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Shigeto KITANO

Kenya TAKAKU

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Research Institute for Economics and Business Administration

Kobe University

2-1 Rokkodai, Nada, Kobe 657-8501 JAPAN

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Shigeto Kitano† Kenya Takaku‡

Abstract

We develop a small open economy model with financial frictions between domestic banks and foreign investors, and examine the welfare-improving effect of capital controls. We show that capital controls are effective in addressing the amplification effect due to financial frictions. As the degree of financial frictions increases, the welfare-improving effect of capital controls becomes larger and a more aggressive policy rule is appropriate. Comparing two economies, one with and one without "liability dollarization," we also find that the welfare-improving effect of capital controls is larger in the presence of "liability dollarization," and the difference between the effects becomes larger as the degree of financial frictions increases.

Keywords: capital control; financial frictions; financial intermediaries; balance sheets; small open economy; liability dollarization; DSGE; welfare.
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†Professor, RIEB, Kobe University, 2-1, Rokkodai, Nada, Kobe, 657-8501 Japan, E-mail: kitano@rieb.kobe-u.ac.jp.

‡Associate Professor, Faculty of International Studies, Hiroshima City University, 3-4-1, Ozuka-Higashi, Asa-Minami-Ku, Hiroshima, 731-3194, Japan, E-mail: takaku@hiroshima-cu.ac.jp

1 Introduction

As discussed at the G20 summit in February 2016, possible massive capital outflows from emerging economies, due to prospective increases in the US policy rate, are a growing concern among policymakers. The possibility of capital outflows from emerging economies is preceded by massive inflows to emerging economies due to the low interest rate policies in developed countries after the global financial crisis.[1] The vulnerability of emerging economies to foreign interest shocks has been documented by many previous studies (e.g., Calvo et al. (1993), Dooley et al. (1996), Fernandez-Arias (1996), and Frankel and Okongwu (1996)). An increasing number of policymakers and economists, including the IMF, think that capital controls may be able to mitigate the vulnerability of emerging economies to external shocks.[2] Some emerging economies (Brazil, Taiwan, South Korea, and Thailand) have indeed responded to the instability by imposing capital controls.[3] Against this background, research on capital control policies has regained focus and been extended to a variety of new directions.[4]

Related Literature.—A strand of the literature focuses on pecuniary externalities associated with financial crises, and provides a rationale for prudential capital controls to internalize the externalities and prevent excessive borrowing (e.g., Jeanne and Korinek (2010), Bianchi (2011), Jeanne et al. (2012), and Brunnermeier and Sannikov (2015)).[5] Another strand studies the effects of capital controls in the presence of nominal rigidities. Developing a disequilibrium model featuring a downward rigid wage and an exchange rate peg, Schmitt-Grohé and Uribe (2016) show that capital controls reduce unemployment and can be an effective instrument for macroeconomic stabilization. Farhi and Werning (2012) show that under the peg, capital controls are effective for addressing some shocks, particularly country-specific risk-premium shocks. They also show that even if the exchange rate is not fixed, capital controls may be optimal if wages and prices are sticky.

More effects of capital controls as a policy tool have been rigorously examined

[1]For literature related to issues and policies associated with capital inflows, see Montiel (2014).

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

[3]For details, see for example, Jongwanich and Kohpaiboon (2012), Ahmed and Zlate (2014), and Forbes et al. (2016).

[4]Capital controls are not a new policy instrument. Already before the recent global 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 whether the presence of capital account liberalization (or capital controls) is correlated with higher economic growth. For earlier literature on capital controls, see Kitano (2011).

[5]Harberger (1986) points out that foreign borrowing is accompanied with externalities, which can be internalized by a corrective tax on foreign borrowing. He identifies the externality as the country risk premium.

from a broader perspective. Among many studies, De Paoli and Lipinska (2013) examine capital controls as a policy tool to manage an economy's terms of trade. They show that although capital controls limit international risk sharing, individual countries may benefit from their terms of trade manipulation. Their findings suggest a possibility of welfare gains from international policy coordination. Davis and Presno (2014) examine welfare gains from capital controls as an additional tool under flexible exchange rates. They show that the benefits of capital controls are present even when an optimal monetary policy is employed. Liu and Spiegel (2015) examine the effectiveness and welfare implications of capital controls and sterilization in a small open economy with imperfect international asset substitutability. They show that capital controls and sterilization are complementary policies.[6] Agénor and Jia (2015) focus on the relationship between countercyclical capital controls and reserve requirement rules in cross-border bank borrowing.[7]

Our study also belongs to the growing body of literature that examines the possible effects of capital controls as a policy tool. However, our study differs from the existing literature in that we focus specifically on the relationship between the degree of financial frictions and the effectiveness of capital controls. To the best of our knowledge, this paper is the first to show how the welfare effects of capital controls depend on the degree of financial frictions between banks and foreign investors. We show that when the degree of financial frictions is higher, capital controls are more welfare improving and tighter capital controls are appropriate. We also show that the welfare-improving effect of capital controls is larger in the presence of liability dollarization.

Previous studies on financial frictions emphasized credit constraints faced by non-financial borrowers (e.g., Bernanke et al. (1999) and Lee and Rhee (2013)). After the global financial crisis, the researchers focused on balance sheets of financial intermediaries, such as banks (e.g., Gertler and Kiyotaki (2010) and Gertler and Karadi (2011)). As is well known, the share of financial intermediaries such as banks is more significant in the financial sector in emerging economies than it is in developed economies. Therefore, we develop a small open economy model with financial frictions à la Gertler and Kiyotaki (2010) and Gertler and Karadi (2011).[8] Banks fund capital investments using their net worth, obtaining deposits

[6]Chang et al. (2015) show that under capital controls and pegs, optimal Ramsey policy involves the trade off between inflation and sterilization costs.

[7]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. They show 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.

[8]Aoki et al. (2016), Ghilardi and Peiris (2016), and Nuguer and Cuadra (2016) also develop open economy models with financial frictions à la Gertler and Kiyotaki (2010) and Gertler and

from local households, and borrowing from foreign investors. In this study, we focus on financial frictions between banks and foreign investors, and examine how the effectiveness of capital controls depends on the degree of the financial frictions. We show that capital controls are effective in addressing the amplification effect due to financial frictions. As the degree of financial frictions increases, the welfare-improving effect of capital controls becomes larger and a more aggressive policy rule is appropriate.

In our model, banks are assumed to face the "liability dollarization" problem, and the banks' liabilities are denominated in foreign currency.[9] When the banks' liabilities are "dollarized," exchange rate behavior may exacerbate the effect of financial frictions on a small open economy through their balance sheet. We also examine the case where the economy does not suffer from "liability dollarization." In the "no liability dollarization" economy, there is no direct negative valuation effect of the exchange rate deterioration on the bank's balance sheet. By comparing these two cases, we show that the welfare-improving effect of capital controls is larger in the presence of "liability dollarization," and the difference between the effects becomes larger as the degree of financial frictions is higher.

The remainder of the paper is organized as follows. In Section 2, we present a small open economy model with financial frictions à la Gertler and Kiyotaki (2010) and Gertler and Karadi (2011), in combination with liability dollarization. In Section 3, we examine the welfare-improving effect of capital controls in a small open economy under different degrees of financial frictions. We also compare the welfare-improving effect of capital controls in the economy with "liability dollarization" to that without "liability dollarization." In Section 4, we check the robustness of our results for different values of the key parameters. Our conclusions are presented in Section 5.

2 Model

The model framework is a real business cycle model of a small open economy. We incorporate financial frictions à la Gertler and Karadi (2011) and Gertler and Kiyotaki (2010) into a small open economy model. The small open economy consists of households, banks, non-financial firms (goods producers and capital producers), and the government. Banks raise funds using their net worth, obtaining deposits from local households, and borrowing in international financial markets in order

Karadi (2011), although for different purposes. The two former are a New Keynesian small open economy model and the latter is a two-country model.

[9] The difficulty that emerging economies face in borrowing abroad in their own currencies is also referred to as "original sin" (for details, see Eichengreen and Hausmann (1999), and Eichengreen and Hausmann (2005)).

to finance domestic non-financial firms. The government imposes capital controls to regulate the banks' foreign borrowing.

2.1 Households

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

The household maximizes the following expected lifetime utility:

$$E_0 \sum_{t=0}^{\infty} \beta^t U(C_t, L_t), \tag{1}$$

where

$$U(C_t, L_t) = \frac{(C_t - \frac{\chi}{\varphi} L_t^{\varphi})^{1-\gamma} - 1}{1-\gamma}. \tag{2}$$

Herein, E_0 denotes the mathematical expectations operator conditional on information available at time 0, $\beta \in (0,1)$ is the discount factor, C_t signifies a composite consumption index, L_t represents labor effort, $\gamma\,(>0)$ is the inverse of intertemporal elasticity of substitution, $\chi\,(>0)$ is the labor coefficient, and $\varphi\,(>1)$ is the curvature parameter on labor. We use the so-called GHH preference introduced by Greenwood et al. (1988), which has been used in many open economy models.[10]

The composite consumption index C_t is given by

$$C_t \equiv \left[(1-\upsilon)^{\frac{1}{\iota}} C_{H,t}^{\frac{\iota-1}{\iota}} + \upsilon^{\frac{1}{\iota}} C_{F,t}^{\frac{\iota-1}{\iota}}\right]^{\frac{\iota}{\iota-1}}, \tag{3}$$

where $\iota\,(>0)$ is the elasticity of substitution between domestic and imported goods (i.e., trade elasticity), and $\upsilon \in (0,1)$ is the degree of trade openness (i.e., inverse degree of home bias). Households consume domestic goods ($C_{H,t}$) and foreign goods ($C_{F,t}$). The optimal expenditure allocation between domestic and imported

[10]For details on the GHH preference, see for example, Mendoza (1991) and Neumeyer and Perri (2005).

goods gives the following demand functions of $C_{H,t}$ and $C_{F,t}$:

$$C_{H,t} = (1-\upsilon)\left(\frac{P_{H,t}}{P_t}\right)^{-\iota} C_t\,; \qquad C_{F,t} = \upsilon\left(\frac{P_{F,t}}{P_t}\right)^{-\iota} C_t, \tag{4}$$

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

$$P_t \equiv \left[(1-\upsilon)P_{H,t}^{1-\iota} + \upsilon P_{F,t}^{1-\iota}\right]^{\frac{1}{1-\iota}}. \tag{5}$$

From Eqs. (4) and (5), we obtain

$$P_{H,t}\,C_{H,t} + P_{F,t}\,C_{F,t} = P_t\,C_t. \tag{6}$$

A household's budget constraint in period t is given as

$$C_t + T_{h,t} + D_t = R_t D_{t-1} + w_t L_t + \Pi_t^{fb}, \tag{7}$$

where $T_{h,t}$ is lump-sum taxes, D_t is bank deposits, R_t is the gross return on bank deposits, w_t is the real wage, and Π_t^{fb} denotes dividends from financial and non-financial firms.

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

$$\left(C_t - \frac{\chi}{\varphi}L_t^{\varphi}\right)^{-\gamma} = \varrho_t, \tag{8}$$

$$\chi L_t^{\varphi-1} = w_t, \tag{9}$$

and

$$1 = E_t \beta \Lambda_{t,t+1} R_{t+1}, \tag{10}$$

where $\Lambda_{t,t+1} \equiv \beta\frac{\varrho_{t+1}}{\varrho_t}$.

2.2 Banks

Banks raise funds using their net worth, obtaining deposits from households, and borrowing from foreign investors, and lend them to goods producers. The balance sheet of a bank is given by

$$Q_t s_t = n_t + e_t b_t + d_t, \tag{11}$$

where s_t is the quantity of financial claims on goods producers, Q_t is the price of claims, n_t is the net worth, b_t is foreign debts, e_t is the real exchange rate, and d_t

is deposits from domestic households.

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

$$n_t = R_{k,t}Q_{t-1}s_{t-1} - (1 + \mathcal{T}_t^*)R_{b,t}e_{t-1}b_{t-1} - R_t d_{t-1} + \zeta_t, \tag{12}$$

where R_{kt} is the gross return on assets, $\mathcal{T}_t^*$ is the tax rate on the bank's foreign currency debt, R_{bt} is the gross interest rate on foreign debts in terms of domestic currency, R_t is the gross interest rate on deposits, and ζ_t is a lump-sum transfer from the government to a bank.

The bank maximizes the present discounted value of future dividends, taking into account of the probability of exiting the banking industry. The value of the bank at the end of period t is given by

$$V_t = E_t \sum_{i=1}^{\infty} (1-\sigma)\sigma^{i-1}\Lambda_{t,t+i}n_{t+i}. \tag{13}$$

There is a possibility for bankers to divert funds. The bank may transfer some fraction of "divertable" assets to the household. However, if a bank diverts assets, it is forced into bankruptcy. While a fraction θ of assets financed by deposits (d_t) and net worth (n_t) is assumed to be "divertable," a fraction θ^* of assets financed by foreign borrowing $(e_t b_t)$ is assumed to be "divertable." We assume that the assets financed by foreign borrowing are easier to divert than those financed by deposits and net worth (i.e., $\theta^* > \theta$). Thus, the following incentive constraint must hold for lenders to be willing to supply funds to the banker:

$$V_t(s_t, b_t, d_t) \geq \theta(d_t + n_t) + \theta^* e_t b_t. \tag{14}$$

The value of a bank, V_t, must be not less than a bank's benefit from diverting funds, $\theta(d_t + n_t) + \theta^* e_t b_t$, so that households and foreign investors are willing to supply funds to a bank. For tractability, we set that

$$\theta^* = (1 + \omega)\theta, \tag{15}$$

where $\omega > 0$. If $\omega = 0$, foreign borrowing has the same degree of frictions as domestic deposits. A higher value of $\omega(> 0)$ indicates a higher degree of financial frictions in foreign borrowing, because it implies that the asset financed by foreign borrowing is easier to divert than that financed by domestic deposits. Therefore, the parameter ω indexes the degree of financial frictions between banks and foreign investors. From the bank's balance sheet (11) and Eq.(15), we can rewrite the right-hand side of Eq.(14) as

$$\theta(d_t + n_t) + \theta^* e_t b_t = \theta(d_t + n_t) + \theta(1+\omega)e_t b_t = \theta(Q_t s_t + \omega e_t b_t). \tag{16}$$

Since the "divertable" amount of funds financed by foreign borrowing must not be greater than the total amount of the fund financed by foreign borrowing, it must be that $e_t b_t \geq \theta(1+\omega)e_t b_t$, and then the upper limit for ω exists (i.e., $\frac{1}{\theta} - 1 \geq \omega$).

The value of the bank at the end of period $t-1$ satisfies the Bellman equation:

$$V_{t-1}(s_{t-1}, b_{t-1}, d_{t-1}) = E_{t-1}\Lambda_{t-1,t}\left\{(1-\sigma)n_t + \sigma \max_{s_t, b_t, d_t} V_t(s_t, b_t, d_t)\right\}. \tag{17}$$

We guess and verify that the value function is linear in s_t, b_t, and d_t:

$$V_t(s_t, b_t, d_t) = \nu_{s,t}s_t - \nu_{b,t}b_t - \nu_t d_t, \tag{18}$$

where $\nu_{s,t}$ is the marginal value of assets, $\nu_{b,t}$ is the marginal cost of international borrowing, and ν_t is the marginal cost of deposits. Maximizing the value function (18) subject to the incentive constraint (14) (and (16)), we obtain the following first-order conditions:

$$\left(\nu_t - \frac{\nu_{b,t}}{e_t}\right)(1+\lambda_t) = \theta\omega\lambda_t, \tag{19}$$

$$\left(\frac{\nu_{s,t}}{Q_t} - \frac{\nu_{b,t}}{e_t}\right)(1+\lambda_t) = \theta(1+\omega)\lambda_t, \tag{20}$$

and

$$\left[\theta - \left(\frac{\nu_{s,t}}{Q_t} - \nu_t\right)\right]Q_t s_t + \left[\theta\omega - \left(\nu_t - \frac{\nu_{b,t}}{e_t}\right)\right]e_t b_t = \nu_t n_t, \tag{21}$$

where λ_t is the Lagrange multiplier for the incentive constraint (14). From these conditions and defining $\mu_{b,t} \equiv \nu_t - \frac{\nu_{b,t}}{e_t}$ and $\mu_t \equiv \frac{\nu_{s,t}}{Q_t} - \nu_t$, we obtain

$$\mu_{b,t} = \omega\mu_t, \tag{22}$$

and

$$Q_t s_t = \phi_t n_t - \frac{\phi_t}{\phi_{b,t}} e_t b_t, \tag{23}$$

where

$$\phi_t \equiv \frac{\nu_t}{\theta - \mu_t}, \tag{24}$$

and

$$\phi_{b,t} \equiv \frac{\nu_t}{\theta\omega - \mu_{b,t}}. \tag{25}$$

By combining the conjectured value function with with the Bellman equation (17) and using (12), we can verify that the value function is linear in (s_t, b_t, d_t) if ν_t, μ_t, and $\mu_{b,t}$ satisfy

$$\nu_t = E_t \Lambda_{t,t+1} \Omega_{t+1} R_{t+1}, \tag{26}$$

$$\mu_t = E_t \Lambda_{t,t+1} \Omega_{t+1} (R_{k,t+1} - R_{t+1}), \tag{27}$$

and

$$\mu_{b,t} = E_t \Lambda_{t,t+1} \Omega_{t+1} [R_{t+1} - (1 + \mathcal{T}^*_{t+1}) R_{b,t+1}], \tag{28}$$

where

$$\Omega_t \equiv (1 - \sigma) + \sigma(\phi_t \mu_t + \nu_t). \tag{29}$$

Since ϕ_t and $\phi_{b,t}$ are independent of bank-specific factors, we can aggregate across banks. It follows from Eq.(23) that

$$N_t = \frac{1}{\phi_t} Q_t S_t + \frac{1}{\phi_{b,t}} e_t B_t, \tag{30}$$

where capital letters indicate aggregate variables. By using Eqs.(22), (24), and (25), we can rewrite Eq.(30) as

$$Q_t S_t + \omega e_t B_t = \phi_t N_t. \tag{31}$$

Substituting (31) into the aggregate balance sheet ($Q_t S_t = N_t + e_t B_t + D_t$), we obtain the aggregate deposit:

$$D_t = -(1 + \omega) e_t B_t + (\phi_t - 1) N_t. \tag{32}$$

In each period, the fraction σ of banks continue to operate in the next period. As we will argue in Section 2.5, the government returns the tax revenue on capital controls to banks as a lump-sum transfer in each period (i.e., $\zeta_t = \mathcal{T}^*_t R_{b,t} e_{t-1} b_{t-1}$). Therefore, it follows from Eq.(12) that the existing bank's net worth N_{et} is given by

$$N_{e,t} = \sigma(R_{k,t} Q_{t-1} S_{t-1} - R_{b,t} e_{t-1} B_{t-1} - R_t D_{t-1}). \tag{33}$$

Following previous related studies, we assume that the household transfers the fraction $\xi/(1-\sigma)$ of the total final period assets of exiting bankers to its entering bankers. Thus, the new bank's net worth is given by

$$N_{n,t} = \xi R_{k,t} Q_{t-1} S_{t-1}. \tag{34}$$

The total net worth N_t is the sum of the net worth of existing banks $N_{e,t}$ and that of new banks $N_{n,t}$:

$$N_t = N_{e,t} + N_{n,t}. \tag{35}$$

Substituting (33) and (34) into (35), we obtain the evolution of N_t as follows:

$$N_t = (\sigma + \xi) R_{k,t} Q_{t-1} S_{t-1} - \sigma R_{b,t} e_{t-1} B_{t-1} - \sigma R_t D_{t-1}. \tag{36}$$

2.3 Goods producers

Competitive goods producers produce domestic goods using capital and labor:

$$Y_t = K_t^{\alpha} L_t^{1-\alpha}, \tag{37}$$

where Y_t is domestic output and K_t is capital. Goods producers finance their capital acquisition by obtaining funds from banks:

$$Q_t K_{t+1} = Q_t S_t. \tag{38}$$

We assume that goods producers do not face financial frictions when they obtain funds from banks, because we focus on financial frictions on banks. From the first-order conditions associated with the firm's optimization, we have

$$(1-\alpha) \frac{P_{H,t}}{P_t} \frac{Y_t}{L_t} = w_t. \tag{39}$$

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

$$R_{k,t+1} = \frac{\frac{P_{H,t}}{P_t} \alpha \frac{Y_{t+1}}{K_{t+1}} + Q_{t+1}(1-\delta)}{Q_t}, \tag{40}$$

where δ is the depreciation rate of capital.

2.4 Capital producers

Similarly to C_t in (3), I_t is composed of domestic and imported goods:

$$I_t \equiv \left[(1-\upsilon)^{\frac{1}{\iota}} I_{H,t}^{\frac{\iota-1}{\iota}} + \upsilon^{\frac{1}{\iota}} I_{F,t}^{\frac{\iota-1}{\iota}} \right]^{\frac{\iota}{\iota-1}}. \tag{41}$$

The optimal allocation of expenditures between domestic and imported goods implies that

$$I_{H,t} = (1-\upsilon) \left(\frac{P_{H,t}}{P_t} \right)^{-\iota} I_t \,; \qquad I_{F,t} = \upsilon \left(\frac{P_{F,t}}{P_t} \right)^{-\iota} I_t. \tag{42}$$

From Eqs.(5) and (42), we have

$$P_{H,t}\,I_{H,t} + P_{F,t}\,I_{F,t} = P_t\,I_t. \tag{43}$$

Capital producers make new capital subject to adjustment costs on investment. Therefore, the capital producer's optimization problem is given by

$$\max_{I_t}\; E_t \sum_{i=0}^{\infty} \Lambda_{t,t+i} \left\{ Q_{t+i} I_{t+i} - \left[1 + f\left(\frac{I_{t+i}}{I_{t+i-1}} \right) \right] I_{t+i} \right\}, \tag{44}$$

where $f(x) = \frac{\eta_i}{2}(x-1)^2$ is the function of adjustment costs on investment. From the first-order condition for I_t, we have that

$$Q_t = 1 + f\left(\frac{I_t}{I_{t-1}}\right) + \frac{I_t}{I_{t-1}} f'\left(\frac{I_t}{I_{t-1}}\right) - E_t \Lambda_{t,t+1} \left(\frac{I_{t+1}}{I_t}\right)^2 f'\left(\frac{I_{t+1}}{I_t}\right). \tag{45}$$

2.5 Government

As we argue in Section 2.2, we assume that the government returns the tax revenue on capital controls to banks as a lump-sum transfer in each period (i.e., $\zeta_t = \mathcal{T}_t^* R_{b,t} e_{t-1} b_{t-1}$). The government's budget constraint in period t is given by

$$G_t + \mathcal{Z}_t = \mathcal{T}_t^* R_{b,t} e_{t-1} B_{t-1} + T_{h,t}, \tag{46}$$

where G_t is government spending and $\mathcal{Z}_t$ is the aggregate variable for ζ_t. Here, G_t consists of domestic and imported goods:

$$G_t \equiv \left[(1-\upsilon)^{\frac{1}{\iota}} G_{H,t}^{\frac{\iota-1}{\iota}} + \upsilon^{\frac{1}{\iota}} G_{F,t}^{\frac{\iota-1}{\iota}} \right]^{\frac{\iota}{\iota-1}}. \tag{47}$$

Similarly to C_t and I_t, it holds that

$$G_{H,t} = (1-\upsilon)\left(\frac{P_{H,t}}{P_t}\right)^{-\iota} G_t; \qquad G_{F,t} = \upsilon \left(\frac{P_{F,t}}{P_t}\right)^{-\iota} G_t. \tag{48}$$

From Eqs.(5) and (48), we have

$$P_{H,t}\,G_{H,t} + P_{F,t}\,G_{F,t} = P_t\,G_t. \tag{49}$$

We assume that G_t is fixed at its steady state level G. Furthermore, as argued above, the government returns the tax revenue on capital controls to banks as a lump-sum transfer. In the government's budget constraint (46), this implies that $T_{h,t}$ is also constant. In other words, the role of the government can be reduced, theoretically, to simple taxation of capital flows and return of the collected revenue to the banks.

We consider a simple rule for capital controls, as follows:

$$\mathcal{T}_t^* = \tau\left[\log\left(\frac{e_{t-1}B_{t-1}}{Q_{t-1}S_{t-1}}\right) - \log\left(\frac{eB}{QS}\right)\right], \tag{50}$$

where $\frac{eB}{QS}$ denotes the steady-state level of $\frac{e_tB_t}{Q_tS_t}$. The capital control rule implies that the government raises (reduces) the tax rate on the bank's foreign borrowing when the fraction of assets financed by foreign borrowing increases (decreases). This rule is intended to discourage banks from borrowing abroad when banks rely excessively on foreign creditors. The low interest rates in developed countries after the recent financial crisis caused a surge in capital inflows into emerging economies. An abrupt reversal of capital flows may ensue from a surge in capital inflows into emerging economies. As argued in the introduction, for this reason, some emerging countries have recently responded to the capital inflows by imposing capital controls. Therefore, we think that the rule denoted as Eq.(50) is appropriate as capital account restrictions to prevent massive capital inflows to emerging countries.[11]

2.6 International relative prices

By the definition of the terms of trade, we have

$$q_t \equiv \frac{P_{F,t}}{P_{H,t}} = \frac{P_t^*}{P_{H,t}}, \tag{51}$$

where P_t^* denotes the price index in the foreign country (in terms of the domestic currency).[12] From the CPI (5) and Eq.(51), we obtain

$$g(q_t) \equiv \frac{P_t}{P_{H,t}} = [(1-\upsilon) + \upsilon q_t^{1-\iota}]^{\frac{1}{1-\iota}}. \tag{52}$$

From (51) and (52), the real exchange rate e_t is given by a function of the terms of trade q_t:

$$e_t \equiv \frac{P_t^*}{P_t} = \frac{q_t}{g(q_t)}. \tag{53}$$

The assumption of a small open economy (i.e., the home country is small enough not to affect the price in the foreign country) implies the asymmetric home bias

[11] We confirm that our main results hold when we employ a different form of rules such as $\mathcal{T}_t^* = \tau\left[\log(e_{t-1}B_{t-1}) - \log(eB)\right]$.

[12] Without loss of generality, we assume that $P_{F,t} = P_t^*$ because the home country is small enough not to affect the price in the foreign country.

in preference so that the purchasing power parity does not hold (i.e., $e_t \neq 1$).

2.7 Equilibrium

In each period, the domestic goods market must clear. It follows that

$$Y_t = (1-\upsilon)g(q_t)^{\iota}(C_t + I_t + \Gamma_t + G_t) + q_t EX_t, \tag{54}$$

where $\Gamma_t \equiv f\left(\frac{I_t}{I_{t-1}}\right)I_t$ is the adjustment costs on investment, and EX_t is the exogenous demand for exports. Eq.(54) indicates that demand for domestic goods comes from consumption, investment, its adjustment cost, government expenditure, and exports.

The capital accumulation process is given by

$$K_{t+1} = (1-\delta)K_t + I_t. \tag{55}$$

The trade balance in terms of the CPI is given by

$$TB_t \equiv \frac{Y_t}{g(q_t)} - C_t - I_t - G_t - \Gamma_t. \tag{56}$$

Thus, the evolution of foreign debt B_t is given by

$$B_t = R^*_{b,t}B_{t-1} - \frac{TB_t}{e_t}, \tag{57}$$

where $R^*_{b,t}$ is the bank's (gross) foreign borrowing rate in terms of foreign currency. Then, the current account is given by

$$CA_t = -B_t + B_{t-1}. \tag{58}$$

The bank's (gross) foreign borrowing rate $R^*_{b,t}$ is assumed to be the sum of the world (gross) interest rate R^*_t, which is an exogenous shock, and a country premium that is increasing in the ratio of foreign debt to output, as follows:

$$R^*_{b,t+1} = R^*_{t+1} + \psi\left[\exp\left\{\frac{q_t B_t}{Y_t} - \frac{qB}{Y}\right\} - 1\right], \tag{59}$$

where $\frac{qB}{Y}$ is the steady-state level of $\frac{q_t B_t}{Y_t}$. As in many previous studies, the country premium that is increasing in foreign debt is implemented to induce the stationarity of foreign debt. The world (gross) interest rate R^*_t is assumed to follow the AR(1) process:

$$\log R^*_{t+1} = (1-\rho_{R^*})\log R^* + \rho_{R^*}\log R^*_t + \varepsilon^{R^*}_{t+1}, \quad \varepsilon^{R^*}_{t+1} \sim i.i.d.\ N(0, \sigma^2_{R^*}). \tag{60}$$

$R_{b,t}$ is in terms of domestic currency, while $R^*_{b,t}$ is in terms of foreign currency. Therefore, the relationship between $R_{b,t}$ and $R^*_{b,t}$ is as follows:

$$R_{b,t+1} = R^*_{b,t+1}\frac{e_{t+1}}{e_t}. \tag{61}$$

2.8 Calibration

We choose the standard parameter values given in the relevant literature for calibration, which are summarized in Table 1. For the parameters for households, we set the discount factor β and the inverse of intertemporal elasticity of substitution γ to 0.98 and 2, respectively, as in Aguiar and Gopinath (2007). The curvature parameter on labor φ is set to 1.455, as in Mendoza (1991). The labor coefficient χ is chosen to generate the steady-state labor hours (L) of 0.2.

Following Gertler and Kiyotaki (2010), Gertler and Karadi (2011), and Gertler et al. (2012), we set the parameters for banks as follows. The fraction of divertable assets, θ, and the transfer to entering banks, ξ, are set to hit the two targets of a steady-state interest rate spread of 100 basis points per year and a steady-state leverage ratio of 4. The survival rate of banks σ is chosen to generate an average horizon of banks of eight years.

The parameters related to the open economy are chosen as follows. The elasticity of substitution between domestic and imported goods ι is set to 1.5, as in Ravenna and Natalucci (2008). Following Cook (2004), we set the degree of openness υ to 0.28. The steady-state ratio of foreign debt to GDP, $\frac{B}{Y}$, is set to 0.4 as in Devereux et al. (2006). The parameter for the country-specific interest rate premium ψ is set to 0.03, which fits between 0.0075 in Unsal (2013) and 0.05 in Akinci and Queraltó (2014). We set the degree of financial frictions, ω, to 0.5 in the benchmark case. The persistence and the standard deviation of the foreign interest rate shock, ρ_{R^*} and σ_{R^*}, are set to 0.98 and 0.0025, respectively.

The other parameters are set as in Gertler and Kiyotaki (2010). The steady-state value of the ratio of government expenditure to GDP, $\frac{G}{Y}$, is set to 0.2. For the parameters for goods producers and capital producers, the effective capital share α, the inverse elasticity of net investment to the price of capital η_i, and the depreciation rate of capital δ are set to 0.33, 1.5, and 0.025, respectively.

Table 1: Calibration.

Parameters	Value	
β	0.98	Discount factor
γ	2	Inverse of intertemporal elasticity of substitution
φ	1.455	Curvature parameter on labor
χ	4.060	Labor coefficient
σ	0.9685	Survival rate of banks
θ	0.391	Fraction of divertable assets
ξ	5.23×10^{-4}	Transfer to entering bankers
$\frac{B}{Y}$	0.4	Steady-state ratio of foreign debt to GDP
ι	1.5	Elasticity of substitution between domestic and imported goods
υ	0.28	Degree of openness
ω	0.5	Degree of financial frictions
ψ	0.03	Parameter for country-specific interest rate premium
ρ_{R^*}	0.98	Persistence: foreign interest rate shock
σ_{R^*}	0.0025	Standard deviation: foreign interest rate shock
$\frac{G}{Y}$	0.2	Steady-state ratio of government expenditure to GDP
η_i	1.5	Elasticity of the price of capital to investment
α	0.33	Effective capital share
δ	0.025	Depreciation rate of capital

2.9 Welfare

We conduct policy evaluations by computing the welfare benefit of a particular capital control rule relative to a no-capital control case. The perturbation method presented by Schmitt-Grohé and Uribe (2004) is used to perform a second-order approximation of the model.[13] Following Schmitt-Grohé and Uribe (2006), we consider expected welfare conditional on the initial state being the non-stochastic steady state. We define the welfare associated with a particular value of τ in the capital control rule (50) conditional on the non-stochastic steady states as

$$\mathcal{W}_0 \equiv E_0 \sum_{t=0}^{\infty} \beta^t U(C_t, L_t) = E_0 \sum_{t=0}^{\infty} \beta^t U((1+\epsilon)C, L), \tag{62}$$

where C and L denote their non-stochastic steady states. We evaluate the welfare-improving effect of the capital control rule (50) by comparing ϵ associated with each value of τ to that in the no-capital control case (i.e., $\tau = 0$).

3 Results

This section presents the main results of our analysis. Before examining the welfare-improving effect of capital controls, we show how the difference in the degrees of financial frictions affects the impulse responses of main variables. As we argued in Section 1, the effect of prospective increases in the US policy rate on emerging economies is a growing concern among policymakers. Therefore, we consider an increase in foreign interest rates as the exogenous shock.

3.1 Impulse responses of main variables under different degrees of financial frictions

The impulse responses of the main variables to an exogenous increase in foreign interest rates under different degrees of financial frictions are shown in Figure 1. The initiating disturbance is a 1% unanticipated annual increase in foreign interest rates R^*. The bold curve in Figure 1 represents the benchmark case of $\omega = 0.5$. The dotted curve and thin curve in Figure 1 represent the case of a higher degree of financial frictions ($\omega = 0.99$) and that of a lower degree of financial frictions ($\omega = 0.01$), respectively.

[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. The second-order computation is conducted with Dynare. See Adjemian et al. (2011) for details on Dynare.

An exogenous rise in foreign interest rates increases the bank's foreign borrowing rate R_b and leads to a decline in the bank net worth N. Since it tightens the bank's borrowing constraint, the decline in the net worth reduces bank assets $S(=K)$ (or capital). The decline in capital leads to a drop in output Y and investment I, which causes a decline in the price of capital Q. The drop in the price of capital exacerbates a decline in the value of capital QK (or bank assets). The decline in the value of bank assets QS causes a further decline in the bank net worth. Therefore, the effects of an exogenous increase in foreign interest rates on output and the other main variables are amplified through the bank's balance sheet.

Comparing the three cases of $\omega = 0.01$, $\omega = 0.5$, and $\omega = 0.99$ in Figure 1, we can see that the negative effects of an exogenous increase in foreign interest rates on Y, C, I, K, and L become larger as the degree of financial frictions increases (i.e., ω increases). The size of an increase in the spread between the expected return on capital and that in the riskless rate $E[R_k] - R$ also becomes larger as the degree of financial frictions increases. A larger drop in investment I compared to that in output Y causes a shortage in the demand for domestic goods and a depreciation of the real exchange rate e, which leads to an improvement in the current account (to output ratio) CA/Y. The size of the improvement in the current account (to output ratio) CA/Y (i.e., capital outflow) becomes larger as the degree of financial frictions increases. As the degree of financial frictions increases, the size of the depreciation of the real exchange rate e increases, which raises the value of foreign debt in terms of domestic currency eB and magnifies the bank's balance sheet effect. Therefore, we can say that as the degree of financial frictions increases, the size of the economy's fluctuation due to the exogenous foreign shock tends to increase.

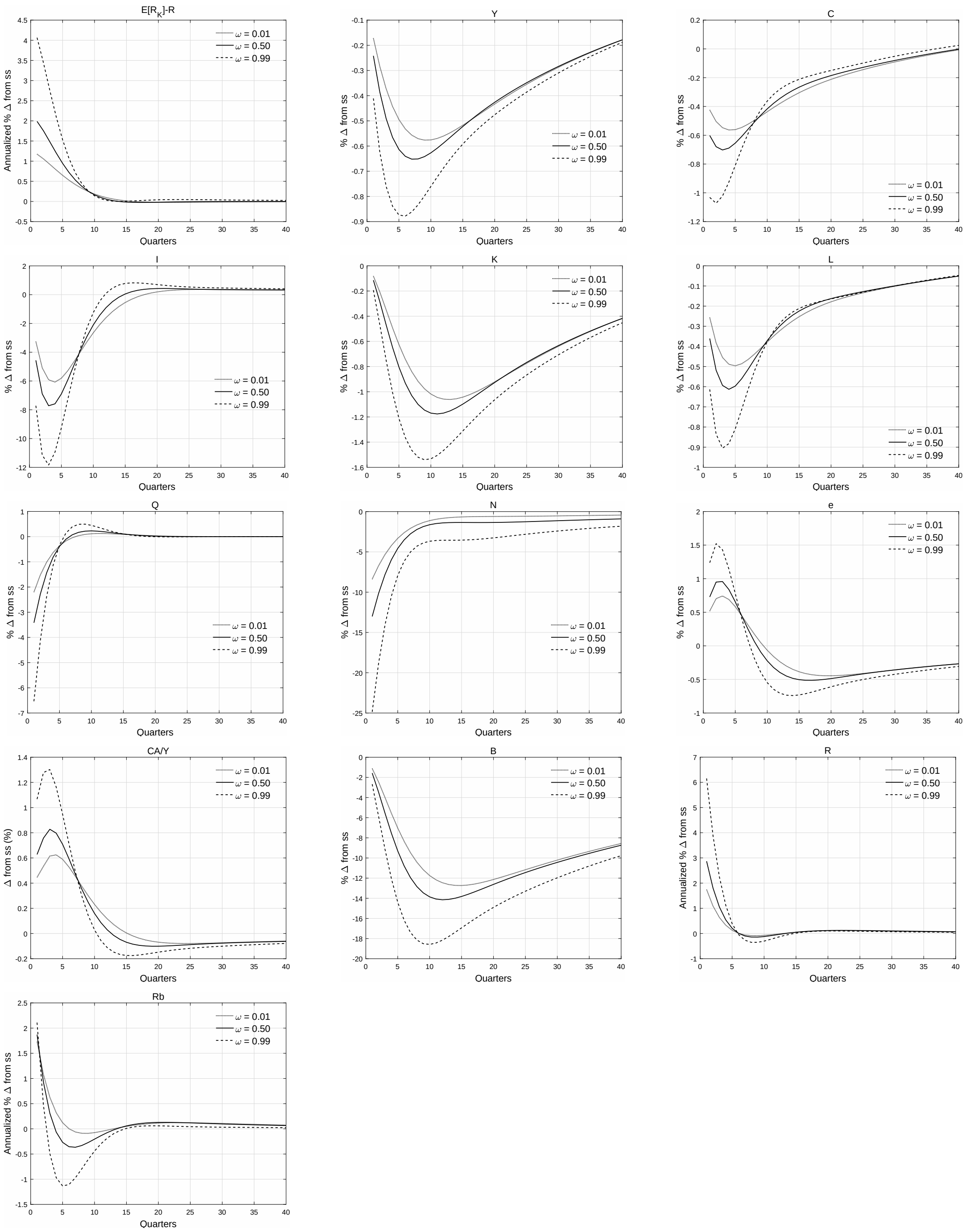

Figure 1: Impulse responses to an increase in the foreign interest rate: $\omega = 0.01, 0.5, 0.99$

3.2 Impulse responses of main variables, with and without capital controls

Next, we show the impulse responses of the main variables to the same shock, with and without a low (not necessarily optimal) degree of capital controls. Figure 2 shows the impulse responses with and without the capital control rule in which τ is set to 0.01 under the benchmark degree of financial frictions ($\omega = 0.5$). In Figure 2, the solid curve represents the impulse responses with the capital control rule of $\tau = 0.01$, and the dotted curve represents those without it.

As is clear from Figure 2, the capital control rule dampens the decline in output Y by mitigating the increase in the spread $E[R_k] - R$. The capital control rule reduces the size of fluctuations in investment I, capital K, and consumption C, as well as in output Y. The fluctuations in the real exchange rate e, the ratio of the current account to output CA/Y, and foreign debt B are also reduced significantly by the capital control rule. The impulse response of the tax rate on foreign borrowing has a similar trajectory to B because of the definition of the capital control rule (50).

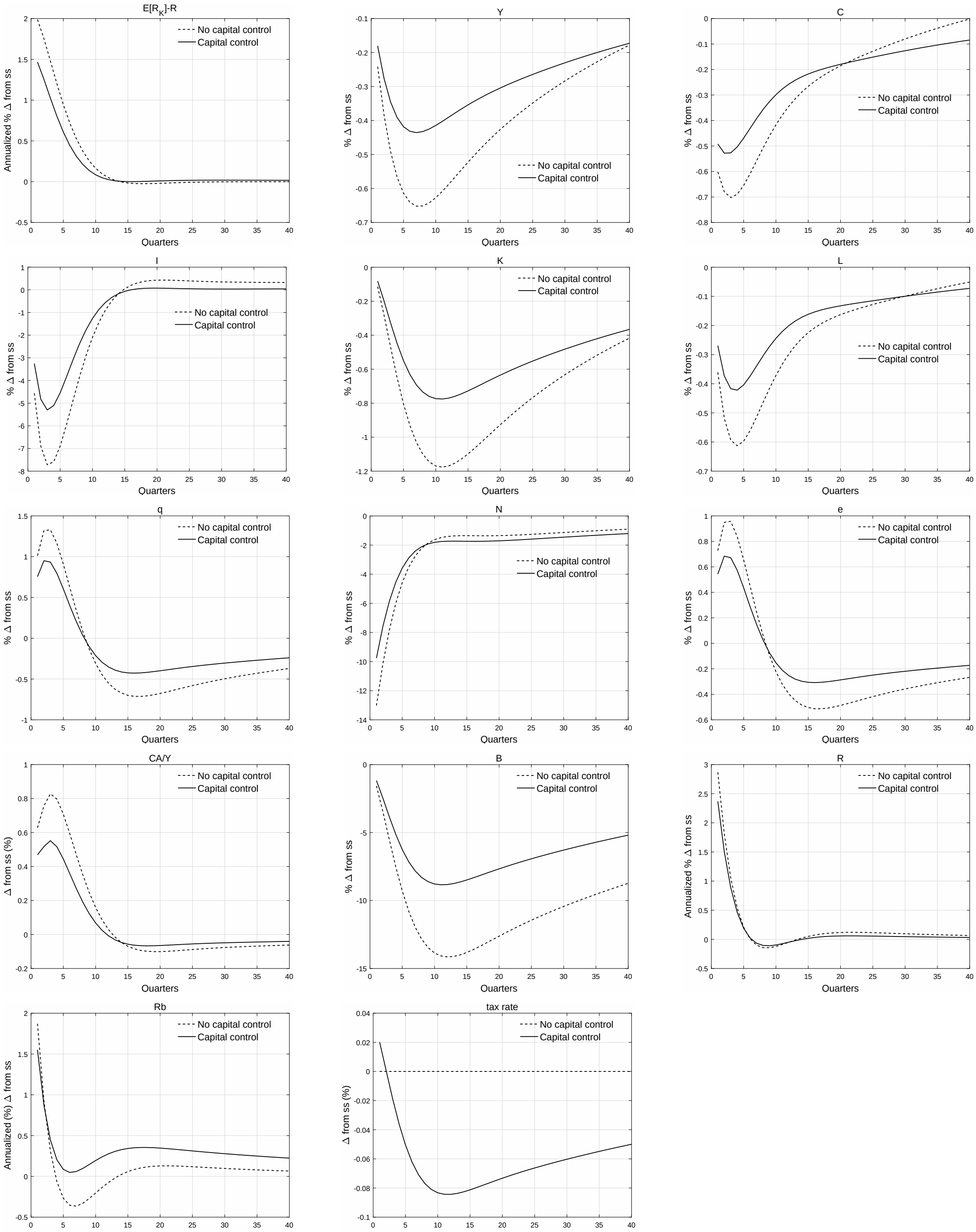

Figure 2: Impulse responses to an increase in the foreign interest rate, with and without capital controls: $\omega = 0.5$

3.3 Welfare analysis

We now examine the welfare-improving effect of capital controls under different degrees of financial frictions. Figure 3 shows the welfare curves associated with different values of τ. In Figure 3, the horizontal axis is τ, and the welfare curves corresponding to three degrees of financial frictions ω are shown. The bold curve, the bold dotted curve, and the thin dotted curve represent the benchmark case of $\omega = 0.5$, a higher degree of frictions case of $\omega = 0.75$, and a lower degree of frictions case of $\omega = 0.25$, respectively. The asterisk "$*$" denotes the maximum welfare point achieved by choosing the optimal level of τ for each of the three degrees of the financial frictions. In Figure 3, zero in the vertical axis indicates that the capital control rule does not improve welfare at all and the welfare-improving effect of capital controls is zero.

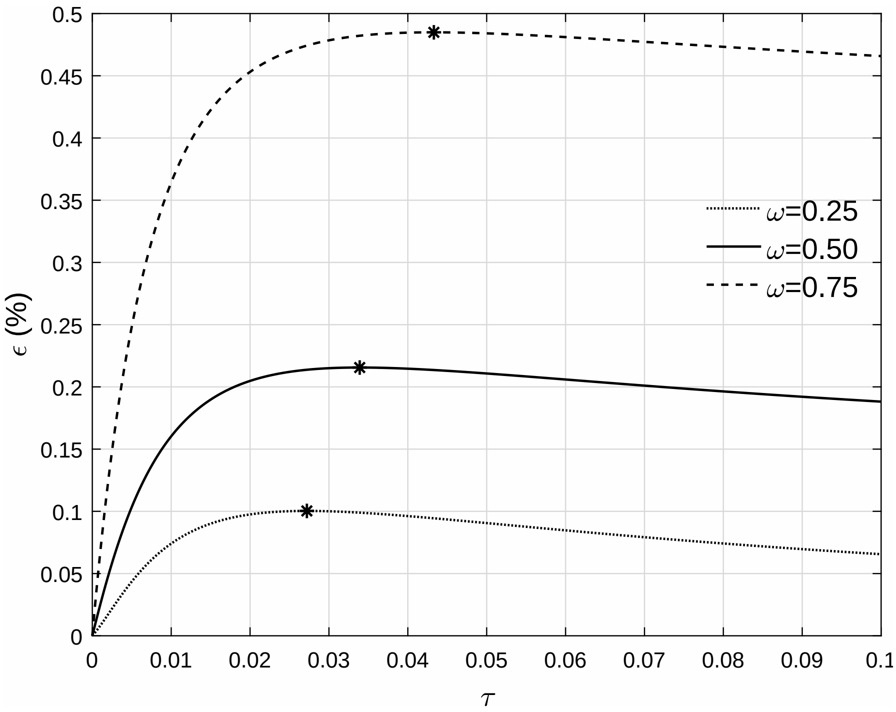

Figure 3: Welfare curves with varying τ: different degrees of financial frictions

As is clear from Figure 3, there is some range of τ that improves welfare levels compared to the no-policy case. By comparing the three welfare curves corresponding to the three degrees of financial frictions, we can see that as the degree of financial frictions increases, the welfare-improving effect of capital controls increases. By comparing the three cases, we can also see that as the degree of financial frictions increases, the optimal value of τ becomes larger (i.e., the optimal values of τ corresponding to $\omega = 0.25$, 0.5, and 0.75 are 0.027, 0.034, and 0.043, respectively.) This result implies that a more aggressive policy rule is appropriate if the degree of financial frictions is higher.

Figure 4 shows the conditional welfare levels under different degrees of financial frictions ω. In Figure 4, the solid curve represents the maximum level of conditional welfare, which is achieved by choosing the optimal level of τ under different degrees of financial frictions ω. The dotted curve represents the case where no capital control is imposed, under different degrees of financial frictions ω. As we can guess immediately, the welfare level in the no-capital control case decreases as the degree of financial frictions increases (i.e., ω increases). The no capital control welfare curve is downward sloping because of the amplified uncertainty due to financial frictions. In contrast, the maximized welfare level achieved by the optimal capital control rule increases as the degree of financial frictions becomes larger. By comparing the no capital control welfare curve and the maximum welfare curve, we can say that the increase in the economy's conditional welfare level caused by the optimal capital control rule becomes larger as the degree of financial frictions increases.

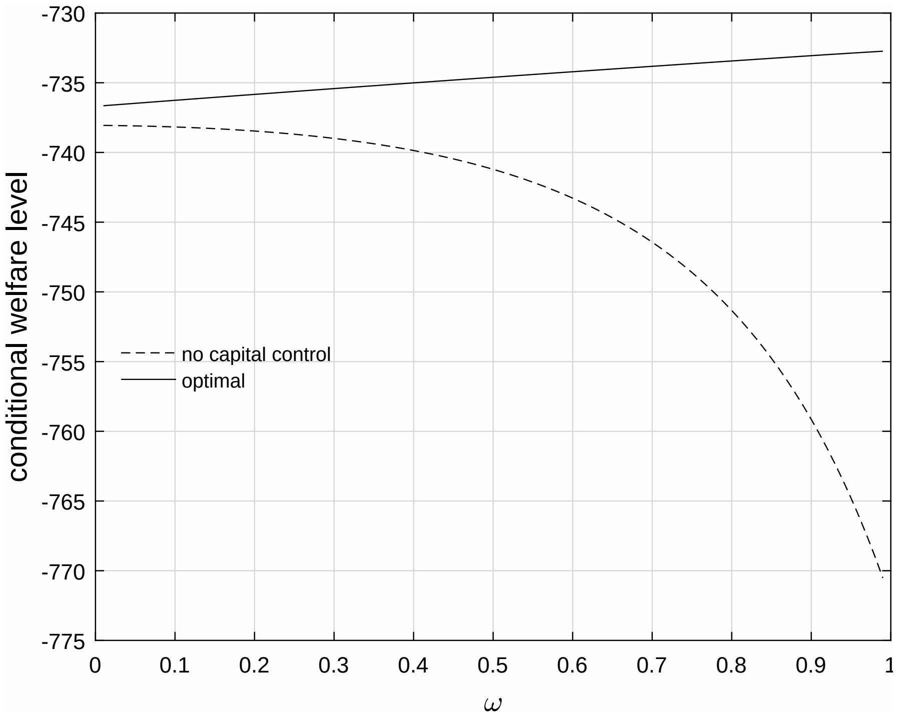

Figure 4: Optimal and no capital control welfare levels

Figure 5 plots the maximum welfare gain of capital controls measured in terms of the non-stochastic steady state level of consumption C under different degrees of financial frictions ω. As argued in Section 2.9, we evaluate the welfare benefit of the capital control rule corresponding to different values of ω by comparing ϵ in (62) associated with each value of τ to that in the no-capital control case (i.e., $\tau = 0$), and calculate the maximum welfare gain of capital controls by choosing the optimal level of τ. Figure 5 shows that as the degree of financial frictions increases, the maximum welfare gain of the optimal capital control rule increases.

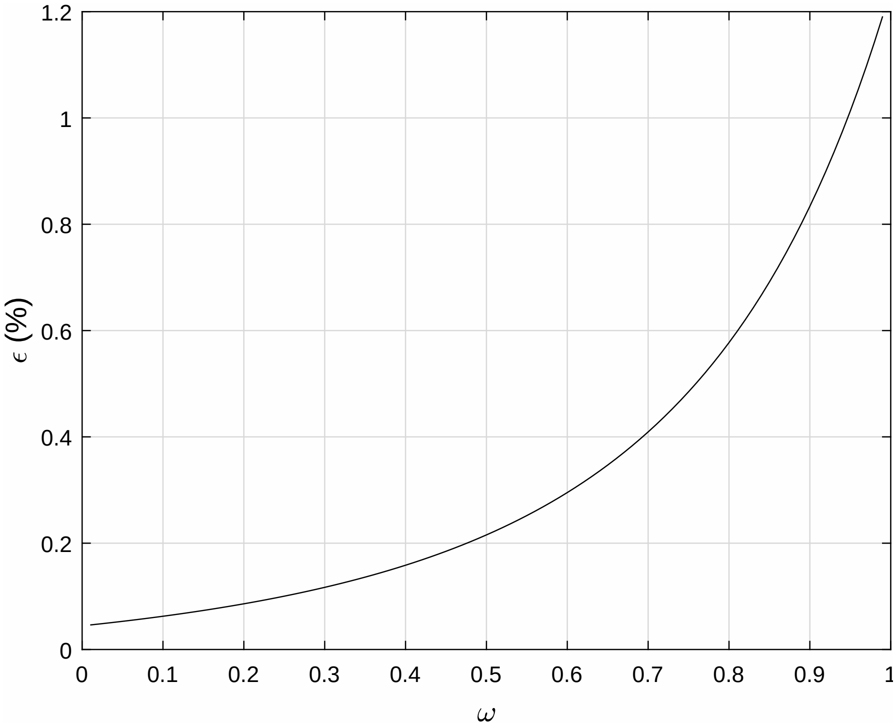

Figure 5: Maximum welfare gains of capital controls under different degrees of financial frictions (ω)

3.4 Liability dollarization

As we argue in the Introduction, we consider an economy where banks face the "liability dollarization" problem and their foreign borrowing is denominated in foreign currency. When the banks' liabilities are "dollarized," exchange rate behavior exacerbates the effect of financial frictions through their balance sheet.

In this section, we examine how the welfare-improving effect of capital controls would differ between a "liability dollarization" economy and a "no liability dollarization" economy. In Appendix A2, we formally explain how the two economies differ. In the "liability dollarization" economy, an unanticipated depreciation in the domestic currency has a direct negative impact on the bank's balance sheet. In contrast, in the "no liability dollarization" economy, the exchange rate change has no direct valuation effect on the bank's balance sheet.

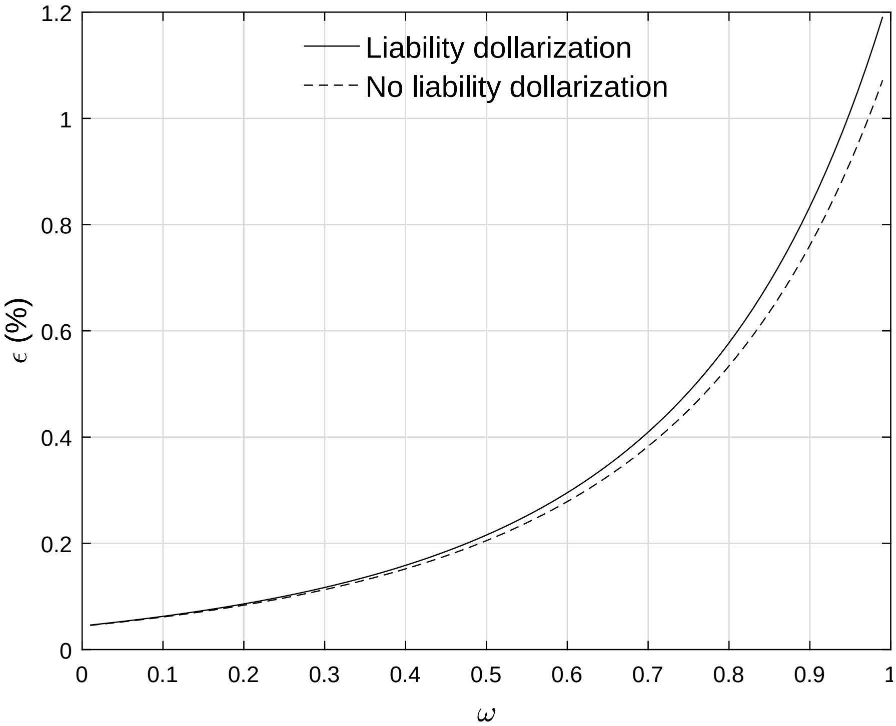

Figure 6: Maximum welfare gains of capital controls under different degrees of financial frictions (ω): Liability dollarization vs. no liability dollarization

Figure 6 represents the welfare gain curve of capital controls in the "no liability dollarization" economy and that in the "liability dollarization" economy. The welfare gain curve in the "liability dollarization" economy is identical to that in Figure 5. As is clear from Figure 6, in both cases, the welfare-improving effect of capital controls increases as the degree of financial frictions increases. However, the welfare-improving effect of capital controls in the "liability dollarization" case is higher than that in the "no liability dollarization" case, and the difference between the effects becomes larger as ω increases. In the "liability dollarization" economy, the exchange rate amplifies the effect of a foreign interest rate shock on the economy through the bank's balance sheet channel. Therefore, capital controls have a larger effect in terms of improving welfare in the "liability dollarization" case with the amplification effect of the exchange rate on the bank's balance sheet.

The difference in the welfare levels between the two cases in Figure 6 may not seem very large. However, in the "no liability dollarization" economy, we only eliminate the direct valuation effect of the exchange rate change on the bank's balance sheet, while the effect of exchange rates on the interest payments on foreign debts (in terms of domestic currency) still exists. That is, the difference in the welfare levels between the two cases in Figure 6 is derived only from whether the direct valuation effect of the exchange rate change on the bank's balance sheet exists or not.

4 Sensitivity analysis

In this section, we examine the robustness of our analysis results in the previous section. We conduct robustness checks for varying degrees of country premium (ψ), trade openness (i.e., inverse degree of home bias) (υ), and trade elasticity (ι), which are key parameters in replicating the small open economy's behavior. Garcia-Cicco et al. (2010) show that the country-specific interest-rate premium parameter (ψ) plays an important role in replicating the business cycle in emerging market economies. The country premium parameter is especially important for the autocorrelation function of the trade-balance-to-output ratio to be close to data. Faia and Monacelli (2008) analyze the optimal monetary policy in a small open economy characterized by home bias in consumption. They examine how the degree of trade openness υ (i.e., inverse degree of home bias) affects a small open economy, and show that υ is especially important for inflation and exchange rate volatilities. The parameter of trade elasticity (or elasticity between domestic and foreign goods) (ι) is also a key parameter in the dynamics of a small open economy. As shown in Faia and Monacelli (2008) and Thoenissen (2011), the parameter of trade elasticity is critical to the behavior of a real exchange rate in a small open economy.

4.1 Robustness check for varying degrees of the country premium parameter ψ

We examine how the welfare-improving effect of capital controls changes as the country premium parameter (ψ) varies. Figure 7 shows the welfare benefit curves for different degrees of financial frictions (ω) in the three cases of $\psi = 0.02$, 0.03, and 0.04. In Figure 7, we find that the welfare benefit in the case of $\psi = 0.02$ is higher than that in the benchmark case of $\psi = 0.03$, and the welfare benefit in the case of $\psi = 0.04$ is lower than that in the benchmark case, for any value of ω. Thus, we can say that as the country premium parameter (ψ) becomes smaller, the maximum welfare gain of capital controls becomes larger. However, in all cases, similarly to the previous section, we confirm that as the degree of financial frictions increases, the maximum welfare gain of capital controls becomes larger.

Figure 8 shows the welfare curves associated with different values of τ in the case of $\psi = 0.02$ or 0.04, whereas Figure 3 shows those in the benchmark case of $\psi = 0.03$. Similarly to the benchmark case of $\psi = 0.03$, we can see that as the degree of financial frictions increases, the optimal value of τ becomes larger, which implies that a more aggressive policy rule is appropriate if the degree of financial frictions is higher. Comparing the two cases of $\psi = 0.02$ and 0.04 in Figure 8, we can see that the optimal value of τ in the case of $\psi = 0.04$ is higher than that in the case of $\psi = 0.02$ for any value of ω. This implies that a higher value of the

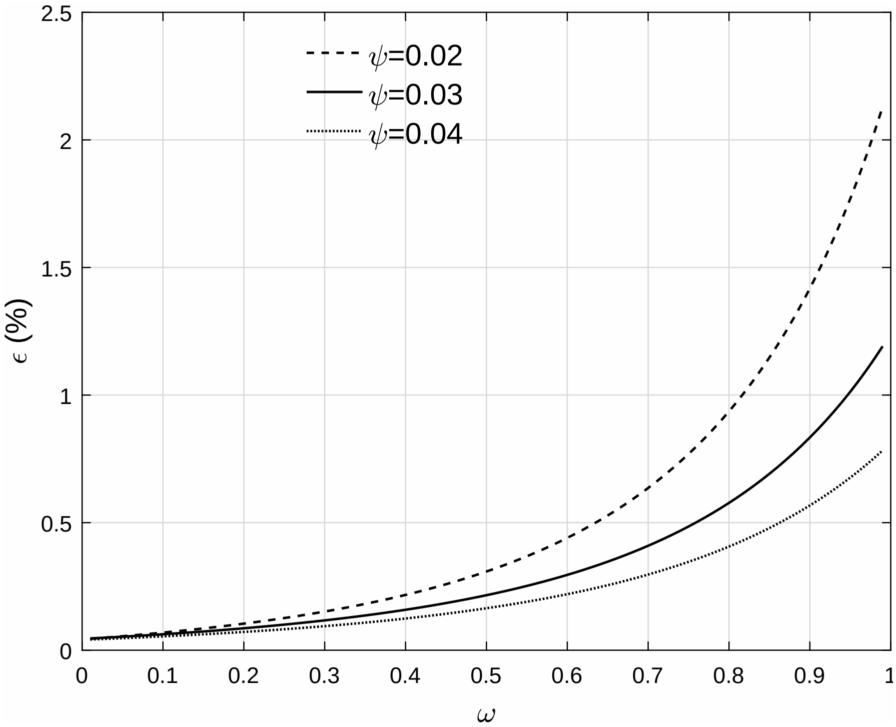

Figure 7: Maximum welfare gain of capital controls under different degrees of financial frictions (ω): varying country premium parameter (ψ)

country risk premium parameter ψ requires tighter capital controls.

Figure 9 shows the welfare gain curve of capital controls in the "no liability dollarization" economy and that in the "liability dollarization" economy in the case of $\psi = 0.02$ or 0.04, whereas Figure 6 shows those in the benchmark case of $\psi = 0.03$. Similarly to the benchmark case of $\psi = 0.03$, we can see that the difference between the effects becomes larger as the degree of financial frictions is higher.

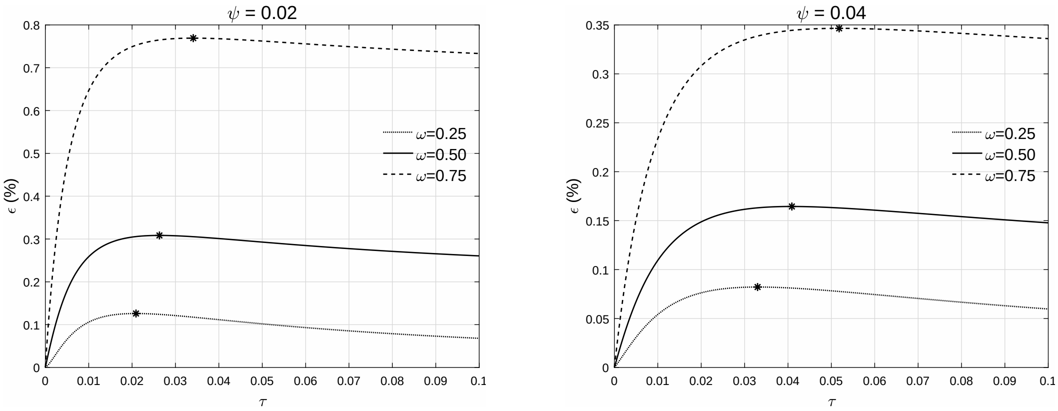

Figure 8: Welfare curves with varying τ: different degrees of financial frictions ($\psi = 0.02, 0.04$)

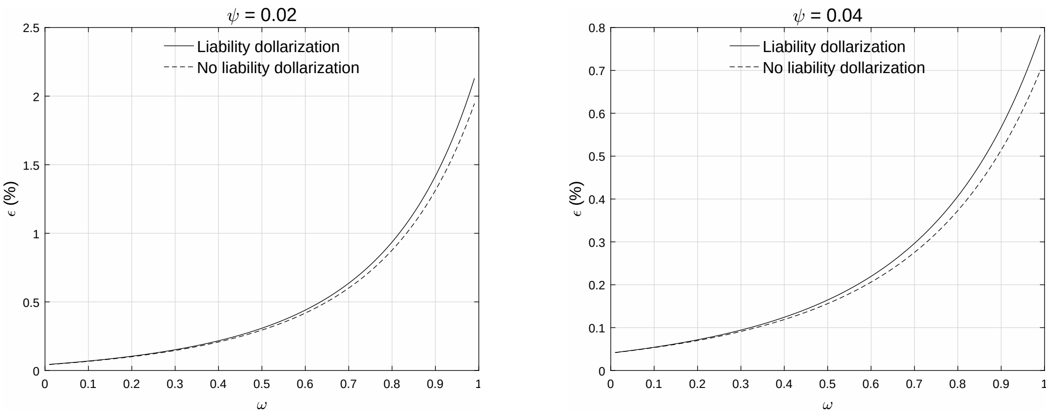

Figure 9: Maximum welfare gains of capital controls under different degrees of financial frictions (ω): Liability dollarization vs. no liability dollarization ($\psi = 0.02, 0.04$)

4.2 Robustness check for varying degrees of the trade openness (i.e., inverse degree of home bias) parameter υ

We next examine how the welfare-improving effect of capital controls changes if the trade openness (or inverse degree of home bias) parameter (υ) varies. Figure 10 shows the welfare gain curves for different degrees of financial frictions (ω) in the three cases of $\upsilon = 0.10$, 0.28, and 0.50. In Figure 10, we see that, unlike ψ, the relationship between the welfare gain and the parameter value of υ is not necessarily monotonic, although when ω is high, the maximum welfare gain of capital controls becomes larger as the degree of trade openness (υ) increases. However, we find that in all cases, it holds that as the degree of financial frictions increases, the maximum welfare gain of the capital controls becomes larger.

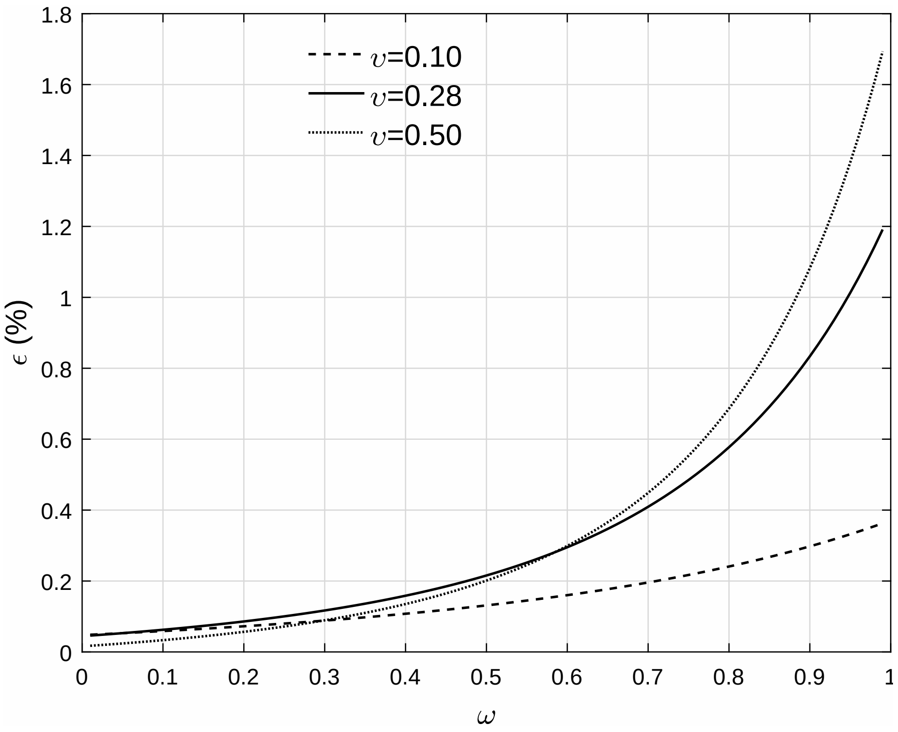

Figure 10: Maximum welfare gain of capital controls under different degrees of financial frictions (ω): varying trade openness (υ)

Figure 11 shows the welfare curves associated with different values of τ in the case of $\upsilon = 0.10$ or 0.50, whereas Figure 3 shows those in the benchmark case of $\upsilon = 0.28$. Similarly to the benchmark case of $\upsilon = 0.28$, we can see that as the degree of financial frictions increases, the optimal value of τ becomes larger, which implies that a more aggressive policy rule is appropriate if the degree of financial frictions is higher.

Figure 12 shows the welfare gain curve of capital controls in the "no liability dollarization" economy and that in the "liability dollarization" economy in the case of $\upsilon = 0.10$ or 0.50, whereas Figure 6 shows those in the benchmark case of $\upsilon = 0.28$. Similarly to the benchmark case of $\upsilon = 0.28$, we can see that the difference between the effects becomes larger as the degree of financial frictions is higher.

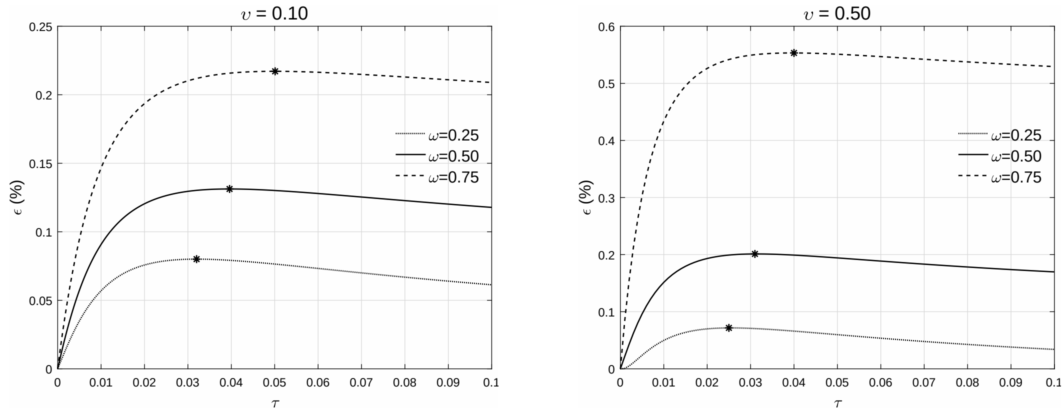

Figure 11: Welfare curves with varying τ: different degrees of financial frictions ($\upsilon = 0.10, 0.50$)

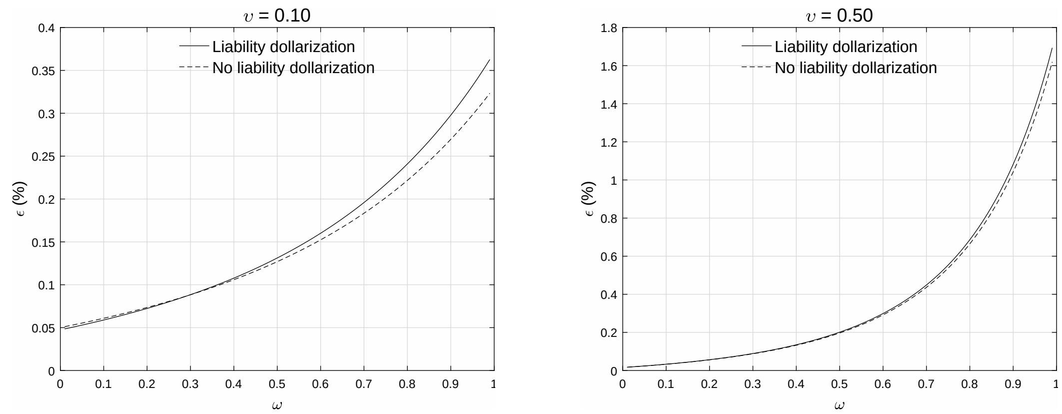

Figure 12: Maximum welfare gains of capital controls under different degrees of financial frictions (ω): Liability dollarization vs. no liability dollarization ($\upsilon = 0.10, 0.50$)

4.3 Robustness check for varying degrees of trade elasticity parameter ι

Figure 13 shows the welfare benefit curves of capital controls under different degrees of financial frictions (ω) in the three cases of $\iota = 0.5$, 1.5, and 2.5. In Figure 13, similarly to the case of ψ, we find the monotonic relationship between the welfare gain and the parameter value of ι, although the welfare gain in the case of $\iota = 2.5$ is close to that in the benchmark case of $\iota = 1.5$. However, in all cases, it again holds that as the degree of financial frictions increases, the maximum welfare gain of capital controls becomes larger.

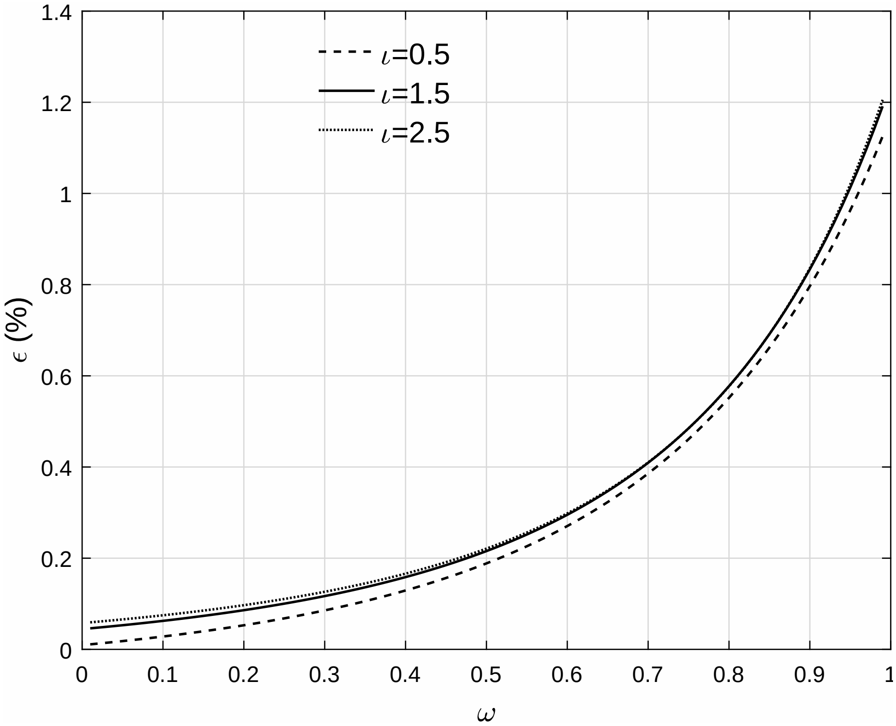

Figure 13: Maximum welfare gain of capital controls under different degrees of financial frictions (ω): varying trade elasticity (ι)

Figure 14 shows the welfare curves associated with different values of τ in the case of $\iota = 0.5$ or 2.5, whereas Figure 3 shows those in the benchmark case of $\iota = 1.5$. Similarly to the benchmark case of $\iota = 1.5$, we can see that as the degree of financial frictions increases, the optimal value of τ becomes larger, which implies that a more aggressive policy rule is appropriate if the degree of financial frictions is higher.

Figure 15 shows the welfare gain curve of capital controls in the "no liability dollarization" economy and that in the "liability dollarization" economy in the case of $\iota = 0.5$ or 2.5, whereas Figure 6 shows those in the benchmark case of $\iota = 1.5$. Similarly to the benchmark case of $\iota = 1.5$, we can see that the difference between the effects becomes larger as the degree of financial frictions is higher.

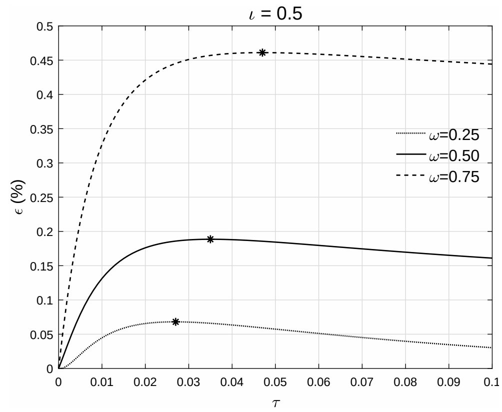

Figure 14: Welfare curves with varying τ: different degrees of financial frictions ($\iota = 0.5, 2.5$)

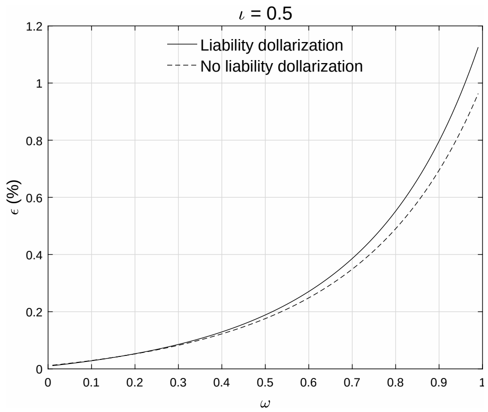

Figure 15: Maximum welfare gains of capital controls under different degrees of financial frictions (ω): Liability dollarization vs. no liability dollarization ($\iota = 0.5, 2.5$)

5 Conclusion

This study falls within a strand of studies that examine the possible effects of using capital controls as a policy tool for open economies. However, our study differs from the existing literature in that we examine the welfare-improving effect of capital controls under different degrees of financial frictions between banks and foreign investors. To this end, we develop a small open economy model with financial frictions à la Gertler and Kiyotaki (2010) and Gertler and Karadi (2011). Banks face financial frictions in the form of time-varying endogenous balance sheet constraints due to the agency problem with foreign investors.

We show that capital controls can be an effective instrument for addressing the amplification effect due to financial frictions. When the degree of financial frictions between banks and foreign investors is higher, capital controls are more welfare improving. We also show that as the degree of financial frictions increases, a more aggressive policy rule is appropriate. In our model, banks also face the "liability dollarization" problem, which we compare with an economy that does not face the same problem. Here, we find that the welfare-improving effect of capital controls in the "liability dollarization" case is larger than that in the "no liability dollarization" case, and the difference between the effects becomes larger as the degree of financial frictions increases. This result reflects the fact that the amplification effect of exchange rates through the balance sheet channel is significant in the "liability dollarization" economy. We confirm the robustness of our main finding for the varying degrees of the three key parameters on country premium, home bias, and trade elasticity.

The intuitive explanation for why capital controls are effective in addressing the amplification effect of financial frictions follows immediately from the argument of Gertler et al. (2012) that "there exists a pecuniary externality which banks do not properly internalize when deciding their balance sheet structure" (page 530). In other words, capital controls can play a role of internalizing the above-mentioned externality due to the financial frictions.

Reflecting the recent policy reactions of emerging countries to their capital inflow problems, we examine "cyclical policies" by which the government increases taxes on capital inflows when a surge in capital inflows occurs. Although it is beyond the scope of this study, it is also important to examine "permanent policies" such as those affecting the steady state fraction of bank lending financed by foreign borrowing. We can also extend our model to include credit constraints faced by non-financial borrowers, which is emphasized by Bernanke et al. (1999). Although this extension is beyond the scope of this study, it seems interesting to explore how the welfare consequences of capital controls would change under this type of financial frictions. We leave these for future research.

Appendices

A1 Steady state

In the steady state, we have

$$\Lambda = \beta, \tag{A1}$$

$$R = \frac{1}{\beta}, \tag{A2}$$

$$Q = 1, \tag{A3}$$

$$q = 1, \tag{A4}$$

$$g(q) = 1, \tag{A5}$$

$$e = 1, \tag{A6}$$

$$CA = 0, \tag{A7}$$

$$\Gamma = 0, \tag{A8}$$

$$R_k = \left(\frac{R_k}{R}\right) R, \tag{A9}$$

$$\frac{Y}{K} = \frac{Q(R_k - 1 + \delta)}{\frac{P_H}{P}\alpha}, \tag{A10}$$

$$\frac{I}{K} = \delta, \tag{A11}$$

$$\frac{I}{Y} = \frac{I}{K}\left(\frac{Y}{K}\right)^{-1}, \tag{A12}$$

$$R_b = R - \omega(R_k - R), \tag{A13}$$

$$\frac{TB}{Y} = (R_b - 1)\frac{B}{Y}, \tag{A14}$$

$$\frac{C}{Y} = \frac{1}{g(q)} - \frac{I}{Y} - \frac{G}{Y} - \frac{\Gamma}{Y} - \frac{TB}{Y}, \tag{A15}$$

$$\frac{K}{L} = \left(\frac{Y}{K}\right)^{-\frac{1}{1-\alpha}}, \tag{A16}$$

$$L = \left\{\frac{(1-\alpha)}{\chi}\left(\frac{P_H}{P}\right)\left(\frac{K}{L}\right)^{\alpha}\right\}^{\frac{1}{\varphi-1}}, \tag{A17}$$

$$K = \left(\frac{K}{L}\right) L, \tag{A18}$$

$$S = K, \tag{A19}$$

$$Y = K^{\alpha} L^{1-\alpha}, \tag{A20}$$

$$I = \left(\frac{I}{Y}\right) Y, \tag{A21}$$

$$B = \left(\frac{B}{Y}\right) Y, \tag{A22}$$

$$G = \left(\frac{G}{Y}\right) Y, \tag{A23}$$

$$C = \left(\frac{C}{Y}\right) Y, \tag{A24}$$

$$EX = \frac{1}{q}\big[Y - (1-\upsilon) g(q)^{\iota} (C + I + G + \Gamma)\big], \tag{A25}$$

$$\rho = \left(C - \frac{\chi}{\varphi} L^{\varphi}\right)^{-\gamma}, \tag{A26}$$

$$N = K \left(\frac{K}{N}\right)^{-1}, \tag{A27}$$

$$R_b^* = R_b, \tag{A28}$$

$$R^* = R_b, \tag{A29}$$

$$\phi = Q\frac{S}{N} + \omega \frac{eB}{N}, \tag{A30}$$

$$D = QS - eB - N, \tag{A31}$$

$$\xi = \frac{1}{R_k QS}(N + \sigma R_b eB + \sigma RD - \sigma R_k QS), \tag{A32}$$

$$\phi_b = \frac{\phi}{\omega}, \tag{A33}$$

$$\Omega = \frac{1-\sigma}{1 - \sigma\{\phi\Lambda(R_k - R) + \Lambda R\}}, \tag{A34}$$

$$\nu = \Lambda \Omega R, \tag{A35}$$

$$\mu = \Lambda\Omega(R_k - R), \tag{A36}$$

$$\mu_b = \Lambda\Omega(R - R_b), \tag{A37}$$

$$\theta = \mu + \frac{\nu}{\phi}, \tag{A38}$$

and

$$\mathcal{T}^* = 0. \tag{A39}$$

In Figure A1, the solid curve represents the non-stochastic steady-state levels of welfare corresponding to different degrees of financial frictions. The dotted curve in Figure A1 is the conditional welfare level corresponding to different degrees of financial frictions, which is identical to the dotted curve in Figure 4. The curve of the non-stochastic steady-state level of welfare is upward sloping, because a higher value of ω decreases the steady-state levels of foreign interest rates (A13) and the trade balance (A14), which leads to higher levels of consumption (A15) and welfare. However, note that although the curve of the non-stochastic steady-state level of welfare is upward sloping, the curve of the conditional welfare level is downward sloping because of the amplified uncertainty due to financial frictions.

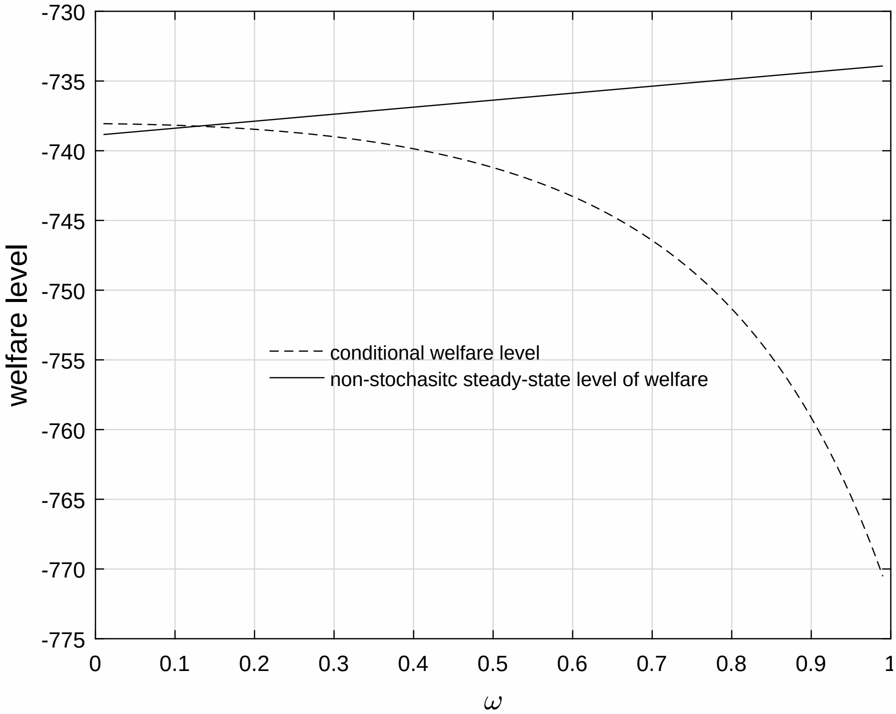

Figure A1: Conditional welfare level and non-stochastic steady-state level of welfare

A2 The economy without "liability dollarization"

In this appendix, we formally show how an economy without "liability dollarization" differs from an economy with "liability dollarization" considered in the main text. In an economy without "liability dollarization," the bank's foreign debt b_t (and B_t) is denominated in domestic currency. The bank's balance sheet (11) and the evolution of the bank's net worth (12) change as follows:

$$Q_t s_t = n_t + b_t + d_t, \tag{A40}$$

and

$$n_t = R_{k,t} Q_{t-1} s_{t-1} - (1 + \mathcal{T}_t^*) R_{b,t} b_{t-1} - R_t d_{t-1} + \zeta_t. \tag{A41}$$

Accordingly, the bank's incentive constraint (14) changes to

$$V_t(s_t, b_t, d_t) \geq \theta(d_t + n_t) + \theta^* b_t. \tag{A42}$$

The bank's first-order conditions (19), (20), and (21) change to:

$$\left(\nu_t - \nu_{b,t}\right)(1 + \lambda_t) = \theta\omega\lambda_t, \tag{A43}$$

$$\left(\frac{\nu_{s,t}}{Q_t} - \nu_{b,t}\right)(1 + \lambda_t) = \theta(1 + \omega)\lambda_t, \tag{A44}$$

and

$$\left[\theta - \left(\frac{\nu_{s,t}}{Q_t} - \nu_t\right)\right] Q_t s_t + [\theta\omega - (\nu_t - \nu_{b,t})] b_t = \nu_t n_t. \tag{A45}$$

Eqs.(31) and (32) change to:

$$Q_t S_t + \omega B_t = \phi_t N_t, \tag{A46}$$

and

$$D_t = -(1 + \omega) B_t + (\phi_t - 1) N_t. \tag{A47}$$

The equations of the foreign debt (57) and the country specific interest rate premium (59) change to:

$$B_t = R_{b,t} B_{t-1} - TB_t, \tag{A48}$$

and

$$R_{b,t}^* = R_t^* + \psi\left[\exp\left\{\frac{g(q_t)B_t}{Y_t} - \frac{g(q)B}{Y}\right\} - 1\right]. \tag{A49}$$

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