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Financial Integration, Excess Consumption Volatility, and the World Real Interest Rate

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Abstract

Contrary to classical macroeconomic theory, the volatility of consumption relative to income has risen in emerging markets despite the international financial integration. This study presents a theoretical mechanism of this phenomenon by developing a small open economy model with an occasionally binding borrowing constraint, named the Interest Coverage Ratio-based borrowing constraint. Calibration exercises show that financial integration improves consumption smoothing and mitigates income shocks. Meanwhile, the foreign debt limit is more sensitive to changes in the world real interest rate. An increase in the world real interest rate tightens the borrowing constraint and decreases consumption significantly for the repayment. Financial integration would make consumption more vulnerable to the world real interest rate changes, resulting the higher volatility in emerging markets.

Keywords: Financial Integration, Excess Consumption Volatility, Emerging Market Economy, World Real Interest Rate, Occasionally Binding Borrowing Constraint

JEL codes: E21, E41, E44, F62

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1 Introduction

Can financial integration contribute to economic stability by reducing consumption volatility? The classical macroeconomic theory suggests that financial integration (hereafter, FI) facilitates international financial transactions and thus allows households to smoothen their consumption, which results in less consumption volatility relative to income volatility. Previous theoretical exercises have also shown that consumption volatility and its ratio to income volatility decrease as the degree of FI increases (Mendoza, 1991; Baxter and Crucini, 1995). However, empirical studies uncover that contrary to these theoretical predictions, in emerging market economies (hereafter, EMEs), consumption is excessively more volatile than income. This empirical finding is called excess consumption volatility (ECV; Aguiar and Gopinath, 2007). Moreover, the size of the ECV is much worse in EMEs with higher FI degrees (Kose et al., 2003; Prasad et al., 2003a). Then, a natural question is, "why does a deeper FI lead to worse ECV in EMEs?"

To answer this question, this study investigates a small-open economy (SOE) endowment model with an occasionally binding borrowing constraint, named the Interest Coverage Ratio (ICR)-based borrowing constraint, which is derived from a one-period international debt contract based on the borrower's interest coverage ratio. The key assumption in this borrowing constraint is that (1) the foreign debt limit depends negatively on a time-varying risk-free world real interest rate (WRI); (2) the borrowing constraint is specified so that the changes in the WRI have a larger impact on the foreign debt limit than standard flow collateral constraints such as Bianchi (2011). These assumptions make the shadow price of the borrowing constraint, which can be interpreted as the country-specific risk premium of SOE, depend positively and significantly on the WRI. This theoretical property of the borrowing constraint is consistent with Uribe and Yue's finding that fluctuations in the U.S. real interest rate affect the EMEs' business cycles mainly through changing risk premiums.

This study emphasizes the sensitivity of the foreign borrowing limit of the SOE to the WRI as the key to explaining the question of why the size of ECV increases in the degree of FI, motivated by numerous past studies advocating the importance of WRI movements to business cycles in SOEs. Some previous exercises with small open economy real business cycle (SOE-RBC) models reveal the role of the WRI shock in business cycle fluctuations of developed SOEs (Blankenau et al., 2001; Kano, 2009). Moreover, other past studies show that the WRI shock has significant effects on business cycles in the EMEs (Uribe and Yue, 2006; Sarquis, 2008; Muhanji and Ojah, 2011), sudden stops (Arellano and Mendoza, 2002; Mendoza, 2010; Davis et al., 2023) and default risks (Foley-Fisher and Guimaraes, 2013).

Moreover, we illustrate the ECV is associated with the negative skewness of consumption in the EMEs. The size of ECV is larger in EMEs with large negative skewness of consumption which indicates consumption declines a lot occasionally. To obtain the skewness in the long-run, we solve our model by a nonlinear method developed by Mendoza and Villalvazo (2020).

Our calibrated model successfully accounts for the ECV observed in the postwar quarterly data of Argentina. The model also implicates that a deeper FI, represented by a looser borrowing constraint, causes a higher ECV and a larger negative skewness of consumption. These successful outcomes of our model steam from the following novel mechanism that this study proposes. A higher degree of FI lowers the probability of binding the borrowing constraint, then households can smooth their consumption more through international financial transactions. As a result, foreign debt increases on average. However, as foreign debt increases, the foreign debt repayment also becomes larger, and therefore consumption must be reduced more when the borrowing constraint will bind. Because the WRI significantly affects the tightness of the borrowing constraint, foreign debt and consumption will be more vulnerable to a change in the WRI. Hence, the ECV increases in the degree of FI.

Our calibration results suggest that the deeper FI facilitates international financial transactions and allows more households' consumption-smoothing activities, but whether the consumption-smoothing is possible depends more on the level of WRI. Previous studies, including Pancaro (2010) and Faia (2011), approached the puzzling relationship between the FI and the ECV differently from our research; they considered collateral constraints á la Kiyotaki and Moore (1997) and abstract from the crucial effects of the WRI on international financial transactions. Contrary to our calibration results, their results indicate that the deeper FI (i.e., the relaxation of collateral constraints) does not promote households' consumption-smoothing behavior. The central mechanisms proposed by these studies highlight how deepening FI amplifies the consumption response against the country-specific productivity shock. A positive country-specific productivity shock increases the demand for collateral for production. It thus increases the price of capital, which results in the relaxed collateral constraint and a further increase in production, inducing a more increase in permanent income. Then, as the permanent income hypothesis predicts, consumption increases more than the current income increase, resulting in the ECV. A deeper FI relaxes collateral constraints and amplifies the effect of the productivity shock on the SOE, causing the worse ECV.

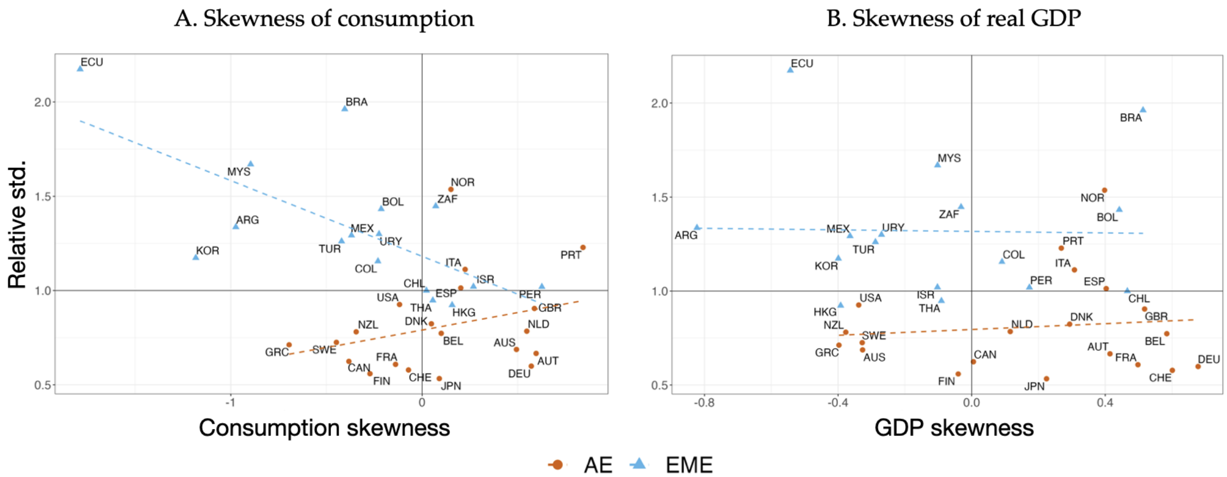
Other previous studies examine the impact of FI on the ECV by modeling the FI as the opening of a closed country to the international financial market (Levchenko, 2005; Leblebiciouglu, 2009; Bhattacharya and Patnaik, 2016; Evans and Hnatkovska, 2007, 2014). These studies illustrate how FI worsens ECV, based on the permanent income hypothesis. FI allows consumption respond more than current income increase against an increase in the permanent income, thus consumption becomes more volatile than income.

The remainder of this paper is organized as follows. Section 3 describes the model. Section 2 discuss empirically the relationship between ECV and skewness of consumption. Section 4 presents the quantitative analysis and evaluates the model. Finally, Section 5 concludes the paper.

2 The ECV and skewness of consumption

Figure 1 shows the cross-country scatter plots regarding the relative standard deviation of consumption to real GDP, the measurement of ECV, and the negative skewness of consumption and of real GDP. In both panels of A and B of figure 1, the y-axis is the relative standard deviation of consumption to real GDP in each countries. If the

Figure 1: The relative standard deviation of consumption to real GDP and skewness of consumption and of eal GDP



Note: Y-axis is the relative standard deviation of consumption to real GDP, x-axis in the panel A is skewness of consumption and that in panel B is skewness of real GDP. The blue-triangle points are for the emerging market economies, and orange-circle ones are for the advanced economies. Sample countries and sample periods are listed in Appendix.

relative standard deviation exceeds to 1, the consumption is more volatile than the real GDP; ECV is observed. The x-axis is the skewness of consumption in the panel A, and the skewness of real GDP, respectively. The blue-triangle points are for the emerging market economies, and orange-circle ones are for the advanced economies.

Figure 1 shows that in the emerging market economies, the relative standard deviation associates with the negative skewness of consumption, not with the skewness of the real GDP. In panel A of figure 1, there is a clear negative relationship between the relative standard deviation and the skewness of consumption in emerging market economies. In other words, the consumption must be excessively volatile than GDP because consumption tends to decline largely and the distribution of consumption has a long tail to the left. In contrast, there is no clear relationship between the relative volatility and the skewness of real GDP in the emerging market economies, as shown in the panel B of figure 1. The ECV is considered to be caused by the occasional large decline in consumption in the emerging economies.

Previous studies, Pancaro (2010); Faia (2011), did not take into account the negative relationship between the relative standard deviation and the skewness of consumption. Their results do not have a skewness of consumption in the long-run because they solved their model by linear approximation around the steady state that the borrowing constraint binds. To illustrate the skewness of consumption in the long-run, we solve the model by non-linear method, developed by Mendoza and Villalvazo (2020).

3 A SOE endowment model with an ICR-based borrowing constraint

3.1 The household problem

Consider an SOE with a single good. An infinitely lived representative household receives exogenous income y_t which varies 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

$$y_t + b_{t+1} = (1 + r_{t-1})b_t + c_t, \tag{1}$$

where c_t is consumption and b_{t+1} is the foreign debt level in period $t+1$.

The household also faces the following the borrowing constraint

$$b_{t+1} \leq \max\left\{\bar{b}, \frac{\tau}{r_t} E_t y_{t+1}\right\}, \tag{2}$$

where $\bar{b} > 0$ is the minimum debt limit and $\tau \geq 0$ is a parameter that determines the tightness of the borrowing constraint, as we will discuss bellow.[3]

The second term in the bracket of the borrowing constraint (2) implies that (i) the foreign debt limit depends negatively on the WRI, and (ii) a higher τ makes the foreign borrowing limit more sensitive to the WRI; a lower (higher) r_t tightens (relaxes) the borrowing constraint.

More precisely, the borrowing constraint is derived from foreign lenders' assessment of the borrower's default risk evaluated based on the interest coverage ratio (ICR), $\frac{y_t}{r_{t-1}b_t}$. We assume that foreign investors lend out to the SOE under the following condition on the ICR

$$\frac{y_t}{r_{t-1}b_t} \geq \bar{\tau}, \tag{3}$$

where $\bar{\tau}$ is the threshold value imposed by foreign lenders. Condition (3) implies that foreign debt level b_t needs to satisfy that the ICR ($\frac{y_t}{r_{t-1}b_t}$) exceeds the threshold value $\bar{\tau}$.

We relay the economic rationale behind the condition on practical and empirical facts. The financial covenant with ICR is one of the common covenants in corporate

[3] It is necessary to set this minimum borrowing $\bar{b}$ for the existence of the optimal solution. Intuitively, if the initial b is small enough, there is no optimal solution depending on the realized value of shocks. For details, see Chapter 18 of Ljungqvist and Sargent (2012).

firms (Private Placement Enhancement Project, 1996; Dothan, 2006). In addition, the ICR is used for default risk evaluations in firms. For example, rating agencies, such as Standard and Poor's, include the ICR in the construction of their ratings (Standard and Poor's , 2013). Furthermore, Gray et al. (2006) show that the ICR has a dominant effect on credit ratings.

We then derive the borrowing constraint (2) by rearranging Eq.(3) and setting $\tau \equiv 1/\bar{\tau}$. Here, the parameter τ can be interpreted as the degree of FI. A deeper FI reflected in, for example, enhancement of information disclosure to foreign investors and/or many local branches of international banks, can reduce monitoring costs of foreign lenders and increase the credibility of the SOE. This higher credibility can lower the threshold value $\bar{\tau}$, thus increasing τ. As a result, a higher degree of FI can increase the foreign debt limit, as the borrowing constraint (2) implies.

Given the exogenous income y_t, the WRI r_t and initial foreign debt level b_0, the household chooses the sequence of consumption c_t and the foreign debt level b_{t+1} by maximizing the following lifetime expected utility

$$E_0 \sum_{t=0}^{\infty} \beta^t \frac{c_t^{1-\gamma} - 1}{1-\gamma}, \tag{4}$$

subject to the budget constraint (1) and the borrowing constraint (2).

The Euler equation of the household's problem presented above is

$$\lambda_t = \beta R_t E_t \lambda_{t+1} + \lambda_t^B, \tag{5}$$

where $\lambda_t = c_t^{-\gamma}$ is the marginal utility of consumption at period t, λ_t^B is the Lagrange multiplier for the borrowing constraint (2) at period t, and $R_t = (1 + r_t)$ is the gross WRI. If $\lambda_t^B = 0$, Eq.(5) is equivalent to the Euler equation in the standard SOE model without borrowing constraints. λ_t^B represents the additional cost, evaluated in terms of utility, imposed when households increase current consumption through foreign borrowing in the binding borrowing constraint. If the borrowing constraint binds, the marginal utility gain from increasing consumption by foreign borrowing (λ_t) equals the marginal utility loss from reducing consumption associated with the increase in interest payments ($\beta R_t E_t \lambda_{t+1}$) and the additional cost due to the binding borrowing constraint ($\lambda_t^B > 0$). Thus, when the borrowing constraint binds, current consumption is smaller than in the case of the standard SOE model without borrowing constraints.

The WRI affects consumption through two channel. The first channel is the intertemporal substitution effect, the first term in the Euler equation (5), which is the standard effect of real interest rate on consumption in the real business cycle model. The second channel is that through the Lagrange multiplier for the borrowing constraint, λ_t^B. Since the borrowing constraint (2) assumes borrowing limit depends negatively on the WRI, a high WRI tighten the borrowing constraint, then λ_t^B increases, which results in reduction of consumption.

We assume that the WRI follows an AR(1) process

$$r_t = (1 - \rho^r) r^* + \rho^r r_{t-1} + e_t^r, \quad e_t^r \sim N(0, \sigma_r^2), \tag{6}$$

where r^* and ρ^r are the mean and the AR root of r_t. The WRI shock e^r is on *i.i.d.*

normal random variate the zero mean and the standard deviation σ_r.

We also assume that the income follows the process

$$\ln y_t = (1-\rho_y^y)\ln y^* + \rho_y^y \ln y_{t-1} + \rho_r^y r_{t-1} + e_t^y, \quad e_t^y \sim N(0, \sigma_y^2). \tag{7}$$

where y^* and ρ_y^y are the mean and the AR root of y_t and ρ_r^y is the sensitivity of the current income y_t to the one period past WRI, r_{t-1}. The country-specific income shock e^y is on *i.i.d.* normal random variate with the zero mean and the standard deviation σ_y. The current income y_t depends on r_{t-1} because if we consider an AR(1) income process independent of r_t, consumption volatility which depends on the multiple shocks in equilibrium should exceed income volatility by construction. Thus, we consider a reduced-form income process, driven by the two shocks to obtain the volatility ratio of consumption and income consistent with the data.

3.2 The steady state

We assume that the degree of FI in EMEs is sufficiently low that the borrowing constraint binds at the steady state. Lower τ leads to a smaller foreign borrowing limit and tighter borrowing constraint. The sufficiently low τ indicates that the borrowing constraint mostly limits foreign borrowing, resulting in the borrowing constraint binds at the steady state. Past studies assume the borrowing constraints unbind at the steady state to investigate the role of borrowing constraints in financial crises. Because our focus is on the effect of FI on the ECV as a whole business cycle, we analyze consumption in EMEs in the case the borrowing constraint binds at the steady state.

Table 1: Calibrated parameter values (baseline case)

Parameter		Value	Source/target
β	subjective discount factor	0.95	Pancaro (2010)
γ	risk aversion	2	Mendoza (2010)
τ	degree of FI	0.0408	std. ratio of consumption to real GDP per capita in Argentina
r^*	steady state value of WRI	0.0356	mean of U.S. real interest rate
$\ln y^*$	steady state value of income (logarithm)	4.460	mean of per capita real GDP in Argentina

The steady state of this model is characterized as follows:

$$y^{ss} = y^*,\ r^{ss} = r^*,\ b^{ss} = \frac{\tau}{r^{ss}} y^{ss},\ tb^{ss} = r^{ss} b^{ss} = \tau y^{ss},$$

$$c^{ss} = y^{ss} - r^{ss} b^{ss} = (1-\tau) y^{ss},\ \lambda^{Bss} = [1 - \beta(1 + r^{ss})] > 0.$$

A higher τ increases the steady state foreign debt level b^{ss} and trade-balance tb^{ss}. Because this model is for an endowment economy, an increase in b^{ss} decreases the steady-state level of consumption c^{ss}. Since the Lagrange multiplier for the borrowing constraint λ^{Bss} does not depend on τ, a fall in c^{ss} decreases the risk premium S^{ss}.

3.3 Calibration

Table 1 reports the calibrated values of the model's structural parameters. The model is calibrated at a quarterly frequency. We set the parameter $\beta = 0.95$ so that $\lambda^{Bss} > 0$, that is, the borrowing constraint binds at the steady state. τ is set to 0.0408 so that the standard ratio of consumption to real GDP per capita obtained from the model fits its data in Argentina for the period 1993Q1-2008Q3. $\ln y^*$ is set to the sample average of real GDP per capita in Argentina, 4.46.[4] We assume that the WRI is approximated by the U.S. real interest rate. Hence r^* is set to the sample average of the U.S. real interest rate for the period 1993Q1-2008Q3.[5]

We calibrate the stochastic processes of the two exogenous shocks by estimating Eqs.(6) and (7) with the U.S. real interest rate and the deviation from the cubic trend of real GDP per capita in Argentina for 1993Q1-2008Q3, respectively. We obtain $\rho^r = 0.937$, $\rho^y_r = -0.100$, $\rho^y_y = 0.9485$, $\sigma_r = 0.0055$, and $\sigma_y = 0.0194$ from the corresponding point estimates. Subsequently, we approximate the bivariate vector autoregression (VAR), which is implied by Eeqs.(6) and (7), by a finite Markov process with nine states of y_t and r_t, using the multi-Tauchen method developed by Tauchen and Hussey (1991). The generated discrete grids of y has a minimum value of 79.93 and a maximum value of 93.51, while r has a minimum value of 0.0165, and maximum value of 0.0547.

We test the effect of FI on the SOE by changing the value of τ. We recalibrate the model with the four different values of $\tau = [0.5\tau^*, 0.75\tau^*, \tau^*, 1.25\tau^*]$, where τ^* is the baseline value of τ set above.

4 Results of the quantitative analysis

The model is solved using the fixed-point iteration method proposed by Mendoza and Villalvazo (2020), which is one of the nonlinear global solution methods with occasionally binding constraints. The endogenous state variable is b, which is chosen from

[4]The real GDP per capita is the deviation from the cubic trend.
[5]The U.S. real interest rate is constructed following Neumeyer and Perri (2005).

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 $n^b = 200$, $b_1 = -0.3b^{ss}$, and $b_{200} = 2.1b^{ss}$ for the baseline τ^* case, where b^{ss} is the deterministic steady state value of b_t. In case τ is smaller than the baseline value of 0.0408, we change b_1 to $-0.8b^{ss}$. The maximum value of B, b_{200}, is set to different values depending on τ value. For $\tau = 0.5\tau^*$, $b_{200} = 1.5b^{ss}$; for $\tau = 0.75\tau^*$, $b_{200} = 1.9b^{ss}$; for $\tau = 1.25\tau^*$, $b_{200} = 2.45$.[6] Because each exogenous state variables r_t and y_t has nine states, there are 200×81 coordinates in the state space of this model.

4.1 Effect of financial integration on the SOE

Table 2 shows the sample moments in Argentina for 1993Q1-2008Q2 (Column 2) and the business cycle moments derived from the stationary distributions of b_t and policy functions under four different values of τ. Here, $\tau^* = 0.0408$ is the baseline value of τ.

The sample moments in Argentina show high volatility and the ECV. Instead, the standard deviations of trade balance, consumption, and income are over five percentage points. Moreover, the relative standard deviation of consumption to income exceeds 1, which signifies the ECV. These observations are consistent with the characteristics of emerging market business cycles, found by Aguiar and Gopinath (2007). In addition, the sample moments show that consumption in Argentina is characterized as a large negative skewness. Hence, high consumption volatility is associated with a large negative skewness of consumption.

[6]The minimum and maximum value of B are chosen so that the Euler equation error is sufficiently small.

Table 2: Business cycle moments: effect of τ change

	Data	Model			
		$0.5\tau^*$	$0.75\tau^*$	τ^*	$1.25\tau^*$
Mean					
Foreign debt	-	45.52	65.53	84.58	102.92
TB-GDP ratio	0.02	0.02	0.03	0.03	0.04
Consumption (log)	4.26	4.44	4.43	4.42	4.42
Real GDP (log)	4.46	4.46	4.46	4.46	4.46
Standard deviation (in percent, except for foreign debt)					
Foreign debt	-	10.96	13.85	16.10	17.87
TB-GDP ratio	5.40	3.18	3.75	4.18	4.52
Consumption (log)	6.82	5.94	6.42	6.83	7.19
Real GDP (log)	5.10	5.10	5.10	5.10	5.10
Relative std. to GDP					
Consumption (log)	1.34	1.17	1.26	1.34	1.41
Skewness					
Foreign debt	-	0.39	0.36	0.33	0.30
TB-GDP ratio	1.00	1.80	1.91	1.96	1.98
Consumption (log)	-0.97	-0.69	-0.94	-1.13	-1.29
Probability of binding (%)	-	16.28	12.04	9.56	8.22
Euler eq. error (log10)					
Max. value	-	-7.86	-7.87	-7.92	-7.87
Mean. value	-	-9.50	-9.59	-9.67	-9.73

Note: Moments are calculated from the stationary distribution in Appendix 5. The probability of binding borrowing constraint means intuitively that how many positive grids, which can be the solution with the positive probability, are in λ_t^B.

Our proposed model performs well at accounting for these observations. In the baseline τ^* case shown in Column 5 in Table 2, the standard deviation of consumption, the size of ECV, and the skewness of consumption are close to the data counterparts. Moreover, the size of ECV reported as the relative standard deviation of consumption to GDP in Table 2 increases in τ. This calibration result shows that a deeper FI worse the ECV in Argentina, which is consistent with the findings of Kose et al. (2003) and

Prasad et al. (2003b). In addition, the higher consumption volatility is associated with a larger negative skewness of consumption. In addition, a larger τ reduces the probability of binding borrowing constraints and increases the average amount of foreign debt. These calibration results indicate that a deeper FI allows more international borrowing, whereas it increases the volatility and the negative skewness of consumption.

4.2 The source of high volatility

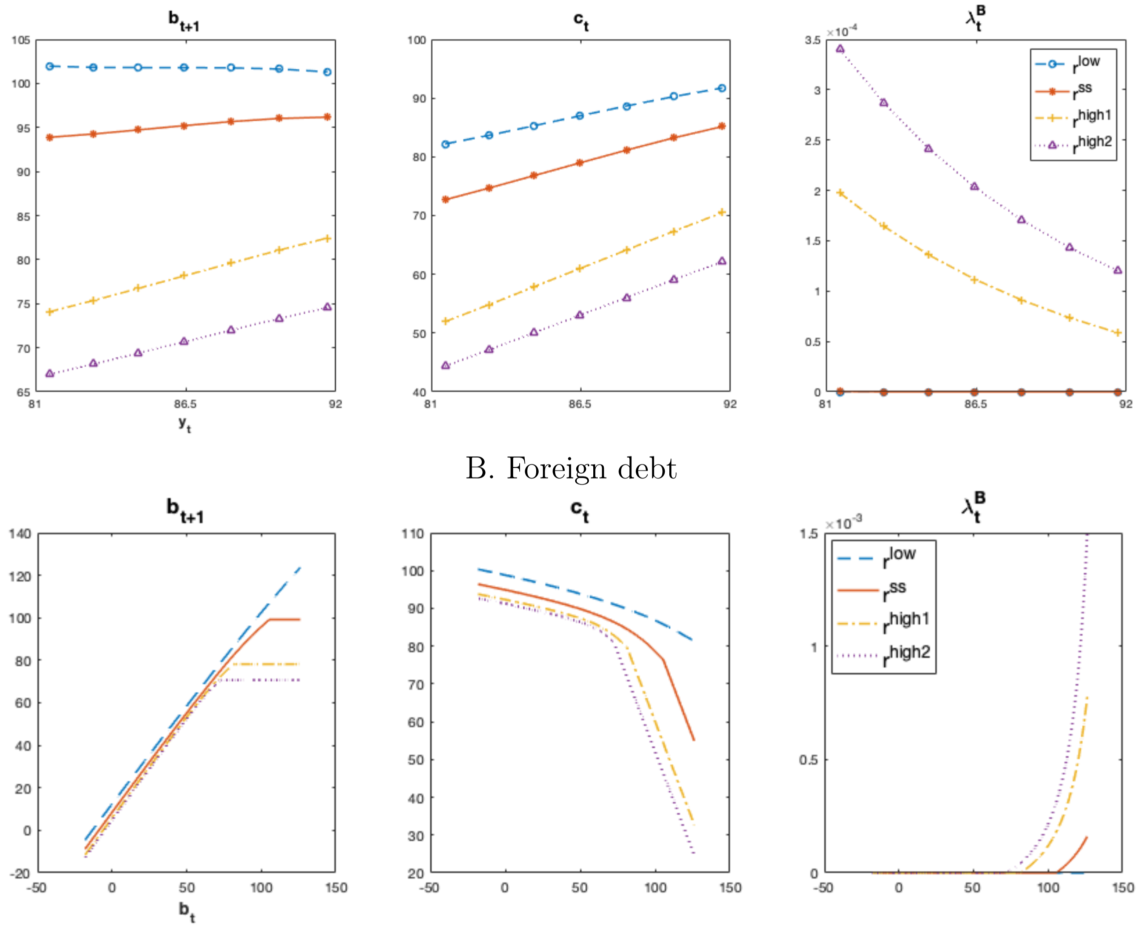
This subsection explains why the model predicts the higher consumption volatility as FI deepens even if deeper FI relaxes the borrowing constraint and increases the average amount of foreign debt. We discuss the source of higher consumption volatility by policy functions under baseline case ($\tau = \tau^*$).

Figure 2 shows the policy functions sliced at the steady state value of income, $y_t = y^{ss}$ (A), and these are sliced at the deterministic steady state value of the foreign borrowing, $b_t = b^{ss}$ (B). The left plot is the policy function of foreign borrowing; the middle plot is that of consumption; and the right plot is that of the Lagrange multiplier for the borrowing constraints. We examine the policy functions under different levels of the WRI. The blue dashed line is the policy functions under the low value of r_t, the solid red line is those under the steady state value of r_t, and the yellow dashed-dotted line and the purple dotted line are those under the high value of r_t.

The upper-right panel of Figure 2A shows that when $r_t = r^{low}$, λ_t^B remains zero, no matter how much the income is. This implies that the borrowing constraint never binds in the low WRI period. Thus, during the r^{low} periods, households can borrow

Figure 2: Policy functions

A. Income



Note: Policy functions in subplot A are calculated with spline completion and sliced at $b = b^{ss}$ (the deterministic steady-state level of foreign borrowing) and those in subplot B are sliced at $y = y^{ss}$ (the deterministic steady-state level of income). In subplot A, both ends of the income grid are dropped. $r^{low}, r^{ss}, r^{high1}, r^{high2}$ mean the states (grids) for the WRI in both subplots A and B. r^{low} is the second level from the bottom of WRI. r^{high2} and r^{high1} are the second and third levels from the top of WRI, respectively.

from foreign countries freely and smooth their consumption against the income shock. Because the income shock is temporal, the households increase foreign borrowing to smooth their consumption when the income is low, and reduce it when the income is high, as shown in the left panel of Figure 2A.

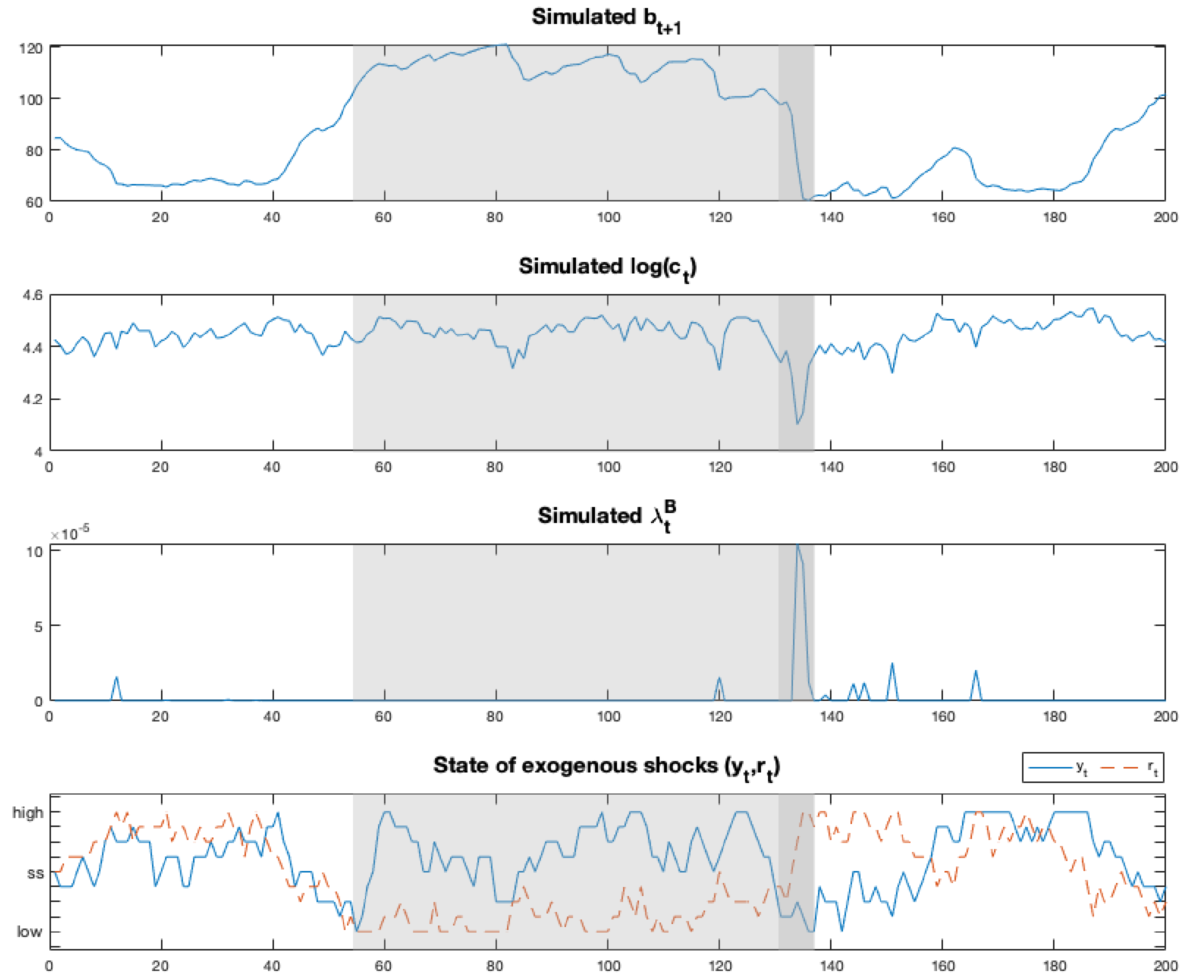
The tightness of the borrowing constraint varies largely depending on the value of the

WRI. As shown in the right panel of Figure 2A, λ_t^B for the borrowing constraint is highly volatile; it varies from zero to near 0.15%, depending on the level of r_t. Such a high dependence of λ_t^B on the WRI makes foreign borrowing and consumption depend on the WRI. A lower (higher) r_t relaxes (tightens) the borrowing constraint and facilitates (limits) foreign borrowing, which results in increasing (reducing) consumption by the budget constraint (1).

Figure 2B indicates that if the foreign debt in the previous period, b_t, is high enough, then the foreign debt and consumption will fluctuate significantly with changes in the WRI. When the WRI is lower than r^{ss}, the borrowing constraint never binds ($\lambda_t^B = 0$), not depending on b_t as shown in the right panel in Figure 2(B). As the WRI increases, λ_t^B varies more depending on b_t; higher b_t increases λ_t^B and an increase in λ_t^B grows with a higher WRI. The more foreign debt in the previous period, the more likely it is that the current foreign debt will be severely limited, depending on the level of the WRI. As a result, a larger b_t with a high WRI reduces consumption more than with a low WRI.

The simulation result in Figure 3, highlighted by the gray shadow, illustrates how the large b_t and high WRI cause a downward spike in consumption associated with the binding borrowing constraint. During the low-WRI period, the borrowing constraint does not bind, causing the accumulation of foreign borrowing. Then, if the WRI rises sharply, the borrowing constraint binds, and the foreign debt is limited. However, households must repay the large amount of foreign borrowing accumulated during the low-WRI period. As a result, consumption decreases significantly to repay the foreign

Figure 3: Simulation result



Note: The simulation is conducted by the following steps; (1) Generate Markov chain simulations of exogenous shocks (y, r) with 200 periods, (2) Calculate responses of b, c, λ^B from policy functions with spline completion. We start the simulation at the mean value of the stationary distribution of b and the deterministic steady state value of y and r.

debt, leading to higher consumption volatility than income volatility.

Now we answer the question, why does the degree of ECV increase as the FI deepens? Accordingly, a larger τ reduces the probability of binding borrowing constraints and increases the average amount of foreign borrowing. However, it also makes borrowing and consumption more volatile because a larger τ amplifies the effect of the WRI on the borrowing limit.[7] If τ is small (i.e., the FI level is low), the borrowing constraint mostly binds even if the WRI is low. The implied higher probability of binding constraint does not allow foreign borrowing to adjust fully against the income shock and results in the smaller volatilities of foreign debt and consumption.

5 Concluding remarks

This study investigates why deeper FI increases the ECV in EMEs. We construct an small open, endowment economy model with a occasionally binding borrowing constraint in which the borrowing limit depends on expected future income and the WRI. The quantitative analysis shows that the model fits better to the actual consumption volatility and the volatility ratio of consumption to income in Argentina.

The mechanism presented in this paper is as follows. Under the baseline calibration, the borrowing constraint does not bind when the WRI is low. Hence, foreign borrowing increases. Large repayments reduce consumption if the WRI increases and the borrowing constraint becomes tight. This reduction in consumption is much larger than that under the standard borrowing constraint model. Consumption smoothing is possible when the borrowing constraint does not bind, but only against income shocks. As a result, consumption under the borrowing constraint model depends more on the WRI shock, which mainly determines whether the borrowing constraint binds or not.

A higher degree of FI reduces the probability of binding the borrowing constraint and increases the average amount of foreign borrowing. However, it also makes foreign

[7] Recall that the borrowing constraint forms $b_{t+1} \leq \frac{\tau}{r_t} E_t y_{t+1}$.

borrowing and consumption more volatile because the higher degree of FI amplifies the effect of the WRI on the foreign debt limit. A large amount of foreign borrowing can reduce consumption significantly once the borrowing constraint binds. Consequently, foreign debt and consumption will be more volatile at higher FI levels, even if the FI increases the average amount of foreign debt and provides a better opportunity for consumption smoothing against income shocks. The FI would make consumption and foreign borrowing more vulnerable to the WRI shock.

Future research should evaluate the empirical validation of this model. Our results indicate that it is necessary to discuss the consumption-smoothing ability in EMEs by checking the consumption response against the identified country-specific income shock. Additionally, our mechanism implies that the asymmetric response of consumption volatility against the WRI shock due to the existence of the borrowing constraint generates high consumption volatility. Empirical exercises incorporating the nonlinear relationship between the economic variables and exogenous shocks are needed to check the model's validity.

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Appendix A. Data source and sample countries

A1. Data source and sample countries in section 2

Table 3 and Table 4 are the list of sample countries in emerging market economies and in advanced economies, respectively. The end of the sample is 2009Q4.

Table 3: Sample countries: emerging market economies

		Beginning of the sample	
Country	Iso3c	Annual	Quarterly
Bolivia	BOL	1991	1991Q1
Ecuador	ECU	1991	1991Q1
Uruguay	URY	1983	1983Q1
Argentina	ARG	1993	1993Q1
Brazil	BRA	1991	1991Q1
Chile	CHL	1996	1996Q1
Colombia	COL	1994	1994Q1
Hong Kong SAR, China	HKG	1980	1980Q1
Israel	ISR	1980	1980Q1
Korea, Rep.	KOR	1980	1980Q1
Mexico	MEX	1980	1980Q1
Malaysia	MYS	1991	1991Q1
Peru	PER	1980	1980Q1
Thailand	THA	1993	1993Q1
Turkey	TUR	1980	1980Q1
South Africa	ZAF	1980	1980Q1
Bulgaria	BGR	1994	1994Q1
Cyprus	CYP	1995	1995Q1
Hungary	HUN	1995	1995Q1

Table 4: Sample countries: advanced economies

		Beginning of the sample	
Country	Iso3c	Annual	Quarterly
Australia	AUS	1980	1980Q1
Austria	AUT	1980	1980Q1
Belgium	BEL	1980	1980Q1
Canada	CAN	1980	1980Q1
Switzerland	CHE	1980	1980Q1
Germany	DEU	1980	1980Q1
Denmark	DNK	1980	1980Q1
Spain	ESP	1980	1980Q1
Finland	FIN	1980	1980Q1
France	FRA	1980	1980Q1
United Kingdom	GBR	1980	1980Q1
Greece	GRC	2000	2000Q1
Italy	ITA	1980	1980Q1
Japan	JPN	1980	1980Q1
Netherlands	NLD	1980	1980Q1
Norway	NOR	1980	1980Q1
New Zealand	NZL	1980	1980Q1
Portugal	PRT	1980	1980Q1
Sweden	SWE	1980	1980Q1
United States	USA	1980	1980Q1

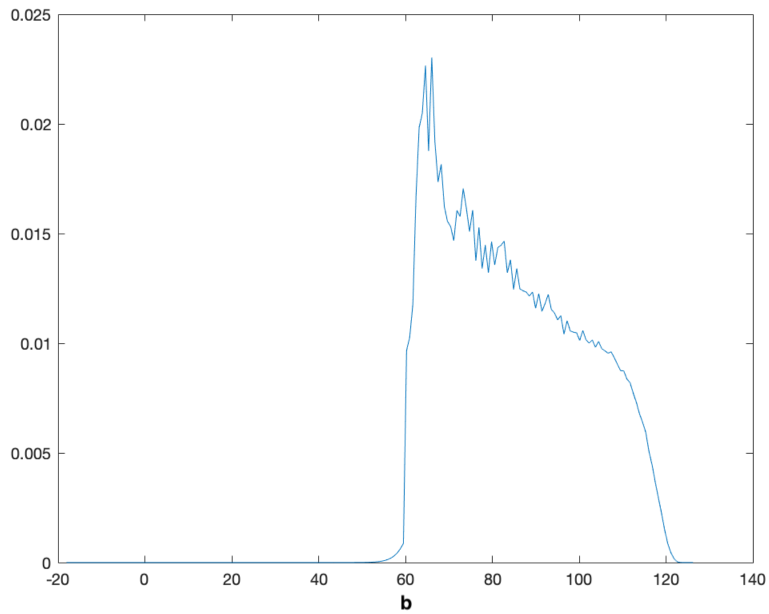
A2. Source of Argentine data and construction of U.S. real interest rate

Sample period is from 1993Q1 to 2008Q3. The Argentine quarterly dataset is by Martín Uribe that available at his homepage. For the real GDP per capita and consumption, we use the deviations from the cubic trend.

The U.S. real interest rate is constructed by following Neumeyer and Perri (2005). First, construct the monthly real interest rate = nominal interest rate - expected inflation. For nominal interest rate, we use 3-month U.S treasury bill. The expected inflation is calculated as the average of past 3 month realization of CPI-based inflation. Then we take an average of quarterly, obtained the quarterly U.S. real interest rates.

Appendix B. Stationary distribution under baseline calibration

Figure 4: Stationary distribution under the baseline calibration



Note: Ergodic distribution under the baseline calibration. The x-axis is foreign debt, b. Moments shown in Table 2 are calculated using this distribution.