Financial Integration and Emerging Market Crises: How Does Financial Integration Cause Severe Sudden Stops*

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Abstract

This paper theoretically investigates the relationship between financial integration and sudden stops by introducing an Interest Coverage Ratio-based borrowing constraint (Yamada, 2023) into an small open economy with tradables and nontradables model. Calibration exercises show that a deeper financial integration makes sudden stops less likely, but worsens the impact of the crises. A deeper financial integration, represented by a looser borrowing constraint, increases average foreign debt and reduces crises probability. Meanwhile, the amount of overborrowing increases, especially during the low world real interest rate periods. Once the borrowing constraint binds, consumption must decrease a lot for the repayment of accumulated borrowing.

Keywords: Financial Integration, Overborrowing, Sudden Stops, Emerging Market Economies, World Real Interest Rate, Occasionally Binding Borrowing Constraint

JEL codes: E21, E41, E44, F62

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1 Introduction

The international financial integration (FI) of emerging market economies (EMEs) has accelerated especially since the 1990s, while crises in emerging economies have been more severe (Reinhart and Calvo, 2000). It has also been noted that financial integration makes the economy more affected by negative external shocks. Recently, as the U.S. and other advanced economies implement a series of interest rate hikes, the risk of capital inflows to emerging economies coming to a halt, called the sudden stops, is said to be increasing.

This paper theoretically investigates the characteristics of sudden stops under various FI levels. Specifically, we analyze following questions; (1) Does the impact of sudden stop crisis differ among economies with different level of FI? (2) Do changes in the world real interest rate (WRI) cause sudden stops? If so, how does it occur?

To answer the above questions, we construct an small open economy (SOE) with tradable and nontradable endowments and an occasionally binding borrowing constraint. The model is basically same as in Bianchi (2011), except for the type of borrowing constraint. While Bianchi (2011) uses the standard flow collateral constraint, we use an Interest Coverage Ratio (ICR)-based borrowing constraint, developed by Yamada (2023). A key feature of ICR-based borrowing constraints is that changes in WRI have a greater impact on external borrowing availability than standard flow-type collateral constraints. The ICR-based borrowing constraint is introduced to illustrate anecdotal facts that theWRI has an large impact on the foreign borrowing availability of EMEs.

Our calibration result shows that a deeper FI, represented by a looser borrowing constraint, reduces the probability of being sudden stops. Meanwhile, the impact of sudden stops on the SOE becomes more severe. FI makes crises less likely to occur, but once a crisis does occur, there will be a significant decline in consumption. Consequently, the entire business cycle becomes more volatile, resulting in a higher consumption volatility in deeply financially integrated EMEs pointed by Kose et al. (2003); Prasad et al. (2003).

We also show that the reason behind rare but severe crises in high FI level economies is increased overborrowing, especially during low WRI periods. As the model in Bianchi (2011), our model also incorporates the market externality; private agents do not internalize the price effects on the tightness of the borrowing constraint. Consequently, private agents borrow more than the social planner. In our calibration results, the overborrowing during the low WRI periods has a dominant impact on the overall amount of overborrowing, and the impact is increases in τ. Private agents accumulate foreign borrowing especially in the low WRI periods, and then, once the borrowing constraint binds, consumption decreases a lot for the repayment.

Previous studies including Calvo et al. (2004) and Martin and Rey (2006) show that there is a nonlinear relationship between the FI and the probability of crises. FI makes crises likely, but only up to a certain level. After the FI reaches the certain level, crises less likely occur. Our model covers the relationship between FI and crises after the FI sufficiently deepens.

The remainder of this paper is organized as follows. Section 2 describes the model.

Section 3 presents the quantitative analysis and evaluates the model and finally, section 4 concludes the paper.

2 Model

2.1 Model environment

Consider an SOE with a tradable goods sector and a nontradable goods sector. An infinitely lived representative household receives exogenous tradable goods y_t^T which can be traded across countries, and nontradable goods y_t^N consumed in the domestic country. Both y_t^T and y_t^N vary stochastically. There is a state non-contingent bond traded in international financial markets. The representative household can borrow for one period from foreign countries at the time-varying WRI r_t, which is exogenous to the SOE.

The household faces the following period-by-period budget constraint

$$y_t^T + p_t y_t^N + b_{t+1} = (1 + r_{t-1})b_t + c_t^T + p_t c_t^N, \quad (1)$$

where p_t is the relative price of nontradable goods in terms of tradable goods, c_t^T is tradable consumption, c_t^N is nontradable consumption and b_{t+1} is the foreign debt level in period $t + 1$.

The household also faces the following an Interest Coverage Ratio based borrowing constraint (ICR-based borrowing constraint; Yamada, 2023),

$$b_{t+1} \leq \max\left\{\bar{b}, \frac{\tau}{r_t}(y_t^T + p_t y_t^N)\right\}, \tag{2}$$

where $\bar{b} > 0$ is the minimum debt limit and $\tau \geq 0$ is a parameter that determines the tightness of the borrowing constraint, implying the degree of FI. The ICR-based borrowing constraint (2) tends to have a larger effect of the WRI on the international borrowing ability, compared to the standard flow type of collateral constraint (Yamada, 2023). We extend the Yamada (2023)'s borrowing constraint to consider two goods , tradables and nontradables, and construct a relative price-dependent type of borrowing constraint.

Given the exogenous sequences of tradable goods y_t^T, nontradable goods y_t^N, the WRI r_t, the relative price p_t and initial foreign debt level b_0, the household chooses the sequence of tradable consumption c_t^T, nontradable consumption c_t^N and the foreign debt level b_{t+1} by maximizing the following lifetime expected utility

$$E_0 \sum_{t=0}^{\infty} \beta^t \frac{c_t^{1-\gamma}}{1-\gamma}, \tag{3}$$

where $c_t = (\omega(c_t^T)^{-\eta} + (1-\omega)(c_t^N)^{-\eta})^{-\frac{1}{\eta}}$ with $\eta > -1, \omega \in (0,1)$, subject to the budget constraint (1) and the borrowing constraint (2).

2.2 Optimality conditions

The household's first-order conditions are:

$$\lambda_t = U_1(c_t^T, c_t^N)p_t,$$

$$\lambda_t = U_2(c_t^T, c_t^N),$$

$$p_t = \frac{1-\omega}{\omega}\left(\frac{c_t^T}{c_t^N}\right)^{\eta+1}, \tag{4}$$

$$\lambda_t = \beta(1+r_t)E_t\lambda_{t+1} + \lambda_t^B,$$

$$b_{t+1} = \frac{\tau}{r_t}(p_t y_t^N + y_t^T) \text{ if } \lambda_t^B > 0,$$

where λ_t is the Lagrange multiplier associated with the budget constraint (1) and λ_t^B is the Lagrange multiplier for the ICR-based borrowing constraint (2).

Market clearing conditions are given by:

$$c_t^N = y_t^N, \tag{5}$$

$$y_t^T + b_{t+1} = c_t^T + (1+r_t)b_t.$$

2.3 Recursive competitive equilibrium

The private agent's optimization problem can be written as follows:

$$V(b, B, s) = \max_{b', c^T, c^N} u(c(c^T, c^N)) + \beta E_{s'|s}V(b', B', s')$$

$$\text{s.t.} \quad b' + y^T + p(B, s)y^N \geq c^T + p(B, s)c^N + (1+r)b,$$

$$b' \leq \frac{\tau}{r}[y^T + p(B,s)y^N],$$

$$B' = \Gamma(B,s),$$

where b is the household's foreign debt in t, B is the aggregate foreign debt in t, s is the state of exogenous variables (y^T, y^N, r), Γ is the household's forecast of aggregate foreign debt in t+1.

Recursive competitive equilibrium – A decentalized recursive competitive equilibrium for this economy is defined by a pricing function $p(B,s)$, a perceived law of motion $\Gamma(B,y)$, and decision rules $\{\hat{b}'(b,B,y),\ \hat{c^T}(b,B,s),\ \hat{c^N}(b,B,s)\}$ with associated value function $V(b,B,y)$ satisfying the following condition:

1. *Household's optimization:* given $p(B,s)$ and $\Gamma(B,s)$, the decision rules and the value function solve the recursive optimization problem of the household.

2. *Rational expectation condition:* $\Gamma(B,s) = b'(b,\hat{B},s)$.

3. *Markets clear:* market clearing conditions $y^N = \hat{c^N}(b,B,s)$ and $\Gamma(B,s) + y^T = \hat{c^T}(b,B,s) + (1+r)B$ hold.

2.4 Social planner's problem

The social planner's optimization problem can be written as follows:

$$V(b,s) = \max_{b',c^T} u(c(c^T, y^N)) + \beta E_{s'|s} V(b', s')$$

$$\text{s.t.} \quad b' + y^T = c^T + (1+r)b,$$

$$b' \leq \frac{\tau}{r}\left[y^T + \frac{1-\omega}{\omega}\left(\frac{c^T}{c^N}\right)^{\eta+1} y^N\right].$$

Difference between the private agents' and social planner's problem – Social planner internalize the effect of price change on the borrowing constraint, whereas the private agent does not. The Euler equations of the social planner's problem and of the private agent's problem are:

$$\text{Social Planner: } u_1(c_t^T, c_t^N) = \beta(1+r_t)E_t\left[u_1(c_{t+1}^T, c_{t+1}^N) + \lambda_{t+1}^{Bsp}\Psi_{t+1}\right] + \lambda_t^{Bsp}(1-\Psi_t), \quad (6)$$

$$\text{Private Agent: } u_1(c_t^T, c_t^N) = \beta(1+r_t)E_t u_1(c_{t+1}^T, c_{t+1}^N) + \lambda_t^B, \quad (7)$$

where λ^B is the Lagrange multiplier for the borrowing constraint of the private agent, λ^{Bsp} is that of the social planner, and $\Psi_t = (\eta+1)\frac{\tau}{r_t}\frac{1-\omega}{\omega}\frac{(c_t^T)^\eta}{(c_t^N)^{\eta+1}} > 0$. Compared to the private agents's Euler equation (7), the social planner is taking account of (i) the possibility of hitting the borrowing constraint in the next period, $\lambda_{t+1}^{Bsp}\Psi_{t+1}$ and (ii) the impact of the borrowing constraint on consumption today by discounting changes in the debt ceiling due to price fluctuations, $-\lambda_t^{Bsp}\Psi_t$. Suppose the agent increases a unit of foreign debt today, b_{t+1}. In the next period, the agent must reduce tradable consumption c_{t+1}^T to repay the debt. Since the equilibrium price is a function of tradable consumption, c^T: $p_t = \frac{1-\omega}{\omega}\left(\frac{c_t^T}{y_t^N}\right)^{\eta+1}$, reducing consumption decreases price, resulting tighter borrowing constraint in the next period. Therefore, a unit increase of foreign debt today will increase the probability of binding the borrowing constraint in the next period. Social planner internalizes this impact of foreign debt increase on the economy through the price change. Compared to the private agent, social planner reduces foreign debt and tradable consumption precautionary when the borrowing constraint is slack today. Now suppose that the agent consumes an additional unit of tradable goods today. Then the equilibrium price also increases.[3] From eq.(2), the borrowing constraint relaxes, appears as $-\lambda_{t+1}^{Bsp}\Psi_{t+1}$ in eq.(6).

Effects of y^T *and* y^N *changes on the SOE* – In the decentralized economy, change in the tradable endowment y^T tightens the borrowing constraint through the following channel. A temporal decrease in y^T directly tightens the borrowing constraint (2), and increase λ_t^B in the Euler equation (7). Then tradable consumption c_t^T decreases, which lowers the relative price of nontradables, p_t from eq. (4). The reduction in p_t also tightens the borrowing constraint, further increase in λ_t^B decreases c^T. Therefore, a unit decrease in y^T reduces c^T more than one unit because the change in price amplifies the effect of tighter borrowing constraint on consumption.

Change in the nontradable endowment y^N also tightens the borrowing constraint, but will have smaller effect on λ^B than change in y^T. On the one hand, as in the case of change in y^T, a temporal decrease in y^N directly tightens the borrowing constraint and increase λ_t^B in the Euler equation (7), which results in the reduction of c^T. From eq. (4), p_t decreases, thus the borrowing constraint becomes tighter. On the other hand, a reduction of y^N decreases c^N from the market clearing condition (5). Then p_t increases from the eq. (4), which relaxes the borrowing constraint. Overall, change in y^N has smaller impact on the SOE than change in y^T.

Effect of r_t *changes on the SOE* – The WRI, r_t, affects to the SOE through the following two channels. The first channel is the intertemporal substitution effect. An

[3] Note that $\eta > -1$ and $\omega \in (0, 1)$.

increase in $r_t$reduces current tradable consumption c_t^T as the result of the intertemporal substitution. Then p_t decreases, tightens the borrowing constraint, an increases λ_t^B in the Euler equation (7). A high λ_t^B induces further decreases in c_t^T, p_t. Hence, the negative impact of a high WRI on consumption is amplified through the price changes reflecting c^T changes.

Secondly, a change in WRI directly affects to the tightness of the borrowing constraint. A high r_t tightens the borrowing constraint and increase λ_t^B, lowers c^T from the Euler equation. Then p_t decrease, which results in the tightening of the borrowing constraint again. This second channel is particular in the model with the ICR-based borrowing constraint. Because of this channel, the impact of WRI on consumption is larger than other borrowing constraints, for example, Bianchi (2011).

2.5 Exogenous variables' processes

y^T and y^N are assumed to be follow an vector auto-regressive process with order one (VAR(1) process) with $X_t = [\ln y_t^T, \ln y_t^N]'$,

$$X_t = \begin{bmatrix} \rho_T^T & \rho_N^T \\ \rho_T^N & \rho_N^N \end{bmatrix} X_{t-1} + \begin{bmatrix} e_t^T \\ e_t^N \end{bmatrix}, \tag{8}$$

where ρ_T^T and ρ_N^N are AR(1) coefficients, ρ_N^T (ρ_T^N) is the sensitivity of tradables (nontradables) to the one period past nontradables (tradables), respectively. The tradable endowment shock e^T and nontradable endowment shock e^N follow a bivariate normal

Table 1: Calibrated parameter values (baseline case)

Parameter		Value	Source/target
β	subjective discount factor	0.906	Bianchi (2011)
γ	risk aversion	2	Bianchi (2011)
η	price elasticity parameter	0.2048	Bianchi (2011)
ω	tradable consumption share	0.2989	share of tradable consumption in Argentina
τ	degree of FI	0.023	probability of being sudden stop in Argentina
r^*	steady state value of WRI	0.055	mean of U.S. real interest rate

distribution with the zero mean and the following variance-covariance matrix,

$$V = \begin{bmatrix} \sigma_T^2 & \sigma_{TN} \\ \sigma_{TN} & \sigma_N^2 \end{bmatrix},$$

where σ_T and σ_N are the standard deviations of tradable endowment shock and nontradable endowment shock, respectively, and σ_{TN} is the covariance of tradable shock and nontradable shock.

We assume the r_t follows an AR(1) process;

$$r_t = (1 - \rho^r)r^* + \rho^r r_{t-1} + e_t^r,\ e_t^r \sim N(0, \sigma_r^2),$$

where r^* is the steady state level of r_t, and ρ^r is the AR(1) coefficient. The WRI shock e^r is on *i.i.d.* normal random variate with the zero mean and the standard deviation σ_r.

2.6 Calibration

Table 1 reports the calibrated values of the model's structural parameters. The model is calibrated at an annual frequency. Following Bianchi (2011), subjective discount factor, β, is set to 0.906, CRRA parameter, γ, is set to 2.0, and the price elasticity parameter, η, is set to 0.248. The share of tradable consumption is 0.2989, which comes from the average for the period from 1980 to 2007 in Argentina. We calibrate the degree of FI, $\tau = 0.023$, so that the probability of sudden stop consistent to the data in Argentina, 5.05%.[4] We use the U.S. real interest rate as the approximation of the world real interest rate, r_t. We estimate the AR(1) process of r_t with the U.S. real interest rate from 1980 to 2007, and obtained $r^* = 0.055$, $\rho^r = 0.3996$, $\sigma_r = 0.0125$. The VAR(1) process of y^T and y^N, eq. (8), is estimated with the HP-filtered cycle component of tradable goods and non-tradable goods in Argentina from 1980 to 2007.[5] We obtain $\rho_T^T = 0.2425$, ρ_N^T =-0.1984, $\sigma_T = 0.0052$, $\rho_T^N = 0.3297$, $\rho_N^N = 0.7576$, $\sigma_N^2 = 0.0059$, and σ_{TN} = -0.002. Subsequently, we approximate the VAR(1) by a finite Markov process with each three states of y_t^T, y_t^N and r_t. To get the finite Markov process for r_t, we use the Tauchen method. For the VAR process of y^T and y^N, we use the multi-Tauchen method developed by Tauchen and Hussey (1991). The generated discrete grids of y^T has a minimum value of 0.91 and a maximum value of 1.099, y^N has a minimum value of 0.88, and a maximum value of 1.13, while r has a minimum value of 0.041, and a

[4]In the model, sudden stop event is defined as the period satisfies the two conditions following Bianchi (2011); (1) the borrowing constraint binds, (2) the current account to GDP ratio deviates from its two standard deviations. Empirically, we the define sudden stop event as the period that the current account to GDP ratio deviates from its two standard deviations.

[5]For y^T, we use the value added of agriculture, fishing, mining and manufacturing, following Schmitt-Grohé and Uribe (2016).

maximum value of 0.069.

3 Result of the quantitative analysis

The model is solved using the time iteration method. The endogenous state variable is b, which is chosen from evenly spaced discrete grids with size n_b, $\boldsymbol{B} = \{b_1 < b_2 < \cdots < b_{n^b}\}$. The state space of the model is defined as $(b, s) \in B \times S$. We set $\boldsymbol{B}$ with $n^b = 100$, $b_1 = 0.2$, and $b_{100} = 1.1$ for the baseline τ^* case. Because each exogenous state variables r_t, y_t^T and y_t^N has three states, there are 100×27 coordinates in the state space of this model.

3.1 FI and business cycle moments

Figure 1 shows business cycle moments obtained by the model with various degree of FI, τ. In all panels, the x-axis is the values of τ. Figure 1A shows, from left to right panel, the averages of the means of foreign debt, tradable consumption, price and the sudden stop probability (in percent) for each τ. Real consumption and real GDP are calculated as

$$x^{real} = (p_t x_t^N + x_t^T)\left(W^N \frac{p_t}{p^*} + W^T\right), \ x = \{c, y\}, \tag{9}$$

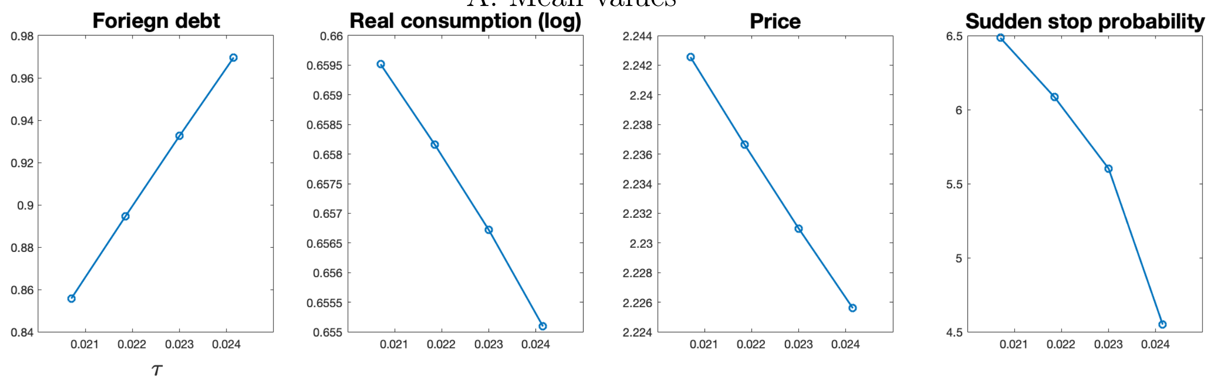
where $W^N = p^* x^{N*} / \left(p^* x^{N*} + x^{T*}\right)$, $W^T = x^{T*} / \left(p^* x^{N*} + x^{T*}\right)$ is the weight for nontradables and tradables, respectively, p^* is the steady state value of price, x^{N*} is that of nontradables, and x^{T*} is that of tradables. For the steady state values, we use the mean values of the variables. Sudden stop event is defined as the time satisfies following two conditions are hold; (1) the borrowing constraint binds, and (2) the current account to GDP ratio exceeds more than two standard deviations. Figure 1B shows that from left to right panel, the averages of the standard deviations of foreign debt and real consumption, the relative standard deviations of consumption to real GDP and the standard deviation of relative price for each τ. Standard deviations are shown in percentage.

Figure 1A illustrates how a deeper FI reduces probability of being sudden stop crisis. As τincreases, the average amount of foreign debt increases because a higher τ relaxes the borrowing constraint. As a result, probability of being sudden stop decreases from about 6.5% in lowest τ to almost 4.5% in highest τ. Real consumption and price are decrease in τ, but to a lesser extent. At most, consumption declines by about 0.7% and the price by only 0.4%.

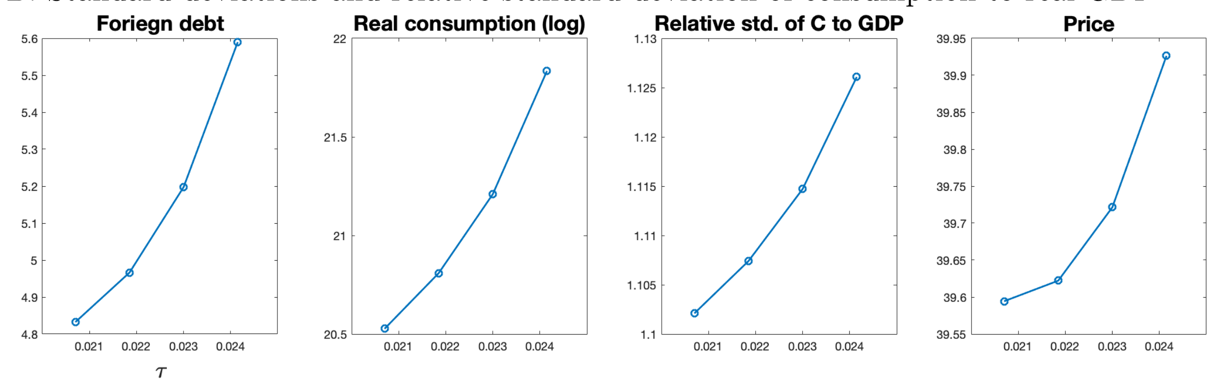
FI reduces the crisis probability, but increases business cycle volatilities. In Figure 1B, the standard deviations of foreign debt, real consumption, the relative price, and the relative standard deviation of consumption to real GDP are increase in τ. In addition, the relative standard deviation of consumption to real GDP exceeds to 1 regardless of the value of τ, implying the excess consumption volatility is observed. Therefore, a deeper FI increases business cycle volatility and worsens the excess consumption volatility, even if FI reduces the probability of being crisis.

Figure 1: Business cycle moments under various degree of τ

A. Mean values



B. Standard deviations and relative standard deviation of consumption to real GDP



Note: Business cycle moments under various degree of $\tau = [0.9, 0.95, 1.0, 1.05]\tau^*$, where τ^* is the baseline $\tau = 0.023$. All moments are calculated based on a simulation of 51000 periods with 1000 burn-in. In all panels, x axis is the value of τ. Figure A shows, from left to right panel, the averages of the means of foreign debt, real consumption, price and the sudden stop probability (in percent) for each τ. Sudden stop event is defined as the time satisfies following two conditions are hold; (1) the borrowing constraint binds, and (2) the current account to GDP ratio exceeds more than two standard deviations. Figure B shows that from left to right panel, the averages of the standard deviations of foreign debt and real consumption, the relative standard deviations of consumption to real GDP and the standard deviation of relative price for each τ. Standard deviations are shown in percentage.

3.2 FI and crisis impact

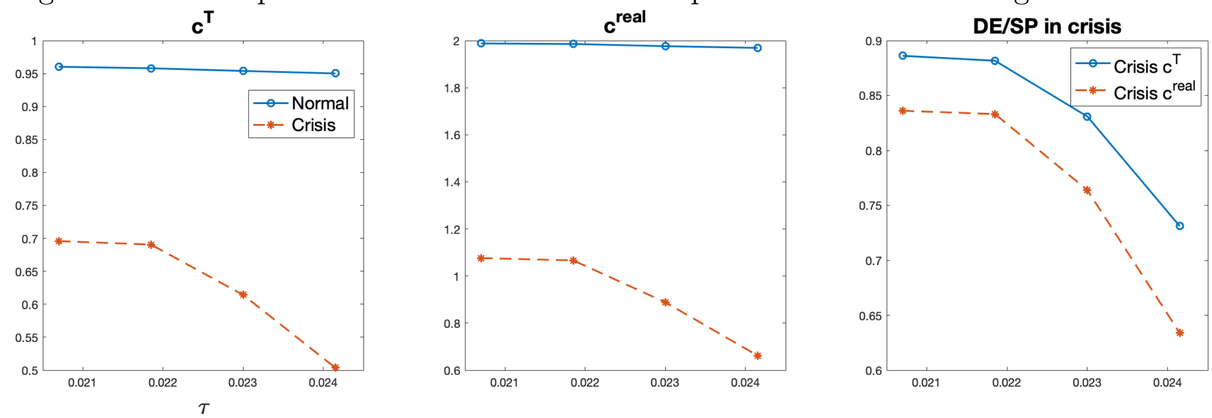
Now we compare consumption in normal times and crisis periods. The left and middle panel of Figure 2 shows the averages of the tradable consumption and real consumption for each τ.[6] In both panel, blue solid lines are the mean values in the normal (non-crisis) periods and orange dashed lines are in the sudden stop crisis periods. The right panel of Figure 2 shows that the averages of c^{DE}/c^{SP} in crisis periods for each τ, where c^{DE} refers consumption under the decentalized economy and c^{SP} is that under the social planner's economy. The blue solid line is for tradable consumption and the orange dashed line is for real consumption.

The impact of crises on consumption worsens as the degree of FI increases. The left and middle panels of Figure 2 shows that as τ increases, both tradable consumption and real consumption decline more severeely during crises and the deviation from normal times increases.

Moreover, a deeper FI, the greater the drop in consumption during a crisis in the decentalized economy compared to in the social planner's economy. In the right panel of Figure 2, both tradable consumption and real consumption in the decentalized economy are smaller than these in social planner's economy, regardless of τ. In addition, as τincreases, private agent reduces consumption more than social planner during crises. This severe impact of crises on decentalized economy implies that the potential effectiveness of policy interventions is higher as FI deepens. We discuss the effect of FI on welfare later in section 3.4.

[6]Real consumption is defined as eq.(9).

Figure 2: Consumption in normal time and crisis period under various degree of τ



Note: In all panel, x-axis is the value of τ. The left and middle panel shows the averages of the tradable consumption and real consumption for each τ. In both panel, blue solid lines are the mean values in the normal (non-crisis) periods and orange dashed lines are in the sudden stop crisis periods. The right panel shows that the averages of c^{DE}/c^{SP} in crisis periods for each τ, where c^{DE} refers consumption under the decentalized economy and c^{SP} is that under the social planner's economy. The blue solid line is for tradable consumption and the orange dashed line is for real consumption.

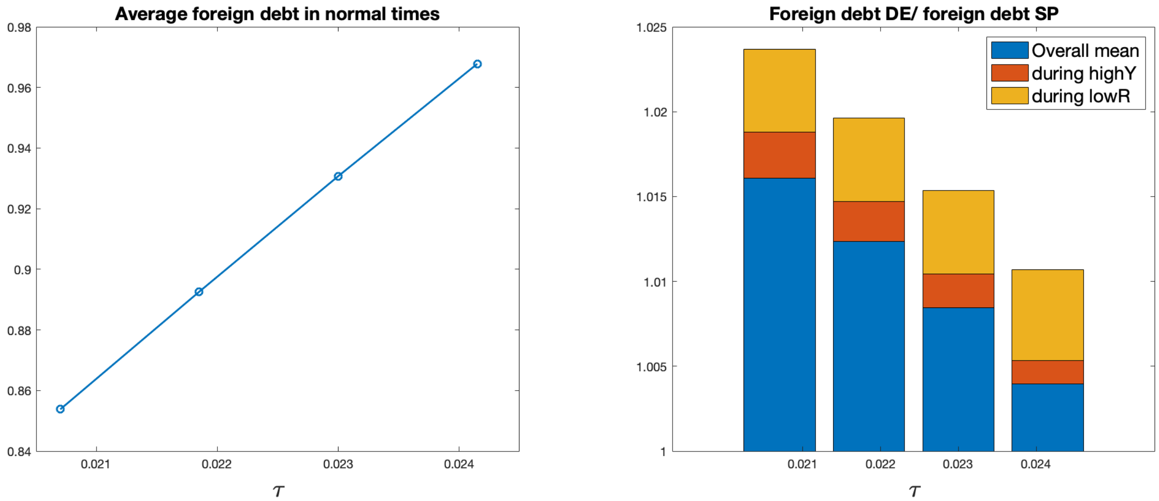
To summarize the results so far, the FI prevents being the sudden stop crises, but worsens the impact of crises on the SOE. This is the reason why FI increases business cycle volatilities. Once the crisis happens, it has severe impact on the high FI countries.

3.3 FI and overborrowing during the low interest rate period

In this subsection, we discuss why the severe crises happen in the high FI countries with the concept of overborrowing (Bianchi, 2011).

Figure 3 shows the average foreign debt in normal times (the left panel) and the ratio of foreign debt under decentalized economy to that under social planner's economy under various degree of τ(the right panel). In both panels, x-axis is the value of τ. In the right panel, the blue bar shows the ratio of foreign debt under decentalized economy to that under social planner's economy. The orange bar is the ratio under the high

Figure 3: Overborrowing and its source under various degree of τ



Note: The left panel is the average amount of foreign debt in normal times under various degree of τ. The x-axis is τ. The right panel shows the ratio of foreign debt under decentalized economy to that under social planner's economy under various degree of τ. The x-axis is the value of τ. The blue bar shows the overall average of ratio of foreign debt under decentalized economy to that under social planner's economy, the orange bar is the ratio under the high endowment period ($y^T \geq 1$ or $y^N \geq 1$) and the yellow one is the ratio during the low WRI period ($r_t \leq r^*$).

endowment period ($y^T \geq 1$ or $y^N \geq 1$) and the yellow one is the ratio during the low WRI period ($r_t \leq r^*$).

In the right panel of figure 3, the ratio is always exceeds to one, indicating private agents borrow more than social planner regardless of τ.Thus, private agents over-borrow in equilibrium, consistent to Bianchi (2011)'s result. The degree of overborrowing is decrease in τ, however, as the left panel of figure 3 shows, average foreign debt in normal times increases in τ. Therefore, the amount of overborrowing increases as τ increases.

In addition, the right panel of figure 3 illustrates as τ increases, the overborrowing during low WRI periods contributes more to the increased amount of overborrowing. This indicates that private agents accumulate foreign borrowing during normal times, especially during low WRI periods. In the right panel of figure 3, overborrowing during low WRI is larger than that during periods with high endowments, regardless of τ. Moreover, as τ increases, the contribution of overborrowing during low WRI period to the overall overborrowing increases, compared to that during high endowment periods. The overborrowing especially in low WRI periods will make borrowing constraints bind and cause sudden stop crises. As FI deepens, the degree of overborrowing tends to be smaller, but the amount of overborrowing increases and private agents accumulate more during low WRI periods, which implies the amount of foreign debt depends more on the WRI.

The increased amount of overborrowing with high FI will cause the severe sudden stop crises, as we already pointed out in section 3.2. Once the borrowing constraint binds, it is difficult for households to repay the large foreign debt during normal times. As the amount of foreign debt increases due to FI, the repayment is much harder and consumption declines more. Consequently, a deeper FI causes rare but severe crises.

3.4 FI and room for policy interventions

Table 2 shows welfare gains from correcting market externalities under various degree of τ. Following Bianchi (2011), the welfare gain $W(b, s)$ is calculated as

$$W(b, s) = \left(\frac{V^{sp}(b, s)}{V^{de}(b, b, s)} \right)^{\frac{1}{1-\gamma}} - 1.$$

In table 2, under the baseline τ, the average of welfare gain is only 0.094 percent of permanent consumption. The small welfare gain is consistent to the result in Bianchi (2011). Meanwhile, the average of welfare gain is increase in τ. As we mentioned in

Table 2: Welfare gains under various degree of τ

τ	0.021	0.022	0.023 (τ^*)	0.024
Welfare gains (%)	0.069	0.079	0.094	0.115

section 3.2, a higher τ exacerbates the impact of the crisis on consumption especially in the decentalized economy, and which results in higher consumption volatility. Therefore, collecting the externality would increase private agent's consumption especially during crisis periods, and mitigates the impact of sudden stop on the SOE.

The result indicates that the welfare gain of collecting the externality is increase in τimplies policy interventions would be more beneficial in high FI countries. As many previous studies have shown, capital taxes will be effective for preventing overborrowing and mitigates the impact of sudden stop rises.

Furthermore, our results suggest that it is more effective to impose capital taxes during periods of low WRI. From the discussion in section 3.2, the overborrowing during the low WRI period has a dominant share of overall oberborrowing. Therefore policies that prevent private agents from accumulating foreign borrowing during the low WRI period is considered to be effective.

4 Concluding remarks

This paper theoretically investigates the characteristics of sudden stops under various FI levels. We introduce an ICR-based borrowing constraint (Yamada, 2023) into an small open economy with tradable and nontradable goods model (Bianchi, 2011).

The quantitative analysis indicates that a deeper FI reduces the probability of being sudden stops, but once the sudden stop occurs, the impact becomes more severe. The reason behind the rare but severe crises as follows. A deeper FI, represented by the looser borrowing constraint, increases average amount of foreign debt and reduces probability of crises. Meanwhile, the amount of overborrowing increases, especially during the low WRI periods. Once the borrowing constraint binds, consumption must be decrease a lot for the repayment of accumulated borrowing.

References

Bianchi, Javier, "Overborrowing and systemic externalities in the business cycle," *American Economic Review*, 2011, *101* (7), 3400–3426.

Calvo, Guillermo A, Alejandro Izquierdo, and Luis-Fernando Mejia, "On the empirics of sudden stops: the relevance of balance-sheet effects," 2004.

Kose, M. Ayhan, Eswar S. Prasad, and Marco E. Terrones, "Financial integration and macroeconomic volatility," *IMF Staff Papers*, 2003, *50*, 119–142.

Martin, Philippe and Helene Rey, "Globalization and emerging markets: With or without crash?," *American economic review*, 2006, *96* (5), 1631–1651.

Prasad, Eswar, Kenneth Rogoff, Shang-Jin Wei, and M Ayhan Kose, "Effects of financial globalization on developing countries: some empirical evidence," *Economic and Political Weekly*, October 2003, *38* (41), 4319–4330.

Reinhart, Carmen and Guillermo Calvo, "When capital inflows come to a sudden stop: Consequences and policy options," 2000.

Schmitt-Grohé, Stephanie and Martin Uribe, "Downward nominal wage rigidity, currency pegs, and involuntary unemployment," *Journal of Political Economy*, 2016, *124* (5), 1466–1514.

Tauchen, George and Robert Hussey, "Quadrature-based methods for obtaining approximate solutions to nonlinear asset pricing models," *Econometrica*, 1991, pp. 371–396.

Yamada, Haruna, "Financial integration, excess consumption volatility and world real interest rate," *HIAS Discussion Paper*, September 2023, (HIAS-E-133).