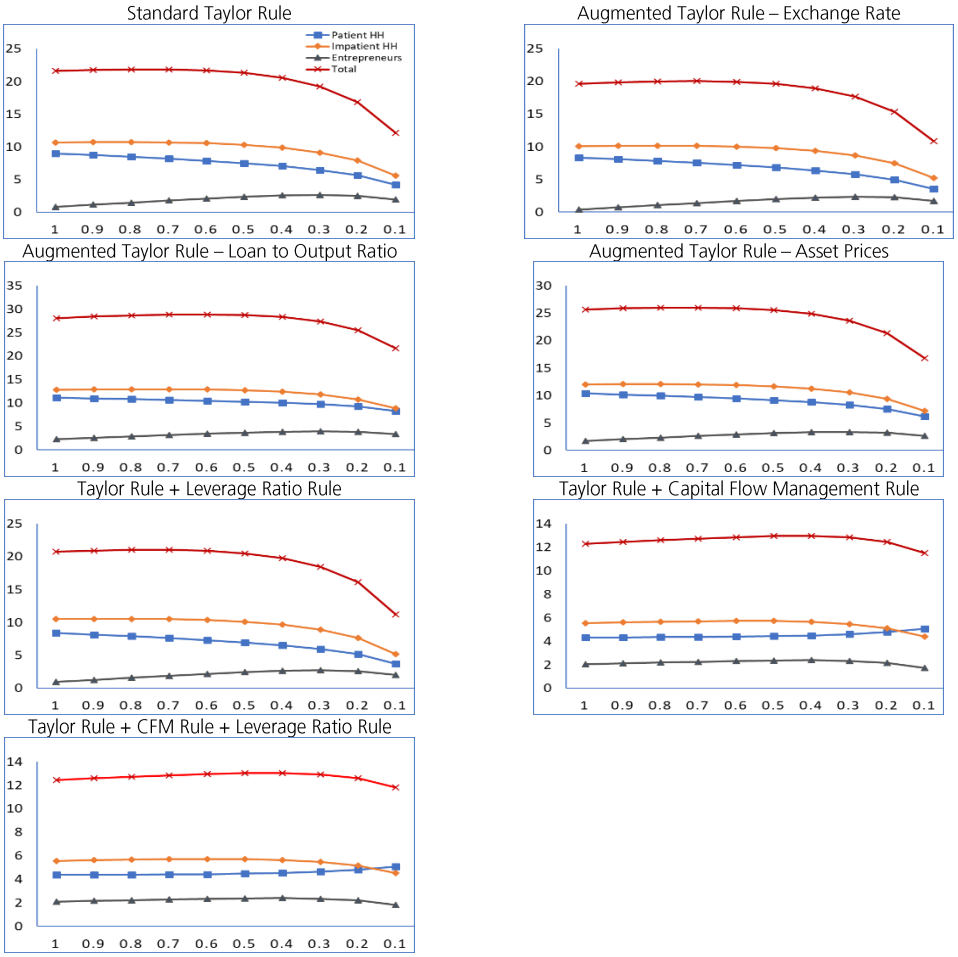


Figure 31: Stabilisation Performances and Welfare Gains of Models with Different Weight of Financial Stability in The Loss Function (Capital Inflow Shock)

Notes: The upper panel shows the models' stabilisation performances. Variances, macroeconomic instability, and financial instability are expressed as percentage difference of the instability/variance with the one acquired from the model with the Taylor rule that has been optimised for only macroeconomic stability. Positive values indicate an increase in instability/variance while negative values indicate a decrease in instability/variance. ATR is Augmented Taylor Rule. CFM is Capital Flow Management. The lower panel shows the welfare gains. The horizontal axis shows the value of financial stability weight in the central bank's loss function. The vertical axis shows the welfare gains relative to the model with the Taylor rule optimised for only macroeconomic stability.

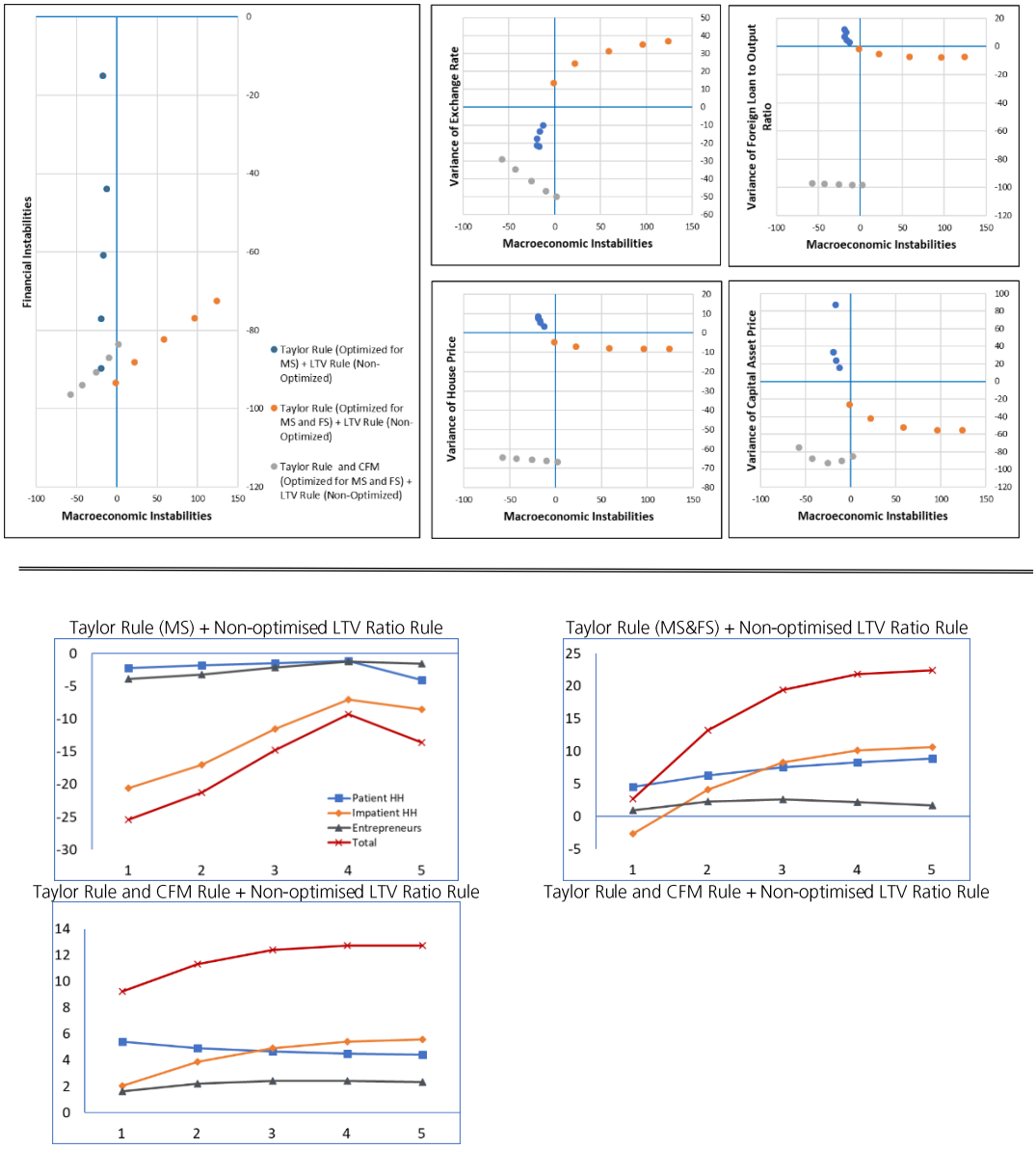


Figure 32: Stabilisation Performances and Welfare Gains of Models in Alternative Scenario (Capital Inflow Shock)

Notes: The upper panel shows the models' stabilisation performances. Variances, macroeconomic instability, and financial instability are expressed as percentage difference of the instability/variance with the one acquired from the model with the Taylor rule that has been optimised for only macroeconomic stability. Positive values indicate an increase in instability/variance while negative values indicate a decrease in instability/variance. MS is Macroeconomic Stability. FS is Financial Stability. LTV is Loan to Value ratio. CFM is Capital Flow Management. The lower panel shows the welfare gains. The horizontal axis shows different calibration of parameter ϕ_{mi} and ϕ_{me} with 1 represents $[\phi_{mi} = 5, \phi_{me} = 5]$, 2 represents $[\phi_{mi} = 2.5, \phi_{me} = 2.5]$, 3 represents $[\phi_{mi} = 1.25, \phi_{me} = 1.25]$, 4 represents $[\phi_{mi} = 0.625, \phi_{me} = 0.625]$, 5 represents $[\phi_{mi} = 0.3125, \phi_{me} = 0.3125]$. The vertical axis shows the welfare gains relative to the model with the Taylor rule optimised for only macroeconomic stability.

5.2.4. Households' Loan Default Shock

When the economy is facing a shock to the households' loan default rate, the implementation of all policy strategies, except the ones that include the LTV ratio rules, results in a reduction in the social welfare, relative to the baseline scenario.

Figure 33 shows the welfare gains and the stabilisation performances of all strategies in the first scenario and the one that combines the Taylor rule and the

leverage ratio rule for different relative weights of financial stability in the central bank loss function. The implementation of these policy strategies results in a reduction in the social welfare that is dominated by the loss in the welfare of the borrowers. This is because the negative effect of higher macroeconomic instability on welfare, cannot be offset by the positive effect of lower financial instability. The instability of the loan to output ratio is still significantly high after implementing these policy strategies. For the case of implementing the policy strategy that utilises the loan to output ratio augmented Taylor rule, the significantly higher instability of asset prices further exacerbates the welfare of the borrowers. The best stabilisation performance is obtained by implementing the policy strategy that combines the Taylor rule and the leverage ratio rule. The implementation of this strategy also results in a lower social welfare loss compared to all strategies in the first scenario.

Table 37: Welfare Gain (Households' Loan Default Shock)

Policy Strategies	Welfare			
	Patient HH	Impatient HH	Entrepreneurs	Total
Scenario 1				
Standard Taylor Rule	-0.1214	-5.4255	-3.2757	-8.6335
ATR - Exchange Rate	-0.1209	-5.4538	-3.2919	-8.6756
ATR - Loan to Output ratio	0.0851	-8.6398	-5.0471	-13.1777
ATR - Asset Price	-0.1155	-6.1012	-3.6829	-9.6629
Scenario 2				
Standard Taylor Rule + Leverage Ratio Rule	-0.0312	-3.0232	-1.7464	-4.7463
Standard Taylor Rule + LTV Ratio Rule	-2.7442	39.2168	17.9205	59.7041
Alternative Scenario				
Standard Taylor Rule (Optimised for MS) + Non-optimised LTV Ratio Rule $[\phi_{mi} = 2.25, \phi_{me} = 0.5]$	-1.4082	27.0201	12.2004	40.5299
Standard Taylor Rule (Optimised for MS and FS) + Non-optimised LTV Ratio Rule $[\phi_{mi} = 2.25, \phi_{me} = 0.5]$	-1.1645	17.6655	8.4244	26.1071

Notes: The table shows the welfare gain of each policy strategy relative to the baseline scenario. ATR is Augmented Taylor Rule. LTV is Loan to Value. MS is Macroeconomic Stability. FS is Financial Stability.

In Chapter 4, we learned that the implementation of the policy strategy that combines the Taylor rule and the LTV ratio rules results in the best overall stabilisation performance compared to the other strategies. The implementation of this policy strategy also results in the highest overall social welfare improvement. This mostly comes from the improvement in the welfare of the borrowers, while the welfare of the patient households is lower than the one from the baseline scenario. Unfortunately, the implementation of this strategy also results in significantly higher

instability of inflation, output, real exchange rate, house price, capital asset price and foreign loan to output ratio. If the central bank concern about the possibility of higher financial/macroeconomic vulnerabilities caused by the higher instability of these variables, it may be better off choosing the two strategies in the alternative scenario that combines the non-optimised LTV ratio rules with the optimised Taylor rule. The countercyclical parameters of the LTV rules are decided based on a certain target reduction in financial instability.

Figure 34 shows the welfare gains and the stabilisation performances of the alternative scenario in which the central bank combines the non-optimised LTV ratio rules with either the Taylor rule that is optimised for both macroeconomic and financial stability or the Taylor rule that is optimised for only macroeconomic stability. The stabilisation performances of the two policy strategies are quite similar, but their effect on the social welfare are significantly different, especially if the countercyclical LTV ratio rules are calibrated to have stronger responses. The difference in the social welfare performance is mainly caused by the significant difference in the instability of inflation. The instability of inflation has an adverse effect on all agents' welfare, especially the borrowers'. The negative effect of inflation on the borrowers' welfare is caused by its effect on the borrowing constraints. Implementing policy strategy that utilises the Taylor rule that is optimised for macroeconomic and financial stability results in a significantly higher inflation instability. This results in significantly lower welfare gains relative to implementing the strategy that utilises the Taylor rule that is optimised for only macroeconomic stability.

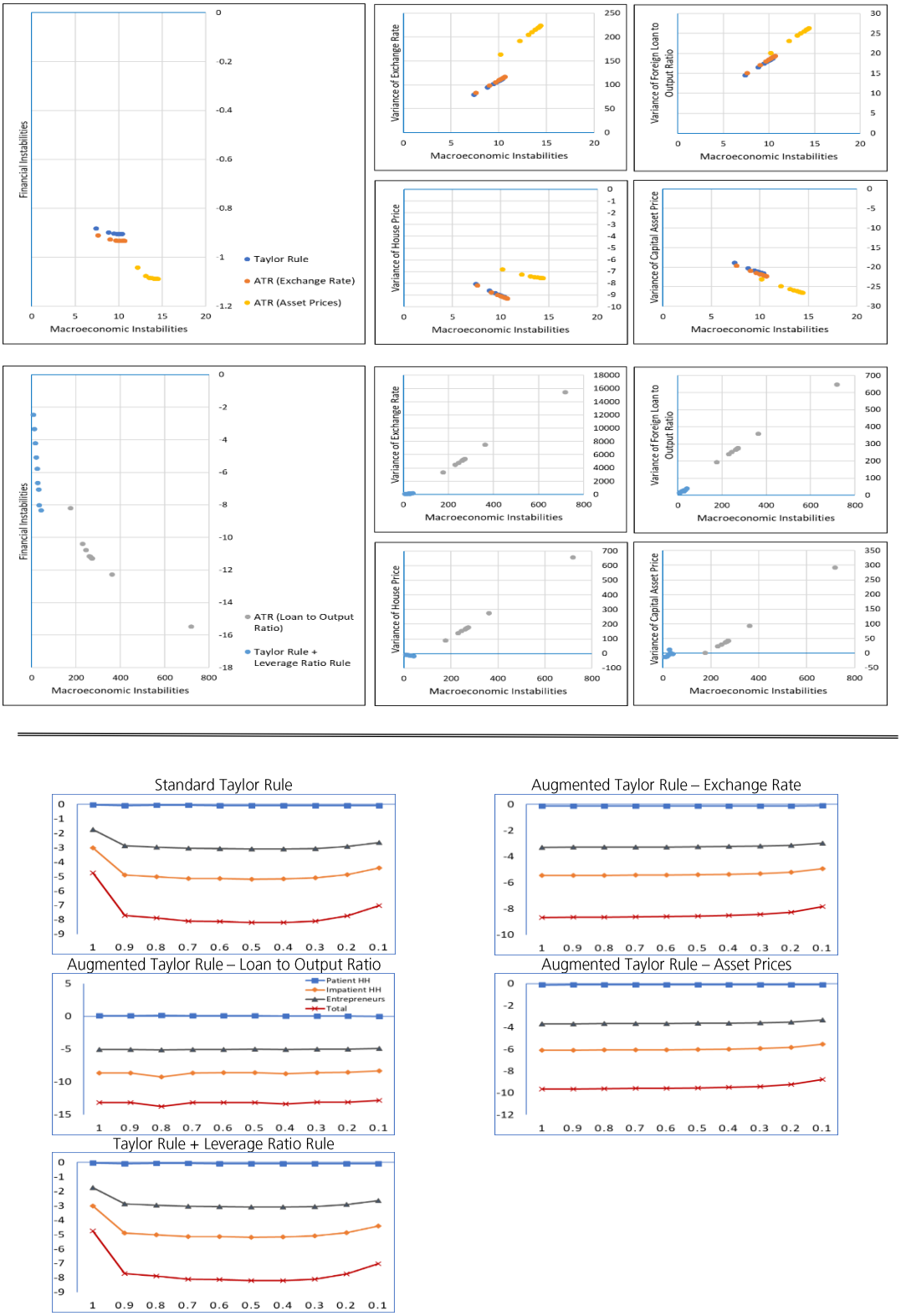


Figure 33: Stabilisation Performances and Welfare Gains of Models with Different Weight of Financial Stability in The Loss Function (Households' Loan Default Shock)

Notes: The upper panel shows the models' stabilisation performances. Variances, macroeconomic instability, and financial instability are expressed as percentage difference of the instability/variance with the one acquired from the model with Taylor rule that has been optimised for only macroeconomic stability. Positive values indicate an increase in instability/variance while negative values indicate a decrease in instability/variance. ATR is Augmented Taylor Rule. The lower panel shows the welfare gains. The horizontal axis shows the value of financial stability weight in the central bank's loss function. The vertical axis shows the welfare gains relative to the model with the Taylor rule optimised for only macroeconomic stability.

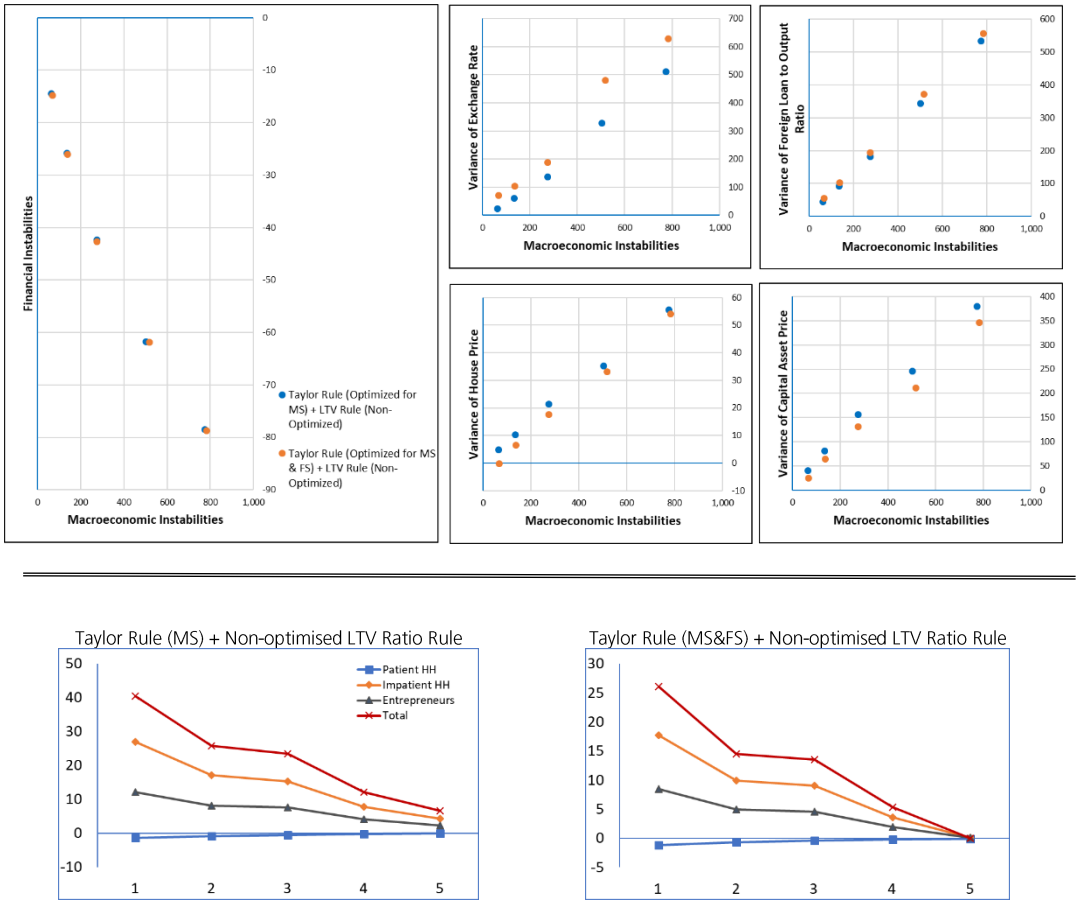


Figure 34: Stabilisation Performances and Welfare Gains of Models in Alternative Scenario (Households' Loan Default Shock)

Notes: The upper panel shows the models' stabilisation performances. Variances, macroeconomic instability, and financial instability are expressed as percentage difference of the instability/variance with the one acquired from the model with Taylor rule that has been optimised for only macroeconomic stability. Positive values indicate an increase in instability/variance while negative values indicate a decrease in instability/variance. MS is Macroeconomic Stability. FS is Financial Stability. LTV is Loan to Value ratio. The lower panel shows the welfare gains. The horizontal axis shows different calibration of parameter ϕ_{mi} and ϕ_{me} with 1 represents $[\phi_{\mathrm{mi}} = 2.25, \phi_{\mathrm{me}} = 0.5]$, 2 represents $[\phi_{\mathrm{mi}} = 1.125, \phi_{\mathrm{me}} = 0.25]$, 3 represents $[\phi_{\mathrm{mi}} = 0.5625, \phi_{\mathrm{me}} = 0.125]$, 4 represents $[\phi_{\mathrm{mi}} = 0.28125, \phi_{\mathrm{me}} = 0.0625]$, 5 represents $[\phi_{\mathrm{mi}} = 0.140625, \phi_{\mathrm{me}} = 0.03125]$. The vertical axis shows the welfare gains relative to the model with the Taylor rule optimised for only macroeconomic stability.

5.3. Conclusion

The objective of this chapter is to examine how the welfare of economic agents are affected by the policy of the central bank that has macroeconomic and financial stability mandate. Welfare is defined for each type of agent (patient households, impatient households, and entrepreneurs) based on their utility functions. In addition, I also define a social welfare measure as a weighted sum of these agents' welfare values.

Since the model in this research does not include the possibility of a crisis, the welfare effect of avoiding a crisis due to higher financial stability cannot be measured. This would mean that the best policy strategy for the central bank that tries to minimise its loss function may not be the same as the one that results in the largest

welfare gain for all agents. Nevertheless, studying the impact of the central bank policy on the welfare of agents can still give useful insights for the central banks. Especially, in understanding the possible trade-off between financial stability and the agents' welfare.

When the economy is facing a technology shock, the best policy strategy for the central bank that tries to minimise its loss function is also the one that can improve the welfare of all the agents in the economy. This policy strategy which combines the Taylor rule and the LTV ratio rules do not result in the largest social welfare gain, but it manages to improve the social welfare by increasing all agents' welfare instead of only for the borrowers.

In the case of a domestic price shock, policy strategy that has the highest stabilisation performance is also the one that has the largest social welfare gain. This policy strategy is the one that combines and jointly optimised the Taylor rule and the countercyclical LTV ratio rules. The gain in social welfare from implementing this strategy is mostly due to significant increases in the borrowers' welfares, especially for the impatient households.

Based on the overall stabilisation performances, the best policy strategy when the economy is facing a capital inflow shock is the one that combines the Taylor rule, the LTV ratio rules, and the CFM rule. The implementation of this policy strategy improves the welfare of all agents in the economy. The implementation of the other policy strategies may result in larger welfare gains, but their stabilisation performances may not be preferable for the central bank that tries to reduce the risk of financial and macroeconomic vulnerabilities caused by a capital inflow shock.

When the economy is facing a shock to the households' loan default rate, the implementation of all policy strategies, except for the ones that include the LTV ratio rules, results in a reduction in the social welfare. The implementation of the policy strategy that combines and jointly optimised the Taylor rule and the LTV ratio rules results in the best overall stabilisation performance and the largest social welfare improvement. The social welfare gain mostly comes from the improvement in the welfare of the borrowers, while the welfare of the patient households is lower than the one from the baseline scenario.

Chapter 6: Conclusion

One of the issues in the implementation of macroprudential and capital flow management policies includes the limited information regarding their transmission and interactions with monetary policy. Various measures available to the policymakers also raise the question of how to choose the right policy tools for a particular dominant shock that propagate in the economy. Using a small open economy DSGE model that has been designed and calibrated based on the emerging Asian economies characteristics, I try to answer some of the questions related to those issues.

The transmission of monetary policy and macroprudential policies in the form of countercyclical loan to value ratio requirements and a leverage ratio requirement are explored in Chapter 2. Model simulations show that certain characteristics of the banking sector may have an impact on the transmission of the policy rate, the countercyclical macroprudential tools and the interactions among them:

1. The level of the interest rate pass-through can influence the effect of the policy rate changes to the banking sector portfolio allocation. This may have an impact on how monetary policy interacts with macroprudential policy measures, especially when the measures are aiming at a specific balance sheet condition, such as leverage or loan to deposit ratio. This warrants the need for a periodical inspection of the monetary policy transmission through the banks' balance sheet, not only for monetary policy purpose but also for the benefit of macroprudential policy arrangements.
2. The size of the excess capital buffer determines the dominant strategy taken by the banks to meet the leverage ratio requirement. The dominant strategy will determine the size of the impact of a change in the leverage ratio requirement to the real sector. When the banks dominantly restrict lending and increase their liquid assets, the impact of the policy on output would be more pronounced than when the banks choose another dominant strategy. The excess capital buffer needs to be monitored and be used as a consideration in designing the countercyclical capital/leverage ratio policy since it has a significant effect on the policy's effectiveness.
3. Restricting the LTV ratio requirement to a certain sector involves diversion of loan distribution to the other unrestricted sector. If the goal is to countercyclically react to the increasing output due to a particular shock, the most effective way is to

use both instruments at the same time. The central bank needs to consider the impact of these diversions in designing their countercyclical LTV ratio policies.

The transmission of capital flow management policy is explored in Chapter 3. Model simulations show that a capital inflow tax has the potential to counteract the increase in foreign borrowing that happens after the shock to the country's risk premium. Without the objective of trying to reduce capital inflow, the implementation of a capital inflow tax may have an adverse effect on macroeconomic and financial stability.

The role of monetary, macroprudential and capital flow management policies as macroeconomic and financial stabilisation tools in facing different shocks in the economy are also explored in the previous chapters. Model simulations show that not all countercyclical instruments can be used effectively in every shock. There are conditions in which the implementation of macroprudential policy can complement monetary policy to achieve macroeconomic and financial stability, but there are also conditions in which it may be preferable for the policymakers not to implement them. Understanding the shock that dominantly drives the disturbances in the economy is necessary to choose countercyclical tools to be implemented alongside the policy rate. The previous chapters gave us some guidance on the performance of three different countercyclical tools in facing four different shocks which include technology, domestic price, capital inflow and households' loan default shock.

In Chapter 2, we learn that in facing a technology shock, it may be best for the central bank not to use the policy rate as the instrument for financial stabilisation, because it results in a significant adverse effect on the price and output stability. In addition, utilising the policy rate for this purpose may also create another source of financial vulnerabilities due to a significant increase in the instability of the capital asset prices. By focusing the policy rate only for macroeconomic stabilisation, the central bank can utilise the non-optimised countercyclical LTV ratio policies for financial stabilisation purposes. Implementing this policy also involves adverse effects on price, output and capital asset price stabilites. However, it is possible for the central bank to adjust its financial stability reduction target based on its assessment of the acceptable level of financial/macroeconomic vulnerabilities that are caused by the increase in the instability of price, output and the capital asset prices.

For the purpose of macroeconomic and financial stabilisation in facing a domestic price shock, without additional countercyclical macroprudential tools, the central bank may benefit from implementing the augmented Taylor rule with a reaction to

the growth of loan to output ratio. This policy strategy is the best choice for the central bank that has constraints in implementing countercyclical macroprudential tools either due to conflicting microprudential concerns, the unavailability of policy infrastructure or political pressures. When other countercyclical instruments are available, the central bank will benefit from implementing the non-optimised LTV ratio rules for financial stabilisation, while the Taylor rule can be targeted solely for macroeconomic stabilisation. There is a cost to macroeconomic stability in implementing this strategy which can be reduced by adjusting the response of the LTV ratio rules, based on the central bank assessment on the acceptable level of financial/macroeconomic vulnerabilities caused by the increase in macroeconomic instability and the variances of the other variables of interest.

In Chapter 3, we learn that when the economy is facing a capital inflow shock, without the addition of macroprudential or capital flow management measures, financial stability in the economy will benefit from a monetary policy that leans against the growth of loan to output ratio. The inclusion of macroprudential policy in the form of a countercyclical loan to value (LTV) ratio rule can significantly dampen the effect of the shocks by reducing the procyclicality of the domestic financial sector. Unfortunately, it has the adverse effect of diverting liquidity into fuelling growth in the asset prices. Instead of implementing this strategy, the central bank may be better of implementing one of the two policy strategies that combine the non-optimised LTV ratio rules and the optimised Taylor rule (either only for macroeconomic stability or also for financial stability). A significantly better macroeconomic and financial stabilisation is achieved by combining the Taylor rule, the LTV ratio rules, and the capital flow management rule.

In Chapter 4, we found that a shock to households' loan default rate can propagate in the economy by worsening the balance sheet condition of, not only the households who borrow but also the banking sector. The effect on the banking sector would be large enough so that it will restrict their ability to provide loans to all borrowers. This will result in a significant decrease in loan distribution to other borrowers in the economy. All policy strategies, implemented to minimise the central bank loss function that includes financial stability measures, result in a higher financial stability but with a cost of a significantly lower macroeconomic stability. The implementation of the policy strategy that combines and jointly optimised the Taylor rule and the LTV ratio rules results in the highest increase in the total stability. Unfortunately, the cost of implementing this strategy also includes a significant

decline in the stability of other measures of financial stability that are not included in the loss function. If the central bank concern about the increase in financial/macroeconomic vulnerabilities caused by the reduction in the stability of these variables, it may be better off choosing the strategies that combine the non-optimised LTV ratio rules with the optimised Taylor rule. The countercyclical parameters of the LTV ratio rules can be chosen by the central bank based on a certain target reduction in financial instability. The decision on implementing these policy strategies depend on the central bank assessment on the trade-off between potentially lower financial/macroeconomic risks resulting from the higher financial stability and the potentially higher financial/macroeconomic risks resulting from the lower stability of output, inflation, exchange rate, foreign loan to output ratio and asset prices.

It may be best for the central bank to consider implementing policies that can minimise the initial impact of the shock to the households' loan default rate. These policies may include any incentives that can encourage the banks to properly measure the probability of defaults and the loss given default rates.

The findings based on the model simulations in Chapter 4 show the importance of the households' loan default rate to be monitored closely by the policymakers, especially in the case of growing households' debt, as currently happening in the emerging Asian economies. The findings do not imply the recommendation to restrict the growth of households' loan relative to other types of loan, but it suggests that the policymakers closely monitor its growth along with the consequences to the overall economy in the case of a sudden default shock. This recommendation is especially important if we take into account the findings of Morgan and Zhang (2015). Based on the post-GFC data from 19 emerging Asian economies, they found that if the share of mortgage lending is higher than 30% of the total loans, the effect of these loans is negative to financial stability.

The banking sector ability to properly measure default risk for households' loan is also important so the default shock would have less impact on their balance sheet. The policymakers need to ensure that the banking sector has the incentive to implement a proper risk measurement. They also need to be cautious in introducing a policy that may result in a deviation from the banks' optimal action given they have properly measured the default risk.

Regular monitoring and assessment activities such as stress testing need to include the households' loan default shock scenario so that the policymakers can properly

measure the risk to the banking sector balance sheet and the real sectors. In executing the test, the policymakers need to keep in mind the possibility that banks do not correctly measure the loss given default rate of the households' loan. The policymakers need to do their own assessment of the households' loan default risk with the objective of informing them on the deviation that may occur in the banks' assessment. The result of the assessment can also be used to advise them in designing the policies that can provide the incentive for the banks to adopt a better risk measurement.

The findings of the previous chapters have shown that the countercyclical leverage ratio requirement, a proxy for countercyclical capital to asset ratio, does not seem to play a significant role in macroeconomic and financial stabilisation. In interpreting these results, it is important to acknowledge the limitations caused by the assumptions made in the model. The model assumes a uniform risk weight among different asset of the banks which may result in a less effect of the policy to changes in bank's balance sheet and the real sector. Angelini et al. (2014) try to circumvent this limitation by adding an ad-hoc equation which relates the risk weight to output growth. As mentioned in their paper[100], the calibration of the risk weight needs to be based on the time series data of the risk weight under Basel II regulation which is not available to most countries.

Chapter 5 examines how the welfare of economic agents are affected by the policy of the central bank that has macroeconomic and financial stability mandate. The inclusion of a financial stability measure in the central bank loss function is based on the empirical evidence showing that the gap of the loan to output ratio is an excellent indicator of the increasing level of financial vulnerabilities that may lead to a crisis. Since the model in this research does not include the possibility of a crisis, the welfare effect of avoiding a crisis due to higher financial stability cannot be measured. This would mean that the best policy strategy for the central bank that tries to minimise its loss function may not be the same as the one that results in the largest welfare gain for all agents. Nevertheless, studying the impact of the central bank policy on the welfare of agents can still give useful insights for the central banks. Especially, in understanding the possible trade-off between financial stability and the agents' welfare.

[100] Angelini et al. (2010)

For the case of domestic and households' loan default shocks, the strategy that results in the highest stabilisation performance is also the one that results in the largest social welfare gain. For the case of a technology shock, the best policy strategy for the central bank that tries to minimise its loss function is not the one that results in the largest social welfare gain, but it manages to improve the social welfare by increasing all agents' welfare instead of only for the borrowers. For the case of a capital inflow shock, the strategy that has the highest stabilisation performance is not the one that results in the largest social welfare gain nor the only one that results in welfare improvements for all agents. The implementation of the other policy strategies may result in a larger social welfare gain, but their stabilisation performances may not be preferable for the central bank that tries to reduce the risk of financial and macroeconomic vulnerabilities caused by a capital inflow shock.

Appendix 1

Complete Equations of the Model (Symmetric Equilibrium)

Patient Households:

$$C_t^p + q_t^K K_t^p - (1-\delta_K) q_t^K K_{t-1}^p + q_t H_t^p - (1-\delta_H) q_t H_{t-1}^p + D_t + s_t(1+\rho_{t-1})(1+r_{t-1}^*)\frac{\tilde{B}_{t-1}^*}{\pi_t^*} = w_t^P L_t^P + \left(1+r_{t-1}^d\right)\frac{D_{t-1}}{\pi_t} + R_t^K q_t^K K_{t-1}^P + s_t \tilde{B}_t^* + T_t$$ $where\ \tilde{B}_t^* = \frac{B_t^*}{P_t^*} P_t\ and\ s_t = \frac{e_t\ P_t^*}{P_t}$	*(A 1)*
$$T_t = \Pi_t^H + \Pi_t^F + \Pi_t^{H^*} + (1-\chi)\frac{\Pi_{t-1}^B}{\pi_t} + \frac{\kappa_L}{2}\left(\frac{B_{t-1}^E + B_{t-1}^I}{K_{t-1}^B} - \Psi_{t-1}\right)^2 \frac{K_{t-1}^B}{\pi_t} + \frac{\kappa_d}{2}\left(\frac{r_{t-1}^d}{r_{t-2}^d} - 1\right)^2 r_{t-1}^d \frac{D_{t-1}}{\pi_t} + \frac{\kappa_E}{2}\left(\frac{r_{t-1}^E}{r_{t-2}^E} - 1\right)^2 r_{t-1}^E \frac{B_{t-1}^E}{\pi_t} + \frac{\kappa_I}{2}\left(\frac{r_{t-1}^I}{r_{t-2}^I} - 1\right)^2 r_{t-1}^I \frac{B_{t-1}^I}{\pi_t} - \left(r_{t-1}\right)\frac{B_{t-1}^{CB}}{\pi_t}$$	*(A 2)*
$$\frac{j}{H_t^p} + \frac{\beta_P}{C_{t+1}^p} q_{t+1}(1-\delta_H) = \frac{1}{C_t^p} q_t$$	*(A 3)*
$$\frac{1}{C_t^p} w_t^P = \left(L_t^p\right)^{\eta-1}$$	*(A 4)*
$$\frac{C_{t+1}^p}{\beta_P\ C_t^p}\frac{q_t^K}{q_{t+1}^K} = (1-\delta_K) + R_{t+1}^K$$	*(A 5)*
$$\frac{\left(1+r_t^d\right)}{(1+\rho_t)(1+r_t^*)} = \frac{s_{t+1}\pi_{t+1}}{s_t \pi_{t+1}^*}$$	*(A 6)*
$$\left(1+r_t^d\right) = \frac{C_{t+1}^p}{C_t^p}\frac{\pi_{t+1}}{\beta_P}$$	*(A 7)*

Impatient Households:

$C_t^I + q_t H_t^I - (1-\delta_H) q_t H_{t-1}^I + (1+r_{t-1}^I)\frac{B_{t-1}^I}{\pi_t} = B_t^I + w_t^I L_t^I$	*(A 8)*
$\frac{(1+r_t^I)}{\pi_{t+1}} B_t^I = m_t^I q_{t+1}(1-\delta_H) H_t^I$	*(A 9)*
$(L_t^I)^{\eta-1} = \frac{1}{C_t^I} w_t^I$	*(A 10)*
$\frac{j}{H_t^I} + \left(\frac{\pi_{t+1}}{(1+r_t^I)C_t^I} - \frac{\beta_I}{C_{t+1}^I}\right) m_t^I (1-\delta_H) q_{t+1} + \frac{\beta_I \; q_{t+1}(1-\delta_H)}{C_{t+1}^I} = \frac{q_t}{C_t^I}$	*(A 11)*

Entrepreneurs:

$Y_t^E = A_t\left[(K_{t-1}^E)^{\sigma}(K_{t-1}^P)^{(1-\sigma)}\right]^{\alpha}\left[(L_t^p)^{\gamma}(L_t^I)^{(1-\gamma)}\right]^{(1-\alpha)}$	*(A 12)*
$\frac{(1+r_t^E)}{\pi_{t+1}} B_t^E = m_t^E q_{t+1}^K (1-\delta_K) K_t^E$	*(A 13)*
$C_t^E + q_t^K K_t^E - (1-\delta_K) q_t^K K_{t-1}^E + w_t^P L_t^P + w_t^I L_t^I + (1+r_{t-1}^E)\frac{B_{t-1}^E}{\pi_t} + R_t^K q_t^K K_{t-1}^P = \tilde{p}_t^E Y_t^E + B_t^E$ *Where* $\tilde{p}_t^E = \frac{P_t^E}{P_t}$	*(A 14)*
$(1-\sigma)(\alpha)\tilde{p}_{t+1}^E \frac{Y_{t+1}^E}{K_t^P q_{t+1}^K} = (R_{t+1}^K)$	*(A 15)*
$w_t^P = \gamma(1-\alpha)\tilde{p}_t^E \frac{Y_t^E}{L_t^P}$	*(A 16)*
$w_t^I = (1-\gamma)(1-\alpha)\tilde{p}_t^E \frac{Y_t^E}{L_t^I}$	*(A 17)*

$$\left(\frac{\pi_{t+1}}{C_t^E(1+r_t^E)}-\frac{\beta_E}{C_{t+1}^E}\right)m_t^E q_{t+1}^K(1-\delta_K)+\frac{\beta_E}{C_{t+1}^E}\left((1-\delta_K)q_{t+1}^K+\sigma\alpha\tilde{p}_{t+1}^E\frac{Y_{t+1}^E}{K_t^E}\right) = \frac{1}{C_t^E}(q_t^K)$$	*(A 18)*

Banks:

$$\Pi_t^B = (r_t^E)B_t^E + (r_t^I)B_t^I + (r_t\ )B_t^{CB} - (r_t^d)D_t - \frac{\kappa_L}{2}\left(\frac{B_t^E+B_t^I}{K_t^B}-\Psi_t\right)^2 K_t^B - \frac{\kappa_d}{2}\left(\frac{r_t^d}{r_{t-1}^d}-1\right)^2 r_t^d D_t - \frac{\kappa_E}{2}\left(\frac{r_t^E}{r_{t-1}^E}-1\right)^2 r_t^E B_t^E - \frac{\kappa_I}{2}\left(\frac{r_t^I}{r_{t-1}^I}-1\right)^2 r_t^I B_t^I$$	*(A 19)*
$$B_t^E + B_t^I + B_t^{CB} = D_t + K_t^B$$	*(A 20)*
$$K_t^B = (1-\delta_{KB})\frac{K_{t-1}^B}{\pi_t} + \chi\frac{\Pi_{t-1}^B}{\pi_t}$$	*(A 21)*
$$1+\frac{\varepsilon^{bi}}{r_t^I}\left(r_t\ +\kappa_L\left(\frac{B_t^E+B_t^I}{K_t^B}-\Psi_t\right)\right)+\beta_P\ \frac{C_t^p}{C_{t+1}^p}\left(\kappa_I\left(\frac{r_{t+1}^I}{r_t^I}-1\right)\frac{B_{t+1}^I}{B_t^I}\left(\frac{r_{t+1}^I}{r_t^I}\right)^2\right) = \varepsilon^{bi}+\kappa_I\left(\frac{r_t^I}{r_{t-1}^I}-1\right)\frac{r_t^I}{r_{t-1}^I}$$	*(A 22)*
$$1+\frac{\varepsilon^{be}}{r_t^E}\left(r_t\ +\kappa_L\left(\frac{B_t^E+B_t^I}{K_t^B}-\Psi_t\right)\right)+\beta_P\ \frac{C_t^p}{C_{t+1}^p}\left(\kappa_E\left(\frac{r_{t+1}^E}{r_t^E}-1\right)\frac{B_{t+1}^E}{B_t^E}\left(\frac{r_{t+1}^E}{r_t^E}\right)^2\right) = \varepsilon^{be}+\kappa_E\left(\frac{r_t^E}{r_{t-1}^E}-1\right)\frac{r_t^E}{r_{t-1}^E}$$	*(A 23)*
$$\varepsilon^d\ +\beta_P\ \frac{C_t^p}{C_{t+1}^p}\kappa_d\left(\frac{r_{t+1}^d}{r_t^d}-1\right)\frac{D_{t+1}}{D_t}\left(\frac{r_{t+1}^d}{r_t^d}\right)^2 = 1+\frac{r_t}{r_t^d}(\varepsilon^d)+\kappa_d\left(\frac{r_t^d}{r_{t-1}^d}-1\right)\frac{r_t^d}{r_{t-1}^d}$$	*(A 24)*
$$\Psi_t\ = \left(\frac{\Psi}{\Psi^{reg}}\right)\Psi_t^{reg}$$	*(A 25)*

Housing Producers:

$$H_t = (1-\delta_H)H_{t-1} + \varepsilon_t^H \left(1 - \frac{1}{2}\kappa_H \left(\frac{I_t^H}{I_{t-1}^H} - 1\right)^2\right) I_t^H$$	*(A 26)*
$$H_t = H_t^p + H_t^I$$	*(A 27)*
$$q_t = \frac{1}{\varepsilon_t^H} + \frac{1}{2}\kappa_H q_t \left(\frac{I_t^H}{I_{t-1}^H} - 1\right)^2 + \kappa_H q_t \frac{I_t^H}{I_{t-1}^H}\left(\frac{I_t^H}{I_{t-1}^H} - 1\right) - \beta_P \frac{C_t^p}{C_{t+1}^p}\left(\kappa_H q_{t+1} \frac{\varepsilon_{t+1}^H}{\varepsilon_t^H}\left(\frac{I_{t+1}^H}{I_t^H}\right)^2 \left(\frac{I_{t+1}^H}{I_t^H} - 1\right)\right)$$	*(A 28)*

Capital Producers:

$$K_t = (1-\delta_k)K_{t-1} + \varepsilon_t^K \left(1 - \frac{1}{2}\kappa_k \left(\frac{I_t^K}{I_{t-1}^K} - 1\right)^2\right) I_t^K$$	*(A 29)*
$$K_t = K_t^p + K_t^E$$	*(A 30)*
$$q_t^K = \frac{1}{\varepsilon_t^K} + \frac{1}{2}\kappa_K q_t^K \left(\frac{I_t^K}{I_{t-1}^K} - 1\right)^2 + \kappa_K q_t^K \frac{I_t^K}{I_{t-1}^K}\left(\frac{I_t^K}{I_{t-1}^K} - 1\right) - \beta_P \frac{C_t^p}{C_{t+1}^p}\left(\kappa_K q_{t+1}^K \frac{\varepsilon_{t+1}^K}{\varepsilon_t^K}\left(\frac{I_{t+1}^K}{I_t^K}\right)^2 \left(\frac{I_{t+1}^K}{I_t^K} - 1\right)\right)$$	*(A 31)*

Country's Risk Premium:

$$(1+\rho_t) = exp\left(-\varphi \frac{s_t \tilde{B}_t^*}{Y_t^E}\right) \varepsilon_t^\rho$$	*(A 32)*

Domestic Retailers:

$\left(\frac{1}{1-\theta_H}((\pi_t^H)^{1-\varepsilon_H}-\theta_H(\pi_{t-1}^H)^{1-\varepsilon_H})\right)^{\frac{1}{1-\varepsilon_H}} E_t\sum_{k=0}^{\infty}(\beta_P\theta_H)^k\frac{1}{C_{t+k}^p}y_{t+k}^H(\pi_{t+k}^H)^{\varepsilon_H-1}$ $=\left(\frac{\varepsilon_H}{\varepsilon_H-1}\right)\varepsilon_t^{xh}E_t\sum_{k=0}^{\infty}(\beta_P\theta_H)^k\frac{1}{C_{t+k}^p}y_{t+k}^H(\pi_{t+k}^H)^{\varepsilon_H}\frac{\tilde{p}_{t+k}^E}{\tilde{p}_{t+k}^H}$ *Where* $\tilde{p}_t^E=\frac{P_t^E}{P_t}$ *and* $\tilde{p}_t^H=\frac{P_t^H}{P_t}$	*(A 33)*
$\Pi_t^H=(\tilde{p}_t^H-\tilde{p}_t^E)y_t^H$	*(A 34)*
$\pi_t^H=\frac{\tilde{p}_t^H}{\tilde{p}_{t-1}^H}\pi_t$	*(A 35)*

Importers

$\left(\frac{1}{1-\theta_F}((\pi_t^F)^{1-\varepsilon_F}-\theta_F(\pi_{t-1}^F)^{1-\varepsilon_F})\right)^{\frac{1}{1-\varepsilon_F}} E_t\sum_{k=0}^{\infty}(\beta_P\theta_F)^k\frac{1}{C_{t+k}^p}y_{t+k}^F(\pi_{t+k}^F)^{\varepsilon_F-1}$ $=\frac{\varepsilon_F}{\varepsilon_F-1}E_t\sum_{k=0}^{\infty}(\beta_P\theta_F)^k\frac{1}{C_{t+k}^p}y_{t+k}^F(\pi_{t+k}^F)^{\varepsilon_F}\frac{s_{t+k}\tilde{p}_{t+k}^{F^*}}{\tilde{p}_t^F}$ *Where* $\tilde{p}_t^F=\frac{P_t^F}{P_t}$ *and* $\tilde{p}_t^{F^*}=\frac{P_t^{F^*}}{P_t^*}$	*(A 36)*
$\Pi_t^F=(\tilde{p}_t^F-s_t\tilde{p}_t^{F^*})y_t^F$	*(A 37)*
$\pi_t^F=\frac{\tilde{p}_t^F}{\tilde{p}_{t-1}^F}\pi_t$	*(A 38)*

Exporters:

$y_t^{H^*}=(1-\eta^*)\left(\frac{\tilde{p}_t^{H^*}}{\tilde{p}_t^{X^*}}\right)^{\frac{-(1+\mu_{H^*})}{\mu_{H^*}}}y_t^*$ *Where* $\tilde{p}_t^{H^*}=\frac{P_t^{H^*}}{P_t^*}$ *and* $\tilde{p}_t^{X^*}=\frac{P_t^{X^*}}{P_t^*}$	*(A 39)*

$$\left(\frac{1}{1-\theta_{H^*}}\left(\left(\pi_t^{H^*}\right)^{1-\varepsilon_{H^*}}-\theta_{H^*}\left(\pi_{t-1}^{H^*}\right)^{1-\varepsilon_{H^*}}\right)\right)^{\frac{1}{1-\varepsilon_{H^*}}} E_t\sum_{k=0}^{\infty}(\beta_P\theta_{H^*})^k\frac{1}{C_{t+k}^p}y_{t+k}^{H^*}\left(\pi_{t+k}^{H^*}\right)^{\varepsilon_{H^*}-1} = \frac{\varepsilon_{H^*}}{\varepsilon_{H^*}-1}E_t\sum_{k=0}^{\infty}(\beta_P\theta_{H^*})^k\frac{1}{C_{t+k}^p}y_{t+k}^{H^*}\left(\pi_{t+k}^{H^*}\right)^{\varepsilon_{H^*}}\frac{\tilde{p}_{t+k}^E}{s_{t+k}\tilde{p}_{t+k}^{H^*}}$$	*(A 40)*
$$\Pi_t^{H^*}=\left(s_t\tilde{p}_t^{H^*}-\tilde{p}_t^E\right)y_t^{H^*}$$	*(A 41)*
$$\pi_t^{H^*}=\frac{\tilde{p}_t^{H^*}}{\tilde{p}_{t-1}^{H^*}}\pi_t^*$$	*(A 42)*

Final Goods Producers:

$$y_t^H=\xi(\tilde{p}_t^H)^{-\frac{1+\mu}{\mu}}y_t$$	*(A 43)*
$$y_t^F=(1-\xi)(\tilde{p}_t^F)^{-\frac{1+\mu}{\mu}}y_t$$	*(A 44)*
$$y_t=y_t^H\tilde{p}_t^H+y_t^F\tilde{p}_t^F$$	*(A 45)*

Market Clearings and Balance of Payment:

$$y_t^E=y_t^H+y_t^{H^*}$$	*(A 46)*
$$y_t=C_t^p+C_t^I+C_t^E+I_t^K+I_t^H+\delta_{KB}\frac{K_{t-1}^B}{\pi_t}$$	*(A 47)*
$$s_t\tilde{p}_t^{F^*}y_t^F+s_t(1+\rho_{t-1})(1+r_{t-1}^*)\frac{\tilde{B}_{t-1}^*}{\pi_t^*}=s_t\tilde{p}_t^{H^*}y_t^{H^*}+s_t\tilde{B}_t^*$$	*(A 48)*

External Variables:

$$1+r_t^*=(1-\rho_{r^*})(1+r^*)+\rho_{r^*}(1+r_{t-1}^*)+\epsilon_t^{r^*}$$	*(A 49)*

$\pi_t^* = (1-\rho_{\pi^*})\pi^* + \rho_{\pi^*}\pi_{t-1}^* + \epsilon_t^{\pi^*}$	*(A 50)*
$\tilde{p}_t^{F^*} = (1-\rho_{p^{F*}})\tilde{p}^{F^*} + \rho_{p^{F*}}\tilde{p}_{t-1}^{F^*} + \epsilon_t^{F^*}$	*(A 51)*
$\tilde{p}_t^{X^*} = (1-\rho_{p^{X*}})\tilde{p}^{X^*} + \rho_{p^{X*}}\tilde{p}_{t-1}^{X} + \epsilon_t^{X^*}$	*(A 52)*
$y_t^* = (1-\rho_{y^*})y^* + \rho_{y^*}y_{t-1}^* + \epsilon_t^{y^*}$	*(A 53)*

TFP:

$ln(A_t) = \rho_A ln(A_{t-1}) + \epsilon_t^A$	*(A 54)*

Shocks:

$\varepsilon_t^\rho = (1-\rho_\rho)\varepsilon^\rho + \rho_{\varepsilon^\rho}\varepsilon_{t-1}^\rho + \epsilon_t^\rho$	*(A 55)*

Changes due to the addition of the capital inflow tax:

Patient Households:

$$C_t^p + q_t^K K_t^p - (1-\delta_K) q_t^K K_{t-1}^p + q_t H_t^p - (1-\delta_H) q_t H_{t-1}^p + D_t + s_t(1+\rho_{t-1})(1+r_{t-1}^*)(1+\tau_{t-1}^*)\frac{\tilde{B}_{t-1}^*}{\pi_t^*} = w_t^P L_t^P + \left(1+r_{t-1}^d\right)\frac{D_{t-1}}{\pi_t} + R_t^K q_t^K K_{t-1}^P + s_t \tilde{B}_t^* + T_t$$	*(A 56)*
$$T_t = \Pi_t^H + \Pi_t^F + \Pi_t^{H^*} + (1-\chi)\frac{\Pi_{t-1}^B}{\pi_t} + \frac{\kappa_L}{2}\left(\frac{B_{t-1}^E + B_{t-1}^I}{K_{t-1}^B} - \Psi_{t-1}\right)^2 \frac{K_{t-1}^B}{\pi_t} + \frac{\kappa_d}{2}\left(\frac{r_{t-1}^d}{r_{t-2}^d} - 1\right)^2 r_{t-1}^d \frac{D_{t-1}}{\pi_t} + \frac{\kappa_E}{2}\left(\frac{r_{t-1}^E}{r_{t-2}^E} - 1\right)^2 r_{t-1}^E \frac{B_{t-1}^E}{\pi_t} + \frac{\kappa_I}{2}\left(\frac{r_{t-1}^I}{r_{t-2}^I} - 1\right)^2 r_{t-1}^I \frac{B_{t-1}^I}{\pi_t} - \left(r_{t-1}\right)\frac{B_{t-1}^{CB}}{\pi_t} + s_t(1+\rho_{t-1})(1+r_{t-1}^*)\tau_{t-1}^* \frac{\tilde{B}_{t-1}^*}{\pi_t^*}$$	*(A 57)*
$$\left(\frac{s_{t+1}}{s_t}\right) = \frac{\left(1+r_t^d\right)}{(1+\rho_t)(1+r_t^*)(1+\tau_t^*)}\left(\frac{\pi_{t+1}^*}{\pi_{t+1}}\right)$$	*(A 58)*

Changes due to the addition of the loan defaults' transmission:

Impatient Households:

$C_t^I + q_t(H_t^I - (1-\delta_H)(1-\zeta_t^I)H_{t-1}^I) + (1+r_{t-1}^I)(1-\zeta_t^I)\frac{B_{t-1}^I}{\pi_t} = B_t^I + w_t^I L_t^I$	*(A 59)*
$\frac{j}{H_t^I} + \left(\frac{\pi_{t+1}}{(1+r_t^I)C_t^I} - \frac{\beta_I}{C_{t+1}^I}(1-\zeta_{t+1}^I)\right) m_t^I q_{t+1}(1-\delta_H) + \frac{\beta_I \; q_{t+1}(1-\delta_H)(1-\zeta_{t+1}^I)}{C_{t+1}^I} = \frac{q_t}{C_t^I}$	*(A 60)*
$\zeta_t^I = \rho^{\zeta i}\zeta_{t-1}^I + (1-\rho^{\zeta i})\zeta^I + \varepsilon_t^{\zeta i}$	*(A 61)*

Entrepreneurs:

$C_t^E + q_t^K(K_t^E - (1-\delta_K)(1-\zeta_t^E)K_{t-1}^E) + w_t^P L_t^P + w_t^I L_t^I + (1+r_{t-1}^E)(1-\zeta_t^E)\frac{B_{t-1}^E}{\pi_t} + R_t^K K_{t-1}^P = \frac{P_t^E}{P_t}Y_t^E + B_t^E$	*(A 62)*
$\left(\frac{\pi_{t+1}}{C_t^E(1+r_t^E)} - \frac{\beta_E\,(1-\zeta_{t+1}^E)}{C_{t+1}^E}\right) m_t^E q_{t+1}^K(1-\delta_K) + \frac{\beta_E}{C_{t+1}^E}\left((1-\delta_K)(1-\zeta_{t+1}^E)q_{t+1}^K + \sigma\alpha\frac{P_{t+1}^E}{P_{t+1}}\frac{Y_{t+1}^E}{K_t^E}\right) = \frac{1}{C_t^E}(q_t^K)$	*(A 63)*
$\zeta_t^E = \rho^{\zeta e}\zeta_{t-1}^E + (1-\rho^{\zeta e})\zeta^E + \varepsilon_t^{\zeta e}$	*(A 64)*

Banks:

$\frac{\Pi_{t-1}^B}{\pi_t} = (r_{t-1}^E)\frac{B_{t-1}^E}{\pi_t} + (r_t^I(j))\frac{B_{t-1}^I}{\pi_t} + (r_t\;)\frac{B_{t-1}^{CB}}{\pi_t} - (r_t^d(j))\frac{D_{t-1}}{\pi_t} - \frac{\kappa_L}{2}\left(\frac{B_{t-1}^E + B_{t-1}^I}{K_{t-1}^B} - \Psi_{t-1}\right)^2 \frac{K_{t-1}^B}{\pi_t} - \frac{\kappa_d}{2}\left(\frac{r_{t-1}^d}{r_{t-2}^d} - 1\right)^2 r_{t-1}^d \frac{D_{t-1}}{\pi_t} - \frac{\kappa_E}{2}\left(\frac{r_{t-1}^E}{r_{t-2}^E} - 1\right)^2 r_{t-1}^E \frac{B_{t-1}^E}{\pi_t} - \frac{\kappa_I}{2}\left(\frac{r_{t-1}^I}{r_{t-2}^I} - 1\right)^2 r_{t-1}^I \frac{B_{t-1}^I}{\pi_t} - \zeta_t^E(1+r_{t-1}^E)\frac{B_{t-1}^E}{\pi_t} - \zeta_t^I(1+r_{t-1}^I)\frac{B_{t-1}^I}{\pi_t} + q_t\;\gamma_t^H(1-\delta_H)(\zeta_t^I)H_{t-1}^I + q_t^K\gamma_t^K(1-\delta_K)(\zeta_t^E)K_{t-1}^E$	*(A 65)*

$$loss_t^I = \zeta_{t+1}^I \left(1 - \frac{\gamma_{t+1}^H}{m_t^I}\right)$$	*(A 66)*
$$loss_t^E = \zeta_{t+1}^E \left(1 - \frac{\gamma_{t+1}^K}{m_t^E}\right)$$	*(A 67)*
$$1 - \varepsilon^{bI} + \varepsilon^{bI} loss_t^I - loss_t^I + \frac{\varepsilon^{bI}}{r_t^I} r_t \quad + \kappa_L \frac{\varepsilon^{bI}}{r_t^I} \frac{B_t^E}{K_t^B} + \kappa_L \frac{\varepsilon^{bI}}{r_t^I} \frac{B_t^I}{K_t^B} - \kappa_L \frac{\varepsilon^{bI}}{r_t^I} \Psi_t + \frac{\varepsilon^{bI}}{r_t^I} loss_t^I = \kappa_I \left(\frac{r_t^I}{r_{t-1}^I} - 1\right) \frac{r_t^I}{r_{t-1}^I} - \beta_P \frac{C_t^P}{C_{t+1}^P} \left(\kappa_I \left(\frac{r_{t+1}^I}{r_t^I} - 1\right) \frac{B_{t+1}^I}{B_t^I} \left(\frac{r_{t+1}^I}{r_t^I}\right)^2\right)$$	*(A 68)*
$$1 - \varepsilon^{bE} + \varepsilon^{bE} loss_{t+1}^E - loss_{t+1}^E + \frac{\varepsilon^{bE}}{r_t^E} r_t \quad + \kappa_L \frac{\varepsilon^{bE}}{r_t^E} \frac{B_t^E}{K_t^B} + \kappa_L \frac{\varepsilon^{bE}}{r_t^E} \frac{B_t^I}{K_t^B} - \kappa_L \frac{\varepsilon^{bE}}{r_t^E} \Psi_t + \frac{\varepsilon^{bE}}{r_t^E} loss_{t+1}^E = \kappa_E \left(\frac{r_t^E}{r_{t-1}^E} - 1\right) \frac{r_t^E}{r_{t-1}^E} - \beta_P \frac{C_t^P}{C_{t+1}^P} \left(\kappa_I \left(\frac{r_{t+1}^E}{r_t^E} - 1\right) \frac{B_{t+1}^E}{B_t^E} \left(\frac{r_{t+1}^E}{r_t^E}\right)^2\right)$$	*(A 69)*

Housing Asset Liquidators:

$$LS_t^H = v^h \zeta_t^I (1 - \delta_H) H_{t-1}^I$$	*(A 70)*
$$LS_t^H = Z^H (LQ_t^H)^{(1-\iota h)}$$	*(A 71)*
$$p_t^{LH} = \frac{LQ_t^H}{(1 - \iota h) LS_t^H}$$	*(A 72)*
$$\gamma_t^H = \left(1 - \frac{p_t^{LH} (1 - \iota h) v^h}{q_t}\right)$$	*(A 73)*

Capital Asset Liquidators:

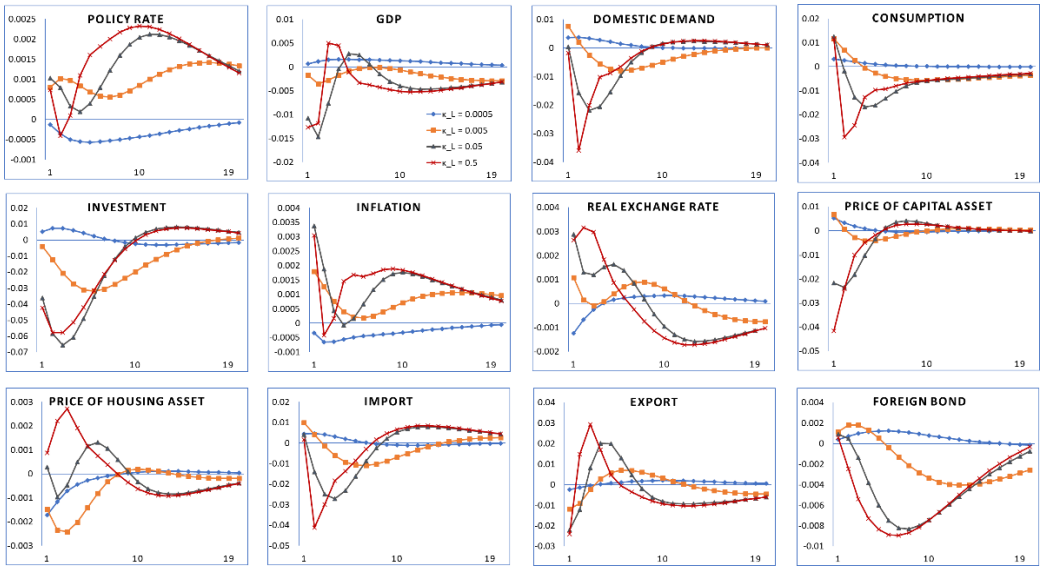
$$LS_t^K = v^k \zeta_t^E (1 - \delta_K) K_{t-1}^E$$	*(A 74)*
$$LS_t^K = Z^K (LQ_t^K)^{(1-\iota k)}$$	*(A 75)*

$$p_t^{LK} = \frac{LQ_t^K}{(1-\imath k)LS_t^K}$$	*(A 76)*
$$\gamma_t^K = \left(1 - \frac{p_t^{LK}(1-\imath k)v^k}{q_t^K}\right)$$	*(A 77)*

Appendix 2

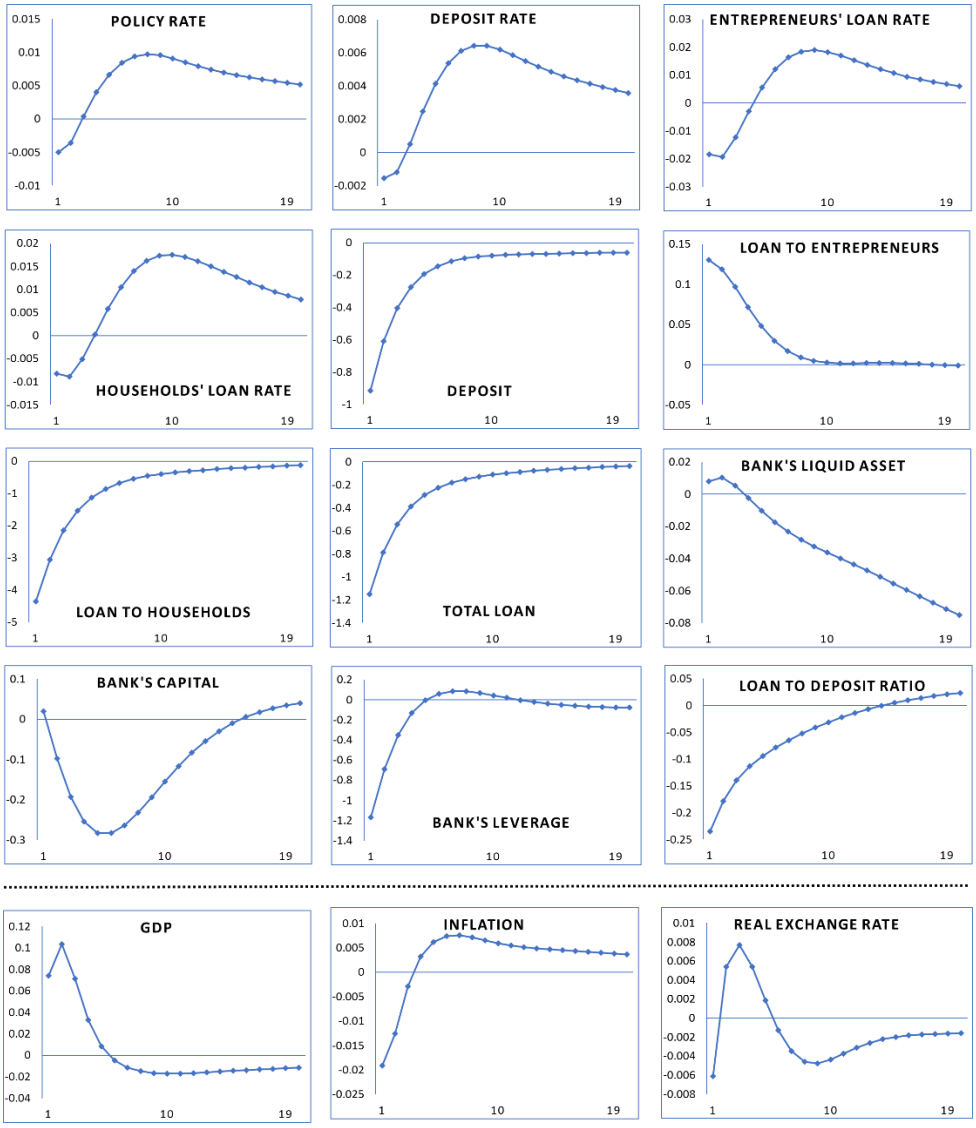
Model's Impulse Responses

Appendix 2 - 1: Leverage Ratio Requirement Shock:



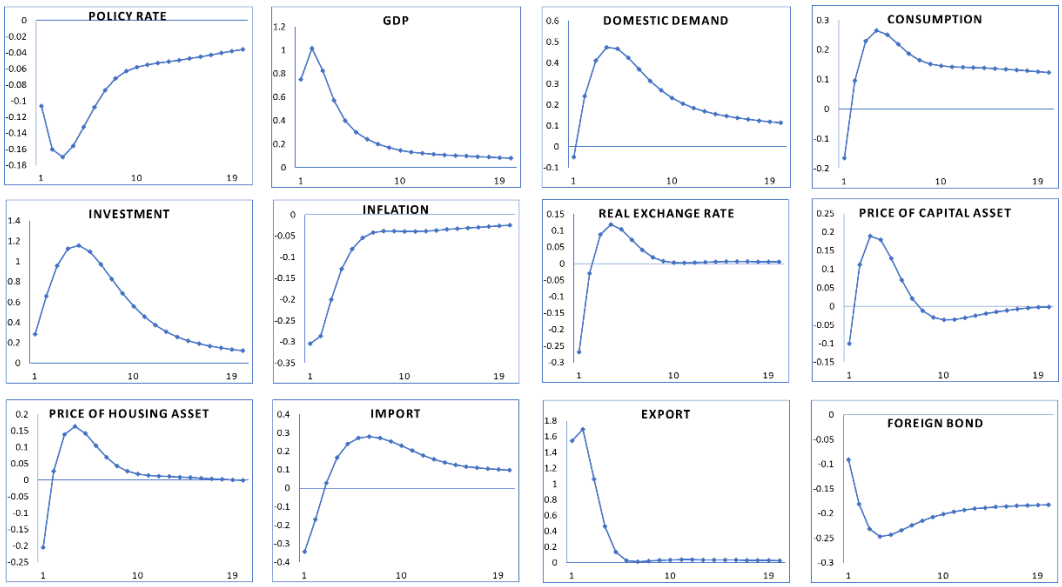
Notes: The figure reports the impulse responses to a one percent negative shock to the leverage ratio requirement (the inverse of capital ratio requirement) for model with only monetary policy with baseline calibration of the Taylor rule's parameters. For interest rate variables, the figure shows absolute deviations from the steady state in percentage points. For other variables, it shows percent deviations from the steady state.

Appendix 2 - 2: LTV Ratio Requirement Shock (Households' Loans):



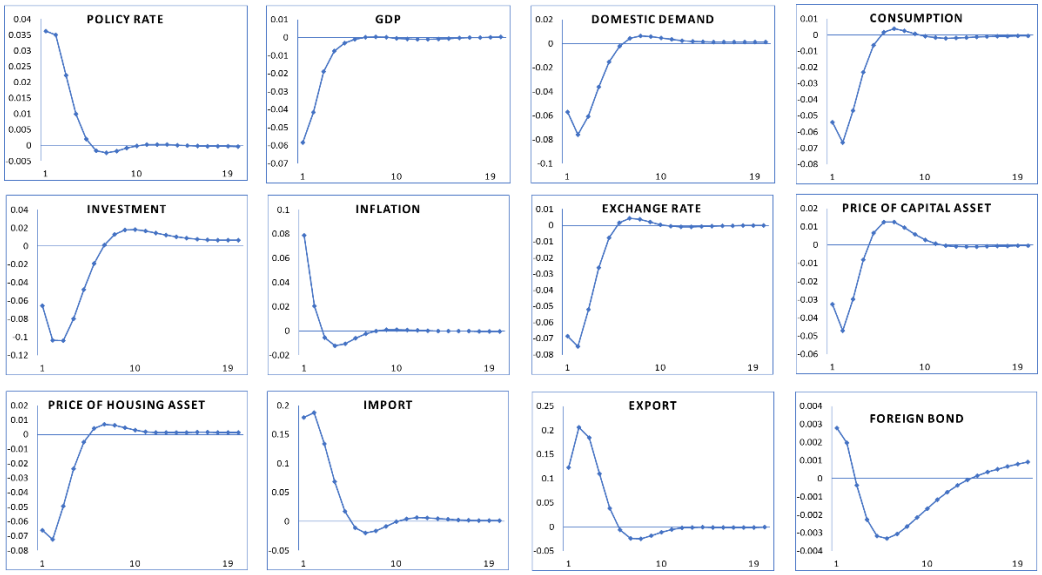
Notes: The figure reports the impulse responses to a one percent negative shock to the LTV Ratio Requirement (Households' loan) for model with only monetary policy with baseline calibration of the Taylor rule's parameters. For interest rate variables, the figure shows absolute deviations from the steady state in percentage points. For other variables, it shows percent deviations from the steady state.

Appendix 2 - 3: Technology Shock



Notes: The figure reports the impulse responses to a one percent positive technology shock for model with only monetary policy with baseline calibration of the Taylor rule's parameters. For interest rate variables, the figure shows absolute deviations from the steady state in percentage points. For other variables, it shows percent deviations from the steady state.

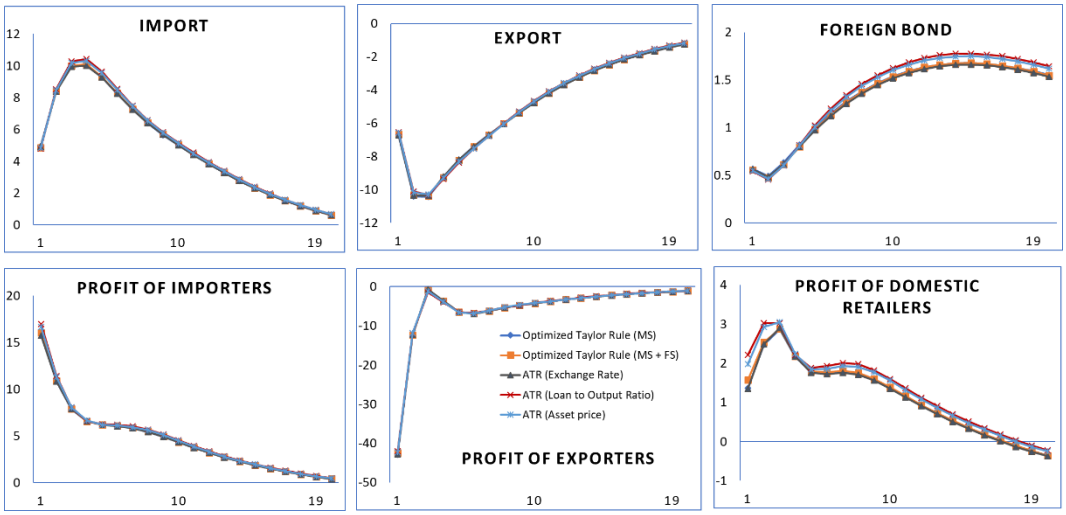
Appendix 2 - 4: Domestic Price Shock



Notes: The figure reports the impulse responses to a one percent positive domestic price shock for model with only monetary policy with baseline calibration of the Taylor rule's parameters. For interest rate variables, the figure shows absolute deviations from the steady state in percentage points. For other variables, it shows percent deviations from the steady state.

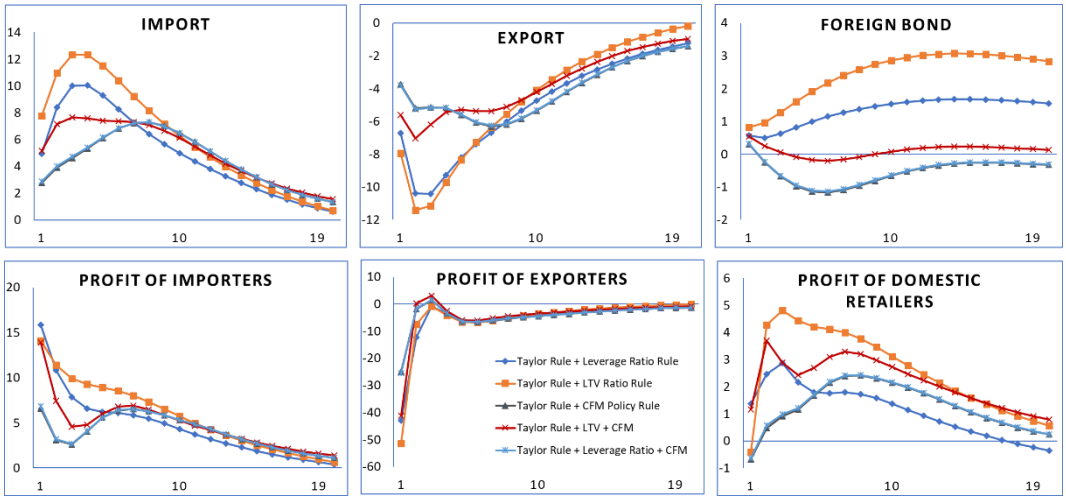
Appendix 2 - 5: Capital Inflow Shock

First Scenario:



Notes: The figure reports the impulse responses to a one percent negative shock to the country's risk premium. The figure shows percent deviations from the steady state. ATR is Augmented Taylor Rule. MS is Macroeconomic Stability and FS is Financial Stability.

Second Scenario:



Notes: The figure reports the impulse responses to a one percent negative shock to the country's risk premium. The figure shows percent deviations from the steady state.

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