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# Cheap but flighty: how global imbalances create financial fragility\*

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## Abstract

Can a wealth shift to emerging countries explain instability in developed countries? Investors exposed to political risk seek safety in countries with better property right protection. This induces private intermediaries to offer safety via inexpensive demandable debt, and increase lending into marginal projects. Because safety conscious foreigners escape any risk by running also in some good states, cheap foreign funding leads to larger and more frequent runs. Beyond some scale, foreign runs also induce domestic runs in order to avoid dilution. When excess liquidation causes social losses, a domestic planner may limit the scale of foreign inflows or credit volume.

**Keywords:** capital flows, unstable funding, safe haven, absolute safety.

**JEL classifications:** F3, G2.

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# 1 Introduction

The scale of the recent crisis has led to a search for global explanations. A leading view is that excess credit was driven by low interest rates, associated with the recycling of large global imbalances into safe US assets.<sup>1</sup> At a time of declining US saving rates, the credit boom was largely funded by inflows seeking safe assets, thus reducing interest rates. Private liabilities created by financial intermediaries helped to satisfy a demand for safety in excess of the supply of Treasury securities. The effect was a portfolio reallocation that increased the risk concentration in holdings by US residents, who became more exposed to shocks.<sup>2</sup>

This narrative explains well how global imbalances may lead to larger risk bearing for US investors. It does not suggest an effect on financial fragility, as foreign inflows are assumed very stable. This paper shows how safety-seeking foreign funding may create risk by increasing the frequency of runs. This result occurs under optimal contracting in a simple setup without deposit insurance or bailouts, when intermediaries bear all risk created by their choices. It is driven by specific features of most capital inflows into developed markets, namely their safety-seeking nature.

Historically, capital moved from developed to emerging countries, though less than implied by neoclassical theory (Lucas, 1990). Developing countries had to borrow in foreign currency because of expropriation risk associated with a weak institutional framework, which caused sudden reversals and financial crises. In contrast, foreigners have for decades accumulated claims in reserve currencies (Gourinchas and Rey, 2007). Net capital flows have in fact reversed since 1998, with developing countries now funding the developed world (Prasad et al., 2007). Estimates on inflows into the US are \$7.8 trillion over the 2002-2007 credit boom. In addition to well-recorded inflows of official reserves, 81% of these US external liabilities were held by the private sector (Forbes, 2010). These inflows often seek anonymity, and are channeled via legal entities in offshore centers.

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<sup>1</sup>Bernanke (2005) discussed a “savings glut” abroad as an explanation for US trade deficits.

<sup>2</sup>Caballero and Krishnamurthy (2009): “[...] the US sells riskless assets to foreigners and in so doing raises the effective leverage of its financial institutions.”(p. 584).

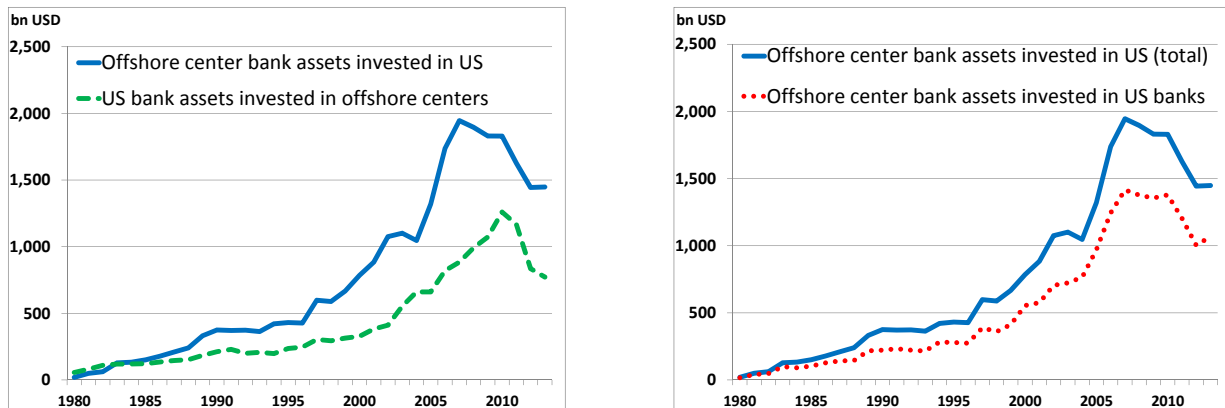


Figure 1: Left panel: Net inflows into the US from offshore centers. Assets owned by offshore center bank invested in the US (solid blue) and assets owned by US bank invested in offshore centers (dashed green). Right panel: Composition of offshore center bank assets invested in the US. Total investment in US (solid blue again) and investment in US banks (dotted red). Source: BIS locational banking statistics. All values in billion USD.

Figure 1 shows the remarkable growth of net private inflows in the US from offshore centers during the credit boom (left panel), and how they targeted privately intermediated safe assets (right panel). This suggests that a strong component of foreign inflows comes from investors for which legal anonymity is a form of safety, and invest through private intermediaries rather than holding assets in their own name. Identification rules on US insured deposits or US Treasury purchases may undermine strict anonymity, so direct holdings of safe assets may be avoided.

This paper analyzes the consequences of such a wealth shift to developing country residents seeking to invest in markets with better protected property rights. Larger foreign inflows are beneficial, as they support higher domestic lending. They are traditionally seen as very stable (Caballero and Krishnamurthy, 2009). Even in the depth of the crisis, the US dollar appreciated (Maggiore, 2013).

Our contribution is to show that demandable debt is the optimal private contract to attract foreign investors, and how satisfying their demand for safety increases the fragility of financial intermediaries (Shin, 2011). Intuitively, providing safety to savers under uncertainty requires offering a less stable form of funding.

Because runs lead to costly early liquidation, long-term debt would be desirable. However, foreigners seeking absolute safety would not accept such claims, as they are sometimes worthless. Thus, intermediaries need to carve out an absolutely safe claim from their assets to attract foreign inflows.<sup>3</sup> The optimal funding arrangement is then a combination of safe demandable debt and a long-term claim that bears losses in a run. Since domestic savers are able to satisfy their safety needs otherwise, they offer insurance by accepting the high return risky claim. This enables intermediaries to capture some safety rents, by targeting cheap demandable debt to safety seeking foreigners. Since intermediaries need enough stable funding to insure such investors, lending may be constrained by available domestic funding.

We show that under the optimal contract, risk intolerant foreigners withdraw whenever information on asset value is imprecise, causing costly liquidation in some good states. Thus foreign funding may be cheap, but it is less stable. The private funding choice will accept greater instability in exchange for a higher return in good states. We also show that there may be insufficient incentives for arbitrageurs to counter inefficient early liquidation.

The framework enables to assess the effect of an increasing supply of foreign funding on the scale and risk profile of domestic credit. First, it leads to a version of excess lending, as the marginal project has a negative NPV at the discount rate demanded by savers. Second, it creates increasingly large runs in good states. The final result is an increase in risk not just for other claims, but also in the aggregate. The effect is not driven by an increase in asset risk as credit increases, but in a combination of a larger scale of lending and less stable funding. The private choice is socially inefficient in the presence of social costs of default.

An important effect of increased credit is that it realistically involves lending against assets whose value is increasingly opaque, holding constant their risk. (For evidence on the role of housing finance in credit booms, see for example Jorda et al., 2014.) We show how in our setting this results in a higher frequency of runs. Thus ultimately both the scale and frequency of financial fragility are related to the scale of non-speculative foreign inflows.

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<sup>3</sup>Gourinchas et al. (2010) show that the US provides insurance to the rest of the world, in the form of a lower yield during normal times, and a transfer of wealth to foreign investors in crises.

We next consider the case when some domestic investors hold demandable debt, e.g. for liquidity needs. As these savers are not risk intolerant, they would not run simply because of infinitesimal uncertainty (that is, when the imprecise signal suggests a high state). However, we show that once foreign funding reaches a certain scale, it will induce also domestic depositors to run in these circumstances. This result arises not out of risk avoidance, but in order to avoid dilution of their claim.

Finally, we consider whether “safe” domestic intermediaries (such as money market funds) may invest on behalf of foreigners in domestic safe assets to avoid runs. As long as the monitoring of asset choice is imperfect, leveraged intermediaries always have an incentive to invest in risky assets, and cannot credibly provide absolute safety via their assets holdings. Kacperczyk and Schnabl (2013) document the risk-taking behavior of money market funds during the financial crisis of 2007–2010.

The simple setup allows a limited welfare analysis. Cheap foreign funding induces a higher credit volume into marginal projects with a negative NPV at domestic rates, subsidized by the insurance premia earned from foreigners. This is efficient under linear preferences, unless there are social costs of excess liquidation. We show how a socially optimal balance between stability and aggregate credit will differ from the private choice. Then our approach may rationalize macroprudential policies targeting short-term foreign inflows, such as a systemic risk tax on non-core funding (Hahm et al., 2013), to complement the capital and liquidity requirements proposed in Basel III. In this context, public guarantees may be damaging, as the increased risk absorption capacity would allow banks to attract more unstable funding. This would shift both exogenous and endogenous risk to public insurance.

The model does not seek to offer a full analysis of portfolio choice. We assume that foreigners who gained safety via domestic claims invest any residual wealth in their own country. This may reflect some advantage in local information, which ensures them a higher return even under some expropriation risk.

**Literature** Demand for absolute safety in our approach is rationalized by a minimum subsistence constraint. Up to this threshold, agents act as infinitely risk-averse as they need to secure some essential needs. Such preferences are consistent with recent evidence on the strength and stability of demand for safe assets (Krishnamurthy and Vissing-Jorgensen (2012); Gorton et al., 2012). Recent work has modeled such demand as arising from infinitely risk-averse agents (Caballero and Farhi, 2013). In the presence of neglected risk, they can cause large shocks (Gennaioli et al., 2013). Gennaioli et al. (2013) pioneered the notion of low probability risk driving runs by infinitely risk averse investors. In our simple version this risk is always salient, but considered negligible by some set of agents.

A strict segmentation between savings and investment markets is modeled in Allen et al. (2014). Segmented demand may arise from non-contingent preference for liquidity to back payments, the classic “money in the utility function”. As money-like claims offer transaction services, they are cheaper to issue (Stein, 2012). This private incentive to offer liquid claims needs to be balanced against any illiquidity externality, such as fire sales (Perotti and Suarez (2011); Stein, 2012). In our approach, demandable debt arise from risk intolerance rather than transaction or liquidity services, though a brief extension considers the interaction between the two motives.

Our approach is consistent with the empirical results in Krishnamurthy and Vissing-Jorgensen (2013) on the effect of changes in the supply of government safe assets. A decrease leads not just to an increase in net short-term financial debt, but also an increase in long-term investments net of long-term funding by financial intermediaries. Here, the credit expansion is boosted by abundant, less expensive funding supply, and is associated with an increase in maturity transformation.

Our paper complements a rich international finance literature on the “original sin”. Most capital inflows in developing countries take the form of short-term foreign loans because of political risk (Eichengreen and Hausmann, 1999). Tirole (2003) explains such demandable claims as a disciplinary device, reflecting greater agency cost in a context of political risk. Our results derive directly from the nature of foreign investment into safe havens, in a context

of symmetric but imprecise information. A critical assumption in the literature is that foreigners need an intermediary to access domestic assets (Caballero and Krishnamurthy, 2009). In our setting this may be justified by the need for safe-keeping, or for the anonymity gained by investing (possibly via an offshore center) into a domestic legal entity.<sup>4</sup>

Official data suggests that the composition of US net external assets is skewed towards risky assets, while foreigners invest in safe dollar assets. There is abundant evidence that foreigners seeking safety accept a lower rates of return (Caballero et al., 2008). Forbes (2010) finds that foreign investors in the US earn less than US investors earn abroad, even after adjusting for exchange rate movements and rough measures of risk. Foreigners with less developed domestic bond markets invest comparatively more in the US, confirming a need for safety. The historical accumulation of US deficits net of official reserves suggests a substantial build-up in the stock of foreign capital, though granular evidence is impaired by a preference for anonymity. However, new evidence links political risk in specific countries to capital flight into safe havens (Badarinza and Ramodorai, 2014). Mendoza et al. (2009) show how countries with better private contractual enforcement benefit by attracting foreign investment inflows, and are able to explain their declining net asset holdings. Our approach is complementary as we highlight differences in protection from public expropriation, and thus describe non speculative capital flows.

Our assumption of a subsistence level in preferences may be seen as an extreme version of habit formation models, which are well supported by evidence in asset pricing and macroeconomics.<sup>5</sup> Intuitively, as agents become wealthier, they adjust their lifestyle requirements or increase their obligations, requiring a higher “safe” component of wealth. This may also explain the stable share of US safe assets (Gorton et al., 2012). Under this interpretation, the demand for safety from emerging countries will increase as they become wealthier. Hence, both credit volume and instability in countries with good property rights would rise.

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<sup>4</sup>Secrecy is a hallmark of capital flight. In 2011, a \$32 bn discrepancy was reported in Angola’s national accounts, widely attributed to rent extraction from its political elite. Estimates of annual capital flight from Russia are a multiple of this amount. Tax evasion and money laundering are other reasons for anonymity.

<sup>5</sup>Habit formation in Abel (1990) and Campbell and Cochrane (1999) offer an explanation for time series anomalies, such as the size of the equity premium. Fuhrer (2000) uses it to explain the ‘hump-shaped’ gradual response of spending and inflation to shocks.



Our setting derives demandable debt as an optimal contract to satisfy savers seeking absolute safety. Traditionally, demandable debt is explained by contingent liquidity demand (Diamond and Dybvig, 1983), also essential for the adverse selection approach in Gorton and Pennacchi (1990). In a two-period setting, demand for liquidity is indistinguishable from safety demand for early withdrawals.<sup>6</sup> Also in this approach investor preferences are extreme, as some savers value consumption only at the interim date. However, late withdrawing savers may suffer default, which is incompatible with absolute safety preferences. Such preferences also create large scale instability under salient beliefs on risk (Gennaioli et al., 2013). Demandable debt is also rationalized as an optimal contract to resolve agency conflicts (Diamond and Rajan (2001); Calomiris and Kahn, 1991). In Diamond and Rajan (2001), demandable debt runs act as a threat to control agency. The presence of jittery investors makes this threat costly since runs may occur in solvent states.

## 2 Model

The economy extends over three dates  $t \in \{0, 1, 2\}$ . It is populated by domestic and foreign savers and a continuum of domestic intermediaries  $i \in [0, 1]$  that raise funding from savers. Each intermediary has access to a specific pool of risky investment  $I_i \geq 0$  that yields  $R(I)$  with probability  $\gamma \in (0, 1)$  at the final date (high state) and zero otherwise (low state). Liquidation at the interim date yields  $\alpha \in (0, 1)$  in all states, so liquidation is efficient in the low state. Investment has decreasing returns to scale, where  $R'(I) < 0$  and  $R''(I) \leq 0$ . Thus, marginal revenue in the high state,  $MR(I) \equiv IR'(I) + R(I)$ , decreases in investment.

At the interim date there is always an imprecise public signal about the investment return. In addition, in the high state, there is a precise signal with probability  $\delta \in (0, 1)$  (contingency  $G$ ). If there is no precise signal, some residual uncertainty remains. The imprecise signal may correctly suggest that the state is high (contingency  $M$ ) or low (contingency  $B$ ), but is incorrect with probability  $\epsilon > 0$  (contingencies  $X$  and  $E$ ). Figure 2 summarizes.

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<sup>6</sup>In a dynamic consumption smoothing setup, liquidity needs cannot easily explain the huge stock of demandable debt held by households.

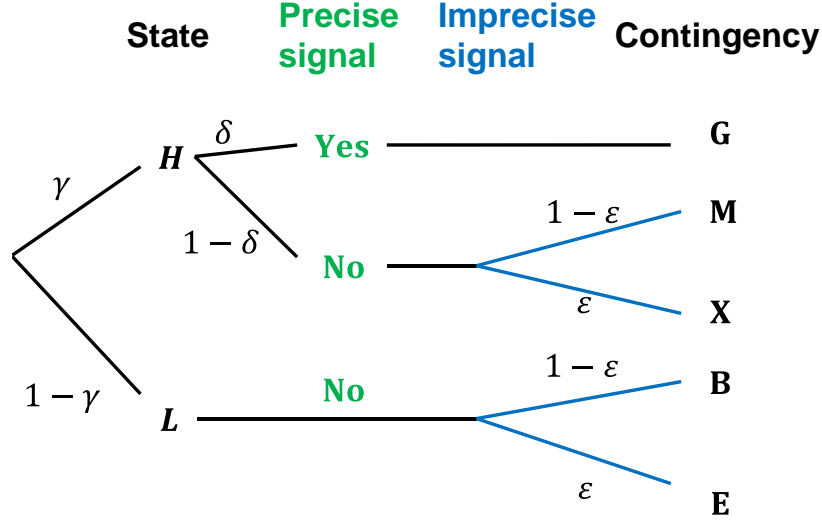


Figure 2: The informations structure of the model.

For simplicity, henceforth we assume that uncertainty persists only after the imprecise signal suggests the high state (so we eliminate contingency  $X$ ).<sup>7</sup> Therefore, conditional on no precise signal, the Bayesian probability of the high state is  $\frac{\gamma(1-\delta)(1-\epsilon)}{\gamma(1-\delta)(1-\epsilon)+(1-\gamma)\epsilon} < 1$ .

All savers need absolute safety for a minimum amount  $S \in (0, 1)$  of total consumption, an amount required for subsistence. Once this level is attained in either period, savers act as risk-neutral investors with no time discounting, where  $c_t$  denotes consumption at date  $t$ :

$$U(c_1, c_2) = \begin{cases} c_1 + c_2 & c_1 + c_2 \geq S \\ \text{if} & \\ -\infty & c_1 + c_2 < S \end{cases} \quad (1)$$

Foreign savers have worse access to a safe store of value, reflecting a lower degree of property right protection in their country. Domestic savers have access to safe short-term storage with unit return at the interim date, and to long-term storage with return  $T > 1$  at the final date that cannot be liquidated early. In contrast, the return on (short- or long-term) foreign storage is  $x \in [S, T)$ . Therefore, foreign savers can satisfy their absolute safety

<sup>7</sup>While a symmetrically imprecise signal is more general, our results are invariant to this simplification.

needs via foreign storage or by investing in a domestic intermediary. As in Caballero and Krishnamurthy (2009), we abstract from foreigners' risky investment by assuming it takes place in their own country and from investment abroad by domestic savers.

Table 1 summarizes the endowments at the initial date. Foreign savers have a unit endowment, so their mass  $W$  measures total foreign wealth. As a normalization, the unit mass of domestic savers is endowed with  $1 + S/T$ . As domestic savers satisfy their absolute safety needs locally by investing  $S/T$  in long-term domestic storage, one unit of domestic wealth is available to invest in risky claims. Its required return is the opportunity cost  $T$ .

Agents	Mass	Endowment
Foreign saver	$W$	1
Domestic saver	1	$1 + S/T$
Banker	1	0

Table 1: Agents and endowments.

The expected marginal revenue of investment is  $\gamma MR(I) + (1 - \gamma)(1 - \epsilon)\alpha$ . We assume that investment initially dominates long-term storage but, because of decreasing returns, domestic funding suffices for efficient investment in autarky:

$$\gamma MR(0) + (1 - \gamma)(1 - \epsilon)\alpha > T > \gamma MR(1) + (1 - \gamma)(1 - \epsilon)\alpha \quad (2)$$

The residual domestic endowment is stored long-term to equalize the expected marginal revenue, so autarky investment  $I^{Aut} \in (0, 1)$  satisfies  $\gamma MR(I^{Aut}) + (1 - \gamma)(1 - \epsilon)\alpha = T$ . Attracting cheaper funding from abroad enables a larger scale of efficient investment.

Intermediaries are subject to limited liability and maximize the expected value of equity, equal to investment proceeds after debt payments. Investment returns are publicly observable at the final date but non-verifiable, so we restrict attention to debt contracts (Hart and Moore, 1998). When funded with demandable debt (so that intermediaries are banks), we abstract from runs based on pure coordination failure (Allen and Gale, 1998).

We next consider the optimal funding arrangement. Each intermediary has unique access to one unit of domestic funding  $d_i \leq 1$ , provided the expected return offered is no

smaller than  $T$ . (This could arise in a model of spatial competition with some dis-utility of distance.) Intermediaries compete for foreign funding in a Walrasian market. At the initial date, each intermediary may offer claims to raise domestic funding  $d_i \geq 0$  and foreign funding  $f_i \geq 0$  in order to invest  $I_i \equiv d_i + f_i$ .

We close the description of the model with an observations about the intermediaries' ability to offer absolute safety. In order to attract foreign funding, an intermediary has to ensure full repayment also in the low state. If foreign savers had very poor own storage options,  $\alpha \geq x$ , their required return is satisfied without insurance from other lenders even in case of early liquidation. In this extreme case, foreign savers actually provide insurance to domestic savers. We henceforth exclude this case by assuming  $\alpha < x$ .

**Benchmark** We establish first the benchmark when agents are perfectly informed in all states ( $\epsilon \rightarrow 0$ ). Banks always terminate investment efficiently in the low state, ensuring a return of  $\alpha$ . Lemma 1 summarizes the optimal funding arrangement in this case.

**Lemma 1 *Debt seniority under efficient liquidation.*** *Under perfect information ( $\epsilon \rightarrow 0$ ), the optimal funding contract is a menu of senior long-term debt and junior long-term debt. Foreign savers select senior debt, while domestic savers select junior debt.*

**Proof** See Appendix A.

The benchmark optimal funding contract uses seniority to ensure the absolute safety of foreign funding. Domestic savers receive a higher yield to compensate for their subordination. Incentive compatibility holds since domestic savers prefer the higher expected return of the subordinated debt contract, while foreign savers seek the absolute safety of senior debt. Long-term debt precludes the possibility of inefficient liquidation at the interim date, triggered by safety-seeking foreign savers when the precise signal is not observed.

### 3 Unstable inflows and endogenous risk

We turn to the main model, where agents make rare mistakes in the low state. As a result, senior long-term debt leads to a complete loss in contingency  $E$ , violating the absolute safety needs of foreign savers. This alters the optimal funding contract radically.

**Proposition 1 *Optimal funding contracts.*** *Suppose investment is not always terminated in the low state ( $\epsilon > 0$ ). Domestic funding is attracted with long-term debt. Foreign funding can only be attracted with demandable debt, provided a sufficient amount of loss-absorbing domestic funding is attracted to offer absolute safety in the low state. Foreign savers withdraw early unless the precise signal is observed.*

The optimal contracting problem is fairly simple in this environment. Foreign savers never accept the long-term debt contract with face value  $L$  as it does not provide absolute safety. However, they accept demandable debt, provided there absolute safety needs are met in all contingencies. Therefore, the bank's ability to offer absolute safety requires the liquidation value to be high enough to cover the demandable debt claim:

$$\alpha I_i \geq x f_i, \tag{3}$$

which requires a sufficient amount of loss-absorbing domestic funding,  $d_i \geq \frac{x-\alpha}{\alpha} f_i$ . Under this condition, the intermediary can offer absolute safety to foreign savers in all contingencies. However, the safety-seeking nature of foreign funding creates financial fragility under the optimal funding contract. To avoid the complete loss in contingency  $E$ , foreign savers withdraw whenever the precise signal is not observed.

**Corollary 1** *If foreign funding is attracted, there are sometimes runs in the high state, leading to the liquidation of investment. While liquidation is efficient in the low state, these withdrawals create an efficiency loss in contingency  $M$ , which increases in the scale of foreign funding. Under the optimal funding contract, the promised amount for early withdrawals is set as low as consistent with absolute safety.*

While attracting foreign funding under the optimal contracting enables to expand investment, it also causes early withdrawals whenever there is uncertainty about the high state. This defines a basic trade-off between cost and stability of foreign funding. The result indicates that domestic intermediaries attract foreign funding only if its low cost compensate for the losses caused by safety-seeking runs in contingency  $M$ . While demandable debt runs also force efficient liquidation in contingency  $E$ , this expected beneficial effect is infinitesimal relative to its average cost. Table 2 summarizes all payoffs when foreign funding is attracted.

State	Probability	Return	$\pi_F$	$\pi_D$	$\pi_i^B$
$G$	$\gamma\delta$	$R(I_i)$	$X$	$L$	$RI_i - Ld_i - Xf_i$
$M$	$\gamma(1 - \delta)$	$R(I_i)$	$x$	$\min \left\{ L, \frac{RI_i - \frac{R}{\alpha}xf_i}{d_i} \right\}$	$\max \left\{ RI_i - \frac{R}{\alpha}xf_i - Ld_i, 0 \right\}$
$B$	$(1 - \gamma)(1 - \epsilon)$	$\alpha$	$x$	$\min \left\{ L, \frac{\alpha I_i - xf_i}{d_i} \right\}$	$\max \left\{ \alpha I_i - xf_i - Ld_i, 0 \right\}$
$E$	$(1 - \gamma)\epsilon$	$0$	$x$	$0$	$0$

Table 2: Payoffs when foreign capital is attracted.  $\pi_D$  and  $\pi_F$  are the payoffs to domestic and foreign savers, respectively, while  $\pi_i^B$  is the payoff to bank  $i$ .

We consider now the supply and demand for foreign inflows. Foreign savers can satisfy their absolute safety needs by investing  $\frac{S}{x}$  in self-storage, or in a demandable debt contract  $(X_1, X_2)$  with return of at least  $x$  in all contingencies. The face value of demandable debt at the final date  $X_2 \equiv X$  may exceed  $X_1 \equiv x$  if there is strong competition for foreign funding.

**Lemma 2 *Supply of foreign funding.*** *Foreign funding is supplied under the condition that the intermediary can offer absolute safety. Under this circumstance, foreign funding can be attracted with demandable debt of face values  $(x, X)$ . The aggregate supply is:*

$$f(X) = \begin{cases} 0 & X < x \\ [0, \frac{WS}{x}] & \text{if } X = x \\ \frac{WS}{x} & X > x \end{cases} \quad (4)$$

**Bank's funding choice** The privately optimal funding choice maximizes the bank's expected profit, equal to expected investment return net of funding costs. Domestic funding has an average cost of  $T$ . Foreign funding costs  $X$  in contingency  $G$ ,  $\frac{R(I_i)}{\alpha}x$  in contingency  $M$  due to costly liquidation, and  $x$  in contingency  $B$ . (In contingency  $E$ , the bank is bankrupt).

**Lemma 3 Demand for funding.** *The intermediary chooses only domestic funding (autarky) if uncertainty is too high. In contrast, if  $\delta > \underline{\delta} \in (0, 1)$ , there exists a unique threshold  $\bar{X} \equiv \frac{T}{\gamma\delta} - \frac{(1-\gamma)(1-\epsilon)}{\gamma\delta}x - \frac{1-\delta}{\delta} \frac{x}{\alpha} R(I^{Aut})$  such that:*

- *If foreign funding is expensive,  $X \geq \bar{X}$ , autarky is optimal:  $f_i^* = 0$  and  $d_i^* = I^{Aut}$ .*
- *If  $\bar{X} > X \geq \underline{X} \equiv \frac{x}{\alpha} MR\left(\frac{x}{x-\alpha}\right) - \frac{x-\alpha}{\alpha} \frac{T}{\gamma\delta}$ , the safety constraint binds:  $d_i^* = \left(\frac{x-\alpha}{\alpha}\right) f_i^*$ . Both domestic and foreign funding is attracted, where  $f_i^*$  is uniquely defined by:*

$$\gamma\delta MR\left(\frac{x}{\alpha} f_i^*\right) = T + \frac{\alpha}{x} \left[ \gamma\delta X - T \right]. \quad (5)$$

*In this interior solution, the expected marginal revenue of investment equals the expected marginal cost of both domestic and foreign funding.*

- *If foreign funding is cheap,  $X < \underline{X}$ , the corner solution  $d_i^* = 1$  and  $f_i^* = \frac{\alpha}{x-\alpha}$  obtains. The intermediary raises the maximum amount of foreign funding consistent with absolute safety, given the limited amount of domestic funding.*

**Proof** See Appendix B, which also contains the definition of  $\underline{\delta}$ .

Uniqueness follows from the decreasing marginal revenue of investment. Aggregation is straightforward under a continuum of identical intermediaries, so  $f \equiv \int_{i \in [0,1]} f_i di$  and  $d \equiv \int_{i \in [0,1]} d_i di$ . We now state the equilibrium.

**Proposition 2 Unique equilibrium.** *Consider the case of small mistakes  $\epsilon > 0$  and sufficiently low uncertainty,  $\delta > \underline{\delta}$ . There exists a unique equilibrium if foreign wealth is abundant,  $W > \underline{W} \in (0, \infty)$ , where this lower bound is implicitly defined by:*

$$\gamma\delta MR\left(\frac{S}{\alpha} \underline{W}\right) + \gamma(1-\delta)R(I^{Aut}) + (1-\gamma)(1-\epsilon)\alpha = T. \quad (6)$$

**Proof** See Appendix C.

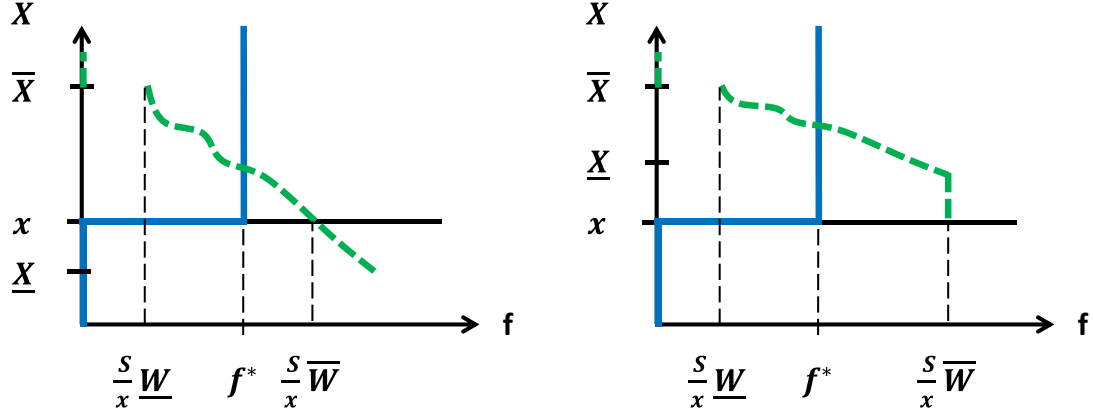


Figure 3: Equilibrium in the market for foreign funding: supply (straight blue) and demand (dashed green). The left panel depicts the unconstrained case, while the limited supply of domestic funding may bind in the right panel ( $\underline{X} > x$ ).

Corollary 2 summarizes the two possible cases, illustrated in Figure 3.

**Corollary 2** *Under the conditions of Proposition 3, the amount of safety seeking foreign wealth determines the equilibrium in the market for foreign funding. If  $\underline{X} > x$ , there are two cases:*

- *If  $\underline{W} < W < \bar{W} \equiv \frac{\alpha}{S} \frac{x}{x-\alpha}$ , the equilibrium is interior: foreign funding is  $f_i^* = f^* = \frac{WS}{x}$  and domestic funding is  $d_i^* = d^* = \frac{x-\alpha}{\alpha x} WS \in (0, 1)$ . The equilibrium face value of demandable debt is:*

$$X^* = \frac{x}{\alpha} MR\left(\frac{S}{\alpha} W\right) - \frac{x-\alpha}{\alpha} \frac{T}{\gamma\delta} \quad (7)$$

- *If foreign wealth is abundant  $W \geq \bar{W}$ , the corner solution  $d^* = 1$  and  $f^* = \frac{\alpha}{x-\alpha}$  occurs. In this case, the amount of inexpensive foreign funding that can be attracted is limited by the risk-absorption capacity of domestic funding.*

*If  $\underline{X} \leq x$ , there is an interior equilibrium with a different upper bound on foreign wealth:*

$$MR\left(\frac{S}{\alpha} \bar{W}\right) = \frac{x-\alpha}{x} \frac{T}{\gamma\delta} + \alpha. \quad (8)$$



We can now assess the risk created by safety-seeking foreign capital.

**Proposition 3 *Financial fragility.*** *When foreign funding is attracted, withdrawals by foreign savers lead to full liquidation of investment. The resulting efficiency loss in contingency  $M$  equals to  $\frac{\underline{S}}{\alpha}R\left(\frac{\underline{S}}{\alpha}W\right)W$  for  $W \in (\underline{W}, \overline{W})$  and to  $R\left(\frac{x}{x-\alpha}\right)\frac{x}{x-\alpha}$  for  $W \geq \overline{W}$ .*

**Proof** See Appendix D.

**Corollary 3 *Foreign wealth and negative NPV.*** *Whenever foreign funding is attracted, the volume of domestic investment increases in foreign wealth, while its net present value at domestic discount rates decreases in foreign wealth. If  $\underline{X} \geq x$  and  $\gamma R\left(\frac{x}{x-\alpha}\right) + (1-\gamma)(1-\epsilon)\alpha < T$ , then there exists a unique wealth threshold  $W^* \in (\underline{W}, \overline{W})$  such that the net present value of investment is negative at domestic discount rates for all  $W > W^*$ .*

**Proof** See Appendix E.

We can now summarize the aggregate effect of capital inflows. Under our initial assumption, condition (2), the NPV of investment in autarky is positive,  $NPV^{Aut} \equiv \frac{\gamma I^{Aut}(-R'(I^{Aut}))}{T} > 0$ . While not an essential assumption, it ensures that some capital inflows are efficient.

If foreign wealth is abundant and thus foreign funding cheap, investment expands until it earns a negative NPV *at domestic discount rates*. Note that this induced expansion in credit is efficient under linear preferences: foreign capital induces more credit not just because it expands available funding, but because it reduces its marginal cost. As investors who supply cheap foreign funding are satisfied, their marginal required rate of return becomes the appropriate discount rate for domestic banks.

## 4 Extensions

### 4.1 Uncertainty over asset return

In our setup, imprecise information may lead to runs by risk intolerant investors, so intermediaries have an incentive to prioritize more “transparent” assets. We study here the realistic case when lending more requires investing in more “uncertain” assets. To keep our focus distinct from the traditional risk shifting incentive in banking, we assume that more lending does not involve inherently riskier assets, but assets that are more opaque. This notion is consistent with evidence that credit booms tend to fund real estate investment. Specifically, assume that uncertainty over asset values at  $t = 1$  increases in the credit volume, as the chance of a precise signal falls. This implies  $\delta = \delta(I_j)$  with  $\frac{d\delta}{dI_j} < 0$ .

It is easy to show that this leads to a greater frequency of runs, since contingency  $M$  occurs more often. As the intermediary bears all cost, the impact of more opaque investment is fully internalized, and it is straightforward to generalize the results of Lemma 3.

The autarky allocation is not affected, given that only long-term debt is offered to domestic savers. Autarky is now optimal whenever

$$X \geq \bar{X}^\delta \equiv \frac{T - (1 - \gamma)(1 - \epsilon)x - \gamma(1 - \delta(I^{Aut}))\frac{x}{\alpha}R(I^{Aut})}{\gamma\delta(I^{Aut})}. \quad (9)$$

If foreign funding is cheap,  $X < \bar{X}^\delta$ , the intermediary would still attract as much foreign funding as possible, constrained by the absolute safety condition  $f_i^* = \frac{\alpha}{x-\alpha}d_i^*$ . The new level of foreign funding raised  $f_i^*(X)$  is implicitly given by:

$$\gamma\delta(I_i^*)MR(I_i^*) = T + \frac{\alpha}{x} \left[ \gamma\delta X - T - \gamma\delta'(I_i^*) \left( \frac{x}{\alpha}R(I_i^*) - X \right) \right]. \quad (10)$$

Relative to the baseline case, now a marginal increase in foreign funded investment leads to more frequent liquidation in the high state. Since the banker now incurs more frequent costly liquidation due to foreign runs, its choice of the scale of foreign funding is lower.

This natural extension shows how risk-intolerant foreign funding is likely to increase the frequency of runs, in addition to their scale.

## 4.2 Social cost of excessive liquidation

Our contracting result with its trade-off between the cost and stability of funding is the optimal choice for risk neutral intermediaries. A proper welfare analysis must consider the possibility that this private choice has social consequences. Aside from risk aversion, a natural case in our setup is that excess liquidation may cause some social costs associated with early termination. Runs may involve bankruptcy costs. Larger runs will affect the liquidation price of assets, or undermine confidence in domestic intermediaries, both causing a negative externality effect (Stein, 2012).

We consider here the simple case of a social cost of excess liquidation  $\xi > 0$  per unit of assets terminated early, in the general case with endogenous uncertainty over assets (as in the previous extension). Recall that in the case of autarky, there are no such costs as funding is long term. We exclude any cost in the case when liquidation is efficient, namely in the low state.

Consider first the investment and funding choice of a constrained planner. The planner (P) internalizes the social cost of excess liquidation, taking the supply of foreign and domestic funding as given (that is, it is aware of the absolute safety constraint of foreign savers). For sufficiently cheap foreign funding, the social optimum of investment  $I_P$  (and thus the volume of foreign funding,  $f_P$ ) is given by:

$$\gamma\delta(I_P)MR(I_P) = T + \frac{\alpha}{x} \left[ \gamma\delta X - T - \gamma\delta'(I_P) \left( \frac{x}{\alpha} R(I_P) - X \right) \right] + \xi \overbrace{\left[ \gamma(1 - \delta(I_P)) - \gamma \frac{x}{\alpha} \delta'(I_P) f_P \right]}^{\text{social cost}}. \quad (11)$$

Relative to the private choice, the planner's problem incorporates the social cost of excessive liquidation. It is easy to see that this implies a lower volume of credit, and a greater degree of stability. In particular, the social demand for foreign funding is lower than the private

demand, since the social cost of investment exceeds the private cost by the highlighted amount in equation (11).

Suppose loss-absorbing domestic is not constrained (so  $d_P \leq 1$ ) and foreign wealth is abundant (so the cost of foreign funding is  $X^* = x$  even in the private equilibrium). The planner then chooses to attract less foreign wealth in order to reduce liquidation volumes in the high state.<sup>8</sup> The second benefit from a reduced intermediation volume is a lower frequency of runs, as asset uncertainty is lower (contingency  $M$  occurs less often). Figure 4 shows this case.

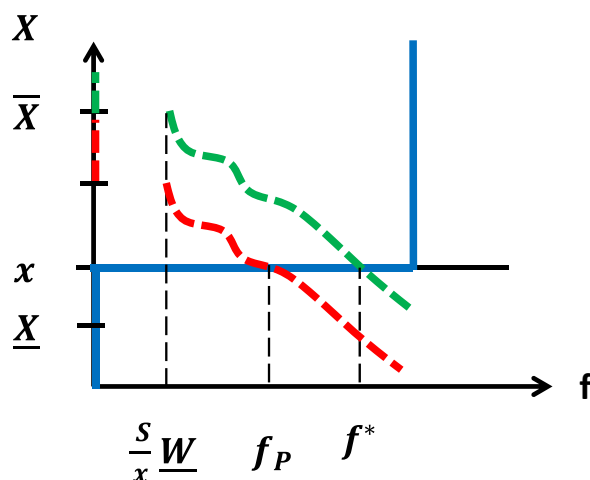


Figure 4: The social and private optimum of foreign funding. The cost  $X$  versus the volume of foreign funding  $f$ . The supply of foreign funding is again the straight blue line, whereas the private and social demand for funding are the dashed green and dashed red lines, respectively. The case of  $\underline{X} < x$  is depicted.

The implication is that more foreign funded credit has a direct effect not just on the amount but also the frequency of excess liquidation, both contributing to systemic risk. Thus capital requirement should be complemented by stable funding norms (as envisioned in the Basel III recommendations, so far not introduced), that recognize the lower stability associated with safety-seeking foreign inflows. In addition, the calibration of liquidity risk

<sup>8</sup>If foreign wealth is scarce, the downward shift in the demand for foreign funding does not affect the allocation, but reduces the cost of foreign funding (vertical supply curve). If access of foreign savers to safe storage were heterogeneous, the result would again be less credit, as well as lower foreign funding.

weights should recognize the sensitivity of outflows to asset opaqueness, as distinct from asset liquidity.

### 4.3 Private arbitrage

We consider next whether domestic investors could resolve the inefficient liquidation by acting as arbitrageurs, relying on their superior risk absorption capacity relative to foreigners. This entails storing some resources until the interim date, which has an opportunity cost of the term premium  $T - 1$ . These arbitrageurs could buy claims from withdrawing foreign savers when the imprecise signal indicates a high state, and negotiate with the bank to appropriate the profit from avoiding liquidation in contingency  $M$ .

Consider the maximum possible benefit from this position, namely when the arbitrageur has all the bargaining power. An arbitrageur with a unit of capital at  $t = 1$  can buy  $1/x$  units of running demandable claims in contingencies  $M$  and  $E$  (recall that there remains some residual uncertainty when the imprecise signal is positive). Next, these claims may be traded for a long-term claim worth at most  $\frac{R(I)}{\alpha}x$  per claim. This strategy generates  $\frac{R(I)}{\alpha}$  in contingency  $M$ , which occurs with probability  $\gamma(1 - \delta)$ , and a complete loss in contingency  $E$ , where the state is low. For any given  $I$ , a sufficient condition to exclude the possibility of domestic arbitrageurs is:

$$T - 1 > \gamma(1 - \delta)\frac{R(I)}{\alpha}. \quad (12)$$

In sum, a private solution to the inefficiency always fails when its opportunity cost (the term premium) exceeds the maximum expected gain in contingency  $M$ . For more general bargaining games, or in the presence of specific costs, the condition will be less stringent.

Note that it is impossible for the arbitrageur to lever up in order to increase its expected profits. First, foreign funding cannot be attracted as the arbitrageur make some infinitesimal errors. Second, other domestic savers have the same opportunity cost  $T - 1$ .

## 4.4 Money market mutual funds and risk-taking incentives

We have so far assumed that domestic intermediaries cannot invest directly in safe storage, because they seek anonymity, or because domestic safe storage requires some local effort (e.g. for safekeeping or maintenance of a real asset). Alternatively, safety demand by domestic or foreign savers may have used up the available stock. In this case, safe assets must be carved out of risky investment by intermediaries.

Consider the case when there is no excess demand for safety, in the sense that some amount of liquid safe assets is available for investment. This creates the option for domestic intermediaries, such as money market mutual funds, to invest in government debt to satisfy some safety demand. Suppose these intermediaries can invest in long-term storage, with a safe return of  $T$ . Competition among such intermediaries will improve returns for foreign savers until the supply of such safe assets is fully exhausted. Beyond this point, the outcome will be as in our model.

However, this solution is fragile in a context of extreme risk aversion. Suppose there is a tiny chance that the asset choice is not fully observed (governance risk), and that these intermediaries can access the same investment opportunities as banks. Because of their leverage, these intermediaries have an incentive to make some risky investment, since its return exceeds  $T$ . As a result, such intermediaries could not attract safety-seeking foreign funding. Kacperczyk and Schnabl (2013) document the risk-taking behavior of money market funds during the financial crisis of 2007–2010.

## 4.5 Induced runs

We consider now the effect of foreign funding on domestic savers holding demandable debt. Suppose a mass  $\omega > 0$  of domestic savers chooses a demandable claim, due to exogenous reasons such as ease of payment or timing of liquidity needs. Let  $\gamma$  be the liquidity discount that domestic savers are willing to accept, where  $1 - \gamma \leq x$ , so that they accept the demandable debt contract targeted at foreign inflows. For simplicity, the available amount

of risk-absorbing domestic funding is unchanged, ensuring an unchanged capacity to insure safety. As a result, some demandable debt is held by risk tolerant domestic savers, who may choose to roll over the claim even when there is only some small uncertainty over the high state (that is, when the imprecise signal suggests asset values are high). Those domestic savers optimally choose to roll over if:

$$\frac{\gamma(1-\delta)(1-\epsilon)}{\gamma(1-\delta)(1-\epsilon) + (1-\gamma)\epsilon} \min \left\{ X^*, \left( R(I^*)I^* - R(I^*)\frac{x}{\alpha}f^* \right) \frac{X^*}{\omega X^* + L^*} \right\} \geq x. \quad (13)$$

where the first term is the probability of the high state conditional on a favorable imprecise signal; the second is the promised return  $X^*$  at the final date, or their expected share of the residual project return in case of default.

This allows to study the comparative static of an increase in the supply of unstable foreign funding. In equilibrium this has several effects. First, more foreign funding reduces the equilibrium face value of demandable debt at the final date,  $X^*$ . Second, it increases the amount of foreign funding  $f^*$  attracted in equilibrium, which leads to larger runs and thus more costly liquidation in contingency  $M$ . Third, there will be a marginal effect on investment value because of diminishing returns.

It is immediate to see that all these effects increase the incentives of domestic savers to withdraw at the interim date. It is easy to show that there is a threshold level of foreign funding such that in equilibrium domestic savers withdraw their demandable debt whenever there is uncertainty, and thus even when asset value is almost certainly high.

In conclusion, an increasing reliance on unstable foreign funding may feed into greater instability of domestic funding even in the good state, as they anticipate large losses due to a foreign run. Here the local savers are not driven by risk intolerance as the foreign savers, but by the incentive to avoid dilution of their claim.

## 5 Conclusion

This paper has sought a foundation for the widespread view that global imbalances shaped the credit boom and ultimately the financial crisis (Caballero and Krishnamurthy, 2009). We show how the accumulation of wealth in countries with a weak protection of property rights create a demand for absolute safety to be provided by intermediaries in safe countries. The optimal contractual arrangement shapes the funding structure of domestic intermediaries, creating a clear link between inexpensive funding, credit expansion and instability.

Our main result is that pressure to provide absolute safety does not just redistribute risk among savers, but increases risk via larger and more frequent runs. This result has clear policy implications, as the socially preferred funding structure would involve less credit volume and lower instability than the private choice.

While large global imbalances reflect major shifts in wealth away from developed countries, a large fraction has flown back as inexpensive liabilities of domestic intermediaries, enabling to expand credit at times of declining savings. We show that the safety seeking nature of these flows makes them jittery, driven by a heightened intolerance for risk. Thus the funding shift leads to greater vulnerability even in solvent states, and may induce runs even by risk tolerant investors seeking to avoid dilution.

Studying inflows into developed countries is specular to the literature on sudden capital outflows in emerging economies. Our contribution is to derive optimal contractual forms shaped by an underlying demand for safety, and to show how it may create endogenous runs, as in recent work by Gennaioli et al. (2013). A distinct contribution is to show how inefficient runs may be triggered by risk intolerance even when a tiny probability of losses is fully anticipated.

In future work, we plan to broaden the simple framework adopted here to accommodate a more general view of portfolio flows across countries with different institutional quality.



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## A Proof of Lemma 1

Consider the supply of funding first. Domestic savers satisfy their absolute safety needs locally, so domestic funding  $d_i \in [0, 1]$  can be attracted by intermediary  $i$  with a claim that yields at least  $T$  in expectation (as does long-term domestic storage). This is best achieved with long-term debt, since domestic savers who seek expected return have no incentive to withdraw prematurely.

Each foreign saver invests  $\frac{S}{x}$  in foreign storage in autarky to satisfy the absolute safety needs. Therefore, foreign funding is supplied to domestic intermediaries if a minimal return of  $x$  is ensured in all contingencies. For an intermediary to satisfy this absolute safety constraint in contingency  $M$  and  $B$ , it (i) offers a senior claim to foreign savers and (ii) attracts a sufficient amount of risk-absorbing domestic funding,  $\alpha(d_i + f_i) \geq x f_i$ . This requires either  $f_i = 0$  or  $d_i \geq \left(\frac{x-\alpha}{\alpha}\right) f_i > 0$ .

Since safety-seeking foreign savers would cause inefficient liquidation of investment in contingency  $M$ , it is optimal for the intermediary to offer long-term debt contracts only. Seniority ensures the safety needs of foreigners, provided enough domestic funding is attracted.

Let  $L_S \geq x$  denote the face value of senior long-term debt and  $L_J \geq T$  denote the face value of junior long-term debt, where the lower bounds arise from the participation constraints of savers. Furthermore, the incentive compatibility constraint of foreign savers is met, since junior long-term debt contract does not guarantee absolute safety,  $\alpha I_i - L_S f_i < x d_i$ . There is a Walrasian market for foreign funding, so all intermediaries and foreign savers take  $L_S$  as given. Hence, the aggregate supply of foreign funding is: ~~DELETE?~~

$$f(L_S) = \begin{cases} 0 & L_S < x \\ [0, \frac{WS}{x}] & \text{if } L_S = x \\ \frac{WS}{x} & L_S > x \end{cases} \quad (14)$$

Increases in foreign wealth shifts out the supply curve of foreign funding.

Conditional on attracting foreign funding, Table 3 summarizes the payoffs to the intermediary and savers in all contingencies. The intermediary always defaults in contingency  $B$ , leading to at least partial default on junior claims, which are held by domestic savers.

State	Probability	Return	$\pi_F$	$\pi_D$	$\pi_i^B$
$G$	$\gamma\delta$	$R(\cdot)$	$L_S$	$L_J$	$R(I_i)I_i - L_Jd_i - L_Sf_i$
$M$	$\gamma(1 - \delta)$	$R(\cdot)$	$L_S$	$L_J$	$R(I_i)I_i - L_Jd_i - L_Sf_i$
$B$	$1 - \gamma$	$\alpha$	$\min \left\{ L_S, \frac{\alpha I_i}{f_i} \right\}$	$\max \left\{ 0, \frac{\alpha I_i - L_S f_i}{d_i} \right\}$	0

Table 3: Payoffs when foreign capital is attracted

Intermediary  $i$  maximizes its expected equity value by choosing the amount of foreign and domestic funding and the face value of junior long-term debt. Since a higher face value  $L_J$  reduces expected profits but makes the participation constraint of domestic savers slacker, it is always optimal for the intermediary to set it at the lowest value consistent with participation of domestic savers:

$$L_J^* = \frac{T}{\gamma} - \frac{1 - \gamma}{\gamma} \max \left\{ 0, \frac{\alpha I_i - L_S f_i}{d_i} \right\} \quad (15)$$

There are two cases. Case (I) describes complete default on domestic savers in contingency  $M$ ,  $L_S f_i \geq \alpha I_i \geq x f_i$ , while case (II) describes partial default in contingency  $M$ ,  $L_S f_i < \alpha I_i$ .

It is always optimal to attract some domestic funding,  $d_i^* > 0$ . Proof by contradiction: if  $d_i = 0$ , then  $f_i = 0$  from the absolute safety constraint. Hence, the expected profits are zero, which is dominated by the autarky allocation with strictly positive profits,  $\pi^{Aut} \equiv I^{Aut}[\gamma R(I^{Aut}) + (1 - \gamma)\alpha - T] > 0$ . This establishes the claim.

We showed that the optimal funding contract when agents are perfectly informed is long-term debt. Seniority is given to foreign savers to satisfy their absolute safety constraint. Since foreign funding is weakly cheaper than domestic funding, some of which is attracted in equilibrium. Specific expressions for the face values of debt contract and the composition of funding can be obtained by solving the constrained optimization problem described above.

## B Proof of Lemma 3

We start by showing that the bank's problem simplifies as stated below. Domestic funding is expensive, as implied by the participation constraint of domestic savers:

$$\mathbb{E}[\pi_D] = \gamma\delta L + \gamma(1-\delta) \min \left\{ L, \frac{R(I_i)I_i - \frac{R(I_i)}{\alpha}xf_i}{d_i} \right\} + (1-\gamma)(1-\epsilon) \min \left\{ L, \frac{\alpha I_i - xf_i}{d_i} \right\} \geq T.$$

The expected profit of bank  $i$  is:

$$\begin{aligned} \mathbb{E}[\pi_i] &= \gamma\delta [R(I_i)I_i - Ld_i - Xf_i] + \gamma(1-\delta) \left[ \max \left\{ R(I_i)I_i - \frac{R(I_i)}{\alpha}xf_i - Ld_i, 0 \right\} \right] \\ &\quad + (1-\gamma)(1-\epsilon) [\max\{\alpha I_i - xf_i - Ld_i, 0\}]. \end{aligned}$$

Each intermediary  $i$  maximizes its expected profits  $\mathbb{E}[\pi_i^B]$  by choosing its funding profile  $(d_i, f_i)$  and the face value of long-term debt  $L$ , taking the face value of demandable debt  $X$  as given. These choices are constrained by the participation constraint of domestic savers and the absolute safety constraint. The face value of long-term debt reduces the bank's expected profits but makes the participation constraint of domestic savers less binding (without affecting the absolute safety constraint). Hence, the bank sets  $L$  for the participation constraint of domestic savers to bind. Thus, the bank's problem can be reduced to the following problem:

$$\begin{aligned} \max_{f_i \in [0, \infty), d_i \in [0, 1]} \hat{\pi}_i &= I_i [\gamma R(I_i) + (1-\gamma)(1-\epsilon)\alpha] - d_i T & (16) \\ &\quad - f_i \left[ \gamma\delta X + x \left( \gamma(1-\delta) \frac{R(I_i)}{\alpha} + (1-\gamma)(1-\epsilon) \right) \right] \\ \text{s.t.} \quad &\alpha I_i \geq xf_i \\ &I_i = d_i + f_i \end{aligned}$$

The objective function is the expected revenue from investment net of the cost of domestic and foreign funding. We now solve this standard constrained optimization problem. Let  $\mathcal{L}_i$  the Lagrangian of the problem and  $\lambda_i$  be the Lagrange multiplier associated with the absolute safety constraint of bank  $i$ . The first-order conditions are:

$$\begin{aligned}\frac{d\mathcal{L}_i}{dd_i} &= \gamma MR(I_i) + (1-\gamma)(1-\epsilon)\alpha - T - \gamma(1-\delta)x\frac{R'(I_i)}{\alpha}f_i + \lambda_i \\ \frac{d\mathcal{L}_i}{df_i} &= \gamma MR(I_i) + (1-\gamma)(1-\epsilon)(\alpha-x) - \gamma\delta X - \gamma(1-\delta)\frac{x}{\alpha}[R'f_i + R] - \left(\frac{x}{\alpha} - 1\right)\lambda_i\end{aligned}$$

and  $\lambda_i \geq 0$  and  $d_i \geq \frac{x-\alpha}{\alpha}f_i$  with complementary slackness.

## B.1 Slack absolute safety constraint

Consider the case in which the constraint to provide absolute safety does not bind ( $\lambda_i^* = 0$ ). There are two subcases: (A) foreign funding is more expensive, (B) foreign funding is cheaper than domestic funding.

**(A) more expensive foreign funding** Suppose that foreign funding is expensive relative to domestic funding,  $X \geq \frac{T}{\gamma\delta} - \frac{(1-\gamma)(1-\epsilon)}{\gamma\delta}x - \frac{1-\delta}{\delta}\frac{x}{\alpha}R(I_i^*)$ . Then, no foreign funding is attracted,  $f_i^* = 0$ , and the autarky level of investment occurs,  $d_i^* = I^{Aut}$ . The profit level is  $\pi^{Aut} \equiv I^{Aut}[\gamma R(I^{Aut}) + (1-\gamma)(1-\epsilon)\alpha - T]$ .

We need to confirm two suppositions. First, the absolute safety constraint is trivially slack,  $\lambda_i^* = 0$ . Second, for foreign funding to be (prohibitively) expensive, we require:

$$X \geq \bar{X} \equiv \frac{T}{\gamma\delta} - \frac{(1-\gamma)(1-\epsilon)}{\gamma\delta}x - \frac{1-\delta}{\delta}\frac{x}{\alpha}R(I^{Aut}). \quad (17)$$

Autarky is the unique equilibrium if  $\bar{X} \leq x$ . However, we impose a lower bound on uncertainty in order to allow for an equilibrium in which foreign funding is attracted. In short:

$$\delta > \underline{\delta}_0 \equiv \frac{\gamma R(I^{Aut}) + (1-\gamma)(1-\epsilon)\alpha - \frac{\alpha}{x}T}{\gamma[R(I^{Aut}) - \alpha]} \in (0, 1) \quad (18)$$

**(B) foreign funding is cheaper than domestic funding** If foreign funding is cheap relative to domestic funding,  $X < \frac{T}{\gamma\delta} - \frac{(1-\gamma)(1-\epsilon)}{\gamma\delta}x - \frac{1-\delta}{\delta}\frac{x}{\alpha}R(I_i^*)$ , then the intermediary would

wish to attract only foreign funding,  $f_i^* > 0$ , and no domestic funding,  $d_i^* = 0$ . This allocation violates the absolute safety constraint, however. Contradiction.

## B.2 Binding absolute safety constraint

Consider now the case in which the constraint to provide absolute safety binds ( $\lambda_i^* > 0$ ). Hence,  $d_i^* = \left(\frac{x}{\alpha} - 1\right) f_i^*$  and  $I_i^* = \frac{x}{\alpha} f_i^*$ . Optimality requires  $f_i^* > 0$ , so we have  $\frac{d\mathcal{L}_i}{df_i} = 0$ . Solving this equation for the Lagrange multiplier yields:

$$\lambda_i = \frac{\alpha}{x - \alpha} \gamma MR(I_i^*) - (1 - \gamma)(1 - \epsilon)\alpha - \frac{\alpha\gamma\delta}{x - \alpha} X - \gamma(1 - \delta) \frac{x}{x - \alpha} [R(I_i^*) + R'(I_i^*) f_i^*]. \quad (19)$$

Inserting the multiplier in  $\frac{d\mathcal{L}_i}{dd_i}$  yields:

$$\frac{d\mathcal{L}_i}{dd_i} = \gamma\delta \frac{x}{x - \alpha} MR\left(\frac{x}{\alpha} f_i^*\right) - T - \gamma\delta \frac{\alpha}{x - \alpha} X. \quad (20)$$

First, if  $d_i^* \in (0, 1]$ , then  $\frac{d\mathcal{L}_i}{dd_i} = 0$ , so the optimal amount of foreign (and domestic) funding is implicitly defined by:

$$MR\left(\frac{x}{\alpha} f_i^*\right) = \frac{x - \alpha}{x} \frac{T}{\gamma\delta} + \frac{\alpha}{x} X. \quad (21)$$

The left-hand side strictly decreases in the amount of foreign funding since  $MR'(\cdot) < 0$ . The right-hand side is a positive constant. Note that the left-hand side at zero strictly exceeds the right-hand side for all  $X \leq \bar{X}$ . Therefore, there exists a unique interior solution  $f_i^*(X) > 0$  for all  $X < \bar{X}$ .<sup>9</sup> The demand for foreign funding in downward-sloping,  $\frac{df_i^*(X)}{dX} < 0$ , since the right-hand side increases in the price of foreign funding.

Since domestic funding is bounded,  $d_i^* \leq 1$ , we require a lower bound on the price of foreign funding to guarantee an interior solution:

$$X \geq \underline{X} \equiv \frac{x}{\alpha} MR\left(\frac{x}{x - \alpha}\right) - \frac{x - \alpha}{\alpha} \frac{T}{\gamma\delta}. \quad (22)$$

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<sup>9</sup>That is,  $R(0) \geq \frac{x - \alpha}{x} \frac{T}{\gamma\delta} + \frac{\alpha}{x} X$  for all  $X \leq \bar{X}$  because of the first boundary condition and the definition of the autarky investment level.



If  $X < \underline{X}$ , then there the corner solution  $d_i^* = 1$  and  $f_i^* = \frac{\alpha}{x-\alpha}$  prevails. For an interior solution  $d_i^* < 1$  to exist, we require  $\underline{X} < \bar{X}$  that imposes a lower bound on the informativeness of foreign funding:

$$\delta > \underline{\delta}_1 \equiv \frac{\gamma R(I^{Aut}) + (1-\gamma)(1-\epsilon)\alpha - T}{\gamma [R(I^{Aut}) - MR(\frac{x}{x-\alpha})]} \in (0, 1). \quad (23)$$

Finally, we need to establish that  $\lambda_i^* > 0$  as supposed. Inserting the optimality condition in the expression for the Lagrange multiplier yields an upper bound on the price of foreign funding  $X < \tilde{X}$ , which is implicitly defined by:

$$\tilde{X} \equiv \frac{T}{\gamma\delta} - \frac{(1-\gamma)(1-\epsilon)}{\gamma\delta}x - \frac{1-\delta}{\delta} \frac{x}{\alpha} R(I_i^*(\tilde{X})). \quad (24)$$

Note that  $\lim_{X \rightarrow \tilde{X}} I_i^*(X) > I^{Aut}$  and  $\lim_{X \rightarrow \tilde{X}} f_i^*(X) > 0$ . This follows from first-order condition, equation (21), and the definition of autarky investment:

$$\gamma R(I_i^*(\tilde{X})) + \gamma\delta I_i^*(\tilde{X})R'(I_i^*(\tilde{X})) + (1-\gamma)(1-\epsilon)\alpha = T. \quad (25)$$

Note that  $\lim_{X \rightarrow \bar{X}} I_i^*(X) > I^{Aut}$  and  $\lim_{X \rightarrow \bar{X}} f_i^*(X) > 0$ . This follows from first-order condition, equation (21), and the definition of autarky investment:

$$\gamma [\delta R(I_i^*(\bar{X})) + (1-\delta)R(I^{Aut}) + \delta I_i^*(\bar{X})R'(I_i^*(\bar{X}))] + (1-\gamma)(1-\epsilon)\alpha = T. \quad (26)$$

Hence,  $I_i^*(\bar{X}) > I_i^*(\tilde{X})$ . Since investment decreases in the face value of foreign funding, we also have  $\bar{X} < \tilde{X}$ .

### B.3 When is autarky optimal?

The expected equity value of the intermediary that chooses autarky is:

$$\pi^{Aut} \equiv I^{Aut}[\gamma R(I^{Aut}) + (1-\gamma)(1-\epsilon)\alpha - T] = \gamma (I^{Aut})^2 (-R'(I^{Aut})). \quad (27)$$

For  $X \in [\underline{X}, \tilde{X}]$ , a bank's expected equity if choosing to attract foreign funding is:

$$\pi_i^*(X) = \gamma \delta \frac{x}{\alpha} f_i^*(X) R\left(\frac{x}{\alpha} f_i^*(X)\right) - \gamma \delta X f_i^*(X) - T \frac{x - \alpha}{\alpha} f_i^*(X), \quad (28)$$

where  $f_i^*(X) \in (0, \frac{\alpha}{x-\alpha}]$  is determined as described above. By the envelope theorem, the expected profit strictly decreases in the face value of foreign funding,  $\frac{d\pi_i^*}{dX} < 0$ .

Suppose a switching threshold of foreign funding  $X_S$  exists. This implies that autarky is preferred for  $X \geq X_S$  and attracting foreign funding is preferred for  $X \leq X_S$ . Two conditions are required: at the lower bound  $\underline{X}$ , attracting foreign funding must be preferable, while autarky is preferable at the upper bound  $\bar{X}$ . One can show that the first condition is more restrictive and imposes another lower bound on the informativeness of foreign savers.

Specifically, the expected profit at the upper bound  $\bar{X}$  – where the foreign funding level is  $f_i^*(\bar{X})$  defined above – is:

$$\pi_i^*(\bar{X}) = I_i^*(\bar{X}) [\gamma \delta R(I_i^*(\bar{X})) + \gamma(1 - \delta)R(I^{Aut}) + (1 - \gamma)(1 - \epsilon)\alpha - T] \quad (29)$$

Hence,  $\pi_i^*(\bar{X}) < \pi^{Aut}$  is implied by a lower bound on the informativeness of foreign savers:

$$\delta > \underline{\delta}_2 \equiv \frac{I_i^*(\bar{X}) - I^{Aut}}{I_i^*(\bar{X})} \frac{\gamma R(I^{Aut}) + (1 - \gamma)(1 - \epsilon)\alpha - T}{\gamma [R(I^{Aut}) - R(I_i^*(\bar{X}))]} \in (0, 1) \quad (30)$$

Then, the effective lower bound is  $\underline{\delta} \equiv \max\{\underline{\delta}_0, \underline{\delta}_1, \underline{\delta}_2\}$ . Collecting the various cases yields the demand for funding stated in Lemma 3.

## C Proof of Proposition 2

This proof builds on Lemma 2 and Lemma 3. To ensure existence of equilibrium, we require a lower bound on foreign wealth. This lower bound  $\underline{W}$  is given by the interaction between the supply of foreign funding,  $f = \frac{WS}{x}$ , and the demand for foreign funding as implied by the solution to the intermediary's problem. The definition stated in the Proposition follows

immediately.

To ensure an interior equilibrium, we require  $\bar{X} > x$ . This condition can be expressed as a lower bound on the informativeness of foreign savers that we derived before. This completes the proof.

## D Proof of Proposition 3

This proof builds on Lemma 2, Lemma 3, and Proposition 2.

Foreign funding is attracted whenever foreign wealth is sufficiently abundant,  $W > \underline{W}$ . For these equilibria, the absolute safety constraint binds,  $\alpha I_i^* = r f_i^*$  for each intermediary  $i$ . Hence, there are no resources left after foreign savers withdrew at the interim date in contingency  $M$  (see Table 2). Thus, the bank makes zero profits and fully defaults on domestic savers.

The total efficiency loss is  $\frac{R(I^*)}{\alpha} x f^*$ . Focusing on the more general case of  $\underline{X} > x$ , we have two relevant ranges of foreign wealth. First, for  $W \in (\underline{W}, \bar{W})$ , we have that  $I^* = \frac{S}{\alpha} W$  and  $f^* = \frac{S}{x} W$ , which yields an efficiency loss of  $R\left(\frac{S}{\alpha} W\right) \frac{S}{\alpha} W$ . Second, for  $W \geq \bar{W}$ , we have that  $I^* = \frac{x}{x-\alpha} W$  and  $f^* = \frac{\alpha}{x-\alpha} W$ , which yields an efficiency loss of  $R\left(\frac{x}{x-\alpha}\right) \frac{x}{x-\alpha}$ . This completes the proof.

## E Proof of Corollary 3

Irrespective of whether  $\underline{X} > x$  or not, the net present value of investment at domestic discount rates for a level of foreign wealth below the upper bound  $\bar{W}$  is:

$$NPV = \frac{\gamma R\left(\frac{WS}{\alpha}\right) + (1-\gamma)(1-\epsilon)\alpha}{T} - 1. \quad (31)$$

Hence, the net present values decreases in foreign wealth:

$$NPV'(W) = \frac{\gamma R' \left( \frac{WS}{\alpha} \right) \frac{S}{\alpha}}{T} < 0. \quad (32)$$

If  $\underline{X} > x$  – which is implied by  $\delta \geq \frac{\frac{x-\alpha T}{\alpha}}{\gamma [MR \left( \frac{x}{x-\alpha} \right) - \alpha]}$  – then the corner solution with  $I^* = \frac{x}{x-\alpha}$  occurs for sufficiently abundant foreign wealth. Thus, the gross present value of investment never smaller than  $\frac{\gamma R \left( \frac{x}{x-\alpha} \right) + (1-\gamma)(1-\epsilon)\alpha}{T}$ . By continuity, the result in Corollary 3 follows.