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# INTERNATIONAL EQUITY AND DEBT FLOWS: COMPOSITION, CRISIS, AND CONTROLS

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**ABSTRACT**

We propose a theory of endogenous composition of capital flows that highlights two asymmetries between international equity and debt financing. In our model, poor institutional quality leads to an inefficiently low share of equity financing as well as an inefficiently high volume of total inflows. The required optimal capital controls naturally become looser as a country's institutional quality improves. Our story differs in important ways from an alternative narrative focusing on collateral constraint.

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# 1 Introduction

International capital flows are volatile. This is especially true for international debt flows to emerging market economies (see Forbes and Warnock (2012)). Abundant inflows in good times are often reversed sharply in bad times, a phenomenon labeled as *sudden stop* by Calvo (1998). Given the damaging effects of the economic and financial crises associated with the sudden stops, emerging market economies often deploy capital controls to manage the capital flows.[1] *Capital controls* have been used by China, Brazil, Malaysia, and other countries.[2] One key justification for using capital controls is the existence of an externality in private sector borrowing in the debt market, which causes countries to over-borrow relative to the social optimum. A tax on debt inflows during normal times can be used as a corrective measure against this externality (see Lorenzoni (2008), Benigno et al. (2013) and Korinek (2018)).[3]

The borrowing constraint is usually assumed to be given exogenously by the nature of emerging market economies (see Mendoza (2010), Bianchi (2011), Jeanne and Korinek (2018) and Bianchi and Mendoza (2018)). If borrowing from the international debt market faces a collateral constraint that can throw countries into a crisis, we need to know why they do not switch to more international equity financing, whose intrinsic risk-sharing property can make them less vulnerable to negative shocks to fundamentals. The existing models of over-borrowing in the debt market also predict that the optimal level of capital controls tends to go up as the collateral borrowing constraint relaxes (see the baseline calibrations in Bianchi (2011)), which does not appear to be consistent with the data. (Developed countries with presumably a stronger borrowing capacity are less, not more, likely to have capital controls.) Nor does it explain the empirical regularity that developed countries

[1] See Cerra and Saxena (2008), Rogoff and Reinhart (2009) and Ball (2014) for the empirical evidence on persistent effects of financial crises.

[2] After a long period of resistance, the International Monetary Fund has been persuaded by the evidence and the literature and now regards capital controls as appropriate in some cases. See Kose, Prasad, Rogoff, and Wei (2009) and Jeanne, Subramanian, and Williamson (2012).

[3] Pecuniary externality refers to externality through prices. In the literature on capital controls, the pecuniary externality is derived from a price-dependent collateral borrowing constraint. See Korinek and Mendoza (2014), Erten, Korinek, and Ocampo (forthcoming) and Rebucci and Ma (forthcoming) for a survey on the related literature.

are generally less affected by sudden stop episodes than developing countries, even though the former typically have a more open capital account (see Jeanne (2012)).

In this paper, we consider international equity and debt financing jointly, and articulate two forms of asymmetries between the two. The first asymmetry is that, from the viewpoint of international investors, equity financing is more vulnerable to expropriation risks in a capital recipient country than debt financing. This means that international investors are more willing to offer debt financing, than equity financing, to a country with a high level of expropriation risk. The second asymmetry is that, from the viewpoint of a capital recipient country, equity financing provides more sharing of the real-side risks than debt financing. This means that the capital recipient country prefers to receive equity financing, other things equal. The equilibrium composition of capital inflows and the equilibrium likelihood of an economic crisis are jointly determined by the capital recipient country's institutional quality (among other factors).

The theory that we propose suggests that a country's external capital structure would naturally vary by stage of economic development (as captured by the quality of public institution). As a country becomes more developed (or sees improvement in its institutions), a greater share of its external liabilities would feature risk sharing between the capital recipient countries and the investors. Moreover, the optimal level of capital controls also declines.

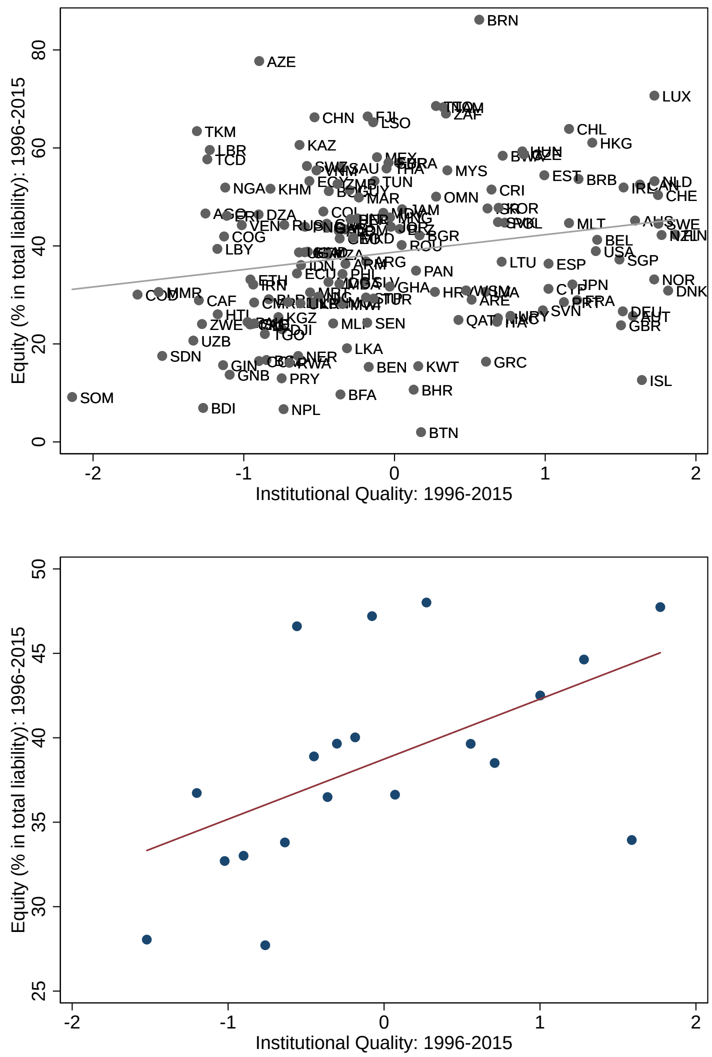
The attention to external capital structure is motivated by the recent literature suggesting that the composition of capital inflows matters for the experience of countries during global financial crises. For example, countries with a relatively high share of debt (as opposed to FDI or equity investment) fare worse during financial crises (see Tong and Wei (2010)). In our model, the quality of domestic institutions determines the share of equity in the country's total external liability, which in turn determines the volatility of capital flows. Countries with good institutional quality (e.g., typical developed countries) can issue more equity-like securities and are therefore less likely to run into sudden stop episodes. As a result, they have less need to use capital controls to manage their capital flows. On the other hand, countries with weaker public institutions (i.e., typical developing countries) need to rely more heavily on debt instruments for financing and are more exposed to the risk of sudden stops. As a result, capital controls become necessary for them.

If some external capital structure is riskier than others, why do so many countries live with the unfavorable structure? One conjecture is that the quality of domestic institution is an important determinant of the external capital structure (see Wei (2000) and Wei and Zhou (2018)). Because equity investment does not have a pre-specified fixed payoff, it is more dependent on legal and other institutions than debt contract. When a country has an inadequate legal protection of investor rights, foreign equity investors are more concerned than foreign debt investors. As a result, there will be relatively less demand for equity-like securities in that country's external liabilities. This intuition is reflected in Figure 1, which shows a positive relationship between the quality of a domestic institution and the share of equity in total external liability during 1996-2015. Therefore, countries with poor domestic institutional qualities are more likely to issue debt-like securities, making them in turn more susceptible to sudden stop episodes. In other words, a country's experience with *sudden stops* is *not* random. Instead, it is related to the external capital structure and domestic institutional quality.

We generalize the models of Bianchi (2011) and Korinek (2018) in two ways. First, we augment the menu of international capital flows by adding cross-border equity financing. Second, we consider both expropriation risks (or the quality of public institutions that limit the expropriation risks) as well as the collateral constraint. This will allow us to investigate how institutional quality affects the volatility of capital flows (probability of crises) and optimal capital controls.

The parameter denoting the degree of collateral constraint is often thought of as representing the level of financial development in the existing literature. It is natural to ask whether cross-country variations in that parameter can generate the same kind of cross-country patterns as our institutional quality story. The short answer is no. While either a relaxation of the borrowing constraint or an improvement in institutions result in fewer crises, the two are different in important ways. First, while an improvement in institutions leads to a rise the relative share of equity financing in a country's external liabilities, a relaxation of the collateral constraint leads to an opposite change (i.e., a decline in the equity share in the external liabilities). Second, while an improvement in institutions reduces the required level

**Figure 1** Equity Share and Institutional Quality: Raw and Bin Scatter Plots




Note. This figure shows the relationship between equity share (% in total external liability) and domestic institutional quality between 1996-2015. The second figure is a bar scatter plot of the first figure. The slope are 3.57 and 3.56 with t statistics at 2.61 and 3.71 for two regression lines. See Appendix B for a detailed data source and variable constructions.

of capital controls to remove economic inefficiency, a relaxation of the collateral constraint leads to the opposite result. (Bianchi (2011), in the simulation of his baseline model, also reports that the optimal tax on capital flows should increase as the collateral constraint on borrowing relaxes.)

Comparing middle-income emerging market economies with poor countries, or comparing developed countries with developing countries, there are differences both in the quality of public institutions that limit expropriation risks and in financial development that affects the extent of collateral constraint in borrowing from the international debt market. We will present evidence that suggests that, to understand cross-country differences in the patterns of capital flows, differences in institutions are more important than differences in collateral constraint.

Our theory enriches the discussion in the existing literature on policy responses to inefficiencies in international finance. First, for a given degree of collateral constraint, an improvement in the domestic institutions can increase the risk-sharing between the capital recipient country and the international investors even in the absence of capital controls. Indeed, when the institutional quality becomes good enough (but not necessarily perfect), we will show that the inefficiency associated with over-borrowing in the debt market can be gone completely. In other words, even if a country cannot alter the binding collateral constraint in the debt market, institutional reforms can nonetheless solve the externality problem by altering the composition of capital flows. Second, capital controls play a useful role in addressing the exterality problem when institutional reforms cannot be done quickly. As a country's institutional quality rises, however, the optimal tax on capital flows would need to fall.

We make two main contributions to the existing literature and the related policy discussions. First, we provide a theory of the capital structure of a country. In the existing literature, the source of market inefficiency is a pecuniary externality (see Lorenzoni (2008), Jeanne and Korinek (2010a), and Dávila and Korinek (2017)) or aggregate demand externalities (see Farhi and Werning (2016) and Korinek and Simsek (2016)). However, these papers do not investigate how the source of inefficiency may vary or evolve as a function of country conditions. In our model, the key determinant of the capital structure is the institutional quality. Unlike the models that are often used in the capital controls literature (see Korinek (2018) and Jeanne and Korinek (2018)), we allow for a country to issue both debt and equity. Importantly, the quality of institutions plays the role of a deep parameter that determines the country's external capital structure. With good institutional quality, equity financing dominates debt financing because it provides superior risk-sharing. In the extreme case of perfect quality, there will be only equity financing. Countries with a poor institutional quality, however, face higher costs of equity financing and are forced to issue debt.

The existing literature on over-borrowing can be thought of as a special case of our theory where equity financing is ruled out by assumption and debt financing is the only available source of funding for these countries. In our framework, the canonical case in the existing literature corresponds to a case where domestic institutional quality is below some threshold value. In general, however, both equity and debt financing co-exist in equilibrium. Their relative importance across countries affects relative financial instability.

Our second contribution is on the design of capital controls. Because most of the literature has featured only one form of capital flows, a capital control is simply a tax on debt flows. For example, in a small open economy dynamic stochastic general equilibrium (DSGE) framework, Bianchi (2011), Benigno et al. (2013), Jeanne and Korinek (2018), Bianchi and Mendoza (2018), and Ma (2020) computed such a tax. In comparison, by allowing for multiple forms of capital flows simultaneously, we have to specify a structure of capital controls, i.e., potentially different tax rates on different forms of capital flows.[4] In particular, the decision margins for equity and debt are affected differently by pecuniary externalities (similar as in Benigno et al. (2016)). Importantly, the optimal tax rates on various forms of capital flows should change as a function of the institutional quality (which can be understood as stages of development). In general, capital controls on equity should be lower than that on debt since debt financing provides less risk sharing benefits and is subject to more pecuniary externalities. For example, Brazil during 2008-2013 imposed a higher tax on foreigners to purchase domestic fixed income securities than equities.[5] This pattern is consistent with our model prediction.

[4] Korinek (2018) provides a general framework to analyze the issuance of state-contingent security. In that framework, he points out that the degree of externalities depends on the feature of securities, with FDI the lowest externality followed by portfolio equity and portfolio debt. However, he analyzes the two cases separately rather than jointly. In our paper, the composition of debt and equity is jointly determined in equilibrium.

[5] See Forbes et al. (2016) for a detailed document for capital controls policy in Brazil.

As a general implication, the optimal policy for financial stability should depend on a country's institutional quality. Countries with a higher quality of domestic institutions leads to a safer external capital structure and therefore a higher level of financial stability. In this case, there is no need for restrictions on cross-border capital flows. On the other hand, a poor domestic institutional quality reduces the country's ability to issue equity-like securities and this leads to more financial vulnerability. In this scenario, capital control policies are needed to correct this inefficiency. These results suggest that if there is a way to improve a country's domestic institutional quality, it is worth pursuing, because it allows the country to fully utilize the benefits from financial globalization (see Kose et al. (2010)). If a country is unable to improve its institutional quality, then capital controls can be beneficial to correct this inefficiency and externality. The need for capital controls declines as an economy matures in the form of improved institutions.

Following the existing literature on over-borrowing and sudden stops, the baseline model in the paper assumes that a typical emerging market economy in the debt market can only borrow in a foreign currency (e.g., US dollar) and in a short maturity. In such case, equity is the only alternative security that features risk-sharing. We may generalize the model by allowing for other securities that also have (partial) risk-sharing properties, such as local currency debt and long-maturity debt. In Appendix D, we provide some extensions of the model that incorporate these new instruments.

The organization of this paper is as follows: Section 2 presents our benchmark model; Section 3 presents the optimal capital controls policy; Section 4 presents a numerical example; Section 5 presents empirical results; and Section 6 concludes. All the tables, figures and proofs are provided in Appendix.

# 2 The Model

We start with a discussion on how poor institutional quality can lead to differential expropriation risks for equity and debt investors. We then introduce a parameter capturing the differential risk into a generalized three-period model in the same spirit of Bianchi (2011) and Korinek (2018). Our generalization is to allow for multiple forms of cross-border capital flows.

## 2.1 Institutional Quality and Expropriation

Both equity and debt investors worry about expropriation risks in the capital recipient countries. If a domestic agent (firm) on the receiving side of international capital flows misrepresents its true revenue or profit and gets away from it, it damages the interest of international investors. In order to cheat a foreign debt holder out of its rightful payoff, the domestic firm needs to falsely declare a bankruptcy, which is likely to be very costly to the borrower. In comparison, in order to cheat a foreign equity shareholder a part of his rightful payoff, the firm only needs to overstate some of its cost items or understate some of its revenue items, which is less costly to implement than a fake bankruptcy. This suggests an important asymmetry between the two forms of capital flows: equity investment is more vulnerable to expropriation risks than debt investment.

To formalize this argument, we start from a simple three-period model. The time periods are denoted by $t = 1, 2$ and 3, respectively. There are two types of goods, tradable and non-tradable goods. To simplify the analysis, the non-tradable consumption only appears in the second period.[6] The preference of domestic agents is given by

$$\omega_T \log C_{T1} + \beta E_1 \left[ \omega_T \log C_{T2} + \omega_N \log C_{N2} + \beta \omega_T \log C_{T3} \right] \tag{1}$$

where $\beta$ is the discount factor, $\omega_T$ equals the share of tradable consumption in the total spending on consumption, and $C_{Tt}(C_{N2})$ is the tradable (non-tradable) consumption at time $t = 1, 2, 3$ (time 2).

**Income Stream** We consider an endowment economy. There is no income in the

[6] The role of the non-tradable consumption good is to provide a relative price of the two goods, which enters into the collateral borrowing constraint. Since the borrowing constraint will be assumed to only appear in the second period, it is innocuous to assume that the consumption of the non-tradable good only occurs in the second period.

first period, and the income streams in the last two periods are given by $\{y_2, y_{N2}, y_3\}$, respectively, where $y_t$ is the tradable income in period $t = 2, 3$ and $y_{N2}$ is the non-tradable income in period 2. We assume that only $y_2$ is stochastic and is uniformly distributed in $U[\underline{y}, \bar{y}]$ with $\underline{y} > 0$.

**Debt and Equity Contracts** The domestic agent can issue either equity or debt contracts (or both) in the first period at unit price of $p_e$ and $p_d$ respectively. In particular, foreign investors purchase $s$ shares of equity from the country at price $p_e s$ at time $t = 1$ in exchange for a future tradable income stream $\{sy_2, sy_3\}$ at time $t = 2$ and $t = 3$ respectively. By doing so, the equity contract provides risk-sharing between the country and international investors. The international investors, however, can also purchase $d$ units of debt from the country with a price $p_d d$ at time $t = 1$ in exchange for a promised fixed payment $d$ at period 2. In the intermediate period ($t = 2$), the country can also roll over its debt that will be repaid in period $t = 3$. As will be explained below, this external financing at time 2 is subject to a collateral borrowing constraint as in the literature (see Korinek (2018) for example).

**Financial Frictions** Following Bianchi (2011) and Korinek (2018), a financial friction exists for rolling over the short term debt in period 2. In particular, the economy can only pledge a fraction $\phi \in [0, 1]$ of its period 2 income to international investors. Therefore, the maximum amount of debt issued in period 2 cannot exceed the collateral value as follows.

$$\frac{d'}{1+r} \leq \phi[p y_{N2} + (1-s) y_2] \tag{2}$$

where $d'$ is the quantity of roll-over debt in period 2, $r$ is a world risk-free rate, $p$ is the price of non-tradable good, and $s \in [0, 1]$ is the share issued in period 1.[7]

The existence of a collateral borrowing constraint (2) has both positive and normative implications. As suggested by the literature, it is a good way to capture

[7] To be consistent with Korinek (2018), we use the actuarially fair price $\frac{1}{1+r}$ for the roll-over debt in period 2. As will be shown later, this is consistent with the price of debt $p_d$ in period 1 when the bankruptcy cost is sufficiently large.

financial crises (see Mendoza (2010) and Bianchi (2011)). In this economy, a binding constraint is characterized as an occurrence of a crisis. It also provides a rationale for policy intervention since it involves a pecuniary externality, which will be explained later (see Korinek (2018) and Dávila and Korinek (2017)).

**Institutional Quality and Payoff Manipulation** To capture the effect of institutional quality, we allow the domestic agents to manipulate the security payoffs after issuance. For example, they can pretend that the firm's income stream is only $\{(1-\kappa)y_2,(1-\kappa)y_3\}$ with $\kappa \in [0,1]$ when the true income stream is $\{y_2,y_3\}$. Such a behavior is costly to the agent as there is a chance that the international investors may discover the true payoff and convince the local court to punish the domestic firm. In this case, the firm has to pay a fine of $\{\chi y_2,\chi y_3\}$ to the investor with $\chi \in (\kappa,1]$. We denote the probability for the international investors to lose the case by $q \in [0,1]$. The probability $q$ reflects the quality of domestic institution — with low-quality institutions, international investors will have difficulty not only to discover the misdeed of the firm, but also to find an impartial local court to win the case. Lower quality institutions can mean poorer corporate accounting standard or more corruptible local judges. All these aspects are reflected in a high value of $q$.

The domestic agent can also manipulate the payoff to international debt holders by falsely claiming an inability to pay back the debt and declaring bankruptcy. We denote the bankruptcy cost by $B$ for each unit of debt contract. In bankruptcy, the domestic agent can reduce each unit of debt contract's payment from 1 to $1-\kappa'$ with $\kappa' \in [0,1]$. Without loss of generality, we assume that the probability for the international investors to suffer a loss in an event of bankruptcy is also given by $1-q$. Once they win in the court, the penalty on the domestic agent is given by $\chi'$ with $\chi' \in (\kappa',1]$.

**International Investors** There is a continuum of risk neutral international investors who have access to a storage technology with a return $r > 0$. They will price the equity contract and debt contract taking into account that their payoffs might be manipulated. In particular, there will be a discount in the actuarially fair price reflecting the degree of manipulation. For example, denote the actuarially fair prices for debt and equity by $\frac{1}{R} \equiv \frac{1}{1+r}$ and $y_1 = \frac{\frac{\underline{y}+\bar{y}}{2}+\frac{y_3}{1+r}}{1+r}$ respectively. The expected fractions of income deduction once domestic agents manipulate equity and debt payoffs are thus given by $[q\kappa-(1-q)\chi]$ and $[q\kappa'-(1-q)\chi']$ respectively. Use an indicator function $\mathbb{1}$ to capture the decisions by the domestic agents to manipulate the equity or debt payoff, i.e. $m_e = 1$ and $m_d = 1$ respectively. The prices $p_e$ and $p_d$ will then be given as follows.

$$\begin{aligned} p_e &= \frac{E\left[y_2 + \frac{y_3}{1+r} - \mathbb{1}_{m_e=1}[q\kappa-(1-q)\chi]\left(y_2+\frac{y_3}{1+r}\right)\right]}{1+r} \\ &= y_1\left(1 - \frac{[q\kappa-(1-q)\chi]E[\mathbb{1}_{m_e=1}\left(y_2+\frac{y_3}{1+r}\right)]}{y_1(1+r)}\right) \\ p_d &= \frac{E[1-[q\kappa'-(1-q)\chi']\mathbb{1}_{m_d=1}]}{1+r} \end{aligned}$$

**Incentive to Manipulate Security Payoffs** The domestic agents choose whether to manipulate the securities payoffs at the beginning of period 2. Intuitively, the net benefit of manipulating equity payoff is the expected fraction of the present value of promised cash flows, $q\kappa-(1-q)\chi$. As long as the net benefit is non-negative, domestic agents find it profitable to manipulate the equity payoff. However, the net benefit for manipulating debt payoff, $q\kappa'-(1-q)\chi'$ has to be higher than a bankruptcy cost $B$. Otherwise, it is not worthwhile to manipulate debt payoffs. The decision is given by Proposition 1.

**Proposition 1.** The incentive for domestic agents to manipulate payoffs depends on parameter values. Specifically,

- Domestic agents never manipulate equity payoffs when $q < \frac{\chi}{\kappa+\chi}$ and will always manipulate equity payoffs when $q \geq \frac{\chi}{\kappa+\chi}$.
- Domestic agents never manipulate debt payoffs when $q < \frac{\chi'+B}{\chi'+\kappa'}$ and will always manipulate debt payoffs when $q \geq \frac{\chi'+B}{\chi'+\kappa'}$.

*Proof.* Proof is given in Appendix E.1. □

When the domestic institutional quality is high, the probability for investors to lose (unfairly) in the court will be low, i.e. $q$ is likely to be low. When it is sufficiently low such as below a threshold $\frac{\chi}{\kappa+\chi}$, domestic agents never manipulate equity payoff in equilibrium. The equity is thus priced at its actuarially fair price. However, when the institutional quality is not high enough, i.e. $q$ is above the threshold, domestic agents will always manipulate the equity payoffs. As a result, the equity is priced at a discount which reflects the degree of domestic institutional quality.

$$p_e = y_1, \text{if } q < \frac{\chi}{\kappa+\chi}$$
$$p_e = y_1(1-\theta), \text{if } q \geq \frac{\chi}{\kappa+\chi}$$

where $\theta = q\kappa - (1-q)\chi$.

The difference between the incentives to manipulate equity and debt payoffs lies in the bankruptcy cost $B$. For the domestic agents to manipulate debt payoffs, the probability $q$ has to be a higher threshold than that for equity, i.e. $q \geq \frac{\chi'+B}{\chi'+\kappa'}$. The debt price also reflects the degree of domestic institutional quality as follows.

$$p_d = \frac{1}{1+r}, \text{if } q < \frac{\chi'+B}{\chi'+\kappa'}$$
$$p_d = \frac{1}{1+r}(1-\theta'), \text{if } q \geq \frac{\chi'+B}{\chi'+\kappa'}$$

where $\theta' = q\kappa' - (1-q)\chi'$.

We focus on the case where $B > \kappa'$, i.e. the bankruptcy is sufficiently high. In this case, domestic agents never find it optimal to manipulate debt payoffs. In equilibrium, the price of debt is at its actuarially fair level, $\frac{1}{1+r}$. For the price of equity, it depends on the degree of domestic institutional quality. In particular, when it is at a high level, i.e. $q$ is low, the international investors can easily win the case in local courts once the domestic agents decide to manipulate the equity payoff. In equilibrium, domestic agents will not choose to manipulate equity payoff and the equity will be priced at its acturially fair level. Only when the probability is high enough, i.e. higher than $\frac{\chi}{\kappa+\chi}$, the equity price is priced at a discount, related with $q$. For simplicity, we use $\theta$ to capture this discount, which can also be thought as as an index for domestic institutional quality.

**Interpretation of Institutional Quality** In our model, $\theta$ captures the expected loss for the equity payoffs in the perspective of international investors. Such a loss is generated by the mis-behavior by domestic agents, such as firms or corruptible judges. This sub-section can be viewed as a micro-foundation for $\theta$ as an expropriation risk.

If we think broadly, $\theta$ as an expropriation risk can also result from actions by government officials. Good institutions can be thought of as strong restraint on expropriation (the risk of having private property taken by the government or a well-connected private party without compensation or a just clause). In either case, the level of expropriation risk matters for the willingness of foreign investors to provide financing.

In the following analysis, we use $\theta$ as a measure for institutional quality and push the manipulation of the security payoff into the background. This expropriation risk will be reflected in the budget constraints in the economy. At time 1, private agents issue equity $s \in [0,1]$ and debt $d$ to finance its consumption. At time 2, they choose the consumption stream $\{C_{N2}, C_{T2}\}$ for the given income stream $\{y_2, y_{N2}\}$ in net of promised equity and debt repayment. The difference can also be financed by a roll-over debt $d'$. At time 3, private agents choose consumption $C_{T3}$ after repaying debt $d'$ and equity $sy_3$. The budget constraints for private agents in the economy are thus given by

$$C_{T1} = sy_1(1-\theta) + \frac{d}{1+r}, \tag{3}$$

$$pC_{N2} + C_{T2} = py_{N2} + (1-s)y_2 - d + \frac{d'}{1+r}, \tag{4}$$

$$C_{T3} + d' = (1-s)y_3. \tag{5}$$

## 2.2 Competitive Equilibrium

The competitive equilibrium is defined as an allocation $\{s,d,d',C_{T1},C_{T2},C_{T3},C_{N2}\}$ and the price of non-tradables $p$ that maximize the utility function (1) subject to the budget constraints, financial constraint (2) and a market clearing condition for non-tradable good, i.e. $C_{N2} = y_{N2}$.

**Discussion** Our economy is more general than the framework in the existing literature. A special case of our model is when $\theta = 1$ (when the expropriation risk on equity financing is extremely high). In this case, there will be no equity financing from international investors, and our model is reduced to an economy with only debt financing, i.e., as in Bianchi (2011) and Korinek (2018). On the other extreme, if $\theta = 0$, the economy chooses only equity financing, i.e. $s = 1$. By continuity, the country can arrive at an external capital structure with both debt and equity when $\theta$ is at some intermediate value. Since equity contracts provide better risk-sharing between the country and international investors but are subject to an expropriation risk, the equilibrium capital structure reflects a balance between these two forces.

### Period 2 Equilibrium

It is convenient to define a liquid net worth at the beginning of period 2 as $m = (1-s)y_2 - d$. The competitive equilibrium can be solved using backward induction. The maximization problem can be written as

$$\begin{aligned} V(m,s,y_2) = \quad & \max_{C_{N2},C_{T2},C_{T3},d'} \omega_T \log C_{T2} + \omega_N \log C_{N2} + \beta\omega_T \log C_{T3}, \\ & \text{s.t. } (2),(4),(5). \end{aligned}$$

Consistent with the existing literature, at the beginning of period 2, two states are possible, depending on the state variables $\{m,s,y_2\}$, where $m = (1-s)y_2 - d$ is the net worth. In the good state, the financial constraint is slack and the economy can borrow to smooth consumption between periods 2 and 3. In the bad state, the financial constraint binds and the economy cannot borrow enough to smooth consumption. The realization of a bad state depends on the external financing decision in period 1.

**Proposition 2.** The financial constraint binds if and only if the debt to income ratio $\frac{d}{1-s}$ exceeds some threshold, i.e.

$$\frac{d}{1-s} > \frac{y_2\left(\frac{\beta}{1+\beta}+\frac{\phi/\omega_T}{1-\phi\frac{\omega_N}{\omega_T}}\right)-\frac{y_3}{(1+\beta)(1+r)}}{\frac{\beta}{1+\beta}+\frac{\phi\frac{\omega_N}{\omega_T}}{1-\phi\frac{\omega_N}{\omega_T}}}$$

*Proof.* Proof is given in Appendix E.2 □

The intuition for Proposition 2 is consistent with the literature. When the country issues too much debt $d$ relative to its income stream share $1-s$, it has a lower net worth at the beginning of the period. Compared to the previous literature, issuing too much equity s can also lead to a lower net worth $m$. Yet, as will be shown later, equity issuance provides better risk-sharing opportunities.

### Period 1 Equilibrium: the Capital Structure

At time 1, the representative private agent chooses the capital structure $\{s,d\}$ of its external financing to solve the following problem.

$$W_1 = \max_{s\in[0,1],d} \omega_T \log C_{T1} + \beta E_1[V(m,s,y_2)],$$
$$\text{s.t. } C_{T1} = sy_1(1-\theta)+\frac{d}{1+r},\ m=(1-s)y_2-d.$$

The first-order conditions for debt and equity are

$$\frac{\omega_T}{C_{T1}} = \beta(1+r)E_1[V_m]$$
$$\frac{\omega_T}{C_{T1}}y_1(1-\theta) = \beta E_1[y_2V_m - V_s]$$

where $V_m = \frac{\partial V(m,s,y_2)}{\partial m}$ and $V_s = \frac{\partial V(m,s,y_2)}{\partial s}$.[8]

The economic interpretation is straightforward. Private agents equate the marginal benefit of debt (equity) with its marginal cost. To better understand the trade-off, we start from an extreme case where there is no expropriation risk, i.e. $\theta = 0$. As we show below, the country will choose to sell all of its future tradable income since equity allows full risk-sharing between the country and international investors.

Given that an equity contract allows the country to sell off all its (risky) income in exchange for a certain income stream without any efficiency loss, the economy prefers to do so. International investors are indifferent since they are risk-neutral. Therefore, the equity contract can achieve full risk-sharing between the country and international investors. The following proposition summarizes the intuition.

**Proposition 3.** When there is no expropriation risk, i.e. $\theta = 0$, the agent chooses (and obtains) $s = 1$ in order to achieve full insurance, i.e. the first best allocation.

*Proof.* Proof is given in Appendix E.3. □

Proposition 3 suggests that the advantage of equity over debt financing is to provide better risk-sharing. When there is no additional cost for equity issuance, the private agent in the country prefers to issue equity over debt. However, in general, a positive expropriation risk $\theta > 0$ raises the equity issuance cost. This presents a trade-off between equity and debt financing. On the one hand, equity financing provides better risk-sharing; On the other hand, the expropriation risk reduces the present value of future income stream, causing investors to apply a discount to the equity price. The equilibrium structure of capital financing reflects a balance between these two forces. The following proposition establishes an equilibrium capital structure in this economy.

[8] The optimality condition for equity is for the interior solution. For the corner solutions, we have

$$\frac{\omega_T}{C_{T1}} y_1(1-\theta) - \beta E_1 \left[ y_2 V_m - V_s \right] > 0, \text{ if } s = 1.$$
$$\frac{\omega_T}{C_{T1}} y_1(1-\theta) - \beta E_1 \left[ y_2 V_m - V_s \right] < 0, \text{ if } s = 0.$$

**Proposition 4.** The equilibrium capital structure reflects the degree of expropriation risk $\theta$.

1. When the institutional quality is sufficiently good, i.e. $\theta < \underline{\theta}$, there will be only equity issuance.

2. When the institutional quality is sufficiently poor, i.e. $\theta > \bar{\theta}$, there will be only debt issuance.

3. When $\theta \in (\underline{\theta}, \bar{\theta})$, there will be a combination of equity and debt. As the cost of issuing equity $\theta$ increases, the country chooses a higher level of debt $d$, a lower share of equity $s$, and a higher leverage, $\frac{d/(1+r)}{s(1-\theta)y_1+d/(1+r)}$. This will result with a more binding collateral constraint in the second period, i.e. a higher probability of crises.

*Proof.* Proof is given in Appendix E.4. □

# 3 Optimal Capital Controls

In general, an economy with incomplete markets and pecuniary externalities may have sub-optimal allocations (see Geanakoplos and Polemarchakis (1986) and Greenwald and Stiglitz (1986)). This opens up a role for policy intervention. The existence of pecuniary externality in our context is due to the collateral borrowing constraint, resulting in a vicious cycle of "*lower price – more binding constraint – asset sale – lower price*". Intuitively, when the collateral constraint binds, the private agent cuts spending. With a decline in the aggregate spending, the price of non-tradable goods falls, which leads to a reduction in the income of other agents, precipitating further deleveraging in the economy. In deciding how much financing to obtain from international investors, private agents do not take into account the effect of their actions on other agents' income and on this vicious cycle. In this sense, they borrow too much (relative to a socially efficient level).

What can be done to correct this externality? Following the literature, it is infeasible to remove the collateral constraint directly. We consider the second-best options by introducing a social planner who faces the same financial constraint as private agents, but can internalize the general equilibrium effect through the price of non-tradable good in the collateral borrowing constraint (i.e. $p = \frac{\omega_N}{\omega_T}\frac{C_{T2}}{y_{N2}}$ in equilibrium). We then compare the allocation chosen by the social planner with the one that arises from competitive equilibrium.

The social planner solves the following maximization problem.

$$\begin{aligned} W_1^{SP} = \max_{d, s\in[0,1]} \quad & \omega_T \log C_{T1} + \beta E_1 \left[ V^{SP}(m, s, y_2) \right] \\ \text{s.t.} \quad & C_{T1} = s(1-\theta)y_1 + \frac{d}{1+r}, \\ & m = (1-s)y_2 - d. \end{aligned}$$

where $V^{SP}(m,s,y_2)$ is given by

$$\begin{aligned} V^{SP}(m,s,y_2) \quad = \quad & \max_{C_{T2}, C_{T3}, d'} \omega_T \log C_{T2} + \omega_N \log y_{N2} + \beta \omega_T \log C_{T3}, \\ & \text{s.t. } C_{T2} = m + \frac{d'}{1+r}, \\ & \frac{d'}{1+r} \leq \phi \left( \frac{\omega_N}{\omega_T} C_{T2} + (1-s)y_2 \right), \\ & C_{T3} + d' = (1-s)y_3. \end{aligned}$$

Given the definition of the social planner, it is straightforward to define a constrained inefficiency as follows:

**Definition 1.** *The competitive equilibrium displays constrained inefficiency if it differs from the allocation chosen by the social planner.*

**Proposition 5.** The social planner values the net worth $m = (1-s)y_2 - d$ more than private agents, i.e. $\frac{\partial V^{SP}(m,s,y_2)}{\partial m} > \frac{\partial V(m,s,y_2)}{\partial m}$.

*Proof.* The proof is given in Appendix E.5. □

While the social planner cannot change the allocation in the second period, she values the net worth at the end of the first period more than the private agents, and will choose a lower level of external financing at time 1 to increase the net worth in the second period. To do so, the social planner will discourage the private agents from issuing too much debt or equity since both are affected by the pecuniary externality. Therefore, the social planner needs two instruments to correct the wedge.

**Corollary 1.** To correct the wedge on the net worth, the social planner needs two instruments to affect both equity and debt issuance.

*Proof.* See the discussion above. □

**Proposition 6.** Capital Structure for the Social Planner

The optimal capital structure depends on the quality of institutions $\theta$,

1. When institutions are of sufficiently high quality, i.e. $\theta < \underline{\theta}^{SP}$, there will be only equity issuance.

2. When institutions are of sufficiently poor quality, i.e. $\theta > \bar{\theta}^{SP}$, there will be only debt issuance.

3. When $\theta \in (\underline{\theta}^{SP}, \bar{\theta}^{SP})$, there will be a mixture of equity and debt. As the cost of issuing equity $\theta$ increases, the country chooses a higher level of debt $d$, a lower share of equity $s$, and a higher leverage, $\frac{d/(1+r)}{s(1-\theta)y_1+d/(1+r)}$ and thus ends up with a higher binding constraints in the second period, i.e. higher probability of crises.

**Proposition 7.** Compared to the private agent, there exists a threshold $\theta^*$ such that the economy is constrained efficient if $\theta < \theta^*$. The allocation in the competitive equilibrium is constrained inefficient if $\theta > \theta^*$. Compared to the private agents, the social planner chooses both a lower level of total external financing and a lower level of leverage ratio $\frac{d}{1-s}$, thus resulting in a lower probability of crises in the second period.

*Proof.* Proof of Proposition 6 and 7 is given in Appendix E.6. $\square$

The optimal capital structure chosen by the social planner also strikes a balance between debt and equity financing. The key determinant is the expropriation risk, $\theta$. The difference between the private agent and the social planner depends on the size of the pecuniary externality. To internalize the externality, the social planner demonstrates a greater precautionary motive in two ways. First, she chooses less external financing, resulting in a higher level of net worth in the second period. Second, she chooses a less risky capital structure featuring a lower debt-to-equity ratio.

Proposition 7 has a number of important policy implications. First, it points to the importance of improving institutional quality. By reducing $\theta$ below a threshold $\theta^*$, the economy converges to a constrained efficient world. Even if the first-best allocation cannot be achieved due to the distortions in equity issuance cost, the economy is free of financial crises. Second, if institutional reforms cannot be obtained in the short run, optimal capital controls have to be deployed to reduce financial vulnerability.

**Implementation** To implement the social planner's allocation, we consider a Pigovian taxation approach following the literature. In particular, the social planner has access to a vector of capital control taxes $\{\tau^s, \tau^d\}$ on the external equity and debt together with a lump-sum transfer $T$. Therefore, the budget constraint of the private agents changes into

$$C_{T1} = (1-\tau^s)\, s(1-\theta)y_1 + \left(1-\tau^d\right)\frac{d}{1+r} + T$$

where $T = \tau^s s(1-\theta)y_1 + \tau^d \frac{d}{1+r}$.

**Proposition 8.** The social planner's allocation can be implemented by a pair of capital control taxes $\{\tau^s, \tau^d\}$ on external equity and debt, where taxes are given by

$$\tau^d = \frac{\beta(1+r)E\left[\phi\mu\frac{\omega_N}{\omega_T}\right]}{\frac{\omega_T}{C_{T1}}} > 0$$

$$\tau^s = \frac{\beta E\left[\phi\mu\frac{\omega_N}{\omega_T}y_1\right]}{\frac{\omega_T}{C_{T1}}(1-\theta)y_1} > 0$$

Furthermore, $\tau^d > \tau^s$.

*Proof.* Proof is given in Appendix E.6. □

Proposition 8 implies that (a) the pecuniary externality applies to both debt and equity financing, and (b) the debt financing embeds more externality than equity financing. As a result, optimal policy package features a higher tax rate on debt financing than on equity financing. As an illustration, this theoretical prediction is consistent with the practice of capital controls by the Brazilian government during 2008-2013, when a higher tax on portfolio debt relative to equity was imposed. Furthermore, it is consistent with the "pecking order" theory of capital controls proposed by Ostry et al. (2010), where controls are first imposed on foreign debt and then on portfolio equity (see Forbes et al. (2016) and Chamon and Garcia (2016)).

# 4 $\theta$ Versus $\phi$: A Comparison by Examples

In our theory, the parameter that describes institutional quality, $\theta$, plays a crucial role in determining both the composition of capital flows and the optimal taxes on capital flows. It is natural to wonder whether another parameter, the degree of collateral constraint, $\phi$, can generate the same predictions. Indeed, in the existing literature on sudden stops, one is tempted to think that the main difference between developing and developed countries is that the former have a more binding collateral constraint (i.e., a smaller value of $\phi$).

In this section, we study the differences and similarities between the two parameters by a series of numerical simulations. As a key similarity between the two, we will show that either an improvement in the institutional quality or a relaxation of the collateral constraint will result in a lower probability of crises. However, there are two key differences. First, while an improvement in institutional quality leads to a rise in the share of equity financing in a country's external liabilities, an opposite pattern is associated with a relaxation of the collateral constraint. Second, while countries with better institutions need less capital control, countries with a more relaxed collateral constraint need more capital control. (Bianchi (2011) also reports that the optimal tax on capital flows becomes higher, in his baseline simulations, when a country's collateral constraint is relaxed.)

As developed countries tend to exhibit a higher share of equity financing in their external liability and a lower level of capital controls than developing countries, we will conclude that the key difference between developed and developing countries (and perhaps between middle-income and poor countries) is more in institutional quality than in the extent of collateral constraint.

We conduct our numerical simulations in two steps. First, we hold the degree of collateral constraint $\phi$ constant (at the same benchmark value as in Bianchi (2011)) and vary the values of $\theta$. This is to generate some numerical examples of the theoretical predictions from the previous section, with the aim of providing further intuition. Second, we re-do the exercise by picking different values $\phi$. This can be understood as a numerical comparative statistics exercise over changes in the degree of collateral constraint.

The parameter values chosen for the simulation exercises are reported in Table A.3. For the share of tradable expenditure in total consumption spending, we choose 30% following Bianchi (2011). The risk-free interest rate is chosen to be 5%, a common value used in the literature. We assume that the discount rate, $\beta$, is the inverse of $1+r$. The collateral constraint value $\phi$ is chosen to be 0.3, meaning that the country can only pledge 30% of its current income to international investors (see Ma (2020)). For period 2 income $y_2$, we use a uniform distribution in $U[\bar{y}_2 - \varepsilon, \bar{y}_2 + \varepsilon]$, with a mean of $\bar{y}_2$ and $\varepsilon$ governing its income risk. We vary the parameter denoting the expropriation risk, $\theta$, to see how it affects of the composition of capital flows and the gap in the allocations between the competitive equilibrium and the social planner's optimal choice.

**Figure 2** Optimal Capital Structure

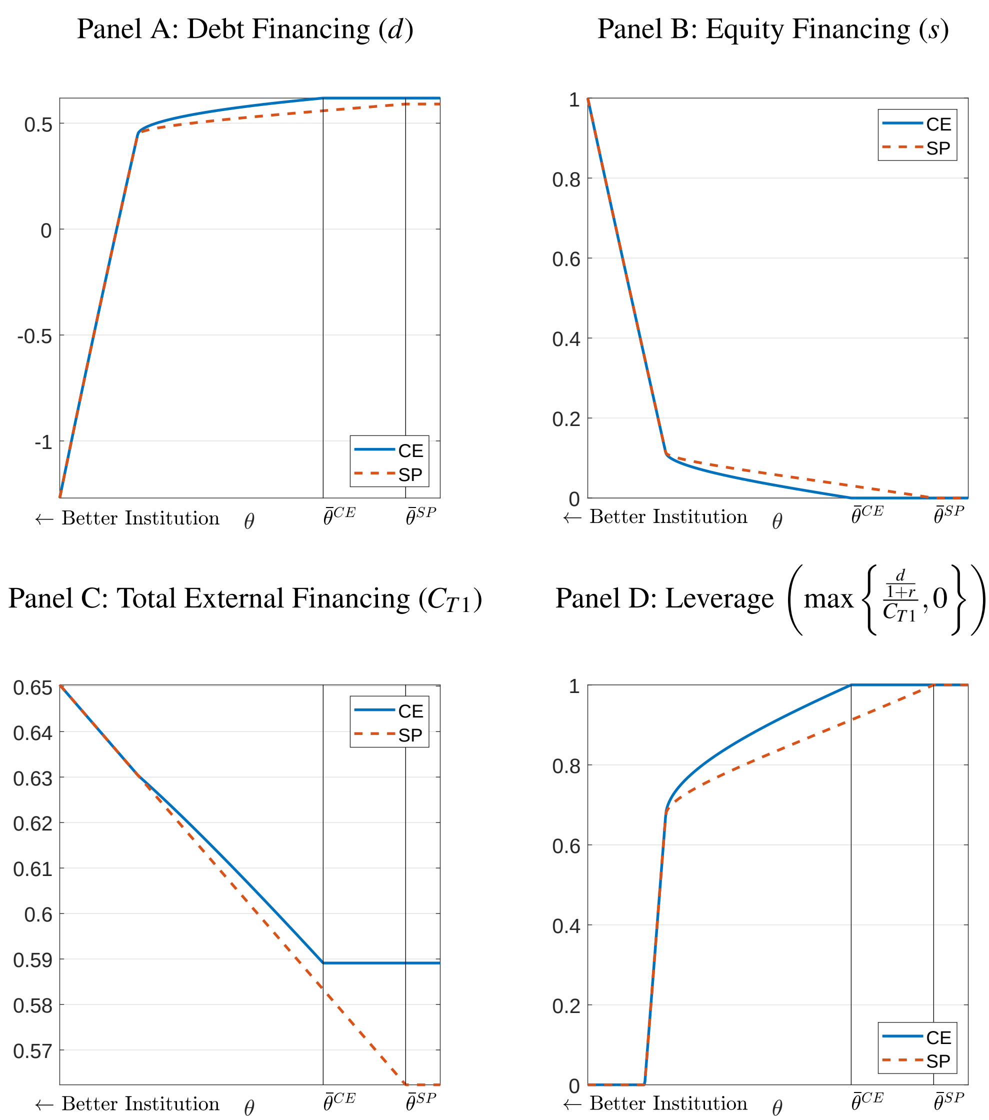



Figure 2 shows the optimal capital structure for different values of $\theta$. A lower level of $\theta$ implies a better institutional quality. Consistent with our theoretical prediction, when expropriation risk $\theta$ increases, the debt $d$ increases while the equity $s$ decreases. When $\theta$ rises up to a certain level, i.e. $\bar{\theta}^{CE}$ in the competitive equilibrium ($\bar{\theta}^{SP}$ in the social planner's allocation), the cost of equity issuance is sufficiently high such that the share of equity goes to zero. The level of total external financing

$C_{T1}$ is also reduced with $\theta$ because a higher equity issuance cost at the margin also increases the cost of debt financing and thus the overall marginal cost of external financing. As a result, the economy takes on more leverage with a higher $\theta$. Such a riskier external capital structure leads to a higher probability of crises as shown in Panel A of Figure 3.[9]

Relative to the private agents, the social planner chooses a lower level of external financing ($C_{T1}$) and a safer capital structure, i.e. lower leverage. In particular, she chooses a lower level of debt and a higher level of equity. Because the social planner prefers equity over debt, the threshold of the institutional quality above which the equity issuance converges to zero is higher for the social planner than for the private agents, i.e. $\bar{\theta}^{SP} > \bar{\theta}^{CE}$.

Due to a less leveraged capital structure, the economy chosen by the social planner is safer than the one in a competitive equilibrium in terms of a lower probability of crises. This means that policy intervention can raise the welfare. The greater the expropriation risk, $\theta$, the greater the welfare gains from the intervention. This is because the over-leveraging problem becomes more severe when the expropriation risk rises. Indeed, when the expropriation risk exceeds some threshold i.e. $\theta \in [\bar{\theta}^{CE}, \bar{\theta}^{SP}]$, private agents would find it too costly to issue equity and thus only issue debt in the competitive equilibrium. For comparison, the social planner prefers equity over debt and would continue to choose equity even with a higher equity issuance cost, $\theta$. In this region, an increase in $\theta$ narrows the welfare gain because the cost of intervention increases with $\theta$. To summarize, the welfare gain from capital controls first increases with the extent of expropriation risk and then declines with a turning point at $\bar{\theta}^{CE}$.

Figure 4 shows the effects of capital controls taxes on external equity and debt. Consistent with the theoretical prediction, both taxes increase with the expropriation risk $\theta$ due to a more inefficient capital structure. Furthermore, the magnitude of capital control tax on debt is larger than that on equity. Compared to the previous literature, the total capital control tax on external debt varies from 0 to 12%, which is comparable to the work by Bianchi (2011). For the tax on external equity, the

[9] In keeping with the norm in the sudden stops literature, the probability of crises is defined as the probability of binding constraints in period 2.

**Figure 3** Financial Stability and Welfare Gains

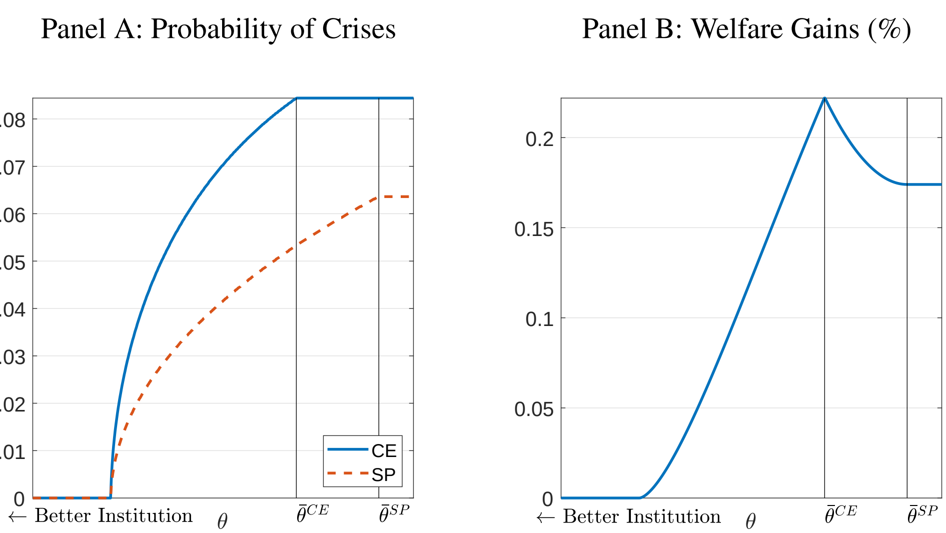
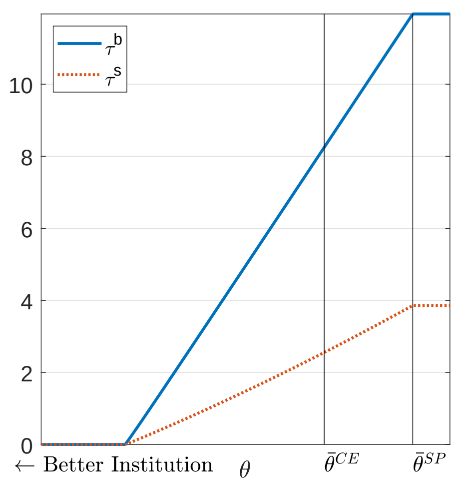



**Figure 4** Capital Control Taxes (%)




number is between 0 to 4%, which is consistent with the policy rates on portfolio equity imposed by the Brazilian government in recent years (see Forbes et al. (2016) and Chamon and Garcia (2016)).

## 4.1 Variations in $\phi$

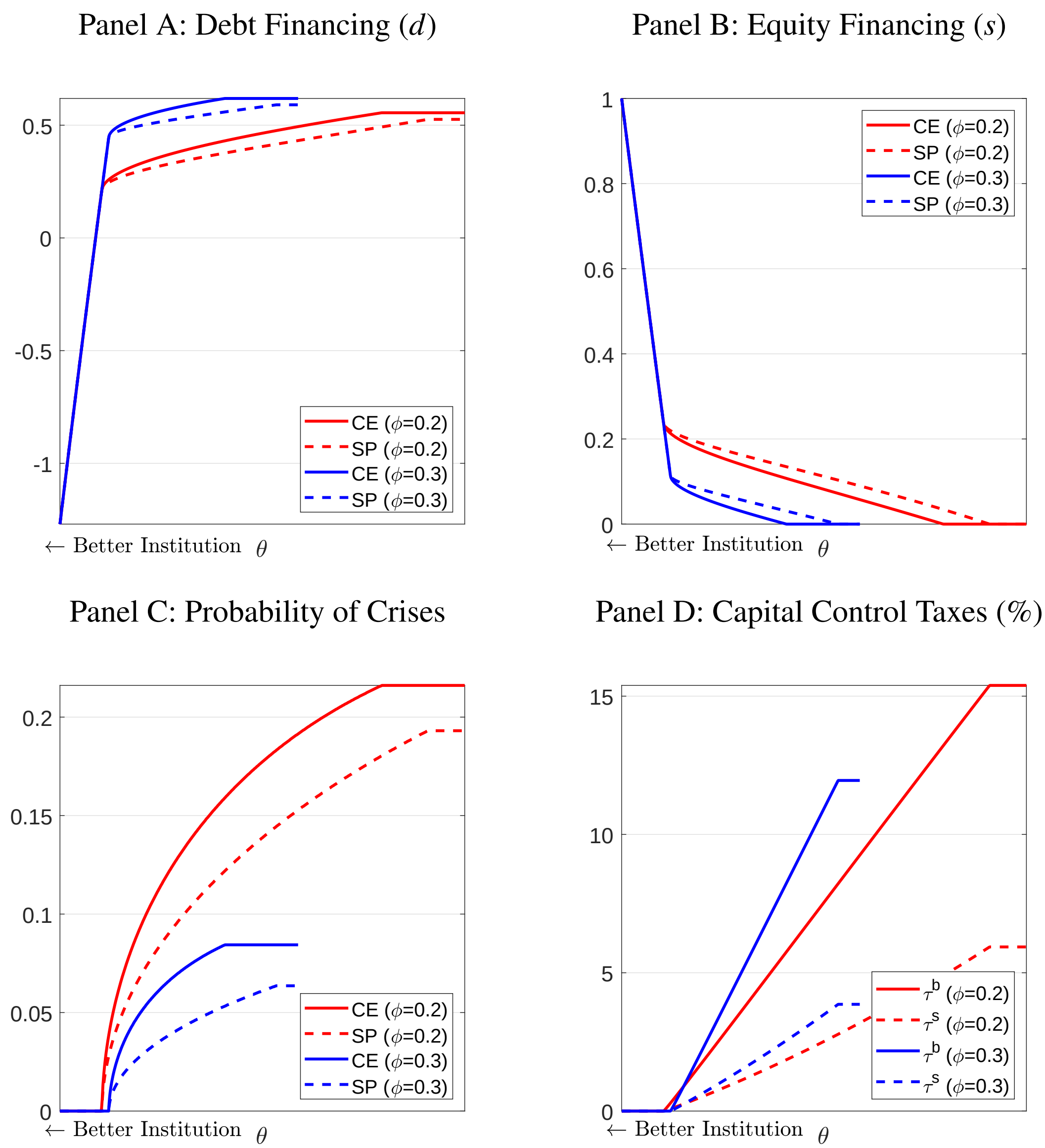
We now contrast the above results with numerical comparative statistics about $\phi$. We do this by picking two different values of $\phi$ to describe two different degrees of collateral constraint. In Panels A, B and C of Figure 5, we present debt financing, equity financing and probability of crises as a function of $\theta$. The blue line represents our baseline calibration with $\phi = 0.3$ while the red line represents the calibration with a lower value of $\phi = 0.2$. The solid line is the allocation for competitive equilibrium and the dashed line is the allocation for the social planner. In panel D, we present the capital control taxes for debt (the solid line) and equity (the dashed line) in the baseline calibration (marked in blue) and the calibration with $\phi = 0.2$ (marked in red).

From the comparative analysis, one can observe an interesting pattern. For a low value of $\theta$ such that the probability of crises is zero for the calibration of $\phi = 0.2$, there is no difference between the two calibrations. That is, the country does not run into a crisis (or binding collateral constraint) for either value of $\theta$. Intuitively, when the institutional quality is high enough such that there is a sufficiently high level of equity financing, the capital structure is not risky, i.e. the constraint does not bind. As a result, there is no inefficiency for either value of $\phi$.

For a higher value of $\theta$ such that the probability of crises is nonzero, one can see that increasing $\phi$ from 0.2 to 0.3 results in a higher level of debt, a lower level of equity, and a lower probability of crises. This is because a higher value of $\phi$ relaxes the collateral borrowing constraint and thus reduces the probability of crises. A reduction in the probability of crises also reduces the cost of debt financing, which at the margin increases debt and reduces equity in the first period.

As for the taxes on debt and equity, they depend on the externality term in the economy, i.e. the wedge between the social and private value of wealth. Intuitively, it is related to the expected social cost of the financial crisis, which can be decomposed into the product of the crisis probability and the crisis severity. An increase in $\phi$ unambiguously lowers the probability of crises, which reduces the externality term. However, as explained before, it also increases the leverage ex-ante, which increases the severity of crises and thus the externality term. The first term dominates for a lower level of $\theta$ as an increase in $\phi$ can bring down the probability of crises

**Figure 5** Comparative Statistics about $\phi$




significantly, close to zero, while the second term dominates for a higher level of $\theta$.

From Panel D, one can see that the red and blue lines for the taxes on debt intersects (at least) once. On the left side of the region for $\theta$, capital controls tax is higher for $\theta = 0.2$ while the tax is lower for $\theta = 0.3$ on the right side of the region for $\theta$. From this analysis, one can see that an increase in $\phi$ can raise the taxes on capital flows.

**Discussion of $\phi$ and capital controls tax** It should be noted that the relationship between $\phi$ and capital controls tax is in general ambiguous. It depends on the relative strength of two opposing forces in terms of the probability of crises versus the severity of crises. In the baseline calibration of Bianchi (2011), i.e. Panel C of Figure 6, he finds that a higher value of $\phi$ leads to a higher value of capital control tax, consistent with our baseline calibration.

To summarize, while economic development may be associated with both better institutions and less binding collateral constraint, we conclude that, from the viewpoint of understanding patterns on cross-border capital flows, cross-country differences in institutional quality may be more important than differences in the extent of collateral constraint.

# 5 Empirical Patterns

In this section, we document some salient patterns about composition of capital flows in the data. While we do not regard them as systematic and rigorous testing of all the implications of the model, they are consistent with a key role of institutional quality in understanding the patterns of capital flows.

Our theoretical model suggests that institutional quality is a key determinant of the composition of capital flows, which in turn affects the probability of subsequent crises, which in turn motivates the use of capital controls. Therefore, one should expect better institutions to lead to a safer external capital structure, a lower probability of crises, and a more open capital account.

We will check if the data reveal the following three patterns:

**Hypothesis 1.** The share of equity in total external liability rises with the strength of a country's institutional quality.

**Hypothesis 2.** The probability of financial crises declines as the share of equity in total external liability rises.

**Hypothesis 3.** Capital controls on debt and equity are negatively correlated with a country's institutional quality.

We combine five data sources: the External Wealth of Nations (EWN) data set from Lane and Milesi-Ferretti (2007), the Worldwide Governance Indicators (WGI) from the World Bank Institute, and data on sudden stop episodes from Korinek and Mendoza (2014), banking crises from Laeven and Valencia (2013), and capital controls from Fernández et al. (2016). The details on the construction of variables are given in Appendix A.

Table 1 presents the relationship between institutional quality and the share of equity in external liability. We find a positive relationship between the two, which is consistent with the prediction of the model. Using the point estimate in Column 3 as an illustration, an improvement in the institutional quality by one standard deviation is associated with a greater share of equity in total liabilities by 5.5 percentage points.[10] This relationship holds even after controlling for economic development, financial development (as proxied by the ratio of bank credit to non-financial sector as a share of GDP), trade, and country and year fixed effects. The coefficients on the control variables are largely consistent with the existing literature (see Wei and Zhou (2018)).[11]

Table 2 presents the relationship between indicators for financial stability and the share of the equity in a country's external liabilities. We use two indicators of financial crises: one for the presence of a banking crisis in a country-year as identified by Laeven and Valencia (2013) and the other for the presence of a sudden stop episode in a country-year as identified by Korinek and Mendoza (2014). Both measures are a 0/1 indicator. The banking crisis indicator is constructed to

[10] The unconditional share of equity in total external liability is 38.57%. In column (3), the slope is 6.02. One standard deviation increase (i.e., 0.92) by in the institutional quality leads to an increase in the equity as a share of total external liabilities by $6.02 * 0.92 = 5.5\%$.

[11] We also use European mortality rates as an IV for institutional quality as in Acemoglu et al. (2001). Table A.5 presents the cross-sectional results using OLS and IV regression. The relationship between institutional quality and the share of equity in external liability still holds as in our panel regression.

**Table 1** External Capital Structure and Institutional Quality

| | Δ Equity share (% in total liability) | | Equity share (% in total liability) | |
|---|---|---|---|---|
| | (1) | (2) | (3) | (4) |
| Δ Quality | 5.29*** | 4.91*** | | |
| | (1.16) | (1.32) | | |
| Quality | | | 6.02* | 8.05** |
| | | | (3.12) | (3.47) |
| log GDP per capita | | -3.92*** | | -3.18 |
| | | (0.83) | | (4.53) |
| Private credit | | -0.02** | | -0.11** |
| | | (0.01) | | (0.04) |
| Trade | | 0.01 | | 0.01 |
| | | (0.01) | | (0.03) |
| Country FE | Yes | Yes | Yes | Yes |
| Time FE | Yes | Yes | Yes | Yes |
| Observations | 3021 | 2725 | 3180 | 2869 |
| Adjusted R-squared | 0.047 | 0.058 | 0.434 | 0.445 |

Note. This table examines the relationship between a country's external capital structure and and its institutional quality. All columns are based on panel fixed effect regressions. The dependent variable in column (1) and (2) is the change of equity share (portfolio equity and FDI) in total liability. The dependent variable in column (3) and (4) is the equity share (portfolio equity and FDI) in total liability. All standard errors are clustered at country level and reported in parentheses. $^{*}$ $p < 0.10$, $^{**}$ $p < 0.05$, $^{***}$ $p < 0.01$.

capture financial distress in the banking system while the sudden stop indicator is constructed to capture sharp reversals in current account balances.

We use a panel Logit model to connect the probability of a crisis to the structure of external liability, controlling for economic development, private credit as a share of GDP (a common proxy for level of financial development), and time fixed effects. We also allow for either country fixed effects (in columns 2, 4, 6, and 8) or random effects (in columns 1, 3, 5, and 7). Our results suggest that a higher share of equity is less likely to be associated with a banking crisis or a sharp current account reversal in a statistically significant way. This is consistent with our model and Tong and Wei (2010). Using Column (4) as an example, an increase in the equity share in total liability by 20 percentage points, or roughly 1 standard deviation in the sample, is associated with a reduction in the incidence of sudden stop crises, by 1 percentage point. The negative association between the equity share and the probability of a crisis holds for a variety of model specifications.

Table 3 presents the relationship between the capital controls measure and institutional quality. We choose the measures in five asset categories to proxy for the capital controls policy in debt and equity as in our model. Specifically, restrictions on equity (EQ), collective investment securities (CI) and derivatives (DE) are grouped into controls on equity while restrictions on bonds with an original maturity of more than one year (BO) and money market instruments (MM) are grouped into capital controls on debt. Our model suggests that both equity and debt flows should be restricted when a country has a poor institutional quality. Furthermore, the restrictions on debt should be higher than that on equity. Unfortunately, because the measures are only 0/1 indicators for the presence of restrictions on each asset category, we can only test whether there is a negative relationship between the presence of capital controls and institutional quality. We are not able to quantify the relative restrictiveness of the controls on equity and debt.

To this end, we use a panel Logit model to conduct our analysis with country controls and time fixed effects. We allow for either random or country fixed effects. The results are consistent with our theoretical prediction of a negative relationship between an institution's quality and its capital controls policy. A country is more likely to put restrictions when it has a poor institutional quality. This relationship is true even after controlling for the level of economic development.[12]

In sum, our empirical results suggest that a country's institutional quality is an important factor in determining the external capital structure and the presence of capital controls. Consistent with our model's prediction, a good institutional quality enables the country to obtain more equity-like financing which reduces the probability of crises. With more risk sharing and more financial stability, there is

[12] We also use colonial settlers' mortality rates as an IV for institutional quality as in Acemoglu et al. (2001). Table A.6 presents the cross-sectional results using OLS and IV regression. The relationship between institutional quality and capital controls still holds as in our panel Logit regression. The only exception is the capital controls on equity, where the IV regression shows a negative but insignificant relationship between institutional quality and capital controls on equity.

**Table 2** FINANCIAL CRISES AND EXTERNAL CAPITAL STRUCTURE

| | Sudden Stop Crises | | | | Systemic Banking Crises | | | |
|---|---|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
| L.equity share | -0.03*** | -0.05*** | -0.03*** | -0.05** | -0.04*** | -0.06*** | -0.04*** | -0.04*** |
| | (0.01) | (0.02) | (0.01) | (0.02) | (0.01) | (0.01) | (0.01) | (0.01) |
| L.log GDP per capita | | | -0.22 | 0.87 | | | -0.28 | -2.18* |
| | | | (0.26) | (1.59) | | | (0.46) | (1.22) |
| L.private credit | | | 0.00 | 0.00 | | | 0.04*** | 0.06*** |
| | | | (0.00) | (0.01) | | | (0.01) | (0.01) |
| L.trade | | | 0.00 | -0.00 | | | 0.01* | 0.02** |
| | | | (0.00) | (0.01) | | | (0.00) | (0.01) |
| Fixed-effects | No | Yes | No | Yes | No | Yes | No | Yes |
| Random-effects | Yes | No | Yes | No | Yes | No | Yes | No |
| Time FE | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Observations | 928 | 736 | 892 | 708 | 2016 | 1083 | 1910 | 999 |

NOTE. This table examines the relationship between crises and equity share. All columns are based on panel Logit model fixed effects regressions. Dependent variable is the dummy for crises. Column (1)-(4) use crises identified by Korinek and Mendoza (2014) while column (5)-(8) use crises identified by Laeven and Valencia (2013). Standard errors are in parentheses. $^{*}$ $p < 0.10$, $^{**}$ $p < 0.05$, $^{***}$ $p < 0.01$.

less need for the country to impose capital controls.

# 6 Conclusion

This paper provides a simple framework to study the role of institutional quality in jointly determining a country's external capital structure and its optimal capital controls policy. In our framework, institutional quality affects the cost of equity issuance and thus the country's ability to issue more equity in its external liability. Poor institutional quality results in a riskier financial structure, which in turn leads to more frequent and inefficient financial crises. In particular, a country's incentive to impose capital controls to correct the inefficiency depends on the quality of its institutions.

Our story can be compared with an alternative narrative that focuses on cross-country differences in the extent of collateral constraint. While either a relaxation of collateral constraint or an improvement in the institutional quality can reduce the

**Table 3** CAPITAL CONTROLS AND INSTITUTIONAL QUALITY

Panel A: Fixed Effects Models

| | EQ | | CI | | DE | | BO | | MM | |
|---|---|---|---|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) |
| Quality | -2.73*** | -3.98*** | -5.55*** | -5.42*** | -3.45*** | -2.40*** | -2.81*** | -4.31*** | -2.07*** | -2.33*** |
| | (0.77) | (0.95) | (0.90) | (1.05) | (0.61) | (0.70) | (0.80) | (0.98) | (0.59) | (0.70) |
| Log GDP per capita | | 1.29 | | -0.45 | | -2.25** | | 5.42*** | | 0.55 |
| | | (1.09) | | (1.22) | | (1.10) | | (1.21) | | (0.94) |
| Private Credit | | -0.02*** | | 0.00 | | -0.01** | | -0.00 | | -0.01** |
| | | (0.01) | | (0.01) | | (0.01) | | (0.00) | | (0.01) |
| Trade | | -0.02* | | 0.00 | | 0.00 | | -0.00 | | -0.01* |
| | | (0.01) | | (0.01) | | (0.01) | | (0.01) | | (0.01) |
| Time Effects | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Observations | 704 | 645 | 698 | 680 | 777 | 754 | 780 | 705 | 859 | 802 |

Panel B: Random Effects Models

| | EQ | | CI | | DE | | BO | | MM | |
|---|---|---|---|---|---|---|---|---|---|---|
| | (11) | (12) | (13) | (14) | (15) | (16) | (17) | (18) | (19) | (20) |
| Quality | -2.85*** | -4.10*** | -4.67*** | -5.05*** | -3.49*** | -2.72*** | -2.73*** | -3.13*** | -2.63*** | -2.01*** |
| | (0.49) | (0.89) | (0.63) | (0.85) | (0.42) | (0.60) | (0.43) | (0.73) | (0.37) | (0.59) |
| Log GDP per capita | | 1.26 | | 0.41 | | -0.97 | | 2.15*** | | -0.21 |
| | | (0.87) | | (0.82) | | (0.73) | | (0.81) | | (0.65) |
| Private Credit | | -0.02*** | | 0.00 | | -0.01 | | -0.00 | | -0.01** |
| | | (0.01) | | (0.01) | | (0.01) | | (0.00) | | (0.01) |
| Trade | | -0.01* | | 0.00 | | 0.01 | | 0.00 | | -0.01 |
| | | (0.01) | | (0.01) | | (0.00) | | (0.01) | | (0.01) |
| Time Effects | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Observations | 1942 | 1795 | 1906 | 1777 | 1797 | 1684 | 1787 | 1657 | 1927 | 1792 |

NOTE. This table examines the relationship between capital controls and institutional quality. All columns are based on panel Logit model regressions. Panel A presents fixed effects models and Panel B presents random effects models. Dependent variable is the dummy for the capital control restriction on different types of assets. We consider five different assets categories: equity (EQ), collective investment securities (CI), derivatives (DE), bonds with an original maturity of more than one year (BO) and money market instruments (MM). Standard errors are in parentheses. $^{*}$ $p<0.10$, $^{**}$ $p<0.05$, $^{***}$ $p<0.01$.

probability of a crisis, there are important differences. First, while a relaxation of the borrowing constraint tends to reduce the ratio of equity to debt financing, an improvement in institutions would produce an opposite change in the composition of capital flows. Second, while a relaxation of the borrowing constraint tends to lead to an increase in the optimal capital control tax, an improvement in institutions would reduce capital controls.

Our paper has important policy implications. First, the best action to correct pecuniary externality is a structural reform aiming at improving the country's institutional quality. Better quality increases both financial stability and economic efficiency simultaneously. The optimal capital controls policy we derive is a second-best policy that can only be used when the structural reform is not attainable within a short period of time. The case for capital controls weakens endogenously with an improvement in the quality of institutions.

To the best of our knowledge, this is the first paper to analyze optimal capital controls in a framework with an endogenous capital structure. Following the existing literature on over-borrowing and sudden stops, the baseline model in the paper assumes that if a typical emerging market economy needs to borrow in the international debt market, it has to borrow in a foreign currency (e.g., US dollar) and in a short maturity. In such case, equity is the only alternative security that features risk-sharing. We may generalize the insight in the paper by allowing for other securities that also have (partial) risk-sharing properties, such as local currency debt and long-maturity debt. In Appendix D, we propose some extensions of the model that incorporate these new instruments, but more can be done in future research.

There are many other new and exciting questions waiting to be answered. For example, it would be interesting to embed our setup in a DSGE framework as in Bianchi (2011) and Jeanne and Korinek (2018). In addition, our formulation may be used to study pro-cyclical leverage ratios and the corresponding optimal policies.

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# A Data (for online posting only)

We combine five data sources: the External Wealth of Nations (EWN) data set from Lane and Milesi-Ferretti (2007), the Worldwide Governance Indicators (WGI) from the World Bank Institute, and data on sudden stop episodes from Korinek and Mendoza (2014), banking crises from Laeven and Valencia (2013), and capital controls from Fernández et al. (2016).

**External Capital Structure** The EWN data set provides detailed information on the external liability structure for most countries from 1970–2015. To construct the share of equity in total liability, we use the sum of portfolio equity liabilities (stock) and FDI liability (stock) divided by total liabilities.

**Institutional Quality** The WGI database provides six measures of government institutional quality for most World Bank member countries from 1996–2017.[13] The six measures for institutional quality include Control of Corruption (CC), Government Effectiveness (GE), Political Stability and Absence of Violence/Terrorism (PS), Rule of Law (PL), Regulatory Quality (RQ) and Voice and Accountability (VA). Each index is constructed in units of a standard normal distribution, i.e. ranging from approximately -2.5 to 2.5, where a higher value means a higher quality of an institution. Following Wei and Zhou (2018), we use the simple average of the six measures as our proxy for institutional quality. This is an important variable since all six measures are highly correlated as shown in Table A.2. Furthermore, the cross country ranking is stable over time.

**Probability of Crises** We use two measures for financial crises. The first is an indicator of banking crises proposed by Laeven and Valencia (2013). The second is an indicator of the sudden stop episodes identified by Korinek and Mendoza (2014). For the identification of sudden stop episodes (typical financial crises in emerging market economies that are accompanied by current account reversals), Korinek and

[13] There are three years with missing data, i.e. 1997, 1999 and 2001. We use a linear method to interpolate the missing data.

Mendoza (2014) extended the analysis of Calvo et al. (2006) by examining episodes with a capital flow reversal and a sharp increase in the aggregate EMBI spread for emerging economies or VIX for advanced economies.

**Capital Controls Measure** We use capital controls data constructed by Fernández et al. (2016) that is based on the IMF's *Annual Report on Exchange Arrangements and Exchange Restrictions* (AREAER). The AREAER contains descriptions and summaries of de jure restrictions in each of the IMF member countries.[14] Fernández et al. (2016) translate the narrative in the AREAER database into a 0/1 qualitative indicator denoting the absence (0) or presence (1) of controls. To proxy for restrictions on foreign purchases by non-residents, we use the measure for "purchase locally by non-residents." We look at the information for five asset categories: Equity (EQ), Collective investment securities (CI), Derivatives (DE), Bonds with an original maturity of more than one year (BO), and money market Instruments (MM). All the measures are positively correlated at a significant level (see Table A.4).

Our final sample consists of 159 economies from 1996-2015. Detailed information on the country list can be found in Appendix B. The summary statistics for the sample can be found in Table A.1 of the Appendix.

[14] There are 10 asset categories in the data set, including equity (EQ), bonds with an original maturity of more than one year (BO), money market instruments (MM), collective investment securities such as mutual funds and investment trusts (CI), derivatives (DE), commercial credits (CC), financial credits (FC), guarantees, sureties and financial back-up facilities (GS), direct investment (DI), and real estate transactions (RE). For our analysis, we use five categories.

# B Data Source (for online posting only)

The sample includes the following 159 economies:

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Albania | Bulgaria | Denmark | Guinea-Bissau | Kyrgyz Republic | Morocco | Qatar | Sao Tome &Principe |
| Algeria | Burkina Faso | Djibouti | Guyana | Lao People's Dem.Rep | Mozambique | Romania | Tanzania |
| Angola | Burundi | Dominican Republic | Haiti | Latvia | Myanmar | Russia | Thailand |
| Argentina | Cambodia | Ecuador | Honduras | Lebanon | Namibia | Rwanda | Togo |
| Armenia | Cameroon | Egypt | Hong Kong | Lesotho | Nepal | Samoa | Trinidad and Tobago |
| Australia | Canada | El Salvador | Hungary | Liberia | Netherlands | Saudi Arabia | Tunisia |
| Austria | Central African Rep. | Eritrea | Iceland | Libya | New Zealand | Senegal | Turkey |
| Azerbaijan | Chad | Estonia | India | Lithuania | Nicaragua | Sierra Leone | Turkmenistan |
| Bahrain | Chile | Ethiopia | Indonesia | Luxembourg | Niger | Singapore | Uganda |
| Bangladesh | China,P.R.: Mainland | Fiji | Iran, Islamic Republic of | Macedonia | Nigeria | Slovak Republic | Ukraine |
| Barbados | China,P.R.:Macao | Finland | Ireland | Madagascar | Norway | Slovenia | United Arab Emirates |
| Belarus | Colombia | France | Israel | Malawi | Oman | Somalia | United Kingdom |
| Belgium | Comoros | Gabon | Italy | Malaysia | Pakistan | South Africa | United States |
| Belize | Congo, Dem. Rep. of | Gambia, The | Jamaica | Maldives | Panama | Spain | Uruguay |
| Benin | Congo, Republic of | Georgia | Japan | Mali | Papua New Guinea | Sri Lanka | Uzbekistan |
| Bhutan | Costa Rica | Germany | Jordan | Malta | Paraguay | Sudan | Venezuela, Rep. Bol. |
| Bolivia | Croatia | Ghana | Kazakhstan | Mauritania | Peru | Suriname | Vietnam |
| Botswana | Cyprus | Greece | Kenya | Mexico | Philippines | Swaziland | Zambia |
| Brazil | Czech Republic | Guatemala | Korea | Moldova | Poland | Sweden | Zimbabwe |
| Brunei Darussalam | Cote d'Ivoire | Guinea | Kuwait | Mongolia | Portugal | Switzerland | |

**Data Sources:**

**Equity (% of total liabilities)** is constructed as the ratio of the sum of portfolio equity liabilities and FDI liabilities over total liabilities, where the variables are from Lane and Milesi-Ferretti (2007).

**Institutional Quality** is measured by the Worldwide Governance Indicators from the World Bank Institute.

**Sudden Stop Indicator** is from Korinek and Mendoza (2014).

**Systemic Banking Crises Indicator** is from Laeven and Valencia (2013).

**GDP per capita** (constant 2010 US$), **Domestic Private Credit (in % of GDP)**, and **Trade/GDP** are from the World Development Indicators (WDI).

**Capital Control** measures are from Fernández et al. (2016).

# C Appendix Tables (for online posting only)

**Table A.1** SUMMARY STATISTICS

| Variable | Obs | Mean | Std.Dev. | Min | Max |
|---|---|---|---|---|---|
| Equity (% of total liability) | 3180 | 38.57 | 20.55 | 0 | 95.22 |
| Institutional Quality | 3180 | -0.05 | 0.92 | -2.45 | 1.97 |
| log GDP per capita | 3107 | 8.39 | 1.58 | 4.81 | 11.61 |
| Private Credit | 2980 | 47.88 | 44.91 | 0.19 | 312.2 |
| Trade | 3038 | 87.64 | 53.38 | 0.31 | 455.3 |

**Table A.2** PAIRWISE CORRELATION FOR INSTITUTIONAL QUALITY

| | CC | GE | PS | RL | RQ | VA |
|---|---|---|---|---|---|---|
| Control of Corruption (CC) | 1.00 | | | | | |
| Government Effectiveness (GE) | 0.94* | 1.00 | | | | |
| Political Stability and Absence of Violence/Terrorism (PS) | 0.75* | 0.74* | 1.00 | | | |
| Rule of Law (PL) | 0.88* | 0.94* | 0.72* | 1.00 | | |
| Regulatory Quality (RQ) | 0.95* | 0.96* | 0.79* | 0.93* | 1.00 | |
| Voice and Accountability (VA) | 0.78* | 0.79* | 0.66* | 0.82* | 0.82* | 1.00 |

NOTE. This table examines the correlation among different measures of institutional quality. The * shows significance at the 0.01 level.

**Table A.3** PARAMETER VALUES FOR NUMERICAL EXAMPLE

| $\omega_T$ | $\omega_T = 1 - \omega_N$ | $r$ | $\beta = (1+r)^{-1}$ | $\varepsilon$ | $\phi$ | $y_{N2}$ | $\bar{y}_2$ | $y_3$ |
|---|---|---|---|---|---|---|---|---|
| 0.3 | 0.7 | 5% | 0.95 | 0.05 | 0.3 | 1 | 1 | 1 |

**Table A.4** PAIRWISE CORRELATION FOR CAPITAL CONTROLS MEASURE

| Variables | EQ | CI | DE | BO | MM |
|---|---|---|---|---|---|
| Equity (EQ) | 1 | | | | |
| Collective investments (CI) | 0.556* | 1 | | | |
| Derivatives (DE) | 0.359* | 0.495* | 1 | | |
| Bonds with an original maturity of more than one year (BO) | 0.549* | 0.529* | 0.405* | 1 | |
| Money market instruments (MM) | 0.506* | 0.638* | 0.489* | 0.688* | 1 |

NOTE. This table examines the correlation among capital controls on different asset categories. The * shows significance at the 0.01 level.

**Table A.5** External Capital Structure and Institutional Quality: OLS and IV Regression

| | Equity Share | | | | | |
|---|---|---|---|---|---|---|
| | OLS | | IV | | | |
| | (1) | (2) | (3) | (4) | (5) | (6) |
| Quality | 3.56*** | -2.25 | 7.73** | 7.64** | 5.17* | 5.07* |
| | (1.36) | (2.73) | (3.13) | (3.05) | (2.81) | (2.60) |
| Log GDP per capita | | 2.96** | | 2.51 | | 1.04 |
| | | (1.39) | | (1.96) | | (1.46) |
| Private Credit | | -0.01 | | -0.00 | | -0.08* |
| | | (0.04) | | (0.06) | | (0.05) |
| Trade | | 0.08*** | | 0.04 | | 0.08*** |
| | | (0.02) | | (0.03) | | (0.03) |
| Observations | 159 | 154 | 84 | 83 | 159 | 154 |
| Adjusted R-squared | 0.036 | 0.110 | 0.098 | 0.121 | 0.027 | 0.081 |

Note. This table examines the relationship between a country's external capital structure and and its institutional quality using cross-country regressions. All the variables are the time-series average for a country during 1996-2015. Column (1) and (2) use OLS regression. Column (3) to (6) use European mortality rates as IV for institutional quality (see Acemoglu et al. (2001)). To solve the missing sample issue, column (5) and (6) use a dummy to flag the missing data points in the mortality rates and then use both the dummy and mortality rates as IV for institutional quality. We also adjust the control variables in column (2), (4) and (6). Specifically, we first regress those control variables on the IV instruments and then use the residuals to replace those controls. By doing so, we isolate the effects of IV instruments on those controls. All standard errors are clustered at country level and reported in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

**Table A.6** CAPITAL CONTROLS AND INSTITUTIONAL QUALITY: OLS AND IV REGRESSION

| | Panel A: OLS Regression | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) |
| | EQ | | CI | | DE | | BO | | MM | |
| Quality | -0.15*** | -0.24*** | -0.18*** | -0.24*** | -0.20*** | -0.18** | -0.18*** | -0.19** | -0.19*** | -0.14* |
| | (0.04) | (0.09) | (0.04) | (0.08) | (0.04) | (0.08) | (0.04) | (0.08) | (0.03) | (0.07) |
| Log GDP per capita | | 0.05 | | 0.06 | | -0.06 | | -0.03 | | -0.06 |
| | | (0.05) | | (0.04) | | (0.04) | | (0.04) | | (0.04) |
| Private Credit | | 0.00 | | 0.00 | | 0.00 | | 0.00 | | 0.00 |
| | | (0.00) | | (0.00) | | (0.00) | | (0.00) | | (0.00) |
| Trade | | -0.00 | | -0.00 | | 0.00 | | 0.00 | | -0.00 |
| | | (0.00) | | (0.00) | | (0.00) | | (0.00) | | (0.00) |
| Observations | 98 | 96 | 98 | 96 | 98 | 96 | 98 | 96 | 98 | 96 |
| Adjusted R-squared | 0.117 | 0.080 | 0.201 | 0.153 | 0.230 | 0.215 | 0.214 | 0.176 | 0.241 | 0.201 |
| | Panel B: IV regression | | | | | | | | | |
| Quality | -0.10 | -0.11 | -0.21** | -0.21** | -0.21** | -0.24** | -0.17* | -0.18** | -0.21** | -0.23** |
| | (0.10) | (0.10) | (0.09) | (0.09) | (0.09) | (0.09) | (0.09) | (0.09) | (0.09) | (0.09) |
| Log GDP per capita | | -0.05 | | 0.05 | | -0.05 | | 0.00 | | -0.03 |
| | | (0.07) | | (0.06) | | (0.06) | | (0.06) | | (0.06) |
| Private Credit | | 0.00 | | 0.00 | | 0.00* | | 0.00 | | 0.00 |
| | | (0.00) | | (0.00) | | (0.00) | | (0.00) | | (0.00) |
| Trade | | -0.00 | | -0.00 | | -0.00 | | -0.00 | | -0.00 |
| | | (0.00) | | (0.00) | | (0.00) | | (0.00) | | (0.00) |
| Observations | 53 | 52 | 53 | 52 | 53 | 52 | 53 | 52 | 53 | 52 |
| Adjusted R-squared | 0.033 | -0.020 | 0.136 | 0.059 | 0.140 | 0.134 | 0.138 | 0.058 | 0.173 | 0.107 |
| | Panel C: IV with missing variable dummy | | | | | | | | | |
| Quality | -0.09 | -0.10 | -0.21*** | -0.22*** | -0.24*** | -0.25*** | -0.17*** | -0.19*** | -0.21*** | -0.23*** |
| | (0.08) | (0.08) | (0.07) | (0.07) | (0.07) | (0.07) | (0.06) | (0.07) | (0.06) | (0.07) |
| Log GDP per capita | | -0.00 | | 0.08* | | -0.03 | | -0.04 | | -0.02 |
| | | (0.05) | | (0.04) | | (0.04) | | (0.04) | | (0.04) |
| Private Credit | | -0.00 | | 0.00 | | 0.00** | | 0.00 | | 0.00 |
| | | (0.00) | | (0.00) | | (0.00) | | (0.00) | | (0.00) |
| Trade | | -0.00 | | -0.00 | | 0.00 | | 0.00 | | 0.00 |
| | | (0.00) | | (0.00) | | (0.00) | | (0.00) | | (0.00) |
| Observations | 98 | 96 | 98 | 96 | 98 | 96 | 98 | 96 | 98 | 96 |
| Adjusted R-squared | 0.097 | 0.056 | 0.197 | 0.174 | 0.223 | 0.209 | 0.213 | 0.179 | 0.238 | 0.192 |

NOTE. This table examines the relationship between a country's external capital structure and its institutional quality using cross-country regressions. All the variables are the time-series average for a country during 1996-2015. Panel A uses OLS regression. Panel B uses European mortality rates as IV for institutional quality (see Acemoglu et al. (2001)). To solve the missing sample issue, Panel C uses a dummy to flag the missing data points in the mortality rates and then uses both the dummy and mortality rates as IV for institutional quality. We also adjust the control variables in column (2), (4), (6), (8) and (10). Specifically, we first regress those control variables on the IV instruments and then use the residuals to replace those controls. By doing so, we isolate the effects of IV instruments on those controls. All standard errors are clustered at country level and reported in parentheses. $^{*}$ $p < 0.10$, $^{**}$ $p < 0.05$, $^{***}$ $p < 0.01$.

# D Model Extensions (for online posting only)

We discuss three extensions of the baseline model. In the first one, we assume that the economy can issue equity in the second period. The main additional insight is a role of an ex post intervention as well as ex ante intervention. In the second one, we introduce long-term debt. In the third one, we introduce local currency debt. Both long-term debt and local currency debt carry more risk-sharing than short-term debt, and therefore share some similarities with equity financing. But each is also different from equity financing in some ways.

## D.1 Equity Issuance During Crises

In this extension, we allow for equity issuance in the intermediate period. A key new insight is a possible role for ex post intervention because pecuniary externality affects two decision margins in the second period.

Suppose that in the second period, the economy can issue an additional share of equity $s' \in [0, 1-s]$ to foreign investors. Since the equity issuance is subject to expropriation risk $\theta$, the share of equity is priced at $(1-\theta)\frac{y_3}{1+r}$. The budge constraints in period 2 and 3 change into

$$pC_{N2} + C_{T2} = \underbrace{(1-s)y_2 - d}_{m} + py_{N2} + \frac{d'}{1+r} + s'(1-\theta)\frac{y_3}{1+r} \tag{6}$$

$$C_{T3} = y_3 - d' - (s+s')y_3$$

The financial constraint in period 2 is unchanged, i.e.

$$\frac{d'}{1+r} \leq \phi((1-s)y_2 + py_{N2}) \tag{7}$$

The economy can choose equity and debt financing to smooth consumption in the second period. However, the usage of equity financing depends on the quality of domestic institutions. Consider the case where $\theta = 0$, i.e. very good domestic institution. In the second period, the economy always uses equity financing as opposed to debt financing since equity financing does not lead to a binding financial constraint. Therefore, there will be no case for debt financing, the same insight as in the benchmark economy. However, equity financing is never used in equilibrium when the institution quality is poor (for example, $\theta = 1$). By continuity, there will be an optimal capital structure in the second period depending on $\theta$.

**Proposition 9.** When the economy is allowed to issue equity in the second period, it chooses to do so when the constraint binds in the second period. However, the economy chooses too little equity financing due to the pecuniary externality, which justifies an ex-post intervention. There will still be an overborrowing in the first period as in the benchmark economy. To correct the externality, the social planner needs to use both ex-ante and ex-post intervention.

*Proof.* Proof is given in Appendix E.7. □

The introduction of equity issuance in the second period allows a role for ex-post intervention since the pecuniary externality affects two decision margins in the second period when the constraint binds. Unlike the previous literature which allows only for debt financing (Bianchi (2011) and Jeanne and Korinek (2018)), introducing equity financing allows the social planner to use ex-post intervention to change the composition of external financing when the constraint binds. In particular, the social planner favors equity financing as it provides better risk-sharing and suffers less pecuniary externality than the debt financing. Nevertheless, the use of ex-post intervention cannot completely eliminate the pecuniary externality in the economy, which calls for a use of ex-ante policy intervention in equilibrium.

It is also worth pointing out that the feature of ex-post intervention is different from the existing form of ex-post intervention in the literature such as Benigno et al. (2013), Ma (2020) and Jeanne and Korinek (forthcoming). Our ex-post intervention is used to change the composition of external financing in order to reduce the cost of binding constraint, while it is used in Benigno et al. (2016) to change the composition of labor supply between tradable and non-tradable sectors or in Ma (2020) the composition of consumption versus investment. The ex-post intervention takes the form of a fiscal transfer in Jeanne and Korinek (forthcoming) but still a tax on capital flows in our case.

## D.2 Long-term Debt

We introduce long-term debt $D$ with a promised return $(1+r)^2$ at period 3 in addition to the short-term debt $d$ at period 1. Without introducing any additional cost, the economy strictly prefers long-term debt to short-term debt because long-term debt avoids the binding constraint in the second period. To this end, we assume that institutional quality also affects the issuance of long-term debt as in Wei and Zhou (2018). Specifically, there is an expropriation risk for international investors to hold long-term debt. As a result, the budget constraints change into

$$\begin{aligned}
C_{T1} &= \frac{d}{1+r} + (1-\theta)\frac{D}{(1+r)^2} \\
pC_{N2} + C_{T2} &= y_2 - d + py_{N2} + \frac{d'}{1+r} \\
C_{T3} &= y_3 - d' - D
\end{aligned}$$

The long-term bond provides better risk-sharing property than the short-term bond since it avoids the possibility of costly binding financial constraints in the second period. However, it also suffers from a cost associated with the expropriation risk. At the margin, the economy strikes a balance between these two. Moreover, due to a pecuniary externality, the economy also displays an over-borrowing that applies only to the short-term bond. The social planner wants to use capital controls to correct it. The following proposition summarizes the key results.

**Proposition 10.** When the economy can issue both long-term and short-term debt, there will be an optimal combination of both depending on the institutional quality $\theta$. Specifically, there exists two thresholds $\{\underline{\theta}, \bar{\theta}\}$ such that a combination of short-term and long-term debt exists when $\theta \in (\underline{\theta}, \bar{\theta})$. When the institutional quality is high enough, i.e. $\theta < \underline{\theta}$, the economy always prefer long-term debt. When the institutional quality is low enough, i.e. $\theta > \bar{\theta}$, the economy always prefers short-term debt. In this economy, pecuniary externality only affects the short-term debt. The social planner wants to use capital controls to correct the overborrowing from issuing short-term debt.

*Proof.* Proof is given in Appendix E.8. □

As in our benchmark model with equity and short-term debt, the combination of long-term and short-term debt depends ultimately on the degree of institutional quality. In our setup, the long-term debt actually is better than the equity since its issuance is not affected by the pecuniary externality. However, this is due to the assumption that the collateral constraint only shows up in the second period and the long-term debt matures in the last period.

In general, the issuance of long-term debt will be affected by the pecuniary externality if a collateral constraint also exists in the period when long-term debt matures. In that case, equity financing likely still dominates the long-term debt other things equal since it provides more risk-sharing. In other words, one could have a model with long-term debt, short-term debt, and equity. The equilibrium proportions of the three securities depend on the effects of institutional quality on their respective prices.

## D.3 Local Currency Debt

We assume that the economy can issue both dollar-denominated debt $d$ and local currency debt $l$ in period 1 to finance its consumption.[15] As in the benchmark economy, the dollar-denominated debt has a promised return of world interest rate $r$ and is thus priced at $\frac{1}{1+r}$. The return on local currency debt is expressed in terms of units of tradable good and denoted by $\rho$. Its value depends on the realization of the real exchange rate $p$ in period 2. Since international investors are risk-neutral,

[15] While we could introduce local currency debt in period 2, it would not be very interesting. With no uncertainty in period 3, the local currency debt and dollar-denominated debt would have been perfect substitutes (see Korinek (2009)).

the no-arbitrage condition requires the following

$$E[\rho] = 1 + r$$

Since the return $\rho$ is linked to the real exchange $p$ at period 2, it implies that

$$\rho = \frac{p}{E[p]}(1 + r)$$

If the local currency debt $l$ could be issued without additional cost, the capital recipient country would always want to issue it due to its better risk-sharing property. However, it has been noted that developing countries cannot issue local currency debt to international investors — a phenomenon labeled as the "original sin" by Eichengreen and Hausmann (1999). One explanation for this is that countries cannot credibly commit not to use inflation to expropriate the holders of local currency debt in economic downturns (see a formulation of the idea by Engel and Park (2018)).

It is reasonable to assume that those countries with poorer institutional quality are likely to suffer more from a lack of commitment in its monetary policy. As a consequence, their local currency debt will be discounted more by international investors. With a slight abuse of notations, we capture the extent of the discount by $\theta$. Given this structure, the budget constraints in period 1 and 2 for the economy become

$$\begin{aligned} C_{T1} &= \frac{d}{1+r} + l(1-\theta), \\ pC_{N2} + C_{T2} &= y_2 + py_{N2} - d - \rho l + \frac{d'}{1+r} \end{aligned}$$

**Competitive Equilibrium** In this economy, there will be an equilibrium combination of local-currency and dollar-denominated debt whose precise composition depends on the value of $\theta$. The following proposition summarizes the result.

**Proposition 11.** When the economy can issue both dollar-denominated and local currency debt, the equilibrium combination of the securities depends on institutional quality $\theta$. More precisely, there exists two threshold levels, $\{\underline{\theta}, \bar{\theta}\}$. When the institutional quality is good enough, i.e. $\theta < \underline{\theta}$, there is only local currency debt. When the institutional quality is poor enough, i.e. $\theta > \bar{\theta}$, there is only dollar debt. When $\theta \in (\underline{\theta}, \bar{\theta})$, there is a combination of local currency and dollar debt.

*Proof.* Proof is given in Appendix E.9. $\square$

**Social Planner with Commitment**

Pecuniary externality in this economy calls for policy intervention. To correct the externality, we introduce a planner who internalizes the general equilibrium effect through real exchange rate $p$.

Note that the policy intervention itself also faces a commitment issue. Since the payoff for the local currency debt $\rho$ is given by $\frac{p}{E[p]}(1+r)$, if the planner could commit in Period 1 to a consumption profile $C_{T2}$, it can change the payoff structure across states in period 2, which ultimately affects period 1 consumption. However, in period 2, the planner has an incentive to deviate from her original plan when a particular state is actually materialized. In this case, the ability to commit matters.

To sort out the efficiencies in this new economy, we set up a social planner problem with commitment power. In this case, one needs three capital controls to correct the inefficiencies in the economy. The following proposition summarizes the main results.

$$
\begin{aligned}
V^C(\theta) = \quad & \max_{d,l,C_{T1},C_{T2},d',C_{T3}} \quad \omega_T \log C_{T1} + \beta E[\omega_T \log C_{T2} + \omega_N \log y_{N2} + \beta \omega_T \log C_{T3}] \\
& \text{s.t.} \quad C_{T1} = \frac{d}{1+r} + (1-\theta) l \\
& \qquad C_{T2} = y_2 - d + \frac{d'}{1+r} - \rho(C_{T2}, E[C_{T2}]) l \\
& \qquad \frac{d'}{1+r} \leq \phi \left( y_2 + \frac{\omega_N}{\omega_T} C_{T2} \right) \\
& \qquad C_{T3} = y_3 - d'
\end{aligned}
$$

**Proposition 12.** A social planner with commitment chooses a different allocation from the private agents. To correct the inefficiency, three capital control policies with lump-sum transfers are needed on period 1 dollar debt and local currency debt $\{\tau_d, \tau_l\}$ and period 2 dollar debt $\tau_{d'}$.

$$\tau_d = \beta(1+r)E_1\left[\frac{\phi\mu^C\frac{\omega_N}{\omega_T} - \frac{\omega_T}{C_{T2}}l\left(\frac{\partial\rho}{\partial C_{T2}} + f(y_2)\frac{\partial\rho}{\partial E[C_{T2}]}\right)}{1+l\left(\frac{\partial\rho}{\partial C_{T2}} + f(y_2)\frac{\partial\rho}{\partial E[C_{T2}]}\right)}\right] / \left(\frac{\omega_T}{C_{T1}}\right)$$

$$\tau_l = \beta E_1\left[\frac{\phi\mu^C\frac{\omega_N}{\omega_T} - \frac{\omega_T}{C_{T2}}l\left(\frac{\partial\rho}{\partial C_{T2}} + f(y_2)\frac{\partial\rho}{\partial E[C_{T2}]}\right)}{1+l\left(\frac{\partial\rho}{\partial C_{T2}} + f(y_2)\frac{\partial\rho}{\partial E[C_{T2}]}\right)}\rho\right] / \left(\frac{\omega_T}{C_{T1}}\right) / (1-\theta)$$

$$\tau_{d'} = \frac{l\left(\frac{\partial\rho}{\partial C_{T2}} + f(y_2)\frac{\partial\rho}{\partial E[C_{T2}]}\right)}{1+l\left(\frac{\partial\rho}{\partial C_{T2}} + f(y_2)\frac{\partial\rho}{\partial E[C_{T2}]}\right)}$$

*Proof.* Proof is given in Appendix E.9 □

Since there are two types of inefficiencies in the competitive equilibrium, it can produce either overborrowing or underborrowing relative to the social planner's solution. The exact parameter values matter. Nevertheless, capital controls can be put in place to implement the optimal allocation under commitment.

### A Government's Solution

A government that sees the market failure in the decentralized equilibrium may wish to intervene. However, a government's ability to commit and hence its ability to replicate the social planner's solution cannot be taken for granted. We consider the case of a government whose ability to commit depends on the institutional quality. A country with poorer institutional quality is assumed to have a weaker commitment ability.

To capture such a distortion, we introduce a welfare loss related to $\theta$, $\Psi(\theta)$, and define a government's problem as follows.

$$V^B(\theta) = V^C(\theta) - \Psi(\theta)$$

One can decide the desirability of capital controls policy by comparing the welfare of the bureaucratic problem $V^B(\theta)$ with the welfare in the competitive equilibrium. Only when the former is larger than the latter would it be desirable to impose capital controls. Otherwise, the welfare loss from weak commitment $\Psi(\theta)$ could overwhelm the gains from capital controls. In short, the institutional quality matters for the type of capital controls — not only through its impact on the price of local currency debt (as in our benchmark economy) but also through its impact on the commitment ability of the government.

To summarize, local currency debt provides better risk-sharing than dollar debt. Similar to equity issuance, its cost depends on the quality of institutions. Therefore, the equilibrium composition of the securities depends on the effect of institutional quality on their costs.

A difference between local currency debt and equity is that the former involves a commitment problem, which depends on the institutional quality. In general, local currency debt does not dominate equity financing since correcting the inefficiency in local currency debt requires the government to have a strong commitment power.

# E Proofs (for online posting)

## E.1 Proof of Proposition 1

*Proof.* The domestic agents choose whether to manipulate the securities payoffs at the beginning of period 2. Their maximization problem is given by the following:

$$\max_{C_{T2},C_{N2},d',\{m_e,m_d\}\in\{0,1\}} \omega_T \log C_{T2} + \omega_N \log C_{N2} + \beta\omega_T \log C_{T3}$$

$$\text{s.t.} \quad pC_{N2} + C_{T2} = py_{N2} + y_2 - sy_2 - d + \frac{d'}{1+r}$$
$$+ s\mathbb{1}_{m_e=1}[q\kappa - (1-q)\chi]y_2 + d\mathbb{1}_{m_d=1}[q\kappa' - (1-q)\chi' - B]$$
$$C_{T3} = y_3 - sy_3 - d' + s\mathbb{1}_{m_e=1}[q\kappa - (1-q)\chi]y_3$$
$$\frac{d'}{1+r} \leq \phi(py_{N2} + (1-s)y_2)$$

Defining a variable $g = d' - s\mathbb{1}_{m_e=1}[q\kappa - (1-q)\chi]y_3$, we can rewrite the budget constraints as follows:

$$\begin{aligned} pC_{N2} + C_{T2} &= py_{N2} + (1-s)y_2 - d + \frac{g}{1+r} \\ &+ s\mathbb{1}_{m_e=1}[q\kappa - (1-q)\chi]\left(y_2 + \frac{y_3}{1+r}\right) + d\mathbb{1}_{m_d=1}[q\kappa' - (1-q)\chi' - B] \end{aligned}$$

and

$$C_{T3} = y_3 - sy_3 - g$$

The collateral constraint also changes into

$$\frac{g}{1+r} + s\mathbb{1}_{m_e=1}[q\kappa - (1-q)\chi]\frac{y_3}{1+r} \leq \phi(py_{N2} + (1-s)y_2)$$

The optimality condition for $m_e = 1$ is thus given by

$$[q\kappa - (1-q)\chi]s\left[\lambda\left(y_2 + \frac{y_3}{1+r}\right) - \mu\frac{y_3}{1+r}\right] \geq 0$$

.

Realize that $\lambda = \mu + \beta(1+r)\frac{\omega_T}{C_{T3}}$, one can simplify the optimality condition for $m_e = 1$ into

$$q\kappa - (1-q)\chi \geq 0$$

.

Similarly, one can obtain the optimality condition for $m_d = 1$ as

$$q\kappa' - (1-q)\chi' \geq B$$

□

## E.2 Proof of Proposition 2

*Proof.* Define net worth at the beginning of period 2 by $m = (1-s)y_2 - d$. The state variables in period 2 include $\{m, s, y_2\}$. The original problem can be written as

$$W_1 = \max_{s,d} \omega_T \log C_{T1} + \beta E_1[V(m,s,y_2)],$$
$$\text{s.t. } C_{T1} = sy_1(1-\theta) + \frac{d}{1+r},\ m = (1-s)y_2 - d.$$

where $V(m,s,y_2)$ is given by

$$V(m,s,y_2) = \max_{C_{N2},C_{T2},C_{T3},d'} \omega_T \log C_{T2} + \omega_N \log C_{N2} + \beta\omega_T \log C_{T3},$$
$$\text{s.t. (2), (4) and (5).}$$

When the constraint is slack, the following condition holds.

$$d' = \frac{(1-s)y_3 - \beta(1+r)m}{1+\beta}$$

The constraint is slack iff

$$\frac{d'}{1+r} \leq \phi\left(\frac{\omega_N}{\omega_T}C_{T2} + (1-s)y_2\right) = \phi\left(\frac{\omega_N}{\omega_T}\left(m + \frac{d'}{1+r}\right) + (1-s)y_2\right) \leq \frac{\phi\frac{\omega_N}{\omega_T}m + \phi(1-s)y_2}{1-\phi\frac{\omega_N}{\omega_T}}$$

It is equivalent to

$$m \geq (1-s)\frac{\frac{y_3}{(1+\beta)(1+r)} - \frac{\phi y_2}{1-\phi\frac{\omega_N}{\omega_T}}}{\frac{\beta}{1+\beta} + \frac{\phi\frac{\omega_N}{\omega_T}}{1-\phi\frac{\omega_N}{\omega_T}}}$$

Equivalently, the constraints bind if

$$\frac{d}{1-s} > \frac{y_2\left(\frac{\beta}{1+\beta} + \frac{\phi/\omega_T}{1-\phi\frac{\omega_N}{\omega_T}}\right) - \frac{y_3}{(1+\beta)(1+r)}}{\frac{\beta}{1+\beta} + \frac{\phi\frac{\omega_N}{\omega_T}}{1-\phi\frac{\omega_N}{\omega_T}}} \tag{8}$$

□

## E.3 Proof of Proposition 3

*Proof.* When $\theta = 0$, the optimality conditions for $d$, $s$ and $d'$ are given by

$$\frac{\omega_T}{C_{T1}} = \beta(1+r)E_1\left[\frac{\omega_T}{C_{T2}}\right] \tag{9}$$

$$-\frac{\omega_T}{C_{T1}}y_1 + \beta E_1\left[\frac{\omega_T}{C_{T2}}y_2 + \mu\phi y_2 + \beta\frac{\omega_T}{C_{T3}}y_3\right] \leq 0 \tag{10}$$

$$\frac{\omega_T}{C_{T2}} = \beta(1+r)\frac{\omega_T}{C_{T3}} + \mu \tag{11}$$

where equation (10) holds with inequality when $s = 1$.

By plugging the optimality conditions (9) and (11) into (10), the LHS of equation (10) becomes

$$\beta E_1\left[\frac{\omega_T}{C_{T2}}\left(y_2 - \frac{\underline{y}+\bar{y}}{2}\right) + \mu\left(\phi y_2 - \frac{y_3}{1+r}\right)\right] \tag{12}$$

which is negative because

$$E_1\left[\frac{\omega_T}{C_{T2}}\left(y_2 - \frac{\underline{y}+\bar{y}}{2}\right)\right] = \mathrm{cov}\left(\frac{\omega_T}{C_{T2}}, y_2\right) < 0,$$

$$E_1\left[\mu\left(\phi y_2 - \frac{y_3}{1+r}\right)\right] = E_1\left[\frac{\mu}{1-s}\left(-\frac{C_{T3}}{1+r} - \phi\frac{\omega_N}{\omega_T}C_{T2}\right)\right] \leq 0$$

where $\mu$ is the Lagrangian multiplier associated with the financial constraint (2). $\mathrm{cov}\left(\frac{\omega_T}{C_{T2}}, y_2\right) < 0$ simply because

$$C_{T2} = \frac{(1-s)y_2 - d + (1-s)\frac{y_3}{1+r}}{1+\beta}, \text{ if the constraint is slack;}$$

$$C_{T2} = \frac{(1+\phi)(1-s)y_2 - d}{1-\phi\frac{\omega_N}{\omega_T}}, \text{ if the constraint binds.}$$

Therefore, the optimal equity share $s$ is 1. □

## E.4 Proof of Proposition 4

*Proof.* The problem can be written as

$$\begin{aligned}
\max_{d,s\in[0,1]} \quad & \omega_T \log C_{T1} + \beta E[V(m,s,y_2)] \\
\text{s.t.} \quad & C_{T1} = s(1-\theta)y_1 + \frac{d}{1+r}, \\
& m = (1-s)y_2 - d.
\end{aligned}$$

The optimality conditions for $d$ and $s$ are given by

$$\frac{\omega_T}{C_{T1}} = \beta(1+r)E\left[\frac{\omega_T}{C_{T2}}\right] \tag{13}$$

$$\frac{\omega_T}{C_{T1}}y_1(1-\theta) - \beta E_1\left[\frac{\omega_T}{C_{T2}}y_2 + \mu\phi y_2 + \beta\frac{\omega_T}{C_{T3}}y_3\right] = 0 \tag{14}$$

From condition (13), one can define $d^* = D(s,\theta)$. By the implicit function theorem,

$$\frac{\partial d^*}{\partial s} = -\frac{-\frac{\omega_T}{C_{T1}^2}(1-\theta)y_1 - \beta(1+r)E\left[-\frac{\omega_T}{C_{T2}^2}\frac{\partial C_{T2}}{\partial s}\right]}{-\frac{\omega_T}{C_{T1}^2}\frac{1}{1+r} - \beta(1+r)E\left[-\frac{\omega_T}{C_{T2}^2}\frac{\partial C_{T2}}{\partial d}\right]} < 0$$

$$\frac{\partial d^*}{\partial \theta} = -\frac{-\frac{\omega_T}{C_{T1}^2}(-sy_1)}{-\frac{\omega_T}{C_{T1}^2}\frac{1}{1+r} - \beta(1+r)E\left[-\frac{\omega_T}{C_{T2}^2}\frac{\partial C_{T2}}{\partial d}\right]} > 0$$

where it follows that $\frac{\partial C_{T2}}{\partial s} < 0$ and $\frac{\partial C_{T2}}{\partial d} < 0$.

We define the following function to capture the optimality condition for equity issuance

$$F(s,d^*,\theta) = -\frac{\omega_T}{C_{T1}}y_1(1-\theta) + \beta E_1\left[\frac{\omega_T}{C_{T2}}y_2 + \mu\phi y_2 + \beta\frac{\omega_T}{C_{T3}}y_3\right]$$

Realize that $\frac{\partial F(s,d^*,\theta)}{\partial s} > 0$, $\frac{\partial F(s,d^*,\theta)}{\partial d^*} > 0$ and $\frac{\partial F(s,d^*,\theta)}{\partial \theta} > 0$, where the first two relationships are implied by the concavity of the problem. Therefore, we have $\frac{\partial s}{\partial d^*} = -\frac{\frac{\partial F(s,d^*,\theta)}{\partial d^*}}{\frac{\partial F(s,d^*,\theta)}{\partial s}} < 0$ and $\frac{\partial s}{\partial \theta} = -\frac{\frac{\partial F(s,d^*,\theta)}{\partial \theta}}{\frac{\partial F(s,d^*,\theta)}{\partial s}} < 0$.

The optimality condition for equity issuance implies that

$$s^* = 1, \text{ } \textit{if}\, F(s,d^*,\theta) < 0 \,\textit{for all}\, s \in [0,1]$$

$$s^* = 0, \text{ } \textit{if}\, F(s,d^*,\theta) > 0 \,\textit{for all}\, s \in [0,1]$$

$$s^* \in (0,1), \text{ } \textit{if there exist } s \in [0,1] \textit{ such that } F(s,d^*,\theta) = 0$$

Since $F(s,d^*,0) < 0$ as shown in E.3 and $F(s,d^*,1) > 0$ for $\forall s \in [0,1]$, by continuity, there exists a $\bar{\theta}$ such that $F(s,d^*,\bar{\theta}) = 0$ for $s = 0$. When $\theta > \bar{\theta}$, $F(s,d^*,\theta) > F(0,d^*,\theta) > F(0,d^*,\bar{\theta}) = 0$ for all $s \in [0,1]$. In this case, the optimal level of $s$ is 0. The equilibrium features only debt and no equity issuance.

Similarly, since there exists a $\underline{\theta}$ such that $F(s,d^*,\underline{\theta}) = 0$ for $s = 1$. When $\theta < \underline{\theta}$, $F(s,d^*,\theta) < F(1,d^*,\theta) < F(1,d^*,\underline{\theta}) = 0$ for all $s \in [0,1]$. In this case, the optimal level of $s$ is 1. The equilibrium features only equity and no debt.

When $\theta \in (\underline{\theta}, \bar{\theta})$, there is an interior solution for equity issuance $s$. As $\theta$ decreases, the optimal level of equity share $s$ increases and debt $d$ decreases as implied by $\frac{\partial s}{\partial \theta} < 0$ and $\frac{\partial d^*}{\partial \theta} > 0$. In equilibrium, it is consistent with $\frac{\partial s}{\partial d^*} < 0$ and $\frac{\partial d^*}{\partial s} < 0$.

One can show that a higher $\theta$ leads to a higher $\frac{d}{1-s}$. To see this, one recognizes that equation (13) can be written as a function of $s$ and $\frac{d}{1-s}$.

$$\frac{\omega_T}{(1-\theta)y_1 - (1-s)\left((1-\theta)y_1 - \frac{d/(1-s)}{1+r}\right)} = \beta(1+r)E\left[\frac{\omega_T}{C_{T2}}\right] \tag{15}$$

$C_{T2}$ is a decreasing function of $d/(1-s)$ and an increasing function of $1-s$ since $C_{T2} = \frac{(1-s)\left(\frac{y_3}{1+r}+y_2-d/(1-s)\right)}{1+\beta}$ if unconstrained and $C_{T2} = \frac{(1-s)((1+\phi)y_2-d/(1-s))}{1-\phi\frac{\omega_N}{\omega_T}}$ if constrained. Therefore, following a higher value of $\theta$, a higher $1-s$ raises the value of the LHS while reducing that of the RHS of equation (15), leading to a higher $d/(1-s)$.

Therefore, in equilibrium a higher $\theta$ leads to a lower $s$, a higher $d$ and $d/(1-s)$, which implies a higher leverage ratio $\frac{d/(1+r)}{s(1-\theta)y_1+d/(1+r)}$. Notice that the probability of binding constraints depends on the level of $d/(1-s)$. A higher level of $d/(1-s)$ implies a higher probability of binding constraints due to equation (8). $\square$

## E.5 Proof of Proposition 5

*Proof.* Given the definition of $V^{SP}(m,s,y_2)$, we have the following

$$\begin{aligned}
V^{SP}(m,s,y_2) \quad = \quad & \max_{C_{T2},d',C_{T3}} \omega_N \log y_{N2} + \omega_T \log C_{T2} + \beta\omega_T \log C_{T3} \\
\text{s.t.} \qquad & C_{T2} = m + \frac{d'}{1+r}, && (16)\\
& C_{T3} + d' = (1-s)y_3, \\
& \frac{d'}{1+r} \leq \phi\left(\frac{\omega_N}{\omega_T}C_{T2} + (1-s)y_2\right). && (17)
\end{aligned}$$

The optimality conditions are given by

$$\lambda = \frac{\omega_T}{C_{T2}} + \phi\mu\frac{\omega_N}{\omega_T}$$
$$\lambda = \mu + \beta(1+r)\frac{\omega_T}{C_{T3}}$$

where $\lambda$ and $\mu$ are the Lagrangian multipliers for the budget constraint (16) and collateral constraint (17).

When the constraint is slack, the following condition holds.

$$d' = \frac{(1-s)y_3 - \beta(1+r)m}{1+\beta}$$

The constraint is slack iff

$$\frac{d'}{1+r} \leq \phi\left(\frac{\omega_N}{\omega_T}C_{T2} + (1-s)y_2\right) = \phi\left(\frac{\omega_N}{\omega_T}\left(m + \frac{d'}{1+r}\right) + (1-s)y_2\right) \leq \frac{\phi\frac{\omega_N}{\omega_T}m + \phi(1-s)y_2}{1-\phi\frac{\omega_N}{\omega_T}}$$

It is equivalent to

$$m \geq (1-s)\frac{\frac{y_3}{(1+\beta)(1+r)} - \frac{\phi y_2}{1-\phi\frac{\omega_N}{\omega_T}}}{\frac{\beta}{1+\beta} + \frac{\phi\frac{\omega_N}{\omega_T}}{1-\phi\frac{\omega_N}{\omega_T}}}$$

Equivalently, the constraints bind if

$$\frac{d}{1-s} > \frac{y_2\left(\frac{\beta}{1+\beta} + \frac{\phi/\omega_T}{1-\phi\frac{\omega_N}{\omega_T}}\right) - \frac{y_3}{(1+\beta)(1+r)}}{\frac{\beta}{1+\beta} + \frac{\phi\frac{\omega_N}{\omega_T}}{1-\phi\frac{\omega_N}{\omega_T}}} \tag{18}$$

Since expressions (8) and (18) are identical, there is no difference between the private agents and the social planner in the condition for the constraints to be binding. The allocation is given by

$$C_{T2} = \frac{m + (1-s)\frac{y_3}{1+r}}{1+\beta}, \text{ if slack}$$
$$C_{T2} = \frac{m + \phi(1-s)y_2}{1-\phi\frac{\omega_N}{\omega_T}}, \text{ if constrained}$$

This is the same as that in the competitive equilibrium, which is characterized in $V(m,s,y_1)$.

By the envelope theorem, we have

$$\frac{\partial V^{SP}(m,s,y_2)}{\partial m} = \frac{\omega_T}{C_{T2}} + \phi\mu\frac{\omega_N}{\omega_T},$$
$$\frac{\partial V^{SP}(m,s,y_2)}{\partial s} = -\phi y_2\mu - \beta\frac{\omega_T}{C_{T3}}y_3,$$

As $\mu > 0$, we see that $\frac{\partial V^{SP}(m,s,y_2)}{\partial m} > \frac{\partial V(m,s,y_2)}{\partial m}$. □

## E.6 Proof of Proposition 6, 7 and 8

*Proof.* In the first period, the social planner's problem can be written as

$$\max_{d,s\in[0,1]} \omega_T \log C_{T1} + \beta E\left[V^{SP}(m,s,y_2)\right]$$
$$\text{s.t.} \qquad C_{T1} = s(1-\theta)y_1 + \frac{d}{1+r},$$
$$m = (1-s)y_2 - d.$$

The optimality conditions for $d$ and $s$ are given, respectively, by

$$\frac{\omega_T}{C_{T1}} = \beta(1+r)E\left[\frac{\omega_T}{C_{T2}} + \phi\mu\frac{\omega_N}{\omega_T}\right] \tag{19}$$
$$\frac{\omega_T}{C_{T1}}y_1(1-\theta) = \beta E_1\left[\left(\frac{\omega_T}{C_{T2}} + \phi\mu\frac{\omega_N}{\omega_T}\right)y_2 + \mu\phi y_2 + \beta\frac{\omega_T}{C_{T3}}y_3\right] \tag{20}$$

Using the same proof as in Appendix E.4, one can show the following: (1) There exists a $\bar{\theta}^{SP}$ such that there will be only debt issuance when $\theta > \bar{\theta}^{SP}$; (2) There exists a $\underline{\theta}^{SP}$ such that there will be only equity issuance when $\theta < \underline{\theta}^{SP}$; (3) When $\theta \in (\underline{\theta}^{SP}, \bar{\theta}^{SP})$, there will be a mixture of equity and debt. Furthermore, a higher $\theta$ leads to a lower $s$, a higher $d$ and $d/(1-s)$, which implies a higher leverage ratio $\frac{d/(1+r)}{s(1-\theta)y_1+d/(1+r)}$. Notice that the probability of the constraints becoming binding depends on the level of $d/(1-s)$: The higher the value of $d/(1-s)$, the greater the probability of binding constraints due to equation (18).

Suppose we impose capital control taxes on debt and equity, $\tau^d$ and $\tau^s$, respectively, the first-period budget constraint becomes

$$C_{T1} = (1-\tau^s)s(1-\theta)y_1 + (1-\tau^d)\frac{d}{1+r} + T$$

where $T = \tau^s s(1-\theta)y_1 + \tau^d \frac{d}{1+r}$.

To close the gap between the social planner's allocation and that of the private agents, we have to have

$$\tau^d = \frac{\beta(1+r)E\left[\phi\mu\frac{\omega_N}{\omega_T}\right]}{\frac{\omega_T}{C_{T1}}} > 0$$
$$\tau^s = \frac{\beta E\left[\phi\mu\frac{\omega_N}{\omega_T}y_2\right]}{\frac{\omega_T}{C_{T1}}(1-\theta)y_1} > 0$$

It can be shown that $\tau^d > \tau^s$ since

$$\tau^d - \tau^s = \frac{\beta(1+r)\phi\frac{\omega_N}{\omega_T}E\left[\mu\left((1-\theta)y_1 - \frac{y_2}{1+r}\right)\right]}{\frac{\omega_T}{C_{T1}}(1-\theta)y_1}$$

and

$$\begin{aligned} & E\left[\mu\left((1-\theta)y_1 - \frac{y_2}{1+r}\right)\right] \\ = \quad & E[\mu]E\left[\left((1-\theta)y_1 - \frac{y_2}{1+r}\right)\right] + cov\left(\mu, \left((1-\theta)y_1 - \frac{y_2}{1+r}\right)\right) > 0. \end{aligned}$$

$E[\left((1-\theta)y_1 - \frac{y_2}{1+r}\right)]$ has to be positive for an positive amount of equity to be issued in equilibrium. $cov(\mu, \left((1-\theta)y_1 - \frac{y_2}{1+r}\right)) > 0$ since a lower level of $y_2$ is associated with a tighter borrowing constraint, i.e. a higher value of $\mu$.

Given that $\tau^d > \tau^s$, the wedge in the debt financing is higher than that in the equity financing. As a result, the social planner chooses a lower overall level of external financing $C_{T1}$, and a smaller component of debt than equity financing. Therefore, the debt to income ratio of $d/(1-s)$ should be lower in the social planner's allocation, resulting in a lower probability of crises.

For $\theta < \underline{\theta}^{SP}$, the decentralized equilibrium features only equity financing. In this case, there is no difference between the social planner's choice and the decentralized equilibrium, and the collateral constraint does not bind. In comparison, for $\theta \geq \bar{\theta}^{SP}$, the decentralized equilibrium features only debt financing. There is a wedge between the private agents' and the social planner's allocations. By continuity, there exists a $\theta^*$ such that the allocation under the competitive equilibrium is constrained efficient when $\theta < \theta^*$, and constrained inefficient when $\theta > \theta^*$. □

## E.7 Proof of Proposition 9

*Proof.* Define the net worth at the beginning of period 2 by $m = (1-s)y_2 - d$. The state variables in period 2 include $\{m, s, y_2\}$. The original problem can be written as

$$\max_{s,d} \omega_T \log C_{T1} + \beta E_1[V(m, s, y_2)],$$
$$\text{s.t. } C_{T1} = s(1-\theta)y_1 + \frac{d}{1+r}, \; m = (1-s)y_2 - d.$$

where $V(m,s,y_2)$ is given by

$$
\begin{aligned}
V(m,s,y_2) = \quad & \max_{C_{N2},C_{T2},C_{T3},d',s'\in[0,1-s]} \omega_T \log C_{T2} + \omega_N \log C_{N2} + \beta\omega_T \log C_{T3}, \\
\text{s.t.} \quad & pC_{N2} + C_{T2} = m + py_{N2} + \frac{d'}{1+r} + s'(1-\theta)\frac{y_3}{1+r} && (21) \\
& \frac{d'}{1+r} \leq \phi((1-s)y_2 + py_{N2}) && (22) \\
& C_{T3} = y_3 - d' - (s+s')y_3 && (23)
\end{aligned}
$$

**Period 2's problem** The optimality conditions in period 2 are given by

$$
\begin{aligned}
&\text{FOC}(C_{T2}) : \lambda = \frac{\omega_T}{C_{T2}} \\
&\text{FOC}(d') : \lambda = \mu + \beta(1+r)\frac{\omega_T}{C_{T3}} \\
&\text{FOC}(s') : \lambda = \theta\lambda + \beta(1+r)\frac{\omega_T}{C_{T3}}
\end{aligned}
$$

where $\lambda$ and $\mu$ are the Lagrangian multipliers associated with equations (21) and (22), respectively.

Depending on the state variables $\{m,s,y_2\}$, the financial constraint might be either slack or binding. When the constraint is slack, i.e. $\mu = 0$, we have $s' = 0$ since the bond financing is cheaper than the equity financing. In this case, the desired level of bond financing is given by

$$
d' = \frac{(1-s)y_3 - \beta(1+r)m}{1+\beta}
$$

The constraint is slack iff

$$
\frac{d'}{1+r} \leq \phi\left(\frac{\omega_N}{\omega_T}C_{T2} + (1-s)y_2\right) = \phi\left(\frac{\omega_N}{\omega_T}\left(m + \frac{d'}{1+r}\right) + (1-s)y_2\right) \leq \frac{\phi\frac{\omega_N}{\omega_T}m + \phi(1-s)y_2}{1-\phi\frac{\omega_N}{\omega_T}}
$$

When this condition is violated, $\mu > 0$, the interior solution of $\{C_{T2}, C_{T3}, s'\}$ is given by

$$\begin{aligned}
C_{T2} &= m + s'(1-\theta)\frac{y_3}{1+r} + \phi\left((1-s)y_2 + \frac{\omega_N}{\omega_T}C_{T2}\right) \\
C_{T3} &= (1-s-s')y_3 - (1+r)\phi\left((1-s)y_2 + \frac{\omega_N}{\omega_T}C_{T2}\right), \\
(1-\theta)\frac{\omega_T}{C_{T2}} &= \beta(1+r)\frac{\omega_T}{C_{T3}}
\end{aligned}$$

The solution $s'$ is given by

$$s' = s'(y_2, y_3, s, d) \equiv \frac{(1-s)[y_3 - \phi(1+r)y_2] - \frac{(1+r)(\beta/(1-\theta)+\phi\omega_N/\omega_T)}{1-\phi\omega_N/\omega_T}[(1-\phi)(1-s)y_2 - d]}{y_3 + \frac{(\beta/(1-\theta)\phi\omega_N/\omega_T)(1-\theta)y_3}{1-\phi\omega_N/\omega_T}}$$

When $s'(y_2, y_3, s, d) > 1-s$, the allocation is given by the following conditions

$$\begin{aligned}
C_{T2} &= m + s'(1-\theta)\frac{y_3}{1+r} + \phi\left((1-s)y_2 + \frac{\omega_N}{\omega_T}C_{T2}\right) \\
C_{T3} &= y_3(1-s-s')y_3 - (1+r)\phi\left((1-s)y_2 + \frac{\omega_N}{\omega_T}C_{T2}\right), \\
s' &= 1-s
\end{aligned}$$

**Period 1's problem** The allocation in the first period is given by the following optimality conditions

$$\begin{aligned}
\text{FOC}(d): \frac{\omega_T}{C_{T1}} &= \beta(1+r)\beta E_1\left[\frac{\partial V}{\partial m}\right] \\
\text{FOC}(s): \frac{\omega_T}{C_{T1}}(1-\theta)y_1 &= \beta(1+r)\beta E_1\left[\frac{\partial V}{\partial m}y_2 - \frac{\partial V}{\partial s}\right]
\end{aligned}$$

**Social planner's problem** The social planner internalizes the general equilibrium effect through the real exchange rate. Her problem is given by

$$
\begin{aligned}
&\max_{s,d} \omega_T \log C_{T1} + \beta E_1 \left[ V^{SP}(m,s,y_2) \right], \\
&\text{s.t. } C_{T1} = s(1-\theta)y_1 + \frac{d}{1+r}, \; m = (1-s)y_2 - d.
\end{aligned}
$$

where $V^{SP}(m,s,y_2)$ is given by

$$
\begin{aligned}
V^{SP}(m,s,y_2) = & \max_{C_{T2},C_{T3},d',s' \in [0,1-s]} \omega_T \log C_{T2} + \omega_N \log y_{N2} + \beta \omega_T \log C_{T3}, \\
\text{s.t.} \quad & C_{T2} = m + \frac{d'}{1+r} + s'(1-\theta)\frac{y_3}{1+r} \qquad (24) \\
& \frac{d'}{1+r} \leq \phi \left( (1-s)y_2 + \frac{\omega_N}{\omega_T} C_{T2} \right) \qquad (25) \\
& C_{T3} = y_3 - d' - (s+s')y_3 \qquad (26)
\end{aligned}
$$

The optimality conditions in the second period are given by

$$
\begin{aligned}
&\text{FOC}(C_{T2}) : \lambda^{SP} = \frac{\omega_T}{C_{T2}} + \phi \frac{\omega_N}{\omega_T} \mu^{SP} \\
&\text{FOC}(d') : \lambda^{SP} = \mu^{SP} + \beta(1+r)\frac{\omega_T}{C_{T3}} \\
&\text{FOC}(s') : \lambda^{SP} = \theta \lambda^{SP} + \beta(1+r)\frac{\omega_T}{C_{T3}}
\end{aligned}
$$

where $\lambda^{SP}$ and $\mu^{SP}$ are the Lagrangian multipliers associated with equations (24) and (25), respectively. The allocation when the constraint is slack is the same as in the competitive equilibrium. However, the allocation when the constraint binds is different and given by

$$
\begin{aligned}
&C_{T2} = m + s'(1-\theta)\frac{y_3}{1+r} + \phi\left((1-s)y_2 + \frac{\omega_N}{\omega_T}C_{T2}\right)\\
&C_{T3} = y_3(1-s-s')y_3 - d',\\
&\left(1-\theta\frac{1-\phi\omega_N/\omega_T}{1-\theta\phi\omega_N/\omega_T}\right)\frac{\omega_T}{C_{T2}} = \beta(1+r)\frac{\omega_T}{C_{T3}}
\end{aligned}
$$

Therefore, one needs to put an ex-post tax on equity issuance. Suppose we introduce a tax $\tau_s'$ on equity issuance and a lump-sum transfer as follows.

$$
pC_{N2} + C_{T2} = m + py_{N2} + \frac{d'}{1+r} + (1-\tau_s')s'(1-\theta)\frac{y_3}{1+r} + T \tag{27}
$$

where $T = \tau_s' s'(1-\theta)\frac{y_3}{1+r}$.

In this case, the optimality condition for $s'$ becomes

$$
(1-\theta)(1-\tau_s')\frac{\omega_T}{C_{T2}} = \beta(1+r)\frac{\omega_T}{C_{T3}}
$$

We need $\tau_s' = -\frac{\theta\phi\omega_N/\omega_T}{1-\theta\phi\omega_N/\omega_T} < 0$ to close the gap between the social planner's and the private agents' allocations. Given that the wedge is negative, the private agents' choice features too little equity financing relative to relative to that of the social planner.

The inefficiency also shows up in the different valuations of wealth $\lambda^{SP}$ and $\lambda$. For the social planner, the envelope theorem implies that

$$
\frac{\partial V^{SP}}{\partial m} = \lambda^{SP} = \frac{\omega_T}{C_{T2}} + \phi\frac{\omega_N}{\omega_T}\mu^{SP} \geq \frac{\omega_T}{C_{T2}} = \frac{\partial V}{\partial m}
$$

Therefore, capital controls in the first period are needed to correct this inefficiency.

Furthermore, there will be overborrowing due to the positive wedge above. The proof is similar to that in Appendix E.6. To fully correct the externality, the social planner has to use both an ex-ante tax on capital flows in the first period and an ex-post policy intervention $\tau_s'$. $\square$

## E.8 Proof of Proposition 10

The problem can be written as

$$\max_{d,D} \omega_T \log C_{T1} + \beta E_1[V(d,D,y_2)],$$
$$\text{s.t. } C_{T1} = \frac{d}{1+r} + \frac{D}{(1+r)^2}(1-\theta)$$

where $V(d,D,y_2)$ is given by

$$V(d,D,y_2) = \max_{C_{N2},C_{T2},C_{T3},d'} \omega_T \log C_{T2} + \omega_N \log C_{N2} + \beta\omega_T \log C_{T3},$$
$$\text{s.t.} \quad pC_{N2} + C_{T2} = y_2 - d + py_{N2} + \frac{d'}{1+r} \tag{28}$$
$$\frac{d'}{1+r} \le \phi(y_2 + py_{N2}) \tag{29}$$
$$C_{T3} = y_3 - d' - D \tag{30}$$

The optimality conditions are given by

$$\text{FOC}(C_{T2}) : \lambda = \frac{\omega_T}{C_{T2}}$$
$$\text{FOC}(d') : \lambda = \mu + \beta(1+r)\frac{\omega_T}{C_{T3}} \tag{31}$$

where $\lambda$ and $\mu$ are the Lagrangian multipliers associated with equations (28) and (29), respectively.

By the Envelope Theorem, we have

$$\frac{\partial V}{\partial d} = -\frac{\omega_T}{C_{T2}}$$
$$\frac{\partial V}{\partial D} = -\beta\frac{\omega_T}{C_{T3}}$$

In the first period, the optimality conditions for $d$ and $D$ are given by

$$\frac{\omega_T}{C_{T1}} = \beta(1+r)E_1\left[\frac{\omega_T}{C_{T2}}\right]$$
$$\frac{\omega_T}{C_{T1}}(1-\theta) = \beta^2(1+r)^2E_1\left[\frac{\omega_T}{C_{T3}}\right]$$

Similar to the benchmark economy, there will be an equilibrium capital structure in which the ratio of $d$ and $D$ depends on $\theta$. Define the marginal benefit function of long-term debt as follows

$$\begin{aligned} MB(d,D,\theta) &\equiv \frac{\omega_T}{C_{T1}}(1-\theta) - \beta^2(1+r)^2E_1\left[\frac{\omega_T}{C_{T3}}\right] \\ &= -\theta\frac{\omega_T}{C_{T1}} + \beta(1+r)E_1[\mu] \end{aligned}$$

where the last relationship combines two optimality conditions.

From the marginal benefit function, it is easy to see that $MB(d,D,0) > 0 > MB(d,D,1)$ for any $d,D \geq 0$. Furthermore, we have $MB_d > 0$, $MB_D > 0$ and $MB_\theta < 0$. Using these relationships, we find that the optimal level of short-term debt $d$ is 0 when $\theta = 0$ while the long-term debt $D$ is 0 when $\theta = 1$. By continuity, there will exists a $\underline{\theta}$ such that $MB(0,D,\underline{\theta}) = 0$. In this case, for any $\theta < \underline{\theta}$, $MB(d,D,\theta) > MB(d,D,\underline{\theta}) > MB(0,D,\underline{\theta}) = 0$, which implies that $d^* = 0$. In this region, only long-term debt will be issued. Similarly, one can define $\bar{\theta}$ such that $MB(d,D,\bar{\theta}) = 0$. In this case, for any $\theta > \bar{\theta}$, $D^* = 0$ as $MB(d,D,\theta) < 0$. Therefore, an interior solution exists in the region of $(\underline{\theta},\bar{\theta})$. Using the same logic in Appendix E.4, one can show that a higher $\theta$ in this region leads to a higher $d$ and a lower $D$.

The case for policy intervention is similar to the benchmark economy since the pecuniary externality only applies to the short term debt. Specifically, the social planner values $d$ differently from private agents. By the same logic as in Appendix E.6, there is overborrowing in the decentralized economy and the social planner uses capital controls to correct the inefficiency. To see this, define a social planner as follows.

$$V^{SP}(d,D,y_2) = \max_{C_{T2},C_{T3},d',} \omega_T \log C_{T2} + \omega_N \log y_{N2} + \beta\omega_T \log C_{T3},$$

$$\text{s.t.} \quad C_{T2} = y_2 - d + \frac{d'}{1+r} \tag{32}$$

$$\frac{d'}{1+r} \leq \phi\left(y_2 + \frac{\omega_N}{\omega_T} C_{T2}\right) \tag{33}$$

$$C_{T3} = y_3 - d' - D \tag{34}$$

From the Envelope Theorem, we have

$$\frac{\partial V^{SP}}{\partial d} = -\lambda^{SP}$$
$$\frac{\partial V^{SP}}{\partial D} = -\beta\frac{\omega_T}{C_{T3}}$$

Therefore, the optimality conditions of $d$ and D for the social planner are given by

$$\frac{\omega_T}{C_{T1}} = \beta(1+r)E_1[\lambda^{SP}] = \beta(1+r)E_1\left[\frac{\omega_T}{C_{T2}} + \phi\frac{\omega_N}{\omega_T}\mu^{SP}\right]$$
$$\frac{\omega_T}{C_{T1}}(1-\theta) = \beta^2(1+r)^2 E_1\left[\frac{\omega_T}{C_{T3}}\right]$$

Because the pecuniary externality only affects the decision margin for short-term debt $d$, one only need one capital controls to correct the inefficiency. Specifically, we introduce a tax $\tau_d$ on short term debt and a lump-sum transfer $T$ as follows.

$$C_{T1} = (1-\tau^d)\frac{d}{1+r} + (1-\theta)\frac{D}{(1+r)^2} + T \tag{35}$$

where $T = \tau^d \frac{d}{1+r}$.

We need to choose $\tau_d = \frac{\beta(1+r)E_1\left[\phi \frac{\omega_N}{\omega_T}\mu^{SP}\right]}{\frac{\omega_T}{C_{T1}}} > 0$ to close the gap between the social planner and private agents.

## E.9 Proof of Proposition 11

The problem can be written as

$$\max_{d,l} \omega_T \log C_{T1} + \beta E_1[V(d,l,y_2)],$$
$$\text{s.t. } C_{T1} = \frac{d}{1+r} + l(1-\theta)$$

where $V(d,l,y_2)$ is given by

$$\begin{aligned}
V(d,l,y_2) = \quad & \max_{C_{N2},C_{T2},C_{T3},d'} \omega_T \log C_{T2} + \omega_N \log C_{N2} + \beta\omega_T \log C_{T3}, \\
\text{s.t.} \quad & pC_{N2} + C_{T2} = y_2 - d + py_{N2} + \frac{d'}{1+r} - \rho l && (36) \\
& \frac{d'}{1+r} \le \phi(y_2 + py_{N2}) && (37) \\
& C_{T3} = y_3 - d' && (38)
\end{aligned}$$

The optimality conditions are given by

$$\begin{aligned}
&\text{FOC}(C_{T2}) : \lambda = \frac{\omega_T}{C_{T2}} \\
&\text{FOC}(d') : \lambda = \mu + \beta(1+r)\frac{\omega_T}{C_{T3}} && (39)
\end{aligned}$$

where $\lambda$ and $\mu$ are the Lagrangian multipliers associated with equations (36) and (37).

In the first period, the optimality conditions for $d$ and $l$ are given by

$$\frac{\omega_T}{C_{T1}} = \beta(1+r)E_1\left[\frac{\omega_T}{C_{T2}}\right]$$
$$\frac{\omega_T}{C_{T1}}(1-\theta) = \beta E_1\left[\frac{\omega_T}{C_{T2}}\rho\right]$$

Simplifying the last optimality condition, the following relationship holds.

$$\begin{aligned}
\frac{\omega_T}{C_{T1}}(1-\theta) &= \beta E_1\left[\frac{\omega_T}{C_{T2}}\rho\right] = \beta(1+r)E_1\left[\frac{\omega_T}{C_{T2}}\frac{p}{E[p]}\right] \\
&= \beta(1+r)\frac{E_1\left[\frac{\omega_T}{C_{T2}}\right]E_1[p] + \mathrm{cov}\left(\frac{\omega_T}{C_{T2}}, p\right)}{E[p]} \\
&< \beta(1+r)E_1\left[\frac{\omega_T}{C_{T2}}\right]
\end{aligned}$$

We can also define the marginal benefit function for issuing local currency debt as follows

$$MB(d^*, l, \theta) \equiv \frac{\omega_T}{C_{T1}}(1-\theta) - \beta E_1\left[\frac{\omega_T}{C_{T2}}\rho\right]$$

We can see that $MB(d^*, l, 0) > 0$ and $MB(d^*, l, 1) < 0$. Furthermore, $MB_{d^*} < 0$, $MB_l < 0$ and $MB_\theta < 0$. Therefore, there exists $\underline{\theta}$ such that $MB(d^*, l, \underline{\theta}) = 0$. For $\theta < \underline{\theta}$, $MB(d^*, l, \theta) > MB(d^*, l, \underline{\theta}) = 0$. The equilibrium condition features a corner solution with only local currency issuance. Similarly, define $\bar{\theta}$ satisfying $MB(d^*, 0, \bar{\theta}) = 0$. In this case, for $\theta > \bar{\theta}$, $MB(d^*, l, \theta) < MB(d^*, 0, \bar{\theta}) = 0$ and the equilibrium features zero local currency debt. In the case of $\theta \in (\underline{\theta}, \bar{\theta})$, there is a combination of local currency and dollar debt. Furthermore, one can also show that as $\theta$ increases $l$ decreases. Similarly, one can show that an increase in $\theta$ increases $d$.

The problem of the social planner is given as follows.

$$
\begin{aligned}
\max_{d,l,C_{T1},C_{T2},d',C_{T3}} \quad & \omega_T \log C_{T1} + \beta E[\omega_T \log C_{T2} + \omega_N \log y_{N2} + \beta\omega_T \log C_{T3}] \\
\text{s.t.} \quad & C_{T1} = \frac{d}{1+r} + (1-\theta)l \\
& C_{T2} = y_2 - d + \frac{d'}{1+r} - \rho(C_{T2}, E[C_{T2}])l \\
& \frac{d'}{1+r} \leq \phi\left(y_2 + \frac{\omega_N}{\omega_T} C_{T2}\right) \\
& C_{T3} = y_3 - d'
\end{aligned}
$$

The optimality conditions are given by

$$
\begin{aligned}
&\text{FOC}(d) : \frac{\omega_T}{C_{T1}} = \beta(1+r)E[\lambda^C] \\
&\text{FOC}(l) : \frac{\omega_T}{C_{T1}}(1-\theta) = \beta E[\lambda^C \rho] \\
&\text{FOC}(C_{T2}) : \lambda^C = \frac{\frac{\omega_T}{C_{T2}} + \phi\mu^C \frac{\omega_N}{\omega_T}}{1 + l\left(\frac{\partial\rho}{\partial C_{T2}} + f(y_2)\frac{\partial\rho}{\partial E[C_{T2}]}\right)} \\
&\text{FOC}(d') : \lambda^C = \mu^C + \beta(1+r)\frac{\omega_T}{C_{T3}}
\end{aligned}
$$

where $\lambda^C$, $\mu^C$ are the Lagrangian multipliers for the period 2 budget constraint and collateral constraint respectively and $f(y_2)$ is the density function of state $y_2$ at time 2.

To implement the social planner's allocation, one need three sets of capital controls $\{\tau_d, \tau_l, \tau d'\}$ together with lump-sum transfers $\{T, T'\}$. With those capital control policies, the budget constraints for the social planner changes into

$$
\begin{aligned}
C_{T1} &= \frac{d}{1+r}(1-\tau_d) + l(1-\theta)(1-\tau_l) + T \\
pC_{N2} + C_{T2} &= py_{N2} + y_2 - d - \rho l + \frac{d'}{1+r}(1-\tau_{d'}) + T'
\end{aligned}
$$

with $T = \tau_d \frac{d}{1+r} + l(1-\theta)\tau_l$ and $T' = \frac{d'}{1+r}\tau_{d'}$.

By comparing the first order conditions, one need

$$\tau_d = \beta(1+r)E_1\left[\frac{\phi\mu^C\frac{\omega_N}{\omega_T} - \frac{\omega_T}{C_{T2}}l\left(\frac{\partial\rho}{\partial C_{T2}} + f(y_2)\frac{\partial\rho}{\partial E[C_{T2}]}\right)}{1+l\left(\frac{\partial\rho}{\partial C_{T2}} + f(y_2)\frac{\partial\rho}{\partial E[C_{T2}]}\right)}\right] / \left(\frac{\omega_T}{C_{T1}}\right)$$

$$\tau_l = \beta E_1\left[\frac{\phi\mu^C\frac{\omega_N}{\omega_T} - \frac{\omega_T}{C_{T2}}l\left(\frac{\partial\rho}{\partial C_{T2}} + f(y_2)\frac{\partial\rho}{\partial E[C_{T2}]}\right)}{1+l\left(\frac{\partial\rho}{\partial C_{T2}} + f(y_2)\frac{\partial\rho}{\partial E[C_{T2}]}\right)}\rho\right] / \left(\frac{\omega_T}{C_{T1}}\right) / (1-\theta)$$

$$\tau_{d'} = \frac{l\left(\frac{\partial\rho}{\partial C_{T2}} + f(y_2)\frac{\partial\rho}{\partial E[C_{T2}]}\right)}{1+l\left(\frac{\partial\rho}{\partial C_{T2}} + f(y_2)\frac{\partial\rho}{\partial E[C_{T2}]}\right)}$$