Banks and Capital Inflows

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Abstract

This paper examines the effects that capital inflows have on the financial system in the context of a demand deposit banking model. In this environment, an adverse-selection problem arises where short-term capital has the incentive to enter the domestic banking system while long-term capital chooses to stay out. Then, short-term capital flows limit the insurance function of banks. As short-term inflows increase, a threshold is reached beyond which it becomes optimal to restrict capital inflows. In addition, if the quantity of inflows is unknown, a banking crisis may occur caused by large short-term capital flows. In this case, the bank's insurance function is lost and assets have to be suboptimally liquidated. In spite of this, limiting capital inflows may not be optimal at all times, since the cost of restricting flows may be greater than the detriment of allowing them in.

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1 Introduction

The past decade has seen many developing economies move towards opening their financial systems to unrestricted inflows and outflows of capital. With the increased liberalization and growth of these flows came a resurgence of financial crises, particularly in Latin America and Asia. At the center of these crises is the interaction between capital flows and financial intermediaries. In particular, short-term capital flows have been pointed out as being a crucial factor in causing financial distress[2]. This has renewed the discussion on the costs and benefits of restricting capital flows.

The goal of this paper is to specifically examine the effects that capital inflows have on domestic banks, and thus depositors, in the context of a demand deposit environment. The model is a two asset version of Diamond and Dybvig (1983), where two types of agents, domestic and foreigners, are introduced. In this model, short-term capital inflows reduce bank's risk-sharing function. As short-term inflows increase, a threshold is reached beyond which it becomes optimal to restrict capital inflows. In addition, if the quantity of inflows is unknown, a banking crisis may occur as short-term inflows become large. In this case, both the insurance function is lost and assets have to be suboptimally liquidated. In spite of this, restricting short-term capital inflows may not be optimal at all times, since the cost of doing so may be greater than the cost of allowing crises to occur.

On the effect capital inflows have on banks, this work is mainly related to the papers of Chang and Velasco (2001) and Goldfajn and Valdez (1998). Chang and Velasco develop an open economy version of Diamond and Dybvig (1983), where agents can borrow in international markets. In a demand deposit environment, a self-fulfilling bank run may occur when banks' potential short-term obligations exceed the liquidation value of its assets. They find that increased international borrowing by agents may exacerbate this potential illiquidity of banks and thus increase their vulnerability. In contrast, Goldfajn and Valdez (1998) model an economy with international depositors, where adverse productivity shocks may trigger a fundamental bank run. They find that intermediation of external funds increases the probability of crises, and magnifies capital outflows.

This analysis is also related to the literature on the insurance function of banks, in particular to the work of Jacklin (1987, 1993) and von Thadden (1997). Jacklin shows that the insurance function provided by demand deposit contracts disappears if trading opportunities are introduced. Von

[2] See, for example, Rodrik and Velasco (1999).

Thadden develops a model where time is continuous, and shows that if agents are allowed to withdraw and re-invest their funds, the insurance function may not be incentive compatible. He shows that, by introducing multiple assets, the moral hazard problem is eased.

My model is a two asset, open economy version of Diamond and Dybvig, where two types of agents are introduced. Agents are either domestic or foreign depositors. They have access to the same savings and production technologies, and share the same preferences, but differ only in the time they learn their idiosyncratic withdrawal demand. Domestic agents are the standard Diamond-Dybvig agent in the sense that they are uncertain about their liquidity needs at the time they deposit their endowments in banks. Foreign agents, on the other hand, know their liquidity preference at the time they are born. This paper then examines the effect that foreign agents have on entering the demand deposit contract offered by domestic banks[3].

Banks arise endogenously in this environment as a coalition of domestic agents to provide two services. They provide insurance among ex-ante identical agents who need to consume at different times, and they prevent suboptimal liquidation of assets. However, when banks are not able to distinguish domestic from foreign deposits, an adverse-selection problem arises. That is, short-term inflows have the incentive to join the financial system while long-term capital does not. Further, as short-term capital flows in, a moral hazard problem emerges, where foreigners exploit the bank's service of liquidity provision at the expense of domestic depositors. Implementing a self-selection constraint in this case fully thwarts liquidity provision, and thus may or may not be preferred, depending on the relative size of short-term flows.

In addition, if the quantity of capital inflows is unknown, then for sufficiently large short-term flows, a banking crisis occurs. In this case, both services banks provide, liquidity provision and prevention of costly liquidation, are lost. A constraint that produces a separating contract will prevent banking crises. In spite of this, restricting short-term capital inflows may not be optimal at all times, since the cost of doing so may be greater than the expected loss in allowing crises to occur with positive probability.

The remainder of the paper proceeds as follows. Section 2 describes the environment and benchmark problem of the banks. The effect of short-term inflows on the domestic financial system when there is no aggregate uncer-

[3] The application of this model is to capital inflows. However, more generally it can be seen as a banking model with two different types of agents, where the results are more widely applicable.

tainty is discussed in section 3. In section 4 we add aggregate uncertainty about withdrawal demand, as in Champ, Smith and Williamson (1996) and Smith (2002). Section 5 concludes.

2 The Model

2.1 *Environment*

The model consists of an open economy populated by a continuum of agents. Time is discrete and there are three periods indexed by $t = 0, 1, 2$. There are two types of agents, domestic and foreigners. Both types are endowed one unit of a single good when young, and nothing in periods 1 and 2. Goods are freely traded across countries. Agents care only about consumption in periods 1 and 2, and are expected utility maximizers. Their utility has the form $U(c) = c^{(1-\rho)}/(1-\rho)$, with the coefficient of relative risk aversion $\rho > 1$.

Domestic and foreign agents differ only in the time they learn their liquidity preference shock. Local agents learn their need of liquidity after the portfolio decision is made, and thus are the classic Diamond-Dybvig agent. Let π_1^d and π_2^d be the total population of domestic impatient and patient agents, respectively, with $\pi_1^d + \pi_2^d = 1$. There is no aggregate uncertainty for the total population or the share of domestic impatient and patient agents.

In contrast, foreigners know at the time they are born whether they will prefer to consume in periods 1 or 2. We label π_1^f, π_2^f as the total population of impatient and patient foreigners, respectively[4]. Agents' type, domestic or foreigner, is observable. However, the liquidity preference shock is private information for both types of agents.

Both types of agents have access to a linear production technology whereby one unit of the good invested in period 0 yields $R>1$ units of the good at time 2. This technology is illiquid, in the sense that an investment that is interrupted in period 1 generates $r<1$ units of consumption. In addition, there is a liquid storage technology, whose return is equal to 1 in both periods. In this sense, the liquid asset dominates the production technology in the short-term, while investing in the production technology dominates the liquid asset in the long-term.

[4] Alternatively, we can think of the π_1^f foreigners as Diamond-Dybvig agents with a larger share of impatient agents relative to domestic agents, where here we look at the limiting special case where all are impatient. Likewise, the π_2^f foreigners have a lower probability relative to locals of becoming impatient, set here at zero.

The timing of events follows. At the beginning of period 0, young agents receive their endowments, and foreigners learn their liquidity preference. Agents then choose their portfolio allocation, i.e. the mix of storage and the illiquid investment. In period 1, domestic agents learn whether they will consume in periods 1 or 2. Following this, period 1 consumption occurs, where the illiquid technology may be liquidated in order to be consumed. In period 2 the long-term investment technology matures, and patient agents consume.

2.2 *Bank Behavior*

Banks arise endogenously in our environment as a coalition of domestic agents. This is because domestic agents benefit from pooling their resources in order to overcome idiosyncratic uncertainty, and they gain from insuring themselves against their liquidity preference shock. In contrast, foreign agents face no uncertainty at the time the investment decision is made, and thus have no need to pool their resources nor require insurance. In this sense, banks arise naturally as domestic banks that care about domestic agents.

Given this, domestic banks will offer a contract that maximizes the expected utility of local agents. Banks announce contracts in period 0, which specify returns to depositors that depend on their liquidity preference (early vs. late-withdrawers) reported by agents. After young agents deposit their endowments with banks, banks use these deposits to save in the liquid asset and make investments in the production technology. In period 1, domestic depositors learn whether they will withdraw in period 1 or 2. Following this, banks pay to agents who wish to withdraw early. In period 2 the long-term investment matures, and banks dispense payments to the patient agents.

Here we do not impose a sequential service constraint, so that self-fulfilling banking crises are ruled out. Banks are able to observe the quantity of early-withdrawers in period one before they make payments. This implies that if all agents choose to withdraw early, banks will be able to liquidate resources and divide them equally among agents, so that no agent may be left without consumption. Thus, it will never be optimal for a patient agent to run, and a self-fulfilling run is not an equilibrium.

Let k denote the share of bank's investments in the production technology, and m denote the share of liquid reserves. Therefore, banks will face the constraint

$$m + k = 1 \tag{1}$$

Assume initially a separated world. Recall that agents' type, whether they are locals or foreigners, is observable, and assume that agents are allowed only to deposit one unit per person. Given this, banks will be able to offer a contract to domestic agents only, where foreigners are not allowed to participate. Let c_1^d and c_2^d be consumption for domestic early and late withdrawers, respectively. Then, the problem of the bank is

$$V^d = \max_{c_1^d, c_2^d} \pi_1^d U(c_1^d) + (1 - \pi_1^d) U(c_2^d) \tag{2}$$

subject to

$$\pi_1^d c_1^d = m \tag{3}$$

$$(1 - \pi_1^d) c_2^d = R(1 - m) \tag{4}$$

$$c_2^d \geq c_1^d \tag{5}$$

$$V^d > V^a \tag{6}$$

$$c_1^d, c_2^d \geq 0 \tag{7}$$

Where (3) and (4) are the resource constraints, and (5) is the incentive compatibility or truth-telling constraint for domestic agents. (6) is the participation constraint of domestic agents, where V^a is the indirect utility of domestic agents behaving in autarky. Given constant relative risk aversion preferences, the solution to this problem sets the share of liquid reserves as

$$m^d = \frac{1}{1 + \frac{(1-\pi_1^d)}{\pi_1^d} R^{(1-\rho)/\rho}} \tag{8}$$

and the return schedule for locals becomes

$$\begin{cases} c_1^d = \frac{1}{\pi_1^d + (1-\pi_1^d) R^{(1-\rho)/\rho}} \\ c_2^d = \frac{R^{(1/\rho)}}{\pi_1^d + (1-\pi_1^d) R^{(1-\rho)/\rho}} \end{cases} \tag{9}$$

Foreign agents, in contrast, are able to achieve their optimal outcome without the need for banks. Young foreigners that know that they will want to withdraw in the first period, can simply acquire the liquid asset, while foreign late-withdrawers can invest all of their endowment in the illiquid technology in order to realize higher returns. Thus, consumption for foreigners will be

$$\begin{cases} c_1^f = 1 \\ c_2^f = R \end{cases} \tag{10}$$

where c_1^f and c_2^f are consumption for foreign impatient and patient agents, respectively.

Local depositors choose to deposit all of their endowments in banks, since the expected utility of an agent whose funds are intermediated will be greater than the expected utility when they behave autarkically, i.e. $V > V^a$. This is because financial intermediation in this model provides two services[5].

First, banks prevent suboptimal holding of assets. When local depositors behave autarkically, their consumption becomes $c_1^d = m + r(1-m) < 1$, and $c_2^d = m + R(1-m) < R$. In period 1 the long-term asset is liquidated at cost, and in period 2 the short-term asset is held suboptimally. In contrast, banks are able to avoid this by pooling depositors and, by applying the law of large numbers, allocating the exact share of endowments to liquid reserves that will be withdrawn. This implies that no reserves need to be held between periods, and no long-term investments need to be terminated early. A coalition of agents takes advantage of the law of large numbers, and is able to offer $c_1^d = 1$ and $c_2^d = R$. Notice that this is identical to (10), the solution for foreigners. For this instance it is particularly clear to see that a coalition of agents completely resolves the idiosyncratic uncertainty about the timing of consumption, which is the distinction between both types of agents. Notice that this service is somewhat different from risk-sharing, since it ex-post benefits both early- and late-withdrawers, and comes at no cost to agents.

Second, banks provide insurance should agents become early withdrawers. That is, for risk aversion greater than one, we have from (9) that $c_1^d > 1$. This is achieved at the cost of foregoing some consumption if they are late-withdrawers, where $c_2^d < R$, also by (9). This risk-sharing service that is realized through financial intermediation is what Diamond and Dybvig define as banks providing liquidity.

Finally, notice that the higher the level of risk aversion, the more agents value liquidity provision. This can be seen by noting that $\frac{\partial m}{\partial \rho} > 0$. As risk aversion increases, in the limit we have $c_1^d = c_2^d$, where agents choose to fully insure against early consumption.

3 Capital Inflows

In this section we examine the case when foreign agents cannot be prevented from depositing their endowments in banks under the contract offered to

[5] Bencivenga and Smith (1991) first introduce two assets in an OG-Diamond-Dybvig environment and discuss these two services, and their effect on growth.

domestic agents, if they wish to do so. We assume that banks are not able restrict deposits to one unit per agent. Therefore, even if foreigners are discernible from domestic agents, if there are gains from depositing in a local bank, foreigners can offer to share the profits with a domestic agent that is willing to deposit for them. Given this, the problem of a domestic bank now becomes

$$V^* = \max_{c_1,c_2} \pi_1^d U(c_1) + (1-\pi_1^d)U(c_2) \tag{11}$$

subject to

$$\lambda c_1 = m \tag{12}$$

$$(1-\lambda)c_2 = R(1-m) \tag{13}$$

$$c_2 \geq c_1 \tag{14}$$

$$V^* > V^a \tag{15}$$

$$\phi_1^f = \begin{cases} 0 & \text{if } c_1 \leq 1 \\ \pi_1^f & \text{if } c_1 > 1 \end{cases} \tag{16}$$

$$\phi_2^f = \begin{cases} 0 & \text{if } c_2 \leq R \\ \pi_2^f & \text{if } c_2 > R \end{cases} \tag{17}$$

$$c_1, c_2 \geq 0, \quad 0 \leq \phi_1^f \leq \pi_1^f, \quad 0 \leq \phi_2^f \leq \pi_2^f$$

where λ is the endogenous share of total impatient depositors given by

$$\lambda = \frac{\pi_1^d + \phi_1^f}{\pi_1^d + \pi_2^d + \phi_1^f + \phi_2^f} \tag{18}$$

In this problem, domestic banks decide whether to allow foreign agents to enter by way of choice of the consumption schedule. This is described by the constraints (16) and (17), which are the participation constraints of foreign agents, where ϕ_1^f and ϕ_2^f are the number of impatient and patient foreigners that choose to enter, respectively.[6].

Before we get to the solution to (11), we can simplify the problem by ruling out participation of patient foreigners.

Lemma 1*:* $\phi_2^f = 0$ *for* ρ*>1.*
Proof: See the appendix.

[6] Truly, when $c_1 = 1$, $\Rightarrow$ $\phi_1^f \in [0, \pi_1^f]$, where foreigners are indifferent between entering or not. In this case we assume for simplicity that they choose not enter.

Lemma 1 says that patient foreigners will never have the incentive to enter the banking contract in equilibrium. In contrast, impatient foreigners may have the incentive to enter, depending on the value of c_1 chosen by banks. This is due to the fact that the income effect dominates the substitution effect for domestic agents when $\rho>1$. It entails that early consumption will be greater or equal to one, and by feasibility, late consumption will be less than or equal to R. Thus, patient foreigners prefer not to enter, since their return in autarky equals R. In this sense, an adverse-selection problem arises, where short-term capital may have the incentive to enter while long-term capital decides to stay out of the domestic financial system.

Given this, we turn our attention to the bank's problem where only short-term capital may want to enter the domestic contract. Consider first the pooling case where banks opt to let foreign short-term capital enter, that is $\phi_1^f = \pi_1^f$. In this case, the solution to (11) sets the optimal reserve ratio as

$$m^p = \frac{1}{1 + \left(\frac{(1-\lambda)}{\lambda}\right)^{1-1/\rho} \left(\frac{(1-\pi_1^d)}{\pi_1^d}\right)^{1/\rho} R^{(1-\rho)/\rho}} \tag{19}$$

However, local agents may prefer a contract that gives foreign impatient agents the incentive not to deposit in banks. Consider the separating case where $\phi_1^f = 0$. This implies from the participation constraint that period 1 consumption needs to be set to $c_1 \leq 1$. It follows that by the resource constraint and the first order condition, the solution sets

$$m^s = \pi_1^d \tag{20}$$

Proposition 1: *Define the threshold*

$$\widehat{\pi}_1^f = \pi_1^d(R^{\rho-1} - 1) \tag{21}$$

Then the solution to the bank's problem is the contract (c_1, c_2) *given by*

$$\begin{array}{ll} \left.\begin{array}{l} c_1 = \frac{1}{\lambda} m^p \\ c_2 = \frac{R}{(1-\lambda)}(1-m^p) \end{array}\right\} & \text{for } \pi_1^f \leq \widehat{\pi}_1^f \\ \left.\begin{array}{l} c_1 = 1 \\ c_2 = R \end{array}\right\} & \text{for } \pi_1^f > \widehat{\pi}_1^f \end{array} \tag{22}$$

Proof: see the appendix.

The solution portrays the trade-off between the bank's contract providing liquidity and the loss of resources to foreigners who exploit this service.

For a small enough share of foreign agents, domestic agents will prefer the loss of transferring some resources to foreigners rather than give up the service of liquidity provision. Conversely, for shares of foreign impatient agents greater than $\widehat{\pi}_1^f$, agents will prefer the self-selection outcome. Here the cost of subsidizing foreigners' consumption exceeds the benefits of liquidity provision, so separation is chosen.

When domestic agents implement a risk-sharing contract, they redistribute resources from late to early-withdrawers. Therefore, when foreign early-withdrawers enter this contract, they are receiving transfers from domestic late-withdrawers. This unintended transfer of goods from local to foreign depositors reduces the welfare of domestic agents.

In addition, as the share of early-withdrawers increases, banks allocate a bigger share of deposits to the liquid asset, and less to the higher yielding production technology. Thus, banks are able to provide less insurance to impatient agents as their share increases. In this sense, short-term inflows reduce liquidity provision.

Notice that the threshold $\widehat{\pi}_1^f$ given by (21) is increasing in π_1^d, ρ and R. That is, when π_1^d is large, then a bigger share of agents benefit from liquidity provision and thus they are less willing to give it up. Also, the higher the degree of risk aversion, the more agents value liquidity provision, and thus are less willing to sacrifice this insurance function of banks. In the limit we have that as $\rho \to \infty$, $\widehat{\pi}_1^f \to \infty$. Finally, the higher the return on the production technology, the higher intertemporal transfers, and thus the threshold at which domestic agents are willing to give up provision of liquidity is raised.

Lastly notice that while liquidity provision is reduced in the pooling case, or is completely lost for the separating case, domestic agents still prefer to deposit their endowments in banks. This is so since the other service banks provide, preventing suboptimal asset holding, is still achieved. However, as $r \to 1$, $V^* \to V^a$ for $\pi_1^f > \widehat{\pi}_1^f$. That is, as the potential cost of holding the production technology disappears, banks lose their role when they do not provide liquidity.

4 Unknown Capital Inflows

In this section we assume aggregate uncertainty about withdrawal demand, similar to Champ, Smith and Williamson (1996) and Smith (2002). In our case we assume that the quantity of foreign agents, π_1^f is now a random variable whose realization is unknown at the time banks make the portfolio decision. Finally, individual foreign agents know whether they are impatient or not at the time they choose to deposit, but the aggregate share of impatient agents is unknown to banks.

The timing of events follows. Banks announce contracts in period 0. Based on the contract banks offer, both foreign and domestic agents choose whether to deposit or not. Banks then choose the portfolio allocation. After domestic depositors learn their type, both domestic and foreign agents who wish to withdraw early report to banks, at which time π_1^f is revealed. Following this, banks pay to agents based on this new information. In period 2 the production technology matures, and banks dispense payments to the remaining patient agents.

As in the previous section, foreign patient agents will never find it optimal to deposit in banks for $\rho > 1$. Define $\pi_1 = \frac{\pi_1^d+\pi_1^f}{\pi_1^d+\pi_2^d+\pi_1^f}$ as the share of both foreign and domestic impatient agents, its value drawn from a distribution $G(\pi_1)$ with pdf $g(\pi_1)$, which is common knowledge, and with finite support in the interval $[\pi_1^d, 1]$.

Then, the bank's problem is given by

$$\tilde{V} = \max_{\substack{c_1(\pi_1), c_2(\pi_1) \\ \alpha, \delta}} \int_{\pi_1^d}^{1} \left[\pi_1^d U(c_1) + (1-\pi_1^d)U(c_2)\right] g(\pi_1) d\pi_1 \tag{23}$$

subject to

$$\lambda c_1 = \alpha m + \delta r(1-m) \tag{24}$$

$$(1-\lambda)c_2 = (1-\alpha)m + (1-\delta)R(1-m) \tag{25}$$

$$c_2 \geq c_1 \tag{26}$$

$$\tilde{V} > V^a \tag{27}$$

$$\phi_1^f = \begin{cases} 0 & \text{if } \int_{\pi_1^d}^{1} U(c_1)g(\pi_1)d\pi_1 \leq U(1) \\ \pi_1^f & \text{if } \int_{\pi_1^d}^{1} U(c_1)g(\pi_1)d\pi_1 > U(1) \end{cases} \tag{28}$$

$$c_1, c_2 \geq 0, \quad \alpha, \delta \in [0,1], \quad 0 \leq \phi_1^f \leq \pi_1^f$$

The resource constraints (24) and (25) are the counterparts of (12) and (13), where α and δ represent the fraction of liquid reserves and investments, respectively, that banks liquidate in period one. They capture the fact that there is aggregate uncertainty, so banks at times may hold liquid reserves across periods or may have to scrap investments in order to meet liquidity needs of early withdrawers. The constraint(28) is the participation constraint for impatient foreigners, the aggregate uncertainty counterpart of (16).

Consider first the pooling case where foreign patient agents choose to deposit. Here we have $\lambda = \pi_1$, which implies aggregate uncertainty.

Proposition 2*:* *The pooling contract to the problem with aggregate uncertainty can be described by the optimal return schedule*

$$c_1 = c_2 = m + R(1-m) \quad \text{for} \quad \pi_1 \in (\pi_1^d, \underline{\pi}_1) \tag{29}$$

$$\left.\begin{array}{l} c_1 = \frac{1}{\lambda} m \\ c_2 = \frac{R}{(1-\lambda)}(1-m) \end{array}\right\} \quad \text{for} \quad \pi_1 \in (\underline{\pi}_1, \overline{\pi}_1)$$

$$\left.\begin{array}{l} c_1 = \frac{1}{\overline{\pi}_1} m \\ c_2 = \frac{R}{r}\frac{1}{\overline{\pi}_1} m \end{array}\right\} \quad \text{for} \quad \pi_1 \in (\overline{\pi}_1, 1)$$

where $\underline{\pi}_1 = \frac{m}{m+(1-m)R}$, $\overline{\pi}_1 = \frac{m}{m+(1-m)r}$, *and the optimal reserves ratio* m *is defined by the first order condition*

$$(R-1)\left(\frac{\underline{\pi}_1}{m}\right)^{\rho} G(\underline{\pi}_1) = \tag{30}$$

$$\int_{\underline{\pi}_1}^{\overline{\pi}_1} \left[\pi_1^d \pi_1^{1-\rho} m^{-\rho} - (1-\pi_1^d)\left(\frac{R}{(1-\pi_1)}\right)^{1-\rho}(1-m)^{-\rho}\right] g(\pi_1) d\pi_1 +$$

$$(1-r)\left(\frac{\overline{\pi}_1}{m}\right)^{\rho}\left[\pi_1^d + (1-\pi_1^d)\left(\frac{R}{r}\right)^{1-\rho}\right][1 - G(\overline{\pi}_1)]$$

Proof: See the Appendix.

As we can see from the optimal return schedule, banks provide full insurance for withdrawal demand in $(\pi_1^d, \underline{\pi}_1)$. Here, $\alpha<1$ and some cash reserves will be forwarded to the next period. For withdrawals in $(\underline{\pi}_1, \overline{\pi}_1)$, cash reserves are exhausted, and impatient get lower returns than patient agents. However, $\delta = 0$ so that no early liquidation of the production technology is carried out. Lastly, when withdrawal demand exceeds $\overline{\pi}_1$, $\delta > 0$ where banks interrupt the production process in order to satisfy early withdrawals. We consider it a banking crisis when the share of early withdrawers is large enough so that cash reserves are depleted and output losses take place.

Proposition 2 also shows that for realizations of $\pi_1 \in (\pi_1^d, \underline{\pi}_1)$, where no crisis occurs, foreigners receive transfers from domestic agents. When cash reserves are exhausted, for $\pi_1 \in (\underline{\pi}_1, \overline{\pi}_1)$, foreigners may exploit liquidity provision, as long as the realization of π_1 is less than the optimal reserve ratio m. Finally, when a full fledged crisis occurs, foreigners receive lower returns compared to when they do not enter.

Similar to the case where the share of capital flows is known, expected utility of local depositors is reduced as foreigners enter the banking contract. In particular, this is so for two reasons. First, as we just discussed, domestic agents that value liquidity provision end up transferring resources to foreign agents for low realizations of π_1. Second, here the uncertainty of withdrawal demand potentially forces both assets to be used suboptimally. That is, liquid assets may be held inefficiently across periods, or the production technology may be liquidated early. Further, for $\pi_1 \in (\overline{\pi}_1, 1)$, both services that banks provide, liquidity provision and prevention of costly liquidation, are lost.

Here again, it is feasible for domestic banks to choose a separating contract by setting $c_1 = 1$. Then, $\phi_1^f = 0$ where foreign agents choose not to enter, and thus we have $\lambda = \pi_1^d$. It follows that the term in brackets in (23) can be pulled out of the integral, since there is no longer aggregate uncertainty when foreigners do not enter. Also by no aggregate uncertainty, we have $\alpha = 1$ and $\delta = 0$, where assets are held optimally.

Define $\tilde{V}^p$and $\tilde{V}^s$as the values to the pooling and separating indirect utilities, and define $T = f(G(\pi_1), R, \rho)$ as the threshold .that satisfies $\tilde{V}^p = \tilde{V}^s$.

Proposition 3*: The solution to the problem given in* (23) *satisfies*

$$\tilde{V} = \max\left\{\tilde{V}^p, \tilde{V}^s\right\}. \tag{31}$$

For certain parameters, domestic agents will ex-ante prefer the pooling contract where banking crises may occur, while for others they will prefer the separating contract. To illustrate this welfare trade-off, consider a representative example of the model. Specifically, assume a uniform distribution $G(\pi_1)$ with pdf $g(\pi_1) = 1/(1 - \pi_1^d)$, and consider the following parameters. The coefficient of relative risk aversion is ρ =3, the share of domestic impatient agents is $\pi_1^d = 0.5$ and the return to investments, are R =2 and r=0.5. Given these parameters, the indirect utilities are $\tilde{V}^p = -0.326$ and $\tilde{V}^s = -0.313$. It follows that for this case the separating contract is chosen. In contrast, if we increase the return to investments to R =3, leaving all other parameters unchanged, we get $\tilde{V}^p = -0.277$ and $\tilde{V}^s = -0.278$, where the pooling contract is preferred. Similarly, increasing the coefficient of relative risk aversion ρ, will raise the threshold T, and thus increase the parameter set at which the pooling contract will be preferred.

The contract where agents self-select comes at the cost of losing the service of liquidity provision but allows for the other service of banks, which is the optimal intertemporal holding of assets. In contrast, the pooling contract will not be able to prevent suboptimal holding of assets, and may or may not be able to provide insurance. That is, for low quantities of short-term capital inflows it will provide insurance, but will not be able to for large quantities of unpredicted capital inflows.

5 Conclusion

This paper attempts to study the effects that capital inflows have on the financial system in the context of a demand deposit banking model. In this environment, banks arise as a coalition of domestic agents to resolve the inefficiencies caused by idiosyncratic uncertainty, and to insure agents against the unwelcome situation of turning out to be an early withdrawer. When banks can 't distinguish domestic from foreign deposits, short-term foreign capital has the incentive to enter the banking contract to take advantage of the insurance service that domestic banks provide. As capital inflows become large, the cost of allowing capital inflows exceed the benefits provided by insurance, and a separating contract is preferred. Further, if the quantity of inflows is unknown, then a banking crisis caused by excessive short-term capital inflows may occur. In this case, the services that banks provide may be lost. In spite of this, restricting short-term capital inflows may not be optimal at all times, since the cost of doing so may be greater than the expected loss in allowing crises with positive probability.

6 Appendix

6.1 Proof of Lemma 1

Suppose the opposite, that is, that foreign patient agents choose to deposit in a domestic bank. Then $\phi_2^f = \pi_2^f$, and by (17) $c_2 > R$. It follows that $c_1 < 1$ by the feasibility constraints. This implies that $\phi_1^f = 0$ by (16). The first order condition to this problem sets

$$m = \frac{1}{1 + \left(\frac{(1-\lambda)}{\lambda}\right)^{1-1/\rho} \left(\frac{(1-\pi_1^d)}{\pi_1^d}\right)^{1/\rho} R^{(1-\rho)/\rho}} \tag{32}$$

where $\lambda = \frac{\pi_1^d}{\pi_1^d + \pi_2^d + \pi_2^f} < \pi_1^d$. Also, $c_1 < 1$ implies $m < \lambda$ by (12). Thus we have

$$\frac{1}{1 + \left(\frac{(1-\lambda)}{\lambda}\right)^{1-1/\rho} \left(\frac{(1-\pi_1^d)}{\pi_1^d}\right)^{1/\rho} R^{(1-\rho)/\rho}} < \lambda \tag{33}$$

after some algebra and taking the natural logarithm to the above expression, we have

$$\ln\left(\frac{(1-\lambda)}{(1-\pi_1^d)} \frac{\pi_1^d}{\lambda}\right) < (1-\rho)\ln(R) \tag{34}$$

Which is a contradiction for $\rho > 1$, since both expressions inside the logarithms are greater than one. ■

6.2 Proof of Proposition 1:

It is easy to verify that the optimal reserve ratios that solve for the pooling and separating outcomes are m^p and m^s given by (19) and (20), respectively.

Consider first the pooling case. Then $\lambda = \frac{\pi_1^d + \pi_1^f}{\pi_1^d + \pi_2^d + \pi_1^f}$. Further suppose that that π_1^f is small enough so that λ is arbitrarily close to π_1^d. It follows that m^p is arbitrarily close to the benchmark m^d given by (7) and is thus preferred to m^s. Then, by continuity, the threshold $\widehat{\pi}_1^f$ given by (21) exists and satisfies $m^p = m^s$, such that $\phi_1^f = \pi_1^f$ for $\pi_1^f \leq \widehat{\pi}_1^f$and $\phi_1^f = 0$ for $\pi_1^f > \widehat{\pi}_1^f$. ■

6.3 Proof of Proposition 2:

The optimal fraction of currency banks liquidate, α, needs to satisfy

$$\frac{(1-\alpha)}{(1-\lambda)}m + \frac{(1-\delta)}{(1-\lambda)}R(1-m) \geq \frac{\alpha}{\lambda}m + \frac{\delta}{\lambda}r(1-m) \tag{35}$$

with strict equality for α<1. Then the threshold $\underline{\pi}_1$follows from setting $\alpha = 1$ with strict equality of (35), and $\delta = 0$. Then we have the optimal currency liquidation strategy

$$\alpha = \begin{cases} \pi_1(1 + R\frac{(1-m)}{m}) & \text{for } \pi_1 \leq \underline{\pi}_1 \\ 1 & \text{for } \pi_1 > \underline{\pi}_1 \end{cases} \tag{36}$$

Similarly, the optimal fraction of investments liquidated, δ, satisfies

$$\frac{(1-\alpha)}{(1-\lambda)}m + \frac{(1-\delta)}{(1-\lambda)}R(1-m) \leq \frac{R}{r}\left[\frac{\alpha}{\lambda}m + \frac{\delta}{\lambda}r(1-m)\right] \tag{37}$$

with strict equality for δ>0. Then the threshold $\overline{\pi}_1$ follows from setting $\delta = 0$ with strict equality of (37), and $\alpha = 1$. Then we have the optimal investment liquidation strategy

$$\delta = \begin{cases} 0 & \text{for } \pi_1 < \overline{\pi}_1 \\ \frac{1}{r}\frac{\pi_1 - \overline{\pi}_1}{\overline{\pi}_1}\frac{m}{(1-m)} & \text{for } \pi_1 \geq \overline{\pi}_1 \end{cases} \tag{38}$$

Then the return schedule in (29) follows from substituting (36) and (38) into (24) and (25), and using the definitions for$\underline{\pi}_1$and$\overline{\pi}_1$. Finally, the first order condition follows from substituting (29) into (23), and using the definitions for $\underline{\pi}_1$and $\overline{\pi}_1$. Noting that c_1 and c_2 are continuous at $\underline{\pi}_1$and $\overline{\pi}_1$, we arrive at the first order condition in (30) that implicitly defines the optimal reserve ratio. ■

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