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Capital Controls and Welfare

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Abstract

This paper computes welfare levels under different degree of capital controls and compares them with the welfare level under perfect capital mobility by using the methodology of Schmitt-Grohé and Uribe (2007). We show that perfect capital mobility is not always optimal and that capital controls may enhance an economy's welfare level. There exists an optimal degree of capital-account restriction that achieves a higher level of welfare than that under perfect capital mobility, if the economy has costly financial intermediaries. The results of our analysis imply that as the domestic financial intermediaries are less efficient, the government should impose stricter capital controls in the form of a tax on foreign borrowing.

Keywords: capital controls, welfare, DSGE, small open economy

JEL Classification: F41

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1 Introduction

The issue of capital controls policy has been one of the most important issues in open macroeconomic policy analysis. 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. Capital inflows and ensuing currency crises in developing regions, such as Latin America and East Asia in the 1990s, have forced economists to reconsider the desirability of international capital mobility.[1] Concerns that a rapid surge in capital inflow and its sudden reversal have significant negative effects on an economy have motivated capital account restrictions.[2] The effectiveness of capital restrictions as a policy instrument has been studied theoretically by various authors, including Wyplosz (1986), Park and Sachs (1987), Auernheimer (1987), Bacchetta (1990), Dellas and Stockman (1993), and Bartolini and Drazen (1997).[3] Wyplosz (1986) and Park and Sachs (1987) were the first to show that capital controls are effective in delaying a crisis. However, Dellas and Stockman (1993) show that capital controls may prove destabilizing. This is because the expectation that the government will impose capital controls can induce a speculative run by private agents. Bartolini and Drazen (1997) argue that a government's current capital-control policy can signal a future fiscal situation. A policy of restrictive capital outflows sends an unfavorable signal and in fact may lead to a net capital outflow. Kitano (2007) also theoretically shows that, contrary to conventional wisdom, capital controls can accelerate currency crises. This is because high interest rates under capital controls can constitute an additional burden on government budget and precipitate crises. The theoretical literature has focused mainly on whether capital controls are effective in delaying a crisis.

A number of empirical analyses of capital controls have been conducted mainly

[1]See for example Cooper (1998), Rodrik (1998), Stiglitz (2002) and Eichengreen and Voth (2003).

[2]As for the capital control episodes in the 1990s, see World Bank (2000) Ch.5 and Ariyoshi et al. (2000).

[3]See Dooley (1996) for a comprehensive survey of earlier literature on capital controls.

to test if the presence of capital account liberalization (or capital controls) is correlated with higher economic growth. Prasad et al. (2003) survey this literature and argue that the majority of the papers tend to find no effect or a mixed effect of international financial integration on economic growth for developing countries. Forbes (2007) argues that there are several possible explanations for these inconclusive results. The first explanation is related to the difficulty of measuring capital account openness accurately. The second explanation is that different types of capital flows and controls may have different effects. The third explanation, offered by Forbes (2007), is that the impact of removing capital account restrictions could depend on a range of hard-to-measure factors such as a country's institutions or corporate governance. Chinn and Ito (2006) provide empirical evidence that financial systems with a higher degree of legal and institutional development tend to benefit more from liberalization. Alfaro et al. (2004) report that countries with better financial systems exploit FDI more efficiently. Kose et al. (2009b) find that there are identifiable thresholds in variables such as financial depth and institutional quality that an economy needs to attain before it can derive the benefits of financial openness. Many other empirical studies also suggest that institutional and financial development can affect growth benefits from capital account liberalization (for example, Klein (2005), Klein and Olivei (2008)).[4]

With the recent surge in capital inflows to emerging market economies, capital controls are again seen as an important policy option to curtail the ensuing boom-and-bust cycle. Brazil, Thailand, South Korea, Taiwan and Indonesia have actually introduced capital controls.[5] When we discuss this reemergent issue of capital controls, it is necessary to reflect the recent empirical findings that financial development is key to a country's benefit from capital account liberalization (Chinn and Ito (2006), Alfaro et al. (2004), Kose et al. (2009b), Klein (2005), Klein and

[4] See Prasad et al. (2003), Forbes (2007), Prasad and Rajan (2008) and Kose et al. (2009a) for detailed surveys of this literature. The topic of order of liberalization has been discussed for a long time. See for example McKinnon (1991).

[5] See for example "Hot Money Roils Growth Currencies," Wall Street Journal, January 3, 2011.

Olivei (2008)). In an undeveloped financial system, resources borrowed from abroad may be allocated in unproductive ways in the domestic economy. If the inefficiency causing the problem cannot be removed, a second-best option may be to restrict foreign borrowing. Motivated by the revival of concern about capital controls and the recent findings of empirical studies, this paper examines the effect of capital controls on the welfare of the economy at different levels of financial development by using the dynamic stochastic general equilibrium (DSGE) model. We will develop a model with inefficient financial intermediaries and then examine the effect of capital controls on welfare levels. Following Edwards and Végh (1997) and Uribe and Yue (2006), we will develop a small open economy model with financial intermediaries such as banks. Edwards and Végh (1997) present a model with costly banking and elucidate that the weak banking sector magnifies the boom-bust cycles caused by domestic policies and external shocks. Uribe and Yue (2006) develop the model with debt adjustment costs, which can be decentralized to a model in which financial transactions between domestic and foreign residents require financial intermediation by domestic banks. Based on the small open economy model with costly financial intermediaries, we examine the effect of capital controls policy on welfare.

Yashiv (1998) argues there are two prevalent forms of capital controls: (i) private sector holdings of foreign assets or debt are prohibited and (ii) the government allows capital flows and domestic ownership of foreign assets or holding of debt, but it taxes interest receipts or payments. Although most of the models mentioned earlier in the theoretical literature on capital controls adopt the first type of capital controls for their modeling, we adopt the second type because it seems more prevalent.[6]

We measure welfare levels and conduct policy evaluations using the method developed by Schmitt-Grohé and Uribe (2007). They study welfare-maximizing monetary and fiscal policies in a model with sticky prices, money and distortionary taxation. They compute welfare levels associated with particular monetary and fiscal

[6]As an exception, Yashiv (1998) constructs a model that encompasses both forms and examines capital controls policy within a unified framework.

policy regimes and compare them with the welfare level achieved by the optimal Ramsey policy.

We will show that perfect capital mobility is not always optimal and that capital controls may enhance an economy's welfare level. There exists an optimal degree of capital-account restriction that achieves a higher level of welfare than that under perfect capital mobility, if the economy has inefficient financial intermediaries. Capital controls can improve welfare as a second-best policy. We also show that as the financial intermediaries are less efficient, more restrictive capital controls are likely to be appropriate. The results of our analysis imply that as the domestic financial intermediaries are less efficient, the government should impose more restrictive capital controls in the form of a tax on foreign borrowing.

The remainder of the paper is organized in four sections. In section 2, we present a small open economy model with financial intermediaries. In this model, the government imposes restrictions on international capital flows. Section 3 computes the welfare levels with different efficiency levels of financial intermediaries under varying degree of capital controls. Section 4 conducts a sensitivity analysis. Conclusions are presented in Section 5.

2 The Model

2.1 Households

Our model here is based on the Schmitt-Grohé and Uribe (2003)'s model. Consider a small open economy in which there are two types of asset, physical capital and an internationally traded bond, and many homogeneous households, each of which maximizes the following utility function:

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

where c_t is consumption in period t, h_t is labor effort, E_t denotes the mathematical expectations operator conditional on information available at time t, $\beta \in (0,1)$ denotes the discount factor, and U is a period utility function assumed to be strictly increasing in its first argument, strictly decreasing in its second argument, and strictly concave.

The household's flow budget constraint is given by

$$d_t^h = (1 + r_{t-1}^d) d_{t-1}^h - w_t h_t - r_t^k k_t - \Omega_t^f - \Omega_t^b - T_t + c_t + i_t + \Phi(k_{t+1} - k_t), \tag{2}$$

where d_t^h is the foreign debt position of the household, k_t is capital, i_t is investment, T_t is government net lump-sum transfer, Ω_t^f and Ω_t^b are dividends from firms and banks, r_t^d is the interest rate at which households can borrow, r_t^k is the rental rate of capital, w_t is the real wage, and $\Phi(\cdot)$ is capital adjustment cost, which is assumed to be convex and to satisfy $\Phi(0) = \Phi'(0) = 0$. The process of capital accumulation is given by

$$k_{t+1} = (1 - \delta) k_t + i_t, \tag{3}$$

where δ denotes the depreciation rate of physical capital. The household takes as given the processes $\{r_t^d, w_t, r_t^k\}_{t=0}^{\infty}$ as well as d_{-1}^h and k_0, and maximizes the utility function (1) subject to Eqs. (2), (3) and a no-Ponzi-game condition:

$$\lim_{j \to \infty} E_t \frac{d_{t+j}^h}{\prod_{s=1}^{j} (1 + r_s^d)} \leq 0. \tag{4}$$

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

$$U_c(c_t, h_t) - \lambda_t = 0, \tag{5}$$

$$U_h(c_t, h_t) + \lambda_t w_t = 0, \tag{6}$$

$$\lambda_t - \beta(1 + r_t^d) E_t \lambda_{t+1} = 0, \tag{7}$$

$$-\lambda_t \{1 + \Phi'(k_{t+1} - k_t)\} + \beta E_t \lambda_{t+1} \{1 + r_{t+1}^k - \delta + \Phi'(k_{t+2} - k_{t+1})\} = 0, \tag{8}$$

and

$$\lim_{j \to \infty} E_t \frac{d_{t+j}^h}{\prod_{s=1}^{j}(1 + r_s^d)} = 0. \tag{9}$$

2.2 Firms

The production function is given by

$$y_t = A_t F(k_t, h_t), \tag{10}$$

where A_t is a stochastic productivity shock, and the function F is assumed to be increasing in both arguments and concave. There are many identical firms in this economy. The firm's flow constraint is given by

$$d_t^f = (1 + r_{t-1}^d) d_{t-1}^f - y_t + w_t h_t + r_t^k k_t + \Omega_t^f, \tag{11}$$

where d_t^f denotes the debt position of the firm, and r_t^d is the interest rate at which firms can borrow.

The firm maximizes the present discounted value of the stream of profits:

$$E_0 \sum_{t=0}^{\infty} \beta^t \tfrac{\lambda_t}{\lambda_0} \Omega_t^f. \tag{12}$$

Following Uribe and Yue (2006), we discount the firm's profits by using the household's marginal utility of wealth since households own firms. The firm's objective is to choose paths of h_t, k_t and d_t^f to maximize (12) subject to the firm's flow constraint (11) and a no-Ponzi-game condition ($\lim_{T\to\infty} d_T^f/R_{0,T}^d \leq 0$).

The optimality conditions associated with the firm's maximization problem are given by (7),

$$r_t^k = A_t F_k(k_t, h_t), \tag{13}$$

$$w_t = A_t F_h(k_t, h_t), \tag{14}$$

and

$$\lim_{T\to\infty} \frac{d_T^f}{R_{0,T}^d} = 0. \tag{15}$$

2.3 Banks

The banking industry is assumed to be perfectly competitive and to have direct access to international financial markets. The role of banks is to borrow from the world and lend to domestic individuals. They borrow at rate r in international financial markets and lend to domestic individuals at rate r_t^d. The foreign debt position of domestic individuals is denoted by d_t:

$$d_t = d_t^h + d_t^f. \tag{16}$$

Following Edwards and Végh (1997) and Uribe and Yue (2006), we assume that financial intermediation is a costly activity and that banks need to use resources to provide credit d_t. Formally, banks face an operation cost $\Psi(d_t)$. The bank's flow budget constraint is given by

$$d_t^b = (1+r)d_{t-1}^b + (r - r_{t-1}^d)d_{t-1} + \mathcal{T}(d_t)d_t + \Psi(d_t) + \Omega_t^b. \tag{17}$$

d_t^b is the debt position of the bank. $\mathcal{T}(\cdot)$ denotes the tax rate that government imposes banks when they lend to domestic individuals. We assume that the tax rate increases as d_t deviates from its steady state level. Integrating Eq.(17), we obtain the present discounted value of the bank's profits as follows:

$$\sum_{t=0}^{\infty} \left(\frac{\Omega_t^b}{1+r}\right)^t = \sum_{t=0}^{\infty} \left(\frac{1}{1+r}\right)^t \left[(r_{t-1}^d - r)d_{t-1} - \mathcal{T}(d_t)d_t - \Psi(d_t)\right] - (1+r)d_{-1}^b + \lim_{T\to\infty} \frac{d_T^b}{(1+r)^{T-1}}. \tag{18}$$

The bank chooses d_t to maximize the present discounted value of the stream of profits, which is given by the right-hand side of Eq.(18), for a given initial stock of debt, d_{-1}^b. A first-order condition of the bank's maximization problem is then given by

$$r_t^d = r + (1+r)\left\{\mathcal{T}(d_t) + \mathcal{T}'(d_t)d_t + \Psi'(d_t)\right\}. \tag{19}$$

Following Edwards and Végh (1997) and Uribe and Yue (2006), we assume that the initial net debt is zero (i.e.,$d_{-1}^b = 0$) and banks finance their operation through retained earnings (i.e., banks do not accumulate/decumulate net debt; $d_t^b = 0$ for all t). Therefore we can pin down the time path of profits Ω_t^b. It then follows from Eq.(18) that

$$\Omega_t^b = (r_{t-1}^d - r)d_{t-1} - \mathcal{T}(d_t)d_t - \Psi(d_t). \tag{20}$$

2.4 Government

As argued in the previous subsection, banks are taxed as much as $\mathcal{T}(d_t)d_t$ when they lend to domestic individuals. Without loss of generality, we assume that the government returns the collected tax $\mathcal{T}(d_t)d_t$ to households as a lump-sum transfer T_t:

$$T_t = \mathcal{T}(d_t)d_t. \tag{21}$$

2.5 Equilibrium

By substituting Eqs.(11), (16), (20) and (21) into (2), we obtain this economy's current account ca_t as follows:

$$ca_t \equiv -d_t + d_{t-1} = tb_t - r\, d_{t-1}, \tag{22}$$

where tb_t denotes the economy's trade balance:

$$tb_t \equiv y_t - c_t - i_t - \Phi(k_{t+1} - k_t) - \Psi(d_t). \tag{23}$$

Note that the current account (22) is also the economy's resource constraint, and then an inefficient bank (i.e., a high value of $\Psi(d_t)$) implies a resource loss to this economy.

The productivity is exogenously evolving according to the following process:

$$\ln A_{t+1} = \rho \ln A_t + \varepsilon_{t+1},\ \ \varepsilon_{t+1} \sim i.i.d.\mathcal{N}(0, \sigma_\epsilon^2). \tag{24}$$

2.6 Functional forms

Following Schmitt-Grohé and Uribe (2003), we adopt the following standard forms for utility function, production function, and capital adjustment cost:

$$U(c,h) = \frac{[c^\omega (1-h)^{1-\omega}]^{1-\gamma} - 1}{1-\gamma}, \tag{25}$$

$$AF(k,h) = Ak^{\alpha}h^{1-\alpha}, \tag{26}$$

and

$$\Phi(x) = \frac{\phi}{2}x^2; \ \ \phi > 0. \tag{27}$$

For the bank's operational cost, we adopt the following form:

$$\Psi(d) = \frac{\psi}{2}(d - \bar{d})^2; \ \ \psi > 0, \tag{28}$$

where $\bar{d}$ is the steady-state level of foreign debt. This form is the same as that of the portfolio (or debt) adjustment cost in Schmitt-Grohé and Uribe (2003) and Uribe and Yue (2006).

We adopt the following form for the tax policy that formally expresses capital controls:

$$\mathcal{T}(d) = \frac{\tau}{2}(d - \bar{d})^2; \ \ \tau > 0. \tag{29}$$

Note that if τ goes to infinity, the private sector will be prohibited from changing their foreign debt position from the steady state level. In this case, our model essentially reduces to the first form of capital controls classified by Yashiv (1998).

2.7 Calibration

We follow the same calibration procedure in Schmitt-Grohé and Uribe (2003). The parameters shown in Table 1 have the same values as the corresponding parameters used in Section 8.1 of Schmitt-Grohé and Uribe (2003).[7]

[7] In assigning values to the structural parameters, Schmitt-Grohé and Uribe (2003) follow Mendoza (1991), who calibrates the model to the Canadian economy.

γ	ω	ψ	α	ϕ	r	δ	ρ	σ_ϵ	β	$\bar{d}$
2	0.22	0.001	0.32	0.084	0.04	0.1	0.42	0.0103	0.96	0.148

Table 1: Calibration

Following Schmitt-Grohé and Uribe (2003), we set the steady-state values of hours (h) and trade-balance-to-GDP ratio ($\frac{tb}{y}$) at 0.2 and 0.02, respectively. By combining Eqs. (8) and (13), and using (26), (27) and the fact that $\beta = 1/(1+r)$ in steady state, we have

$$\frac{h}{k} = \left(\frac{r+\delta}{\alpha}\right)^{1/(1-\alpha)}. \tag{30}$$

From h and (30), we can know the value of $k\left(= h\left(\frac{h}{k}\right)^{-1}\right)$. From h, k and (26), we obtain the steady-state value of output, $y\,(= k^\alpha h^{1-\alpha})$. From y and tb/y, we obtain the steady-state level of trade balance, $tb\,(= y\frac{tb}{y})$. It follows from Eq.(22) in steady state that the steady-state level of foreign debt is given by

$$\bar{d} = \frac{tb}{r}. \tag{31}$$

By Eq.(3) in steady state, we also obtain the steady-state level of investment, $i\,(= \delta k)$. From Eq.(23) in steady state, we then obtain the steady-state level of consumption, $c\,(= y - i - tb)$.[8]

3 Welfare

3.1 Welfare benefit measure

We will measure levels of unconditional life time utility under different degrees of capital controls by using the methodology of Schmitt-Grohé and Uribe (2007). They

[8]By combining Eqs.(5) and (6), substituting (14) into it, and using (25) and (26), we obtain the parameter ω from the values of α, c, h, and k.

compute second-order accurate solutions to policy functions and approximate life time utility up to a second order using perturbation methods.[9] By using the measured welfare levels under different degrees of capital controls and comparing them with the welfare level under perfect capital mobility, we conduct policy evaluations of capital controls.

We define unconditional life time utility under perfect capital mobility (i.e., no capital controls) as the benchmark case:

$$E\,V_0^b \equiv E \sum_{t=0}^{\infty} \beta^t U(c_t^b, h_t^b),$$

where E denotes the unconditional expectations operator. We compute $E\,V_0^b$ accurately up to second order by using the methodology of Schmitt-Grohé and Uribe (2007). We next define the unconditional life time utility under capital controls as alternative policy regimes:

$$E\,V_0^a \equiv E \sum_{t=0}^{\infty} \beta^t U(c_t^a, h_t^a),$$

which also can be approximated to second order of accuracy. We then define λ as the welfare benefit of adopting policy regime a rather than policy regime b. Formally, λ is defined as

$$E\,V_0^a = E \sum_{t=0}^{\infty} \beta^t U((1+\lambda)c_t^b, h_t^b).$$

In other words, λ is the fraction of regime b's consumption process that compensates a household to be as well off under regime b as under regime a. For the particular form of the utility function (25), λ can be expressed as

$$\lambda = \left\{ \frac{(1-\gamma)E\,V_0^a + (1-\beta)^{-1}}{(1-\gamma)E\,V_0^b + (1-\beta)^{-1}} \right\}^{\frac{1}{\omega(1-\gamma)}} - 1. \tag{32}$$

[9]See Schmitt-Grohé and Uribe (2004) for the second-order accurate solutions to policy functions.

We compute the second-order approximation of λ.[10]

3.2 The effect of capital controls on an economy with efficient financial intermediaries

As a starting point, we first look at the effect of capital controls on an economy in which financial intermediaries are perfectly efficient. In our model, this corresponds to the case where the parameter ψ in Eq.(28) is zero, which implies there is no friction in adjusting foreign debt positions in this economy. Figure 1 shows the welfare levels of different degree of capital controls (i.e., varying τ in Eq.(29)) in this case.[11] Figure 1 shows that as capital controls are more severe (i.e., a higher value of τ), the welfare becomes more deteriorated. This is quite obvious because capital controls are a distortion to an economy with efficient financial intermediaries.

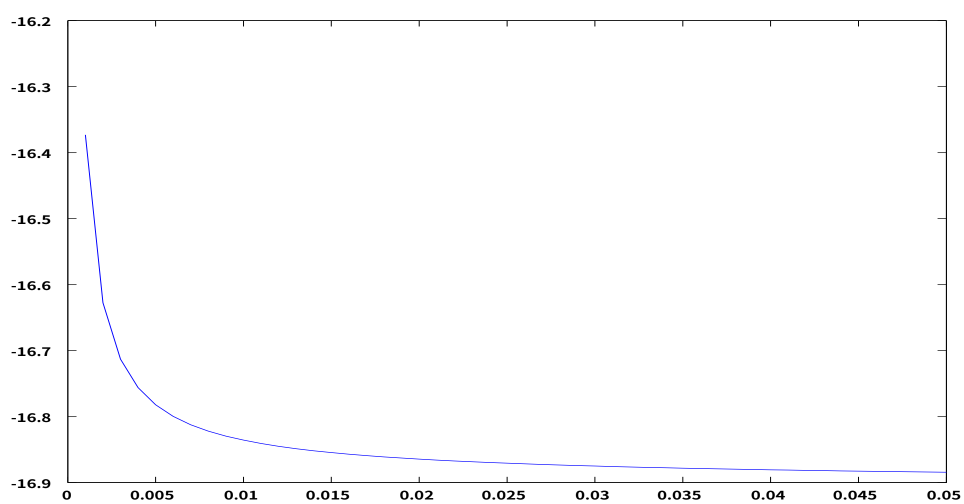

Figure 1: Unconditional welfare levels - varying τ, no operational cost ($\psi = 0$)

[10] For details see Schmitt-Grohé and Uribe (2006).

[11] Since the case where $\tau = 0$ and $\psi = 0$ does not induce stationarity, we omit this case and set $\tau > 0$ (in Figure 1, we set $\tau \geq 0.001$).

3.3 The effect of capital controls on an economy with inefficient financial intermediaries

We next consider the effect of capital controls on an economy with inefficient financial intermediaries. Before we examine the effect of capital controls, we examine the effects of varying financial intermediaries' efficiency on welfare levels without capital controls. As shown in Figure 2, we can make sure that as financial intermediaries are less efficient (i.e., a higher value of ψ), welfare deteriorates.[12]

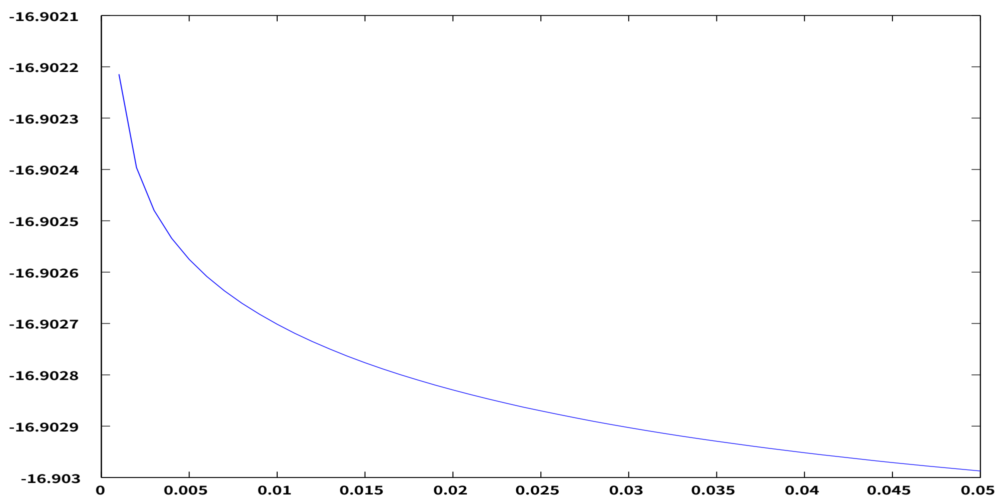

Figure 2: Unconditional welfare levels - varying ψ, no capital control ($\tau = 0$)

We now examine how capital controls influence the welfare level of an economy that has inefficient financial intermediaries. As a benchmark case, we set ψ at 0.001 and τ at 0, since this case corresponds to a case of the portfolio adjustment model of Schmitt-Grohé and Uribe (2003). In this benchmark case where $\psi = 0.001$ and $\tau = 0$, we obtain the unconditional second moments for $y_t, c_t, i_t, h_t, \frac{tb_t}{y_t}$, and $\frac{ca_t}{y_t}$ shown in Table 2, which are same as those in model 3 in Table 5 of Schmitt-Grohé and Uribe (2003).

[12]For the same reason as in the previous footnote, we omit the case where $\tau = 0$ and $\psi = 0$.

	$std(y_t)$	$std(c_t)$	$std(i_t)$	$std(h_t)$	$std(\frac{tb_t}{y_t})$	$std(\frac{ca_t}{y_t})$
benchmark	2.7166	0.5555	9.1756	2.0669	2.2770	2.0183
optimal	2.5714	0.5465	8.9521	1.8880	2.1132	1.9647

Table 2: Second moments

We then compute the unconditional life-time utility level with different values of τ and the fixed value of $\psi(= 0.001)$. Figure 3 shows the corresponding welfare benefits (i.e., the approximated value of λ in Eq.(32)) of adopting different values of τ instead of the benchmark case of $\tau = 0$. Although it is not shown in Figure 3, the welfare-benefit measure finally becomes negative if we continue to increase the value of τ. We can therefore say that there is some range of $\tau\,(> 0)$ that improves welfare levels compared to the perfect capital mobility case ($\tau = 0$). The optimal value of τ that maximizes the value of λ is 0.008, which achieves the maximum value of the welfare benefit (0.2812%). The unconditional second moments of the key variables in the optimal τ case are also shown in Table 2. Although the optimal value of τ slightly diminishes each variable's volatility compared with the benchmark case, the differences are very small. It is safe to say that the results with the optimal τ are not unrealistic at all.

We so far set the value of ψ at the benchmark value of 0.001 and examined the welfare-benefit values for different values of τ. We will now examine the welfare-benefit values for different values of ψ as well as for different values of τ. Figure 4 plots the welfare-benefit values with each combination of ψ and τ. In Figure 4, the maximum points of the welfare-benefit (λ) achieved by the optimal values of τ against the varying values of ψ are plotted with circles. Figure 5 depicts the two dimensional surface of Figure 4. In Figure 5, the optimal values of τ achieving the maximum values of the welfare benefits against the different values of ψ are plotted with circles. Figure 5 clearly shows that the optimal value of τ becomes larger as ψ increases. That is, from Figures 4 and 5, we can say that as the financial intermediaries are progressively less efficient, stricter capital controls are likely to

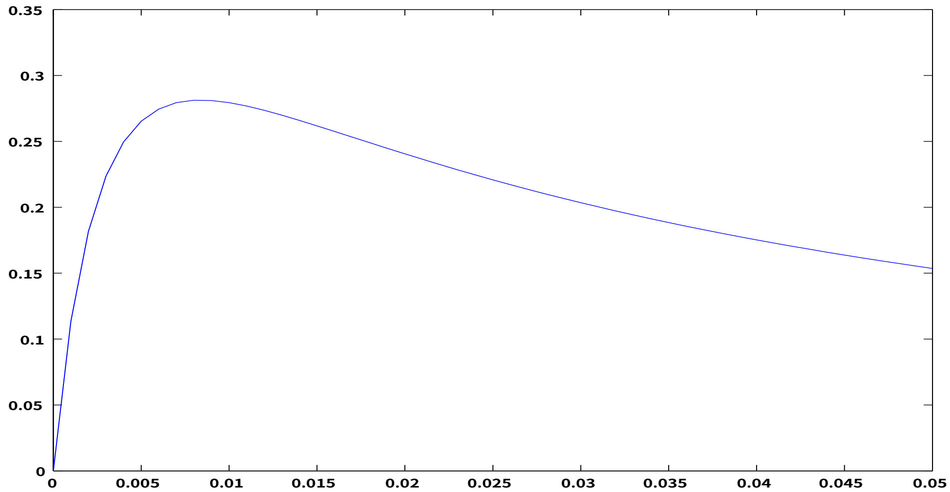

Figure 3: Welfare benefit measure $(\lambda \times 100)$ — varying τ, fixed $\psi\,(= 0.001)$

be appropriate. It is also notable that in Figure 4 the maximized welfare benefit achieved by the optimal value of τ decreases as banks are less efficient. Figure 4 shows that capital controls can improve welfare as a second-best policy. The first-best situation cannot be achieved unless banks are completely efficient.

Although they cause an intertemporal distortion on the consumption equilibrium path, capital controls can improve the welfare level in an economy with less efficient financial intermediaries. The rationale for our analysis results can be explained by using Figure 6. Figure 6 shows the impulse responses of variables y, c, i, h, tb/y, ca/y, $\mathcal{T}$, d to a negative unit technology shock. The solid line plots those in the benchmark case (i.e., $\tau = 0$).[13] The impulse responses in the optimal case (i.e., $\tau = 0.008$) are plotted by circles. For comparison, we also plot the impulse responses in the case of a higher value of $\tau(= 0.1)$ by a dotted line.[14] In Figure 6, one can see a notable difference in responses of consumption. Although

[13] That is, the impulse responses in the benchmark case in Figure 6 are equivalent to those in the portfolio adjustment case of Figure 2 in Schmitt-Grohé and Uribe (2003).

[14] Brazil introduced a 2% tax on the purchase of bonds by foreigners and then increased it to 6% in 2010 ("Waging the currency war," The Economist, January 13th 2011). For Chile's capital control case during 1991–1998, Gallego et al. (1999) calculated the tax equivalence of the unremunerated reserve requirement imposed by the Central Bank of Chile, and argued that the tax equivalence averaged 4.24% per year with a standard deviation of 2.14%, and its maximum was 7.7%.

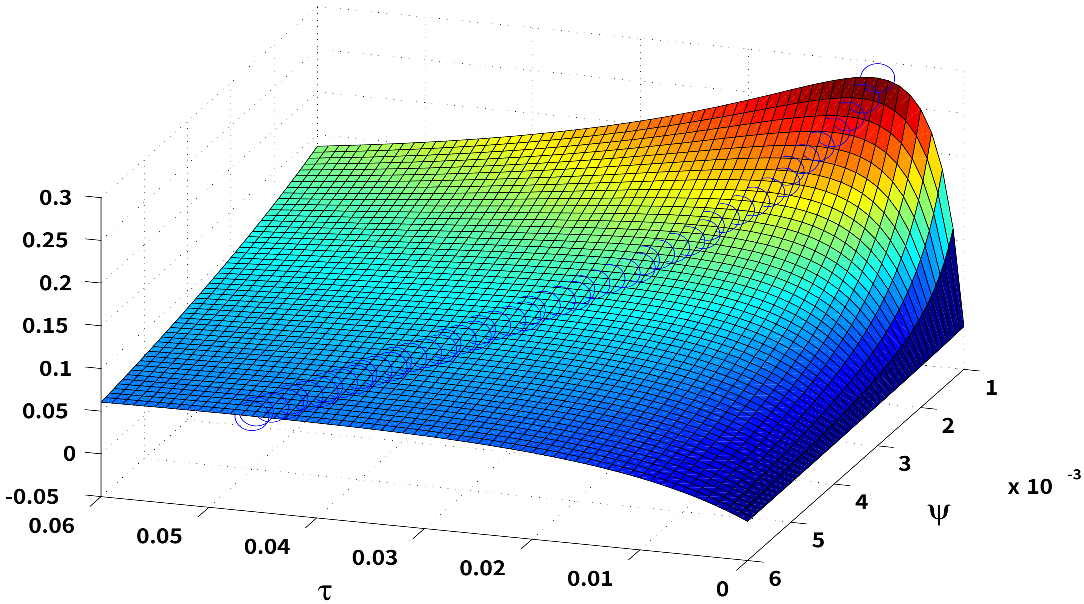

Figure 4: Welfare benefit: $100 \times \lambda$

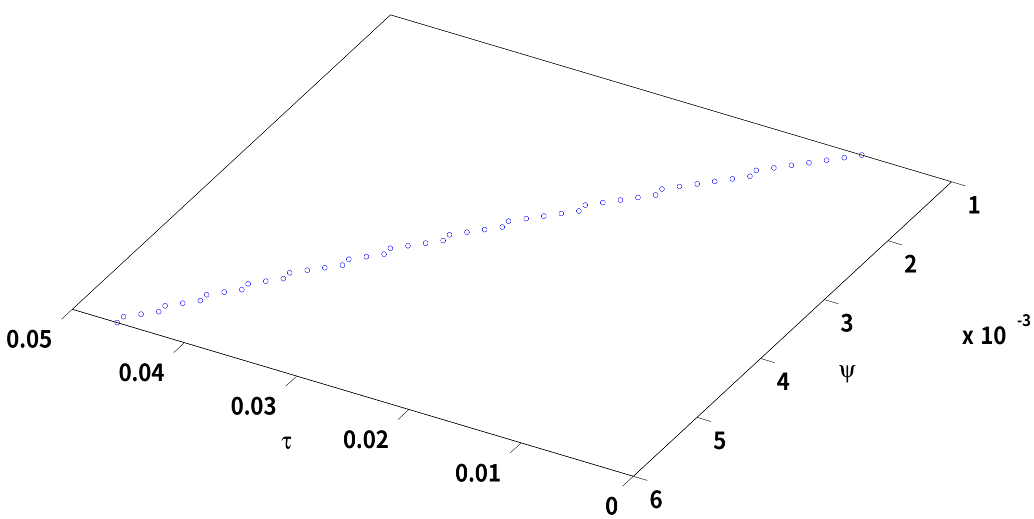

Figure 5: The optimal values of τ for different values of ψ

the difference between consumption response in the benchmark case and that in the optimal case is negligible, the difference between consumption response in the high τ case and those in the two other cases seems substantial. As we expect, it seems that tight controls on capital have a large distortion on the consumption equilibrium path. We can also see a noticeable difference in the current-account-to-GDP ratio in Figure 6. It seems that a higher value of τ diminishes the response of the current-account-to-GDP ratio. If we look at the response of the stock of foreign debt in Figure 6, we can see the effect of τ more clearly. A higher value of τ plays the role of halting the deterioration of the foreign debt position due to a negative technology shock and returning the foreign debt position back to its steady-state level more smoothly. This also explains why the optimal value of τ becomes larger, as the value of ψ increases. As the intermediaries are less efficient (i.e., a higher value of ψ), a deviation of foreign debt position from its steady state value causes a larger resource loss. Hence, as the intermediaries are less efficient, it would be appropriate for the government to impose a higher value of τ and reduce the resulting resource loss due to the deviation of foreign debt position from its steady-state level.

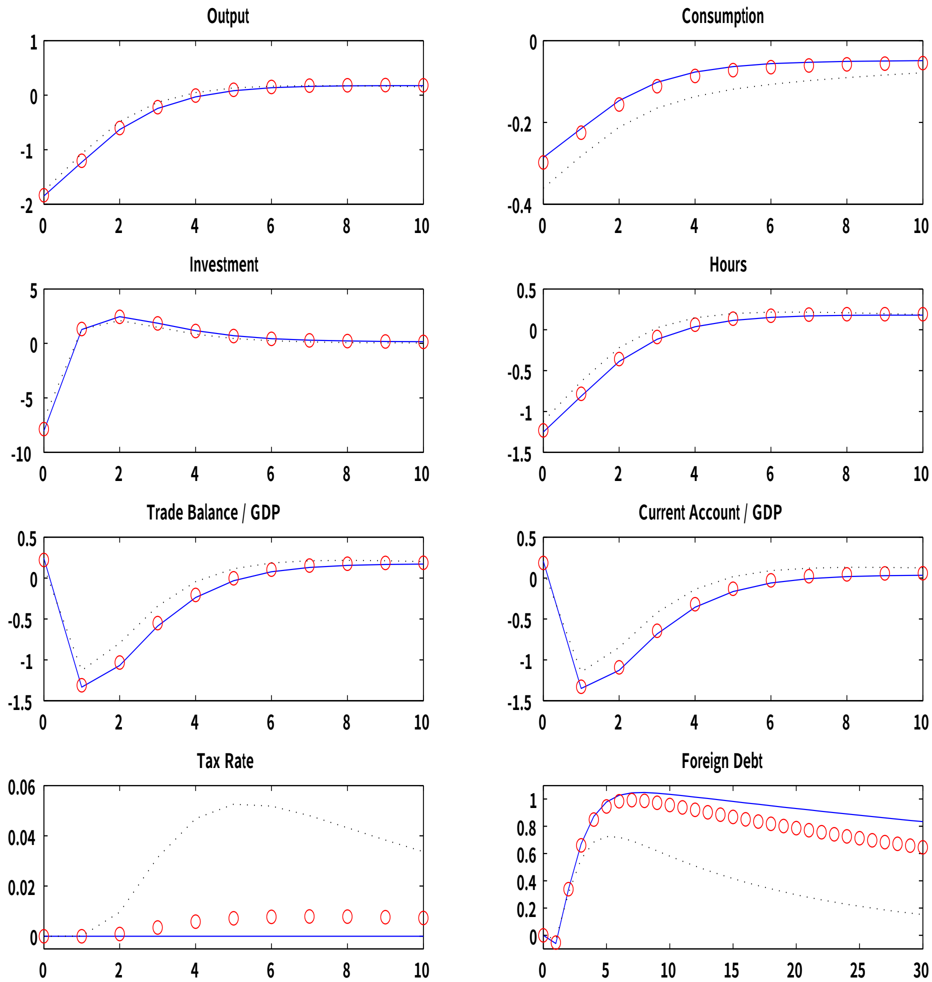

Figure 6: Impulse responses: y, c, i, h, tb/y, ca/y, $\mathcal{T}$, d; Solid line: benchmark case, Circles: optimal case, Dotted line: high $\tau(= 0.1)$ case

4 Sensitivity Analysis

In this section, we check the robustness of our results. First, we take same procedure in Section 3 using an alternate specification of the utility function. Instead of (25), we consider the following form:

$$U(c,h) = \frac{[c - \omega^{-1}h^{\omega}]^{1-\gamma} - 1}{1-\gamma}, \tag{33}$$

which implies that the marginal rate of substitution between consumption and leisure depends only on the level of leisure.[15] [16] A noticeable difference in this case lies in the unconditional second moments for each variable (Table 3). Second moments in the benchmark case are same as those in model 3 in Table 3 of Schmitt-Grohé and Uribe (2003). Consumption is more volatile compared with Table 2. However, we still obtained the similar figures as Figures 1 - 5, and confirmed that our main results remain unchanged.

	$std(y_t)$	$std(c_t)$	$std(i_t)$	$std(h_t)$	$std(\frac{tb_t}{y_t})$	$std(\frac{ca_t}{y_t})$
benchmark	3.0831	2.6806	9.0367	2.1190	1.7581	1.4524
optimal	3.0981	2.5639	8.9830	2.1293	1.6037	1.4199

Table 3: Second moments: Utility function (33) case

We also checked the robustness of our main results by using the same parameters and steady state levels as in Guajardo (2008) that calibrated to Chile characterized by capital control:

γ	α	r	δ	ρ	β	d/y	h
1.5	0.46	0.06	0.08	0.409	0.943	0.19	0.267

[15]For details on the difference between the two forms of utility function, see Schmitt-Grohé and Uribe (2003). Following Schmitt-Grohé and Uribe (2003), we also set the structural parameters in this section.

[16]However, due to the difference in the form of the utility function, we cannot obtain λ of Eq.(32) that is shown in Figure 3. Instead, following Dib (2008), we measure the percentage change in consumption in the deterministic steady state that would give households the same unconditional expected utility in the stochastic economy in each case and calculate the welfare benefits of adopting different values of τ in place of the benchmark case of $\tau = 0$.

Table 4: Calibration: Chile

The other parameters and steady state levels are set similarly as in Section 2.7. We obtained similar figures corresponding to Figures 1–5. A notable difference between this case and Section 3 lies in the achieved maximum value of the welfare benefits with capital control. We find that the optimal degree of capital control in this case brings about a higher level of welfare benefit corresponding to each value of ψ than in Section 3. For example, for $\psi = 0.001$, the maximum value of the welfare benefit achieved by the optimal degree of capital control is 0.4963%, while it is 0.2812% in Section 3.

Following Uribe (2006), we also doubled the standard deviation of the productivity shock, σ_ϵ, holding the other parameters to the same values as in Section 3, because business cycles in developing countries seem to be more volatile than those in developed countries. We again confirmed that our main results remain unchanged. A notable difference between this case and Section 3 again lies in the achieved maximum value of the welfare benefits. In this case, the maximum value of the welfare benefit for $\psi = 0.001$ is 1.1248%, while it is 0.2812% in Section 3.

5 Conclusion

We have computed unconditional life-time utility levels under different degrees of capital controls and compared them with the unconditional life time utility level under perfect capital mobility by adopting the method developed by Schmitt-Grohé and Uribe (2007). We have shown that perfect capital mobility is not always optimal and that capital controls may enhance an economy's welfare level. There exists an optimal degree of capital control that achieves a higher level of welfare than under perfect capital mobility, if we assume that the economy's financial intermediaries are inefficient.

The results of our analysis imply that as the financial intermediaries in an economy are less efficient, the appropriate degree of control on financial transactions imposed by the government would be tighter. The intuition behind these results of our analysis is simple. Capital controls have two opposite effects on welfare levels. On one side, capital controls have the intertemporal distortion effect on the consumption equilibrium path. When the domestic financial intermediaries are perfectly efficient, the imposition of capital controls therefore results in welfare deterioration. On the other side, capital controls tend to curtail the deviation of the foreign debt position from its steady-state level due to a negative shock to the economy, and then enhance the speed of reversion to its steady-state level. The less efficient the domestic financial intermediaries, the larger the resource losses are due to foreign borrowing. The imposition of capital controls therefore may improve welfare. If capital controls are too strict, however, the intertemporal distortion effect on consumption would dominate the beneficial effect in withholding foreign borrowing. Hence, by imposing an appropriate level of restriction, it is very probable that the government achieves a higher level of welfare compared with the perfect capital mobility case, unless the domestic financial intermediaries are perfectly efficient.

This paper is based on a simple real business cycle model. However, in reality, the choice of exchange rate regime would matter for the optimal degree of capital control. As argued by Agénor (2004), exchange rate flexibility is a policy response option to a surge in capital flows as well as capital control, because greater exchange rate flexibility can discourage capital flows through the exchange rate risk. Therefore, it is likely that the optimal degree of capital control for a country that adopts a fixed exchange rate is stricter than that for a country with a flexible exchange rate. It would be worthwhile to extend our model to include exchange rates and analyze the policy combination of exchange rate flexibility and capital control. We will leave this for our future work.

Another possible extension will be to consider the effect of capital control on long-term economic growth. If foreign borrowing is mainly used to finance consumption or speculative investment such as real estate investments, capital inflows will not lead to an increase in the economy's long-term growth rate. In the case of the capital inflows to Asian and Latin American countries at the beginning of the 1990s, Calvo et al. (1994) point out that in Asian countries investment as a share of GDP increased by about 3 percentage points, while investment fell on average in the Latin American countries during the capital inflow period. It would be interesting to introduce different types of capital inflows such as foreign direct investment and short-term borrowing into the model, and examine the effects on economic growth of different tax rates for the different types of capital inflow.

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