

International Capital Flows, Financial Frictions and Welfare (Preliminary and incomplete)*

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Abstract

The financial crisis of 2007-08 has underscored the importance of adverse selection in financial markets. This friction has been mostly neglected by macroeconomic models of financial imperfections, however, which have focused almost exclusively on limited pledgeability. We fill this gap by developing a standard growth model with adverse selection and extend it to the more general case in which adverse selection and limited pledgeability coexist. We conclude that both frictions complement one another and show that limited pledgeability may exacerbates the effects of adverse selection. We apply this result to show that (i) the welfare effects of international capital flows depend on the nature of the prevailing financial frictions at the domestic and international level and; (ii) the appropriate policy response depend on the specific nature of financial frictions.

Keywords: Limited Pledgeability, Adverse Selection, International Capital Flows

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1 Introduction

The staple of financial imperfection in macroeconomic models typically is limited pledgeability. This friction, which is introduced by assuming that an economy's stock of collateral equals a fixed proportion of output, has been widely studied in stylized models of the financial accelerator. Real-world financial markets are characterized not only by a potential scarcity of collateral but also by asymmetric information regarding its true worth. Arguably, it was this last aspect that played a key role in the recent financial crisis. In the case of the financial crisis of 2007-09, financial frictions have also been invoked to explain the run-up to the crisis and the unfolding of events during the crisis itself (e.g. Bernanke 2009, Brunnermeier 2009). This raises a key question, namely, how do these two frictions interact, and how do the implications of standard models change when both are present?

These questions are hard to address with existing macroeconomic models, which focus mostly on limited pledgeability while neglecting adverse selection. To address them, there is the need for a stylized model that brings adverse selection to the foreground. In a recent paper (Martin and Taddei (2012)), we have developed a stylized model of growth where entrepreneurs need to borrow in order to undertake an investment project. The projects themselves are used as collateral, but financial markets are characterized by two frictions: (i) collateral is limited by a pledgeability constraint, which restricts what creditors can grab in the event of a default, and; (ii) there is asymmetric information regarding the quality of collateral, as the productivity of projects is not observable.

In the context of our model, we find that adverse selection fosters unproductive investment and, in doing so, it: (i) raises the economy's equilibrium interest rate, and; (ii) generates a negative wedge between the marginal return to investment and the equilibrium interest rate. Under international financial integration, which is a case of particular interest to us, we show how this translates into excessive capital inflows and endogenous cycles. After studying this benchmark model of adverse selection, we extend it to the more general case in which adverse selection and limited pledgeability coexist. We show that both frictions complement one another and that limited pledgeability exacerbates the effects of adverse selection.

Although interesting, this first set of results has been obtained in a very stylized setting. At least two assumptions limit the analysis. First, the size of investment projects is assumed to be fixed, a feature that simplifies the model but also eliminates some of the interesting interactions

between adverse selection and limited pledgeability. Second, the study of financial integration is done for the case of a small open economy, i.e. it is essentially a partial equilibrium exercise. In this paper, we plan to address both limitations.

In this paper, we will embed this richer framework into a two-country, general equilibrium model of the world economy. Like much of the recent literature on capital flows, this model would assign a key role to the world supply and distribution of collateral. Take the “asset shortage” view of global imbalances (Caballero, Fahri and Gourinchas (2008)). According to this view, collateral has been at the heart of recent capital flows between Asia and the United States. Even though Asian economies grow fast and have good investment opportunities, it says, they lack the collateral that is required to undertake these investments. Capital therefore flows to those economies where collateral is abundant, i.e. the United States. While being consistent with this view, our model will allow us to address new and important questions by incorporating adverse selection. Could capital inflows into the United States, by exacerbating adverse selection, affect the average quality of collateral in that economy and lead to inefficient investments? Could the United States ultimately suffer a welfare loss if the rest of the world uses its financial system to intermediate resources? Our results suggest that, in fact, international capital flows that are driven primarily by differences in the supply and quality of collateral across economies could be excessive from the perspective of all parties involved, so that all could benefit from some degree of capital controls. These are crucial questions for the management of financial integration and reform, and our model will provide a rich and parsimonious framework to address them.

This paper is related to the large body of research that studies the macroeconomic effects of financial frictions. This literature, which goes back to Bernanke and Gertler (1989) and Kiyotaki and Moore (1997), stresses the role of borrowing constraints for macroeconomic outcomes. Most of these papers illustrate how contracting frictions can restrict an economy’s ability to borrow. Gertler and Rogoff (1990), Boyd and Smith (1997), Matsuyama (2004) and Aoki et al. (2009) fall within this category. Similar models have been used recently to account for global imbalances. In Caballero et al. (2008), for example, high-growing developing economies may experience capital outflows due to pledgeability constraints that restrict their supply of financial assets. In Mendoza, Quadrini, and Rios-Rull (2007), it is instead the lack of insurance markets in developing economies that fosters precautionary savings and the consequent capital outflows.

To the best of our knowledge, however, this would be the first paper to analyze the interaction of adverse selection with pledgeability constraints to deliver the relevant policy implications in terms

of financial and macro-prudential regulation.

2 Basic setup

Consider an economy lasting two periods $t = 0, 1$ inhabited by a continuum of individuals endowed with wealth w . Individuals in each generation are indexed by $j \in J_t$ and they are uniformly distributed over the unit interval. Each of them is endowed with an investment project of fixed size, which requires I units of output at time $t = 0$. The project of individual $j \in J_t$ succeeds with probability $p_j = j \in [0, 1]$, in which case it delivers $\alpha \cdot I$ units of output in period $t = 1$. With probability $1 - p_j$, the project of individual $j \in J_t$ fails and it delivers nothing.

All individuals maximize the expected consumption in period 1 so that $U_j = E_t(c_j)$; where U_j and c_j are the welfare and the consumption of the economy.

In this setting, output at $t = 1$ depends not only on the total investment made at $t = 0$, but also on the productivity of such investment. In particular, if we let $E(p)$ denote the expected probability of success among investment projects undertaken at time t , we can define $A = A(p) = \alpha \cdot E(p)$ as the average productivity of such investment.

A full characterization of such an equilibrium clearly requires an understanding of the way in which A is determined: this depends on the workings of credit markets, which intermediate resources among the young in each generation. To save for old age, each young individual must choose between (i) becoming an entrepreneur and undertaking an investment project, which requires credit whenever $I > w$, and; (ii) lending his wealth to other individuals who want to become entrepreneurs in exchange for an interest payment. We assume that all such borrowing and lending is intermediated through banks. Banks are finite in number, risk neutral and competitive. They act as intermediaries that collect deposits from individuals to offer loan contracts to active entrepreneurs. On the deposit side, they take the gross interest factor on deposits r_{t+1} as given and they compete on the loan market by designing contracts that take the following form:

Definition 1 *Entrepreneurs and banks sign a contract defined by the couple (L, R) , where L is the amount lent to entrepreneurs for investment at time $t = 0$ and R is the gross contractual interest rate on the loan at time $t = 1$. In the event of success, entrepreneurs pay back the amount borrowed adjusted by the interest factor. Otherwise, they default and the bank gets nothing.*

This implies that the expected profit that individual $j \in J_t$ obtains from loan contract (L, R)

in the event that he chooses to become an entrepreneur is

$$\pi(p_j, L, R) = p_j \cdot [\alpha \cdot I - R \cdot L]. \quad (1)$$

Since competition among banks is usually crucial in determining the types of contracts that are offered in equilibrium, it is important to specify how we model it. We follow the traditional model of Rothschild and Stiglitz (1976) and model competition in the credit market as a two-stage game of screening. In the first stage, banks design a menu of loan contracts and, in the second stage, individuals that want to become entrepreneurs apply to the contract that they find most attractive. It is assumed that each bank gets the same share of total deposits and, if they design the same contract, they get the same share and composition of loan applications.

3 Equilibrium in the closed economy

The key driving force behind the dynamics of our economy lies clearly in the production of capital and hence in the functioning of credit markets. We now analyze the competitive equilibrium of the economy under different assumptions regarding these markets. We first consider the case of frictionless credit markets, which will provide a useful benchmark that we can turn to throughout the paper. We then analyze the case in which credit markets are characterized by the presence of asymmetric information, and we contrast it to the more familiar one of limited pledgeability.

Regardless of the particular credit-market friction that is imposed, there are two features that any equilibrium must satisfy. First, all contracts offered must satisfy a zero-profit condition for banks: clearly, no equilibrium contracts can yield negative profits to intermediaries, and – due to perfect competition – no equilibrium contracts can yield positive profits either. Second, investment in equilibrium must satisfy a “participation constraint”: since all individuals care only about old-age consumption, they will only choose to become entrepreneurs if the return of doing so exceeds that of being a depositor in the banking system.

3.1 Adverse selection

Consider now that we modify the previous setup by introducing a friction in credit markets. In particular, we initially focus on a type of friction that has allegedly been at the heart of the recent turmoil in financial markets: adverse selection. Relative to the model of Section ??, the only modification that we make is to assume that individual j ’s probability of success is private

information and is thus unobservable to banks.¹ Because this is the only dimension along which projects differ from one another, banks will now offer one “pooling” contract that will be accepted by individuals that differ in their probability of success.²

If we use $(\widehat{L}, \widehat{R})$ to define the pooling loan contract offered by banks under adverse selection, the participation constraint of an individual $j \in J_t$ is now given by:

$$\pi(p_j, \widehat{L}, \widehat{R}) = p_j \cdot \left[\alpha \cdot I - \widehat{R} \cdot (I - w) \right] \geq r \cdot w, \quad (2)$$

which is essentially the same as Equation (??) with the difference that the contractual interest rate $\widehat{R}$ is now independent of the individual’s probability of success p_j . We can use Equation (2) to obtain the marginal investor, i.e. the investor that is indifferent between applying to a loan contract or depositing his savings in the bank. We use $\widehat{p}_{AS}$ denote the probability of success of this investor, where the subscript AS indicates the presence of adverse selection. The zero-profit condition of banks takes this into account because, since banks must break even on average, the contractual interest rate $\widehat{R}$ must reflect the average quality in the pool of borrowers. Formally, it must hold in equilibrium that:

$$\begin{aligned} E_j [p_j | p \geq \widehat{p}_{AS}] \cdot \widehat{R} - r &= 0 \\ \Leftrightarrow \\ \widehat{R} &= \frac{r}{E_j [p_j | p \geq \widehat{p}_{AS}]} = 2 \cdot \frac{r}{1 + \widehat{p}_{AS}} \end{aligned} \quad (3)$$

By combining Equations (2) and (3) we can obtain the equivalent of Equation (??):

$$\begin{aligned} \widehat{p}_{AS} \cdot \left[\alpha \cdot I - 2 \cdot \frac{r}{1 + \widehat{p}_{AS}} \cdot (I - w) \right] &= r \cdot w \\ \Leftrightarrow \\ r_{AS} &= \frac{\widehat{p}_{AS} \cdot \alpha \cdot I}{w + 2 \cdot \frac{\widehat{p}_{AS}}{1 + \widehat{p}_{AS}} \cdot (I - w)}, \end{aligned} \quad (4)$$

which defines an increasing relationship between $\widehat{p}_{AS}$ and r that must be satisfied in equilibrium. Together with the market clearing condition of Equation (??), this relationship determines the

¹In our setup, in which this is the only dimension along which projects differ from one another, the debt/loan contracts analyzed in the previous section cannot be improved upon by banks.

²In this sense, our environment is similar to DeMeza and Webb (1987).

credit-market equilibrium of the economy $(\hat{p}_{AS}, r)$ which is characterized as follows:³

$$\hat{p}_{AS} = 1 - \frac{w}{I}, \quad (5)$$

$$r_{AS} = \alpha \cdot \frac{[2I - w] \cdot [I - w]}{I^2 + [I - w]^2}. \quad (6)$$

A direct comparison of Equations (??) and (5) reveals that $\hat{p} = \hat{p}_{AS}$, so that the introduction of asymmetric information does not change the average productivity of projects undertaken in the closed economy. This follows from two special assumptions in our model: (i) since savings are inelastic, investment must equal the total wage bill of the economy at all times, regardless of whether there is asymmetric information or not, and; (ii) since projects are of fixed size, the total investment undertaken in the economy is simply equal to this wage bill divided by the size of each project I .

But how is it that, despite the presence of asymmetric information, no individual with $p_j < \hat{p}_{AS}$ is tempted to become an entrepreneur? The answer, as can be seen by comparing Equations (??) and (6), is that the equilibrium interest rate increases in order to discourage this type of entry. In the presence of adverse selection, less productive individuals are effectively cross-subsidized in their loan payments by their more productive peers: consequently, for any given interest rate on deposits, the demand for credit is larger than it would be in the frictionless economy, i.e. the productivity of the marginal investor is lower. In other words, under adverse selection, the productivity of the marginal investor lies below the market interest rate. In the closed economy, in which the total amount of investment must necessarily equal the total wage bill, this leads to an increase in the interest rate in order to restore equilibrium. This increase in the interest rate relative to the frictionless economy of Section ?? is the sole consequence of adverse selection.⁴

³Once again, we do not include the rental price of capital q_{t+1} in the definition of equilibrium because it is determined by $\hat{p}_{AS,t}$ (see Footnote ??).

⁴Once again, this result depends on our assumptions regarding the perfectly inelastic supply of total savings and the fixed size of investment projects. It is because of these two features that adverse selection does not affect the amount or the productivity of investment. If total savings were increasing on the interest rate, for example, adverse selection would lead to an increase in the equilibrium level of investment. If projects did not have a fixed size, adverse selection would also affect the composition of investment. These modifications would complicate the exposition without adding much to our results.

3.2 Limited pledgeability

In analyzing the macroeconomic effects of financial frictions, the recent literature has focused predominantly on the effects of limited pledgeability.⁵ The severity of this friction, which arises when borrowers are capable of diverting part of their ex-post resources away from the reach of creditors, is believed to be a good indicator of the quality of financial institutions in an economy.⁶ To do so, we first show briefly how the introduction of this friction affects – by itself – the equilibrium of the frictionless economy of Section ??.

Consider then that we modify the frictionless economy by assuming that, in the event of default, lenders can seize at most a fraction $\lambda \in [0, 1]$ of the resources of borrowers. In this case, the set of loan contracts (L, R) that can be implemented are those for which:

$$R(j) \cdot L = R(j) \cdot (I - w) \leq \lambda \cdot \alpha \cdot I. \quad (7)$$

Equation (7) introduces an additional constraint that, in addition to the participation constraint of entrepreneurs in Equation (??) and the zero-profit condition of banks in Equation (??), loan contracts must satisfy in equilibrium. Note that, when the pledgeability constraint of Equation (7) binds in equilibrium, the participation constraint of Equation (??) is slack. In this case, some individuals that would invest in the frictionless economy cannot do so in the presence of limited pledgeability because they cannot commit to a repayment that would allow the bank to break even. Hence, under a binding pledgeability constraint, the marginal investor for a given interest rate becomes an individual with a higher probability of success relative to the frictionless economy. Formally, if we use $\hat{p}(\lambda)$ to denote the probability of success of the marginal investor in this economy, we have that:

$$\hat{p}(\lambda) = r \cdot \frac{1}{\alpha} \cdot \max \left\{ 1, \frac{1}{\lambda} \cdot \frac{I - w}{I} \right\}. \quad (8)$$

Equation (8) illustrates the two types of equilibria that may arise under limited pledgeability. On the one hand, if $\lambda > 1 - \frac{w}{I}$, the pledgeability constraint does not bind in equilibrium and we are back in the frictionless case: these are economies in which wages are high relative to the size

⁵See, for example, Aoki et al. (2009), Caballero and Krishnamurthy (2001), Matsuyama (2004) and Lorenzoni (2008).

⁶This is true both in the theoretical and in the empirical literature. In the latter, the quality of financial institutions is usually proxied with the creditor rights index based on La Porta et al. (1998). This index, which is the leading “institutional” predictor of credit market development around the world, measures the powers of secured lenders in bankruptcy and it essentially reflects the ability of these lenders to seize assets in the event of default.

of investment, so that leverage is low and pledgeability is not a concern. On the other hand, if $\lambda \leq 1 - \frac{w}{I}$, the pledgeability constraint binds in equilibrium and investment is constrained relative to the frictionless economy: these are economies in which wages are low relative to the size of investment and the required level of leverage is too high given the institutional constraints.

To determine the credit-market equilibrium of the economy $(\hat{p}(\lambda), r)$, we can combine Equation (8) with the credit market clearing condition of Equation (??).⁷ A first result that emerges is that $\hat{p}_t(\lambda) = \hat{p}_t$ in equilibrium, so that limited pledgeability has no effect on the average productivity of projects that are undertaken: as was the case in the economy under adverse selection, ultimately the totality of labor income must be directed towards investment in the closed economy. Hence, the law of motion of capital is still given by Equation (??) and pledgeability constraints have an effect only through the equilibrium interest rate. Indeed, the equilibrium interest rate is given by,

$$r(\lambda) = \begin{cases} \alpha \cdot \lambda & \text{if } w < (1 - \lambda) \cdot I \\ \alpha \cdot \left(1 - \frac{w(k_t)}{I}\right) & \text{if } w \geq (1 - \lambda) \cdot I \end{cases} \quad (9)$$

Equation (9) illustrates the basic workings of this economy. A binding pledgeability constraint implies that, for each given level of the interest rate, investment is lower than it would be in the frictionless economy, i.e. the productivity of the marginal investor is higher. Under limited pledgeability, the productivity of the marginal investor thus raises above the interest rate. In the closed economy, in which total investment equals the total wage bill, the interest rate must fall to restore equilibrium. Economies with more severe credit frictions, i.e. with lower λ , therefore display lower equilibrium interest rates. The severity of credit market frictions, however, does not affect the law of motion of the closed economy: once again, it affects neither total investment nor the order in which projects are financed.⁸

4 The open economy: world equilibrium

We now consider the world equilibrium where two countries become financially integrated and savings can freely move from one country to the other. Thus all individuals can borrow from

⁷We have already stressed that, when the pledgeability constraint of Equation (7) is binding, the participation constraint of Equation (??) is slack. Hence, as in the previous sections, an equilibrium is characterized in this case by two equations (the participation constraint and the market-clearing condition) and two unknowns ($\hat{p}_t(\lambda)$ and r_{t+1}).

⁸This feature of our model, which closely mirrors Matsuyama (2004), is of course due to the particular set of assumptions that we make (see Footnote 4).

and/or lend to the international financial market at the new equilibrium gross return r^* . Here we integrate an economy characterized by adverse selection *only* with an economy characterized by limited pledgeability *only*.

In the closed economy, aggregate investment is constrained by the availability of domestic resources and – ultimately – by the domestic capital stock. In the open economy, this is no longer the case because investment can be financed with foreign resources: in principle, the determinant of investment is the international interest rate r^* . To reflect this, we use $\hat{p}^*$ (in all its variations) throughout to denote the probability of success of the marginal project undertaken, where the apex (*) signals that the variable refers to the open economy. Once the value of $\hat{p}^*$ is determined in equilibrium, it follows that total investment in the economy equals $(1 - \hat{p}^*) \cdot I$.

4.1 Equilibrium conditions

First we observe that under financial autarky

$$r_{AS} = \alpha \cdot \frac{[2I - w] \cdot [I - w]}{I^2 + [I - w]^2} > r(\lambda) = \alpha \cdot \lambda \quad (10)$$

and thus we know that when the two economy open up capital will flow from the limited pledgeability economy to the adverse selection economy as long as the following condition, deroived from the previous one, is satisfied:

$$\lambda < \frac{w(I - w)(2I - w)}{I(I^2 + (I - w)^2)} \quad (11)$$

The world equilibrium interest rate r^* is thus determined by the following system of equations. The first is the world equilibrium condition equating the supply of savings to the demand of investment:

$$(\hat{p}^*(\lambda) + \hat{p}_{AS}^*)w = (2 - \hat{p}^*(\lambda) - \hat{p}_{AS}^*)(I - w) \quad (12)$$

where the marginal investor in the limited pledegability economy is equal to

$$\hat{p}^*(\lambda) = \frac{r^*(I - w)}{\lambda \alpha I} \quad (13)$$

and $\hat{p}_{AS}^*$ is the marginal investor in the economy characterized solely by asymmetric information:

$$r^* = \frac{\hat{p}_{AS}^* \cdot \alpha \cdot I}{w + 2 \cdot \frac{\hat{p}_{AS}^*}{1 + \hat{p}_{AS}^*} \cdot (I - w)} \quad (14)$$

These last three equation are a system tat needs to be solved simultaneously in $r^*, \hat{p}_{AS}^*, \hat{p}^*(\lambda)$.

Once we have done so we can compare the consumption (output level) obtained in each country. The two consumption levels are given by the following:

$$c^*(\lambda) = \hat{p}^*(\lambda) \cdot r^* w - (1 - \hat{p}^*(\lambda)) \cdot r^* \cdot (I - w) + \frac{1 - (\hat{p}^*(\lambda))^2}{2} \cdot [\alpha \cdot I]$$

$$c_{AS}^* = \hat{p}_{AS}^* \cdot r^* w - (1 - \hat{p}_{AS}^*) r^* \cdot (I - w) + \frac{1 - (\hat{p}_{AS}^*)^2}{2} \cdot [\alpha \cdot I]$$

Under international financial autarky we know that, if countries have the same level of wealth w , they will also consume/produce the same that can be determined by the average probability of success $E_j [p_j | p \geq \hat{p}]$:

$$c(\lambda) = c_{AS} = E_j [p_j | p \geq \hat{p}] \cdot \alpha I \cdot w = \frac{1 + \hat{p}}{2} \cdot \alpha I \cdot w = \frac{2I - w}{2} \cdot \alpha \cdot w$$

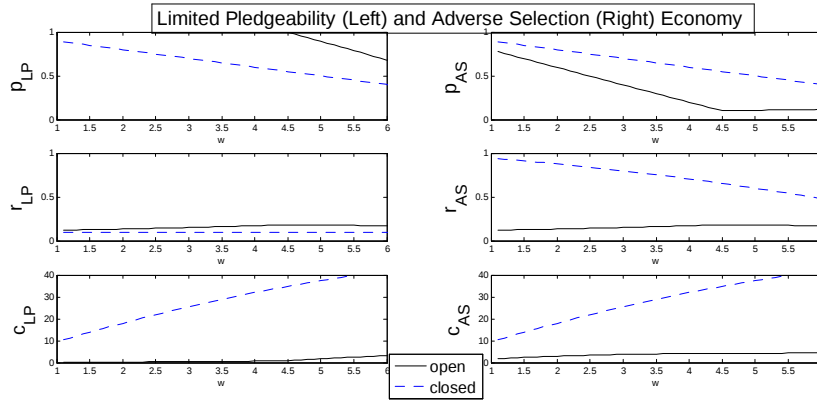


Figure 1

The following figure illustrates how the allocation of consumption in each country changes as a function of individual wealth. Most importantly, Figure 1 compares the consumption level in the two economies under financial autarky and under international financial integration. It shows that the world equilibrium under international financial integration displays strictly lower consumption level in both economies. This is an example where international capital flows determine a reallocation of world investment that is welfare reducing in both countries. This extreme case of globally welfare reducing capital flows give an indication of the potential of this framework in providing a full taxonomy of the relationship between the global distribution of financial frictions and the welfare

effects of international capital flows.

5 Conclusion (preliminary)

The financial crisis of 2007-08 has underscored the importance of adverse selection in financial markets. This friction has been mostly neglected by macroeconomic models of financial frictions, however, which have focused almost exclusively on the effects of limited pledgeability. In this paper, we have attempted to fill this gap by developing a standard growth model with adverse selection. Our main results are that, by fostering unproductive investment, adverse selection: (i) leads to an increase in the economy's equilibrium interest rate, and; (ii) it generates a negative wedge between the marginal return to investment and the equilibrium interest rate. We have shown how, under financial integration, these effects translate into excessive capital inflows. We have also extended our model to the more general case in which adverse selection and limited pledgeability coexist, and we have concluded that there is a sense in which both frictions complement one another: if anything, limited pledgeability exacerbates the consequences of adverse selection on the macroeconomy. If two economies identical in every respect, but for the type of financial friction, become internationally financial integrated, international capital flows may be welfare reducing on a global scale.

Our analysis is still incomplete as we are only presenting a simple example in the current version. We have stopped short of characterizing the full welfare implications of adverse selection and limited pledgeability on international capital flows. The prevailing view on global imbalances and financial frictions is that limited pledgeability has been at the heart of capital flows between Asia and the United States. According to this view, the United States has only stood to gain from these inflows. How is this view affected once the importance of adverse selection is acknowledged? Is it possible that, through their effects on the interest rate, these capital inflows exacerbate adverse selection and lead to inefficient investment in the United States? Can the United States ultimately suffer a welfare loss if the rest of the world uses its financial system to intermediate resources? Addressing these questions is the contribution of this paper.

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