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Abstract

We develop a sticky price, small open economy model with financial frictions à la Gertler and Karadi (2011), in combination with liability dollarization. An agency problem between domestic financial intermediaries and foreign investors of emerging economies introduces financial frictions in the form of time-varying endogenous balance sheet constraints on the domestic financial intermediaries. We consider a shock that tightens the balance sheet constraint and show that capital controls, the effects of which are rigorously examined as a policy tool for the emerging economies, can be a credit policy tool to mitigate the negative shock.

Keywords: capital control; credit policy; balance sheets; small open economy; nominal rigidities; New Keynesian; DSGE; financial intermediaries; financial frictions; crisis.
JEL Classification: E44, E58, F32, F38, F41.

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1 Introduction

The low interest rates in developed countries after the recent financial crisis caused a surge in capital inflows into emerging economies. The ensuing normalization of US monetary policy now causes a serious concern for capital outflows from emerging economies. Recent volatile international capital movements in emerging economies have been the subject of rigorous discussion among concerned policymakers and economists (e.g., G20 summit in February 2016). An increasing number of policymakers think that capital controls can be an effective instrument to stabilize economies against volatile capital flows. In fact, some emerging economies (Brazil, Taiwan, South Korea, and Thailand) have recently responded to instability by imposing capital controls. Even the IMF, a former critic of capital controls, reconsiders such measures as a possible suitable policy response to volatile capital flows under certain circumstances.[1]

Against this background, a rapidly growing body of literature related to capital controls has emerged.[2] A strand of the literature focuses on pecuniary externalities associated with financial crises and provides a rationale for prudential capital controls to prevent excessive borrowing (e.g., Jeanne and Korinek (2010), Bianchi (2011), Jeanne et al. (2012), and Brunnermeier and Sannikov (2015)). Another strand studies the effects of capital controls in the presence of nominal rigidities (e.g., Farhi and Werning (2012), and Schmitt-Grohé and Uribe (2016)).[3]

[1]For details, see Ostry et al. (2010) and Ostry et al. (2012).

[2]Capital controls are not a new policy instrument. Already before the recent financial crisis, capital controls have been widely discussed both theoretically and empirically. Theoretical analyses on capital controls have been mainly related to the issue of currency crises. Empirical analyses of capital controls have been conducted mainly to test if the presence of capital account liberalization (or capital controls) is correlated with higher economic growth. For the earlier literature on capital controls, see Kitano (2011).

[3]For a more detailed explanation on the recent literature, see Kitano and Takaku (2017).

More effects of capital controls as a policy tool have been rigorously examined from a broader perspective (e.g., De Paoli and Lipinska (2013), Liu and Spiegel (2015), Chang et al. (2015), and Agénor and Jia (2015)). For example, Davis and Presno (2017) examine the interaction of capital controls with optimal monetary policy under flexible exchange rates in a small open economy. They show that in the presence of occasionally binding collateral constraints, capital controls affect the behavior of optimal monetary policy following shocks to the foreign interest rate, and capital controls help restore monetary policy autonomy. Kitano and Takaku (2017) show how the welfare effects of capital controls depend on the degree of financial friction between banks and foreign investors. It is shown that when the degree of financial friction is higher, capital controls are more welfare improving, and tighter capital controls are appropriate. It is also shown that the welfare-improving effect of capital controls is larger in the presence of liability dollarization.[4]

As is well known, advanced economies have employed credit policy in response to the recent crisis. The recent crisis has featured a significant disruption in the balance sheets of financial intermediaries. To mitigate the disruption, the central banks in developed countries directly injected credit into private markets and expanded central bank credit intermediation. As argued by many observers, the credit market interventions were effective in stabilizing the financial system, consequently dampening the decline of real activity. These interventions, which break tradition, are justified only in crisis situations not during normal times. There-

[4]Kitano and Takaku (2015) compare the welfare implications of an optimal capital control policy under fixed exchange rates and an optimal monetary policy under flexible exchange rates. It is shown that in an economy with a financial accelerator, an optimal capital control policy under fixed exchange rates is superior to an optimal monetary policy under flexible exchange rates, and vice versa in an economy without a financial accelerator.

fore, the credit policy is also described as "unconventional" central bank measures. Against this background, there has emerged a rapidly growing body of literature related to credit policy (e.g., Gertler and Karadi (2011), Gertler and Kiyotaki (2010), and Gertler et al. (2012)). However, credit policies in emerging economies have not been examined as extensively as those in advanced economies.[5] This is probably expected because the use of credit policy in emerging economies has been rare. According to Ishi et al. (2009), only one country employed the credit policy during the crisis period (from September 2008 to June 2009).[6] As for the reason why emerging economies barely used the credit policy, Ishi et al. (2009) argue as follows: "The unpleasant history of emerging economies with quasi-fiscal activities may also help explain their limited use of unconventional, especially credit easing, measures. During the 1970s and 1980s, central banks, in particular those of emerging economies, undertook a variety of quasi-fiscal roles, including implementing direct credit policies.... These roles were seen as compromising central bank independence and monetary policy objectives (page 15)." Another reason why emerging economies barely used the credit policy may come from their economic structures as argued by Aoki (2011): "...those countries tend to have less-developed domestic financial markets. Markets for securities and corporate bonds are much smaller. Then there may be no scope for credit easing (page 119)."

Our paper belongs to a growing literature that examines the possible effects of capital controls as a policy tool. However, our study differs from the existing literature in that we examine whether capital controls, which are becoming more

[5]A notable exception is Chang and Velasco (2016).

[6]The bank of Korea purchased corporate debt and commercial paper. In November 2008, the central bank announced that it would provide up to $ 3.3 billion to a bond fund to purchase commercial papers.

prevalent among policy makers, can mitigate a crisis shock and play the same role as a direct credit policy which is employed in advanced economies and proved effective but unpopular in emerging economies as documented above. In other words, we examine whether capital controls are effective in the crisis situation that requires credit policy. As argued above, the effects of capital controls as a policy tool for emerging economies have been rigorously examined. To the best of our knowledge, however, this is the first study to show that capital controls can play a similar role to that of credit policy in mitigating a crisis shock.

To this aim, we develop a sticky price, small open economy model with financial frictions à la Gertler and Karadi (2011), in combination with liability dollarization. Financial intermediaries transfer funds collected from foreign investors to non-financial firms. Owing to an agency problem between intermediaries and foreign investors that limits the ability of intermediaries to raise funds from foreign investors, financial intermediaries are subject to endogenously determined constraints on their leverage ratios. Further, financial intermediaries face the "liability dollarization" problem, and all the economy's liabilities are denominated in foreign currency. When the intermediaries' liabilities are "dollarized," exchange rate behavior may exacerbate the effect of financial frictions through their balance sheet. We then consider a shock that tightens the balance sheet constraint and show that capital controls may alleviate the negative effect due to the balance sheet shock as much as a direct credit policy does. Our study is in line with Mimir et al. (2013) that investigate the role of reserve requirements as a credit policy tool. Mimir et al. (2013) show that a time-varying reserve requirement policy mitigates the fluctuations in key macroeconomic variables in response to macroeconomic and financial shocks. In contrast, our paper shows that capital controls, the effects of which are rigorously examined as a policy tool for emerging economies, can be a credit policy tool to mitigate crisis shocks.

As we argue above, we develop a small open economy model with financial frictions à la Gertler and Karadi (2011). Both credit policy and capital controls mitigate inefficiencies due to financial frictions between financial intermediaries and foreign investors. As shown by Gertler and Karadi (2011), credit policy significantly reduces the contraction due to the balance sheet shock. This is mainly because the central bank reduces the rise in the spread, which in turn moderates the drop in investment. We consider alternative policy rules for capital controls. Some of the capital control rules reduce the rise in the spread as much as (or more than) the credit policy does. These rules reduce tax rates on foreign borrowing on impact when the negative shock hits the economy. The impact reduction of the tax rates implies that these policies play a role of dampening the initial rise in the spread as the direct credit policy does. The other capital control rules mitigate the impact increase in the spread compared to the no policy case but do not reduce it as much as the direct credit policy does. However, this group of rules reduces the fluctuations of the real exchange rate more compared to the direct credit policy. The stabilization of the real exchange rate leads to less fluctuations of output and consumption in a small open economy. In other words, in addition to the risk premium channel, there is another channel of the real exchange rate through which capital controls can stabilize a small open economy.

The remainder of the paper is organized as follows. In Section 2, we present a sticky price, small open economy model with financial frictions à la Gertler and Karadi (2011) in combination with liability dollarization. In Section 3, we perform a comparative analysis for direct credit policy and capital control policy.

The conclusions are presented in Section 4.

2 Model

We develop a small open economy model accompanied with financial frictions. The core framework is a standard small open economy model such as Galí and Monacelli (2005) and Faia and Monacelli (2008). We incorporate financial frictions à la Gertler and Karadi (2011) into the standard small open economy model.

The small open economy consists of households, financial intermediaries, intermediate goods firms, capital producing firms, retail firms, and the government. In addition to the traditional monetary policy, the government has two policy options: the direct credit policy that expands government credit intermediation and the capital control policy that regulates financial intermediary's foreign borrowing.

2.1 Households

Following Gertler and Kiyotaki (2010) and Gertler and Karadi (2011), we assume that there are two types of members: a fraction $1 - f$ of workers and a fraction f of bankers within a representative household with a continuum of members of measure unity. Workers supply labor and return their wages to the household. Each banker manages a financial intermediary and returns dividends to the household. There is perfect consumption insurance within the household. For each period, a banker remains a banker in the next period with probability θ. $(1 - \theta)f$ bankers exit and become workers, and the same number of workers randomly become bankers. The fraction of each type of members remains constant over time. Bankers who exit transfer their retained earnings to the household, whereas new bankers receive some start-up funds from the household.

The household maximizes the following expected lifetime utility:

$$E_t \sum_{i=0}^{\infty} \beta^i \left[\ln\left(C_{t+i} - hC_{t+i-1}\right) - \frac{\chi}{1+\varphi} L_{t+i}^{1+\varphi} \right], \tag{1}$$

where E_t denotes the mathematical expectations operator conditional on information available at time t, $\beta \in (0,1)$ is the discount factor, C_t signifies a composite consumption index, $h \in (0,1)$ is the habit parameter, L_t represents labor effort, $\chi > 0$ is the relative weight of labor in the utility function, and $\varphi > 0$ is the inverse of Frisch elasticity of labor supply. The composite consumption index C_t is given by

$$C_t \equiv \left[(1-\varpi)^{\frac{1}{\iota}} C_{H,t}^{\frac{\iota-1}{\iota}} + \varpi^{\frac{1}{\iota}} C_{F,t}^{\frac{\iota-1}{\iota}} \right]^{\frac{\iota}{\iota-1}}. \tag{2}$$

where $\iota(> 0)$ is the elasticity of substitution between domestic and imported goods, and $\varpi \in (0,1)$ represents the measure of openness. Households consume domestic goods ($C_{H,t}$) and foreign goods ($C_{F,t}$). The optimal expenditure allocation between domestic and imported goods gives

$$C_{H,t} = (1-\varpi)\left(\frac{P_{H,t}}{P_t}\right)^{-\iota} C_t\,; \qquad C_{F,t} = \varpi\left(\frac{P_{F,t}}{P_t}\right)^{-\iota} C_t, \tag{3}$$

where $P_{H,t}$ is the domestic price, and $P_{F,t}$ is the import price. P_t represents the consumer price index (CPI):

$$P_t \equiv \left[(1-\varpi) P_{H,t}^{1-\iota} + \varpi P_{F,t}^{1-\iota} \right]^{\frac{1}{1-\iota}}. \tag{4}$$

From Eqs. (3) and (4), we obtain

$$P_{H,t}\,C_{H,t} + P_{F,t}\,C_{F,t} = P_t\,C_t. \tag{5}$$

Households have access to domestic and foreign asset markets. A household's budget constraint in period t is given as

$$\begin{aligned} P_t\,C_t + (1+i_t)A_t + (1+i_t^*)\mathcal{E}_t D_{h,t} + P_t\frac{\psi_D}{2}(D_{h,t+1} - D_h)^2 + P_t\,T_{h,t} \\ = A_{t+1} + \mathcal{E}_t D_{h,t+1} + W_t L_t + P_t\,\Pi_t^{fb}, \end{aligned} \tag{6}$$

where i_t is the nominal interest rate of domestic currency assets, A_{t+1} is the domestic currency debt position, i_t^* is the exogenous nominal interest rate of foreign currency assets, $\mathcal{E}_t$ represents the nominal exchange rate (in terms of the domestic currency), $D_{h,t+1}$ is the households' foreign currency debt position, $T_{h,t}$ is lump-sum taxes, W_t is the nominal wage, and Π_t^{fb} denotes dividends from financial and non-financial firms. $P_t\psi_D(D_{h,t+1} - D_h)^2/2$ denotes the portfolio adjustment costs, which yield the stationarity of the equilibrium dynamics in a small open economy.

The optimality conditions associated with the household maximization problem are given by

$$\varrho_t = \frac{1}{C_t - hC_{t-1}} - \beta h E_t\left(\frac{1}{C_{t+1} - hC_t}\right), \tag{7}$$

$$\varrho_t w_t = \chi L_t^{\varphi}, \tag{8}$$

$$1 = E_t \beta \Lambda_{t,t+1} R_{t+1}, \tag{9}$$

and

$$1 = E_t \beta \Lambda_{t,t+1} R_{t+1}^* \big[1 - \psi_D(D_{h,t+1} - D_h)\frac{P_t}{\mathcal{E}_t}\big]^{-1}, \tag{10}$$

where $w_t \equiv \frac{W_t}{P_t}$. Herein, $\Lambda_{t,t+1}$, R_{t+1}, and R^*_{t+1} are defined as

$$\Lambda_{t,t+1} \equiv \frac{\varrho_{t+1}}{\varrho_t}, \tag{11}$$

$$R_{t+1} \equiv (1 + i_{t+1}) \frac{P_t}{P_{t+1}}, \tag{12}$$

and

$$R^*_{t+1} \equiv (1 + i^*_{t+1}) \frac{\mathcal{E}_{t+1}}{\mathcal{E}_t} \frac{P_t}{P_{t+1}}. \tag{13}$$

Combining (9) and (10), we obtain the interest parity condition:

$$E_t \Lambda_{t,t+1} R_{t+1} = E_t \Lambda_{t,t+1} R^*_{t+1} \big[1 - \psi_D (D_{h,t+1} - D_h) \frac{P_t}{\mathcal{E}_t}\big]^{-1}. \tag{14}$$

We assume that the law of one price holds for individual goods. The terms of trade are therefore given as

$$s_t \equiv \frac{P_{F,t}}{P_{H,t}} = \frac{\mathcal{E}_t P^*_t}{P_{H,t}}, \tag{15}$$

where P^*_t denotes the CPI in the foreign country (in terms of foreign currency).[7] From (15), we obtain

$$\frac{s_t}{s_{t-1}} = \frac{\Delta \mathcal{E}_t}{\Pi_{H,t}}, \tag{16}$$

where $\Pi_{H,t} \left(\equiv \frac{P_{H,t}}{P_{H,t-1}}\right)$ and $\Delta \mathcal{E}_t \left(\equiv \frac{\mathcal{E}_t}{\mathcal{E}_{t-1}}\right)$ represent the rate of domestic inflation and the depreciation rate of the nominal exchange rate, respectively. From CPI

[7] Without loss of generality, we assume that P^*_t is exogenous and constant ($= 1$) for all t.

(4) and (15), we obtain

$$\frac{P_t}{P_{H,t}} = [(1-\varpi) + \varpi s_t^{1-\iota}]^{\frac{1}{1-\iota}} \equiv g(s_t). \tag{17}$$

From (17), CPI inflation $\Pi_t \left(\equiv \frac{P_t}{P_{t-1}}\right)$ is given by

$$\Pi_t = \Pi_{H,t} \frac{g(s_t)}{g(s_{t-1})}. \tag{18}$$

From (15) and (17), the real exchange rate is given by

$$e_t \equiv \frac{\mathcal{E}_t P_t^*}{P_t} = \frac{s_t}{g(s_t)}. \tag{19}$$

2.2 Financial intermediaries

Financial intermediaries raise funds in international financial markets and lend them to domestic non-financial firms. The balance sheet of a financial intermediary j is given by

$$P_t Q_t S_{j,t} = P_t N_{j,t} + \mathcal{E}_t D_{b,j,t+1}, \tag{20}$$

where $S_{j,t}$ is the quantity of financial claims on non-financial firms, Q_t is the relative price of each claim, $N_{j,t}$ is the net worth of financial intermediaries, and $D_{b,j,t+1}$ is the financial intermediary's foreign debt position. Dividing both sides of Eq.(20) by P_t yields

$$Q_t S_{j,t} = N_{j,t} + e_t D_{b,j,t+1}. \tag{21}$$

The net worth of the financial intermediary is the difference between earnings on assets and interest payments on foreign debts. Under capital controls, a tax is imposed on the financial intermediary's foreign borrowing. The evolution of the financial intermediary's net worth is then given as

$$P_{t+1}N_{j,t+1} = R_{k,t+1}P_{t+1}Q_tS_{j,t} - (1+\tau_t^*)(1+i_{t+1}^*)\mathcal{E}_{t+1}D_{b,j,t+1} + P_{t+1}\Omega_{j,t+1}, \quad (22)$$

where $R_{k,t+1}$ denotes the real gross return on assets, τ_t^* is the tax rate on the intermediary's foreign currency debt, and $\Omega_{j,t}$ is a lump-sum transfer. Dividing both sides of Eq.(22) by P_{t+1} yields

$$N_{j,t+1} = R_{k,t+1}Q_tS_{j,t} - (1+\tau_t^*)R_{t+1}^*e_tD_{b,j,t+1} + \Omega_{j,t+1}, \quad (23)$$

where $R_{t+1}^* \equiv (1+i_{t+1}^*)\frac{P_t}{P_{t+1}}\frac{\mathcal{E}_{t+1}}{\mathcal{E}_t}$. Substituting (21) into (23) yields the evolution of net worth as follows:

$$N_{j,t+1} = [R_{k,t+1} - (1+\tau_t^*)R_{t+1}^*]Q_tS_{j,t} + (1+\tau_t^*)R_{t+1}^*N_{j,t} + \Omega_{j,t+1}. \quad (24)$$

For financial intermediaries to operate in period t, the discounted risk adjusted premium needs to be positive:

$$E_t\beta^i\Lambda_{t,t+1+i}[R_{k,t+1+i} - (1+\tau_{t+i}^*)R_{t+1+i}^*] \geq 0, \quad i \geq 0 \quad (25)$$

where $\beta^i\Lambda_{t,t+1+i}$ is the stochastic discount rate.

The objective of financial intermediaries is to maximize the terminal wealth that would be transfered to households when they exit. Financial intermediaries maximize the following expected terminal wealth:

$$
\begin{aligned}
V_{j,t} &= \max \ E_t \sum_{i=0}^{\infty} (1-\theta)\theta^i \beta^{i+1} \Lambda_{t,t+1+i} N_{j,t+1+i}, \\
&= \max \ E_t \sum_{i=0}^{\infty} (1-\theta)\theta^i \beta^{i+1} \Lambda_{t,t+1+i} \{ [R_{k,t+1+i} - (1+\tau^*_{t+i}) R^*_{t+1+i}] Q_{t+i} S_{j,t+i} \\
&\qquad + (1+\tau^*_{t+i}) R^*_{t+1+i} N_{j,t+i} + \Omega_{j,t+1+i} \}. \qquad (26)
\end{aligned}
$$

As long as $\beta^i \Lambda_{t,t+1+i}[R_{k,t+1+i} - (1+\tau^*_{t+i})R^*_{t+1+i}]$ is positive, financial intermediaries borrow from foreign investors and expand assets infinitely. To motivate an endogenous constraint on the financial intermediaries' ability to obtain funds, we introduce an agency problem à la Gertler and Karadi (2011) but between financial intermediaries and foreign investors. We assume that there is a possibility for bankers to divert a fraction λ of assets and transfer them to the household to which the banker belongs. If a banker diverts the fund, foreign investors can only recover the remaining fraction $1-\lambda$ of assets. Since foreign investors recognize the banker's incentive to divert funds, they restrict the amount they lend, which motivates an endogenous constraint on bankers. To ensure that financial intermediaries do not divert funds and lenders are willing to supply funds, the following constraint must hold:

$$V_{j,t} \geq \lambda Q_t S_{j,t}. \qquad (27)$$

The financial intermediary's expected terminal wealth can be expressed as

$$V_{j,t} = \nu_t Q_t S_{j,t} + \eta_t N_{j,t}, \qquad (28)$$

with

$$\nu_t = E_t\{(1-\theta)\beta\Lambda_{t,t+1}[R_{k,t+1} - (1+\tau_t^*)R_{t+1}^*] + \beta\Lambda_{t,t+1}\theta x_{t,t+1}\nu_{t+1}\}, \tag{29}$$

and

$$\eta_t = E_t\{(1-\theta)\beta\Lambda_{t,t+1}(1+\tau_t^*)R_{t+1}^* + \beta\Lambda_{t,t+1}\theta z_{t,t+1}\eta_{t+1}\}, \tag{30}$$

where $x_{t,t+i} \equiv \frac{Q_{t+i}S_{j,t+i}}{Q_tS_{j,t}}$ is the gross growth rate of assets, and $z_{t,t+i} \equiv \frac{N_{j,t+i}}{N_{j,t}}$ is the gross growth rate of net worth. Substituting (28) into (27) yields

$$\nu_t Q_t S_{j,t} + \eta_t N_{j,t} \geq \lambda Q_t S_{j,t}. \tag{31}$$

Since this constraint binds in equilibrium, we obtain

$$Q_t S_{j,t} = \phi_t N_{j,t}, \tag{32}$$

where

$$\phi_t \equiv \frac{\eta_t}{\lambda - \nu_t}. \tag{33}$$

Here, ϕ_t is the (private) leverage ratio.

As we argue in Section 2.6, the government returns the collected tax from capital controls as a transfer to a financial intermediary (i.e., $\Omega_{j,t+1} = \tau_t^* R_{t+1}^* e_t D_{b,j,t+1}$). Substituting (32) into (24), we can thus express the evolution of the financial intermediary's net worth as

$$N_{j,t+1} = [(R_{k,t+1} - R_{t+1}^*)\phi_t + R_{t+1}^*]N_{j,t}. \tag{34}$$

From Eqs.(32) and (34), we obtain the gross growth rate of net worth $z_{t,t+i}(\equiv \frac{N_{j,t+i}}{N_{j,t}})$ and the gross growth rate of assets $x_{t,t+i}$ $(\equiv \frac{Q_{t+i}S_{j,t+i}}{Q_t S_{j,t}})$ as follows:

$$z_{t,t+1} = (R_{k,t+1} - R^*_{t+1})\phi_t + R^*_{t+1}, \tag{35}$$

and

$$x_{t,t+1} = \frac{\phi_{t+1}}{\phi_t} z_{t,t+1}. \tag{36}$$

Since the leverage ratio $\phi_t(\equiv \frac{\eta_t}{\lambda - \nu_t})$ does not depend on bank-specific factors, we can sum up Eq.(32) across j and obtain the relation of the aggregate financial intermediary's assets S_t to the aggregate financial intermediary's net worth N_t as follows:

$$Q_t S_t = \phi_t N_t. \tag{37}$$

Further, we can sum up Eq. (21) across j to obtain

$$Q_t S_t = N_t + e_t D_{b,t+1}. \tag{38}$$

Aggregate net worth is the sum of the net worth of existing bankers $N_{e,t}$ and the net worth of new bankers $N_{n,t}$:

$$N_t = N_{e,t} + N_{n,t}. \tag{39}$$

Since in each period, the fraction θ of bankers continues to operate in the next period, the existing banker's net worth $N_{e,t}$ is given by

$$N_{e,t} = \theta[(R_{k,t} - R^*_t)\phi_{t-1} + R^*_t]\xi_{t-1}N_{t-1}, \tag{40}$$

where ξ_{t-1} denotes an exogenous shock to the net worth.

The aggregate assets of exiting bankers at period t are denoted by $(1-\theta)Q_t S_{t-1}$. It is assumed that households transfer the fraction $\omega/(1-\theta)$ of the assets to new bankers. Thus, the new banker's net worth is given by

$$N_{n,t} = \omega Q_t S_{t-1}. \tag{41}$$

Substituting (40) and (41) into (39), we obtain the evolution of the aggregate net worth:

$$N_t = \theta[(R_{k,t} - R_t^*)\phi_{t-1} + R_t^*]\xi_{t-1}N_{t-1} + \omega Q_t S_{t-1}. \tag{42}$$

2.3 Intermediate-good firms

Competitive firms produce intermediate goods by using capital and labor and sell their products to retail firms. The firms finance their capital acquisition by obtaining funds from financial intermediaries. The firms issue S_t claims, which equal K_{t+1} at the price of a unit of capital Q_t:

$$Q_t K_{t+1} = Q_t S_t. \tag{43}$$

The firms sell capital after production on the open market. The production function is given by

$$Y_{H,t}^m = Z_t (U_t K_t)^\alpha L_t^{1-\alpha}, \tag{44}$$

where $Y_{H,t}^m$ is the domestic output of intermediate goods, Z_t is total factor productivity, and U_t is the utilization rate of capital. From the first-order conditions associated with the firm's optimization, we have

$$\frac{P^m_{H,t}}{P_t}\alpha\frac{Y^m_{H,t}}{U_t} = \delta'(U_t)K_t, \tag{45}$$

and

$$\frac{P^m_{H,t}}{P_t}(1-\alpha)\frac{Y^m_{H,t}}{L_t} = w_t, \tag{46}$$

where

$$\delta(U_t) = \delta_c + \frac{b}{1+\zeta}U_t^{1+\zeta}. \tag{47}$$

Here, $\delta(U_t)$ is the depreciation rate of capital, and $P^m_{H,t}$ is the domestic price of intermediate goods.[8]

Since competitive firms earn zero profits, the expected gross return to holding a unit of capital from t to $t+1$ is given by

$$R_{k,t+1} = \frac{\frac{P^m_{H,t+1}}{P_{t+1}}\alpha\frac{Y^m_{H,t+1}}{K_{t+1}} + Q_{t+1} - \delta(U_{t+1})}{Q_t}. \tag{48}$$

2.4 Capital producing firms

Competitive capital producing firms buy capital from intermediate-good firms. They repair depreciated capital and produce new capital. The value of a unit of new capital is Q_t, and net investment is subject to adjustment costs. Since capital producing firms are owned by households, the firm's optimization problem is

$$\max_{I_{n,t}} \ E_t\sum_{i=0}^{\infty}\beta^i\Lambda_{t,t+i}\left[(Q_{t+i}-1)I_{n,t+i} - \frac{\eta_I}{2}\left(\frac{I_{n,t+i}+I}{I_{n,t+i-1}+I}-1\right)^2(I_{n,t+i}+I)\right], \tag{49}$$

[8]The cost of replacing depreciated capital is assumed unity.

where

$$I_{n,t} = I_t - \delta(U_t) K_t. \tag{50}$$

Herein, I_t is gross investment and $I_{n,t}$ is net investment. The first-order condition for $I_{n,t}$ is given by

$$\begin{aligned} Q_t \;\; = \;\; & 1 + \frac{\eta_I}{2}\left(\frac{I_{n,t}+I}{I_{n,t-1}+I} - 1\right)^2 + \eta_I \left(\frac{I_{n,t}+I}{I_{n,t-1}+I} - 1\right)\left(\frac{I_{n,t}+I}{I_{n,t-1}+I}\right) \\ & - E_t \beta \Lambda_{t,t+1} \eta_I \left(\frac{I_{n,t+1}+I}{I_{n,t}+I} - 1\right)\left(\frac{I_{n,t+1}+I}{I_{n,t}+I}\right)^2. \end{aligned} \tag{51}$$

We assume that the production of capital needs domestic and imported goods. I_t is composed of domestic and imported goods as follows:

$$I_t \equiv \left[(1-\varpi)^{\frac{1}{\iota}} I_{H,t}^{\frac{\iota-1}{\iota}} + \varpi^{\frac{1}{\iota}} I_{F,t}^{\frac{\iota-1}{\iota}}\right]^{\frac{\iota}{\iota-1}}. \tag{52}$$

The optimal allocation of expenditures between domestic and imported goods gives

$$I_{H,t} = (1-\varpi)\left(\frac{P_{H,t}}{P_t}\right)^{-\iota} I_t\,; \qquad I_{F,t} = \varpi \left(\frac{P_{F,t}}{P_t}\right)^{-\iota} I_t. \tag{53}$$

From Eqs. (4) and (53), we have

$$P_{H,t}\, I_{H,t} + P_{F,t}\, I_{F,t} = P_t\, I_t. \tag{54}$$

2.5 Retail firms

Using domestic intermediate goods as the sole input, retail firms produce differentiated goods. The final output is expressed by the CES form of differentiated goods:

$$Y_{H,t} \equiv \left[\int_0^1 (Y^f_{H,t})^{\frac{\varepsilon-1}{\varepsilon}} \, df \right]^{\frac{\varepsilon}{\varepsilon-1}}, \tag{55}$$

where $Y_{H,t}$ is the domestic final output, and $Y^f_{H,t}$ denotes the domestic differentiated good. An optimal expenditure allocation for the domestic final output implies that

$$Y^f_{H,t} = \left(\frac{P^f_{H,t}}{P_{H,t}} \right)^{-\varepsilon} Y_{H,t}, \tag{56}$$

where $P^f_{H,t}$ is the domestic differentiated good price. $P_{H,t}$ denotes the domestic price index:

$$P_{H,t} \equiv \left[\int_0^1 (P^f_{H,t})^{1-\varepsilon} \, df \right]^{\frac{1}{1-\varepsilon}}. \tag{57}$$

Following Calvo (1983), we assume that in each period, a fraction $1-\gamma$ of retail firms reset their prices, while a fraction γ keep their prices unchanged. This implies that the domestic price index can be expressed as

$$P_{H,t} \equiv \left[\gamma (P_{H,t-1})^{1-\varepsilon} + (1-\gamma)(\bar{P}_{H,t})^{1-\varepsilon} \right]^{\frac{1}{1-\varepsilon}}, \tag{58}$$

where $\bar{P}_{H,t}$ represents the price reset in period t. Transforming (58) yields

$$1 = \gamma (\Pi_{H,t})^{-1+\varepsilon} + (1-\gamma)(\tilde{P}_{H,t})^{1-\varepsilon}, \tag{59}$$

where $\tilde{P}_{H,t} \equiv \frac{\bar{P}_{H,t}}{P_{H,t}}$.

Each retail firm chooses its price to maximize the present discounted value of its profit stream:

$$\max_{\bar{P}_{H,t}} \quad E_t \sum_{i=0}^{\infty} \gamma^i \beta^i \Lambda_{t,t+i} \left[\frac{\bar{P}_{H,t}}{P_{H,t+i}} - \frac{P^m_{H,t+i}}{P_{H,t+i}} \right] Y^f_{H,t+i}, \tag{60}$$

subject to

$$Y^f_{H,t+i} = \left(\frac{\bar{P}_{H,t}}{P_{H,t+i}}\right)^{-\varepsilon} Y_{H,t+i}. \tag{61}$$

From the first-order condition associated with the above problem, the optimal price is determined as

$$\tilde{\Pi}_{H,t} = \frac{\varepsilon}{\varepsilon - 1} \Pi_{H,t} \frac{X^1_t}{X^2_t}, \tag{62}$$

where $\tilde{\Pi}_{H,t} \equiv \frac{\bar{P}_{H,t}}{P_{H,t-1}}$. X^1_t and X^2_t are given by

$$X^1_t = \frac{P^m_{H,t}}{P_{H,t}} Y_{H,t} + E_t \gamma \beta \Lambda_{t,t+1} (\Pi_{H,t+1})^{\varepsilon} X^1_{t+1}, \tag{63}$$

and

$$X^2_t = Y_{H,t} + E_t \gamma \beta \Lambda_{t,t+1} (\Pi_{H,t+1})^{\varepsilon - 1} X^2_{t+1}. \tag{64}$$

2.6 Government

In this subsection, we describe the government's policies. Irrespective of whether direct credit policy or capital control policy is employed, we assume that monetary policy follows a simple Taylor rule:

$$i_t = i^{\rho_i}_{t-1} \left[\frac{1}{\beta} (\Pi_{H,t})^{\kappa_\pi} \left(\frac{Y_t}{Y^m_{H,t}}\right)^{\kappa_y}\right]^{1-\rho_i}, \tag{65}$$

where $Y^m_{H,t}$ corresponds to the flexible price equilibrium level of final output.

2.6.1 Direct credit policy

We assume that the government adopts exactly the same type of direct credit policy described in Gertler and Karadi (2011). The government directly lends funds to non-financial firms. The aggregate assets are expressed by the sum of the privately intermediated assets $Q_t S_{p,t}$ and the publicly intermediated assets $Q_t S_{g,t}$:

$$Q_t S_t = Q_t S_{p,t} + Q_t S_{g,t}. \tag{66}$$

The publicly intermediated assets are the fraction ψ_t of the aggregate assets:

$$Q_t S_{g,t} = \psi_t Q_t S_t. \tag{67}$$

Substituting (37) and (67) into (66), we obtain

$$Q_t S_t = \phi_t N_t + \psi_t Q_t S_t. \tag{68}$$

Rearranging (68), we have

$$Q_t S_t = \phi_{c,t} N_t, \tag{69}$$

where $\phi_{c,t} \equiv \frac{1}{1-\psi_t}\phi_t$ is the leverage ratio for total (private and public) intermediated funds.

To conduct direct credit policy, the government obtains funds by issuing the government bond $B_{g,t}$, which equals $\psi_t Q_t S_t$, to domestic households.[9] The government intermediation involves an efficiency cost of τ per unit. Since the government borrows at R_{t+1} from households, the government's net earnings are given by $(R_{k,t+1} - R_{t+1})B_{g,t}$. In a case where the government performs direct credit policy,

[9]Following Gertler and Karadi (2011), we assume that there is no agency problem between the government and households.

its budget constraint in period t is given by

$$G_t + \tau\psi_t Q_t K_{t+1} = (R_{k,t} - R_t)B_{g,t} + T_{h,t}, \tag{70}$$

where G_t is the exogenous government spending.[10] It is assumed that the government injects credit in response to movements in credit spreads (or risk premium). The direct credit policy rule is given by

$$\psi_t = \kappa E_t[(\ln R_{k,t+1} - \ln R^*_{t+1}) - (\ln R_k - \ln R^*)], \tag{71}$$

where κ is the (positive) coefficient for the direct credit policy rule.

2.6.2 Capital controls

As we argued in Section 2.2, the government imposes a tax on the financial intermediary's foreign borrowing and transfers the tax revenue to financial intermediaries in each period. Therefore, in a case where the government conducts capital controls, its budget constraint in period t is given by

$$G_t + \Omega_{t+1} = \tau^*_t R^*_{t+1} e_t D_{b,t+1} + T_{h,t}, \tag{72}$$

[10] The aggregate government spending G_t is composed of domestic and imported goods:

$$G_t \equiv \left[(1-\varpi)^{\frac{1}{\iota}} G_{H,t}^{\frac{\iota-1}{\iota}} + \varpi^{\frac{1}{\iota}} G_{F,t}^{\frac{\iota-1}{\iota}}\right]^{\frac{\iota}{\iota-1}}.$$

Similar to C_t and I_t, it holds that

$$G_{H,t} = (1-\varpi)\left(\frac{P_{H,t}}{P_t}\right)^{-\iota} G_t; \qquad G_{F,t} = \varpi\left(\frac{P_{F,t}}{P_t}\right)^{-\iota} G_t.$$

It follows from Eq. (4) that

$$P_{H,t}\,G_{H,t} + P_{F,t}\,G_{F,t} = P_t\,G_t.$$

where $\Omega_{t+1} = \int_0^1 \Omega_{j,t+1} dj = \tau_t^* R_{t+1}^* e_t D_{b,t+1}$.

We consider four alternative policy rules for capital controls as follows. The first is a feedback rule that changes the tax rate τ_t^* in response to movements in the real exchange rate:

$$\tau_t^* = \kappa_e (\ln e_t - \ln e), \tag{73}$$

where κ_e denotes the positive coefficient for the the real exchange rate (RER) rule, and e denotes the steady state level of the real exchange rate. The second is a feedback rule that changes the tax rate τ_t^* in response to movements in the current account level to output ratio:

$$\tau_t^* = -\kappa_{ca} \left(\frac{s_t CA_t}{Y_{H,t}} - \frac{sCA}{Y_H} \right), \tag{74}$$

where κ_{ca} denotes the positive coefficient for the current account (CAY) rule, and $\frac{sCA}{Y_H}$ denotes the steady state level of the current account level to output ratio. The third is a feedback rule that changes the tax rate τ_t^* in response to movements in the debt level to output ratio:

$$\tau_t^* = \kappa_d \left(\frac{s_t D_t}{Y_{H,t}} - \frac{sD}{Y_H} \right), \tag{75}$$

where κ_d denotes the positive coefficient for the debt level to output ratio (DY) rule, and $\frac{sD}{Y_H}$ denotes the steady state level of the debt level to output ratio. The fourth is a feedback rule that changes the tax rate τ_t^* in response to movements in the risk premium level:

$$\tau_t^* = -\kappa_r E_t[(\ln R_{k,t+1} - \ln R_{t+1}^*) - (\ln R_k - \ln R^*)], \tag{76}$$

where κ_r denotes the positive coefficient for the risk premium (RP) rule, and $\ln R_k - \ln R_b^*$ denotes the steady state level of the risk premium.

2.7 Equilibrium

In each period, the domestic goods market must clear. Thus, we have

$$Y_{H,t} = (1-\varpi)g(s_t)^{\iota}(C_t + I_t + G_t + \Gamma_t^D + \Gamma_t^f + \Gamma_t^{\psi}) + s_t EX_t, \tag{77}$$

where $\Gamma_t^D \equiv \frac{\psi_D}{2}(D_{h,t} - D_h)^2$, $\Gamma_t^f \equiv f\left(\frac{I_{n,t}+I_{ss}}{I_{n,t-1}-I_{ss}}\right)(I_{n,t} + I_{ss})$, $\Gamma_t^{\psi} \equiv \tau\psi_t Q_t K_{t+1}$, and EX_t is the exogenous demand for exports. Eq.(77) indicates that demand for domestic goods comes from consumption, investment, government expenditure, and export. In addition, since the portfolio adjustment costs Γ_t^D, the adjustment costs for investment Γ_t^f, and the efficiency costs Γ_t^{ψ} are represented in terms of composite final good, part of these costs must be incurred in terms of domestic goods.

Since differentiated domestic retail goods are produced by using domestic intermediate goods as the sole input, the aggregation of differentiated domestic retail goods is expressed as

$$\int_0^1 Y_{H,t}^f df = Y_{H,t}^m = Z_t(U_t K_t)^{\alpha} L_t^{1-\alpha}. \tag{78}$$

From the demand function for differentiated retail goods (56), it follows that

$$\int_0^1 \left(\frac{P_{H,t}^f}{P_{H,t}}\right)^{-\varepsilon} Y_{H,t} df = Z_t(U_t K_t)^{\alpha} L_t^{1-\alpha}. \tag{79}$$

We define $\theta_t \equiv \int_0^1 \left(\frac{P^f_{H,t}}{P_{H,t}}\right)^{-\varepsilon} df$, which indicates a measure of price dispersion across firms. Here, θ_t can also be expressed as[11]

$$\theta_t = (1-\gamma)\tilde{P}_{H,t}^{-\varepsilon} + \gamma \Pi^{\varepsilon}_{H,t}\theta_{t-1}, \tag{80}$$

where $\tilde{P}_{H,t} \equiv \frac{\bar{P}_{H,t}}{P_{H,t}}$. Using θ_t, we can rewrite Eq.(79) as

$$Y_{H,t} = \theta_t^{-1} Z_t (U_t K_t)^{\alpha} L_t^{1-\alpha}, \tag{81}$$

In Eq.(81), a larger value of θ_t indicates the larger resource cost due to the price dispersion.

Dividing the nominal trade balance $P_{H,t}Y_{H,t} - P_t(C_t + I_t + G_t + \Gamma^D_t + \Gamma^f_t + \Gamma^{\psi}_t)$ by P_t, we define the (real) trade balance as

$$TB_t \equiv \frac{Y_{H,t}}{g(s_t)} - C_t - I_t - G_t - \Gamma^D_t - \Gamma^f_t - \Gamma^{\psi}_t. \tag{82}$$

Using the trade balance (82), we obtain the evolution of the total foreign debt:

$$D_{t+1} = (1+i^*_t)D_t - \frac{TB_t}{e_t}, \tag{83}$$

where $D_t \equiv D_{h,t} + D_{b,t}$. We define the current account in terms of foreign currency as

$$CA_t \equiv -D_{t+1} + D_t. \tag{84}$$

[11]For the derivation of (80), see Schmitt-Grohé and Uribe (2006).

From the definition of D_t, we also have

$$D_{h,t} = D_t - D_{b,t}. \tag{85}$$

The equilibrium of this economy is a set of stationary stochastic processes $\{ C_t,\ C_{H,t},\ C_{F,t},\ A_t,\ \varrho_t,\ w_t,\ R_{t+1},\ R^*_{t+1},\ \Pi_t,\ \mathcal{E}_t,\ s_t,\ \Pi_{H,t},\ e_t,\ \nu_t,\ \eta_t,\ \phi_t,\ z_{t,t+1},\ x_{t,t+1},\ S_t,\ D_{b,t},\ N_{e,t},\ N_{n,t},\ N_t,\ K_{t+1},\ P^m_{H,t},\ Y^m_{H,t},\ U_t,\ L_t,\ \delta(U_t),\ R_{k,t+1},\ I_t,\ Q_t,\ I_{H,t},\ I_{F,t},\ Y^f_{H,t},\ \tilde{P}_{H,t},\ X^1_t,\ X^2_t,\ i_t,\ S_{p,t},\ S_{g,t},\ T_{h,t},\ \psi_t,\ Y_{H,t},\ \theta_t,\ TB_t,\ CA_t,\ D_t,\ D_{h,t}\ \}^{\infty}_{t=0}$ satisfying Eqs. (2), (5)-(10), (12), (13), (15), (16), (19), (29), (30), (33), (35)-(38), (40)-(48), (50)-(52), (54), (56), (59), (63)-(67), (70 or 72), (71), (77), (80)-(85) (combined with the equations for other variables), given initial values for A_{-1}, D_{-1}, $D_{b,-1}$, $D_{h,-1}$, K_0, N_{-1}, and S_{-1}, and exogenous stochastic processes ξ_t, Z_t, EX_t, G_t, and i^*_t.

2.8 Calibration

We choose standard parameter values in the related literature for calibration, which are summarized in Table 1.

Since we consider credit policy in Gertler and Karadi (2011) as our benchmark, we choose the same parameter values except for the parameters related to the open economy.[12] For the parameters for households, and financial intermediaries, we set the discount factor β, the habit parameter h, the relative utility weight of labor χ, the inverse of the Frisch elasticity of labor supply φ, the survival rate of the bankers

[12] We also confirm that our main results are robust when we use the Mimir et al. (2013)'s parameter values in the financial sector by setting the standard deviation of the net worth shock, the fraction of diverted loans, and the survival probability of the bankers at 0.0531, 0.514, and 0.9625, respectively.

θ, the fraction of capital that can be diverted λ, and the proportional transfer to the entering bankers ω to 0.99, 0.815, 3.409, 0.276, 0.972, 0.381, and 0.002, respectively. For the parameters for intermediate-good firms, capital producing firms, and retail firms, we set the effective capital share α, the elasticity of marginal depreciation with respect to utilization rate ζ, the investment adjustment cost parameter η_i, the elasticity of substitution among differentiated goods ϵ, and the price rigidity parameter γ to 0.33, 7.2, 1.728, 4.167, and 0.779, respectively. We set the steady state values of the capital utilization rate U, the depreciation rate δ, and the ratio of government expenditure to GDP $\frac{G}{Y_H}$ to 1, 0.025, and 0.2, respectively.

For parameters related to the open economy, we choose standard values in the related literature. Following Ravenna and Natalucci (2008), we set the elasticity of substitution between domestic and imported goods ι to 1.5. With respect to the degree of openness ϖ, we follow Cook (2004) and set it to 0.28. The parameter for bond adjustment cost ψ_{Dh} and steady state debt ratio to GDP $\frac{D}{Y_H}$ are set to 0.0007 and 0.4, respectively, as in Devereux et al. (2006).

In the direct credit policy rule (71), we set the coefficient κ to 10, which equals that in the base line case in Gertler and Karadi (2011).

In the capital control rules (73)-(76), we set the respective coefficients so that each rule yields the equal level of welfare to the direct credit policy rule (71). Formally, we measure conditional welfare levels by writing the household utility in a recursive form:

$$V_t = U(C_t, C_{t-1}, L_t) + \beta V_{t+1}, \tag{86}$$

and using the second-order perturbation methods as described in Schmitt-Grohé and Uribe (2004) and Schmitt-Grohé and Uribe (2007).[13] The coefficients κ_e, κ_{ca}, κ_d, and κ_r are set to 4.4, 25.1, 1.6, and 35, respectively.

Table 1: Calibration.

Parameters	Value	
β	0.99	Discount factor
h	0.815	Habit parameter
χ	3.409	Relative utility weight of labor
φ	0.276	Inverse Frisch elasticity of labor supply
θ	0.972	Survival rate of the bankers
λ	0.381	Fraction of capital that can be diverted
ω	0.002	Proportional transfer to the entering bankers
α	0.33	Effective capital share
U	1	Steady state capital utilization rate
δ	0.025	Steady state depreciation rate
ζ	7.2	Elasticity of marginal depreciation with respect to utilization rate
η_i	1.728	Parameter for investment adjustment cost
ϵ	4.167	Elasticity of substitution among differentiated goods
γ	0.779	Fraction of firms that do not reset their prices
ι	1.5	Elasticity of substitution between domestic and imported goods
ϖ	0.28	Degree of openness
ψ_{Dh}	0.0007	Parameter for bond adjustment cost
$\frac{D}{Y_H}$	0.4	Steady state ratio of debt to GDP
$\frac{G}{Y_H}$	0.2	Steady state ratio of government expenditure to GDP
κ	10	Coefficient for the credit policy rule
κ_e	4.4	Coefficient for the RER rule
κ_{ca}	25.1	Coefficient for the CAY rule
κ_d	1.6	Coefficient for the DY rule
κ_r	35	Coefficient for the RP rule

[13]Kim and Kim (2003) show that second-order solutions are necessary, because conventional linearization may generate spurious welfare reversals when long-run distortions exist in the model.

3 Crisis experiment

This section presents the main results of our analysis. Following Gertler and Karadi (2011), we consider a shock that tightens the balance sheet constraint of financial intermediaries. We consider a direct disturbance to the net worth that causes about 50% decline in the net worth of financial intermediaries on impact.[14]

Figures 1, 2, 3, and 4 show the response of the model economy to the net worth shock. In each figure, the thickest solid line ("No policy") and the thick solid line ("Direct policy") depict the impulse response for the case without policy interventions and that with the direct credit policy rule, respectively. As for the capital controls, the capital control rule targeting real exchange rate ("RER policy"), the rule targeting the current account level to output ratio ("CAY policy"), the rule targeting the debt level to output ratio ("DY policy"), and the rule targeting the risk premium level ("RP policy") are depicted by the solid line, the dashed dotted line, the dotted line, and the dashed line, respectively.

As we argue in Section 2.8, we set the coefficients in capital control rules (κ_e, κ_{ca}, κ_d, and κ_r) so that the conditional welfare level under each of the capital control rules equals that under the baseline credit policy rule in Gertler and Karadi (2011). That is, except for the no policy case, the direct credit policy rule and all the capital control rules yield the same welfare level in Figures 1, 2, 3, and 4.

As in Gertler and Karadi (2011), the direct credit policy significantly reduces the contraction. This is mainly because the central bank reduces the rise in the spread, which in turn moderates the drop in investment. Some of the cap-

[14]Gertler and Karadi (2011) consider a disturbance to capital quality that generates a decline in the net worth of financial intermediaries as large as 62.4% on impact in the economy without policy interventions.

ital control rules ("CAY policy" and "RP policy") reduce the rise in the spread ($E[R_K] - R_b$) as much as (or more than) the credit policy does. The "CAY policy" and "RP policy" yield a fall in the tax rates on impact. A fall in the tax rates due to the "CAY policy" and "RP policy" implies that these policies play a role of dampening the initial rise in the spread as the direct credit policy does.

The other capital control rules ("RER policy" and "DY policy") reduce the rise in the spread compared to the no policy case but do not reduce it as much as the direct credit policy does. However, it should be noted that "RER policy" and "DY policy" reduce the fluctuations in the real exchange rate more compared to the direct credit policy, which in turn stabilize output and consumption in a small open economy in general. In other words, in addition to the risk premium channel, there is another channel through which capital controls can stabilize a small open economy, and that is the real exchange rate.

As we argue in the calibration section, in the first place, we set the coefficients for the respective capital control rules to achieve the same level of welfare as that of the direct policy. We then compare the impulse responses for the respective cases to the direct credit policy case. From the impulse response analysis, over all, we can say that the capital control rules are basically equivalent to the direct credit policy rule in moderating the contraction.

The intuition behind the results of our analysis is as follows. In Eq.(28), we can interpret that ν_t is the expected marginal gain of having another unit of $Q_t S_{j,t}$ holding $N_{j,t}$ constant, and that η_t is the expected marginal gain of having another unit of $N_{j,t}$ holding $Q_t S_{j,t}$ constant. Equations (29) and (30) imply that a decrease in τ_t^* reduces η_t but increases ν_t. In other words, we can say that a decrease in the tax rate raises the expected marginal gain of having another unit of the financial intermediary's assets but reduces the expected marginal gain of having another unit of the financial intermediary's net worth. Therefore, we can know that the tax reduction restores the financial intermediary's leverage ratio $\frac{Q_t S_{j,t}}{N_{j,t}}$. This implies that capital controls play the same role as the credit policy of restoring the financial intermediary's leverage ratio and dampening the negative shock that tightens the financial intermediary's balance sheet constraint.

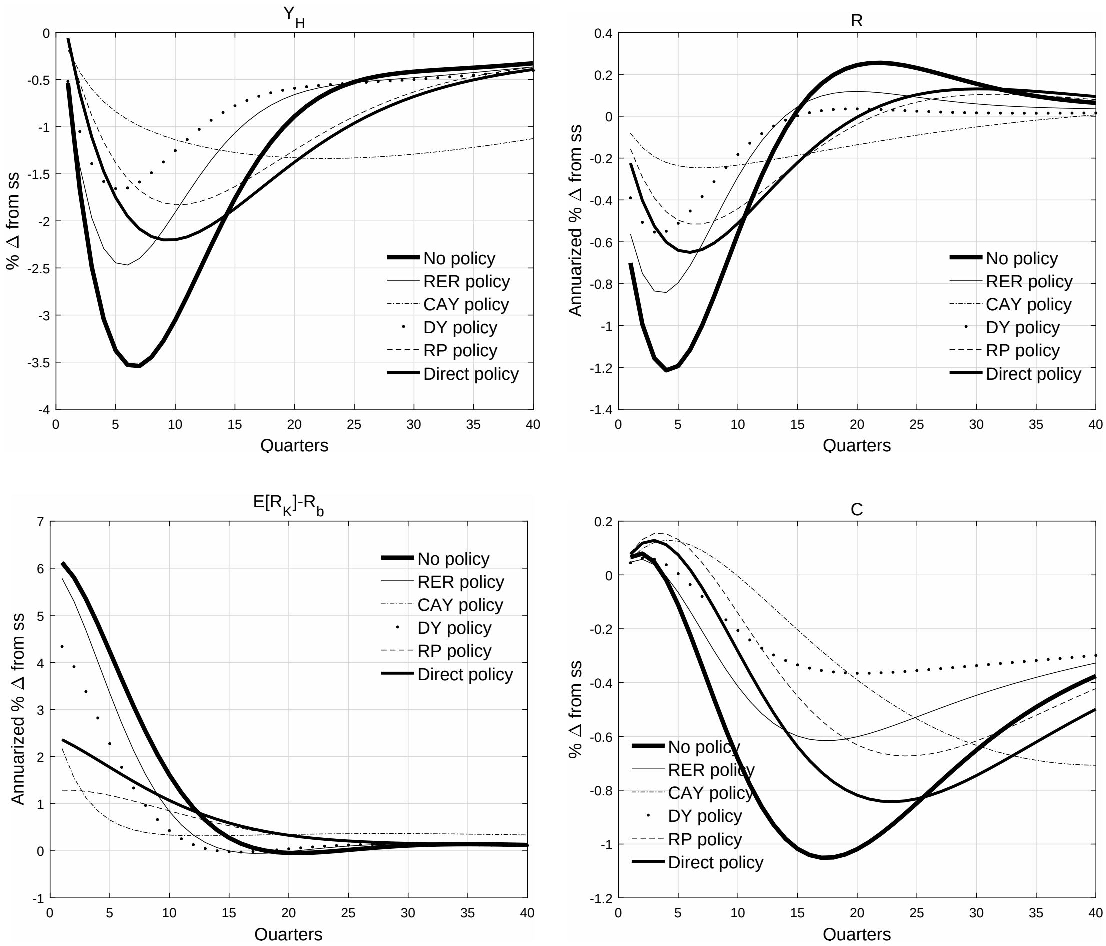

Figure 1: Responses to Net Worth Shock (Y_H, R, $E[R_k] - R_b$, C).

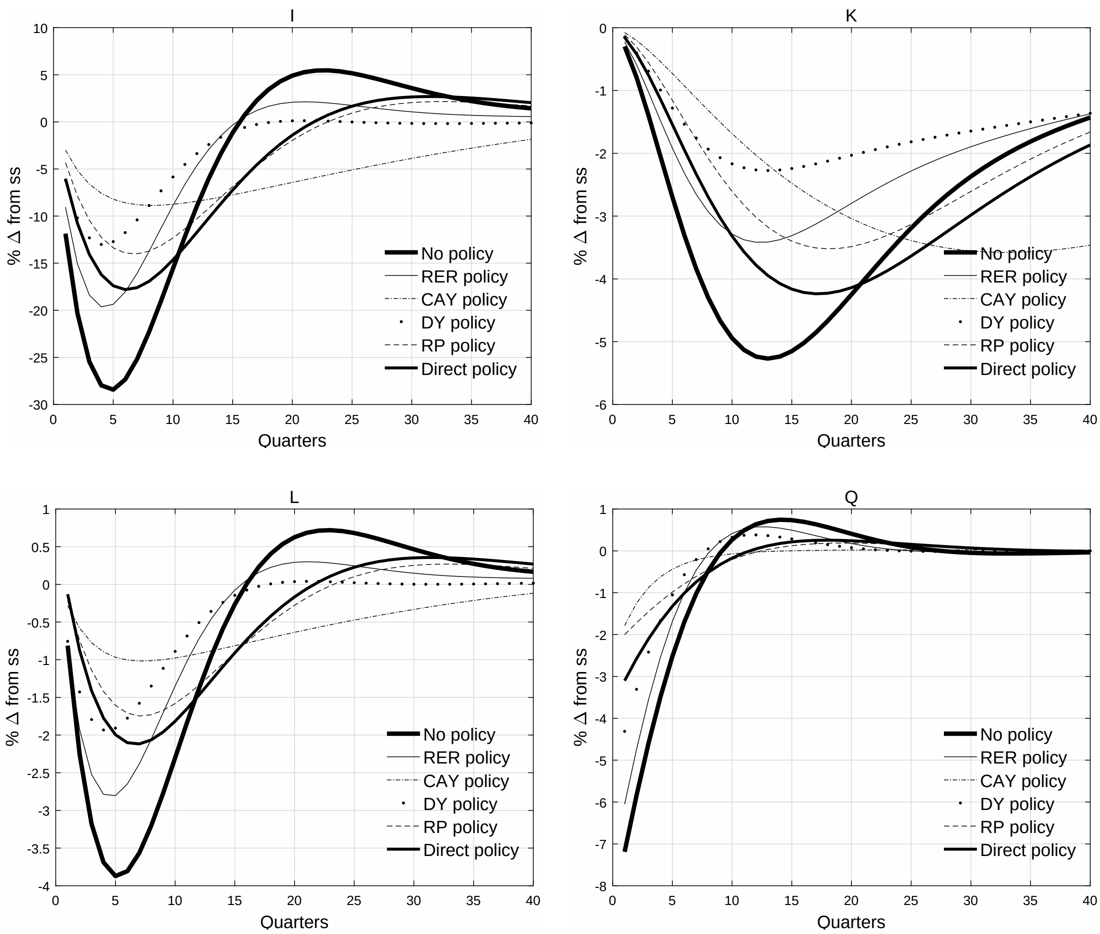

Figure 2: Responses to Net Worth Shock (I, K, L, Q).

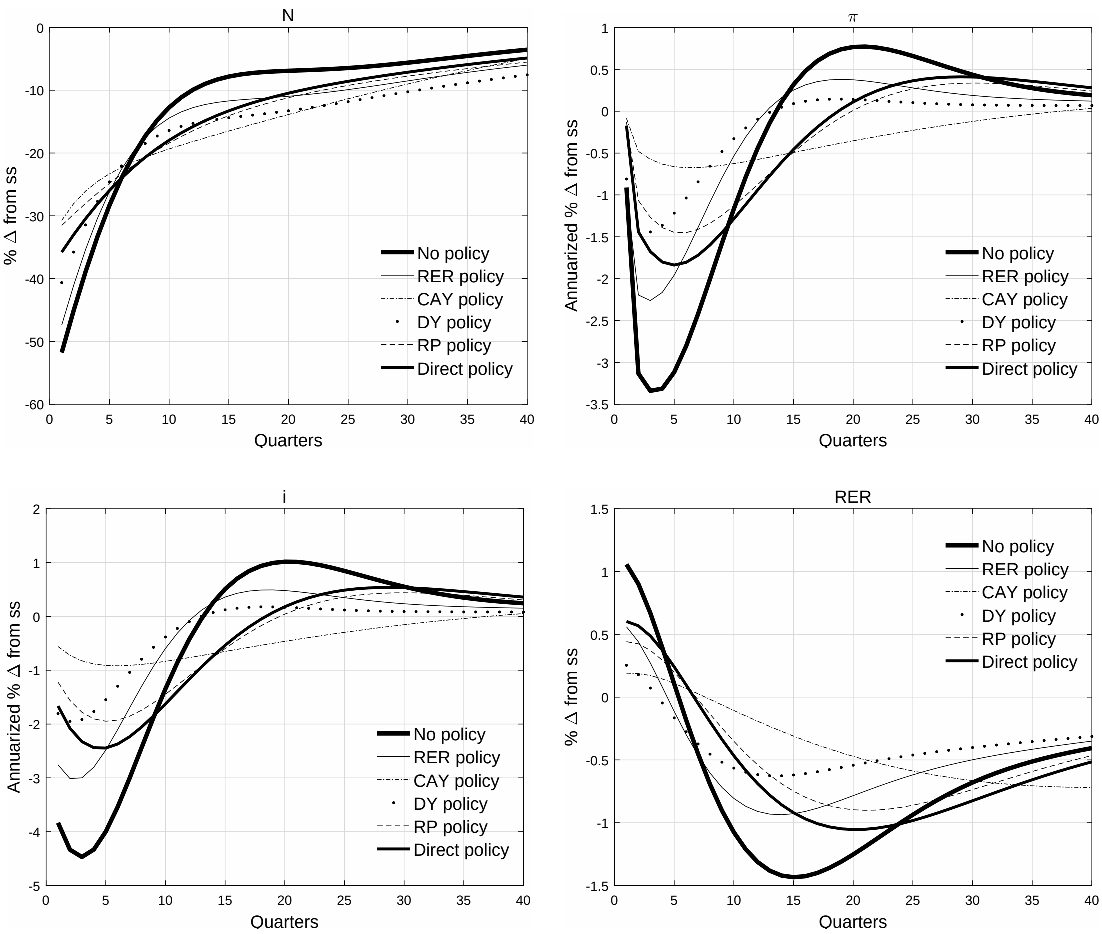

Figure 3: Responses to Net Worth Shock (N, Π, i, RER(e)).

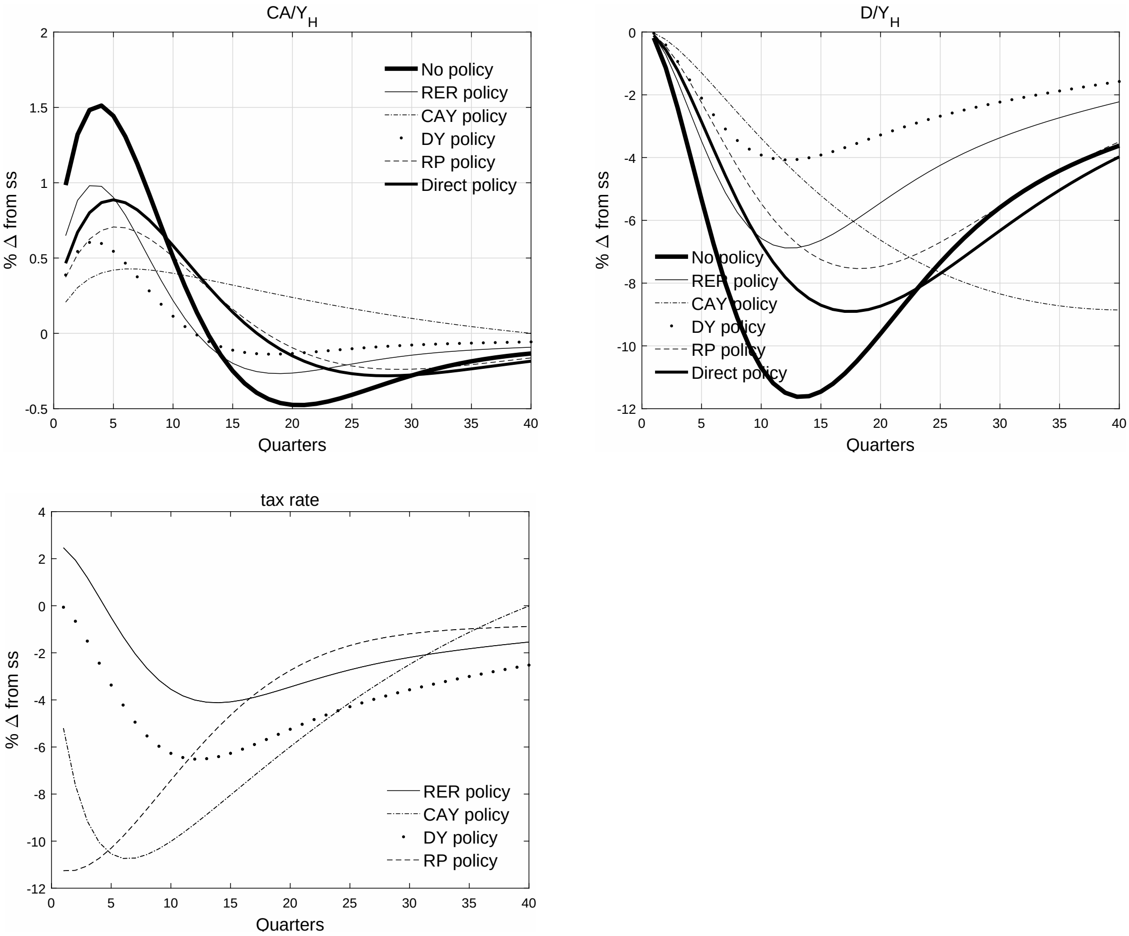

Figure 4: Responses to Net Worth Shock (CA/Y_H, D/Y_H, tax rate (τ^*)).

4 Conclusion

In this paper, we developed a sticky price, small open economy model with financial frictions representing emerging economies. In combination with liability dollarization, domestic financial intermediaries face financial frictions in the form of time varying endogenous balance sheet constraints due to the agency problem with foreign investors. This paper falls in a strand of studies that examine the possibility of capital controls as a policy tool for emerging economies. However, our study differs from the existing literature in that we examine the alternative rules of capital controls and compare them with the direct credit policy. Our findings suggest that capital controls can play an alternative role to the direct credit policy in mitigating the contraction after a crisis. Our study is in line with Mimir et al. (2013) that examine the possibility of reserve requirements as a credit policy tool. Whereas Mimir et al. (2013) show that reserve requirement policy can mitigate the economy's fluctuations in response to financial shocks, our paper shows that capital controls, the effects of which are rigorously examined as a policy tool for emerging economies, also can be a credit policy tool.

As well known, capital inflows into emerging economies and abrupt reversals of the capital flows significantly amplify boom-bust cycles and destabilize emerging economies. Following previous critical studies that feature financial frictions in emerging economies, we therefore assume that financial intermediaries raise funds only in international markets and lend them to domestic non-financial firms. While this is beyond the scope of this study, it might be better to include domestic financial markets as a source of external financing. We leave this as a subject for future research. While direct credit policy was employed by advanced economy central banks and proved useful and important, there was almost no case for direct credit policy in emerging economies. Although we mentioned the several related arguments about it in the introduction, the reason why emerging economies do not adopt the direct credit policy is beyond the scope of our study. We also leave this as a subject for future research.

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