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Banking crises, sudden stops, and the effectiveness of short-term lending

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Abstract: This paper sheds light on the linkages between banking crises and sudden stops and discusses the effectiveness of short-run lending in their prevention. It develops an overlapping generations framework and incorporates the possibilities of bank runs and moral hazard of financial intermediaries. Consequently, I find that the strategy to overcome liquidity problems could worsen banks' positions and cause bank runs and sudden stops. A small liquidity shock may still lead to a banking crisis through the depositors' expectation. A large shock would require short-run lending to prevent an immediate bank run, but the repayment obligation may worsen moral hazard problems.

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1 Introduction

Sudden stops, or a sudden slowdown of private capital inflows, have been considered to be one of the main reasons of current account reversal. Edwards (2004) documents the empirical relationship between sudden stops and current account reversals, and notes that even without restrictions on capital mobility may not be possible to lower the probability of such a reversal. Moreover, Eichengreen, Gupta and Mody (2008) find that a large share (around 50%) of sudden stops coincide with banking crises, rather than currency crises, and that the impacts of sudden stops on portfolio capital flows is about 2% of GDP[1]. They, however, find that these sudden stops have no discemible impact on net foreign direct investment. Their findings highlight the important impact of banking crises on private capital flows, especially on short-run portfolio capital flows, and point out that such linkages provide key insights to enhance our understanding of the occurrence of sudden stops.

Although there have been many studies on capital flows and sudden stops, most are empirical in nature and limited in their ability to uncover the transmission mechanism between banking crises and sudden stops. To be more specific, it is still a puzzle whether the causality between banking crises and sudden stops is unidirectional. Furthermore, since it is generally understood that the failure to meet demand deposits is one of the main reasons for bank runs [Diamond and Dybvig (1983)], international organizations, including the International Monetary Fund (IMF), provide their member countries with a short-run lending (SRL) facility as a crucial resource to stop/prevent sudden stops. Although SRL is designed to remedy the liquidity problems of financial institutions and may prevent banking crises under some circumstances, the financial crisis which started in 2007 has shown us once again that another important cause of banking crises is the moral hazard problem facing lenders, an issue that has often been neglected by the literature on sudden stops.

The contribution of this paper is to provide a mechanism linking banking crises and sudden stops in the presence of moral hazard and to analyze the effectiveness of SRL facilities in overcoming these crises. The paper extends a three-period-lived overlapping generations model to an open economy with international credit markets that involve transactions in debt and equity between countries.

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[1]This is based on the three main measures of capital accounts, which are foreign direct investment, portfolio investments, and other investment.

The credit market imperfections introduced to the model are similar to those in Kiyotaki and Moore (1997). There are no capital controls imposed by either country. The financial intermediaries serve as middlemen in the credit markets and as portfolio managers for their depositors. These intermediaries can trigger a banking crisis by either failing to meet demand deposits or the moral hazard problem.

Consequently, there are three main findings of this paper. First, should there be liquidity shortage, a solution which finances the shortfall of demand deposits with an injection of additional funds (new deposits) could worsen the situation. To be more specific, the financial intermediaries may respond to the need for additional reserves by offering even more competitive deposit rates to attract new depositors, and thus excerbate the impact of future bank runs in the following period. Second, an adverse shock may or may not trigger bank runs and sudden stops, depending on the size of the shock and the impact on depositors' expectations. Even a small productivity shock, which does not affect the financial intermediaries' ability to meet demand deposits, might lead to a self-fulfilling expectation if the shock increases the likelihood of a bank run. Therefore, the availability of SRL facility could serve as insurance to prevent bank runs and sudden stops in this case. Third, a large shock, which affects banks' ability to meet demand deposits, would require SRL to prevent immediate bank runs and sudden stops. However, the obligation to repay could aggravate the moral hazard issue, especially when financial intermediaries are unable to accumulate sufficient profits to repay. To prevent this worst scenario for both the depositors and the institutions which provide the SRL facilities, these short-term loan contracts must be incentive compatible and ensure a reasonable length of time for financial intermediaries to repay.

The rest of the paper is organized as follows. Section 2 describes the environment. Discussions on banking crises, sudden stops and SRL facilities follow in Section 3. Conclusions and possible extensions are stated in Section 4.

2 THE MODEL

This paper extends Bencivenga and Smith's (1991) work to an open-economy overlapping generations model and incorporates capital market imperfections, which are similar to those in Kiyotaki

and Moore (1997, 2002) and Boyd and Smith (1999), to examine how banking crises and sudden stops are linked together. Additional to the main findings of the benchmark model, the effectiveness of short-run lending facilities to prevent banking crises and sudden stops is considered.

The benchmark model considers an economy with two countries, home and foreign. The population growth rate (n) is the same for both countries, $N_t = nN_{t-1}$ and $N^* = nN_{t-1}^*$, where N and N^* represent the population of the home and the foreign country, respectively. The economy of each country is composed of households, firms, and financial intermediaries (banks), which serve as middlemen in the credit markets, including both loan and equity markets, and act as a portfolio manager for their depositors. Banking literature suggested that individuals are better off in an economy with financial intermediaries, which save monitoring costs and share risks to some degree[2], compared to an economy without financial intermediaries. In fact, the average rate of return earned and offered by financial intermediaries is often higher than the rate of return earned by self-investing. Therefore, in an economy with financial intermediaries, individuals would rather deposit their income in the financial intermediaries than self-invest. To reflect this fact, and to simplify the model, it is assumed that all individuals deposit their income in the financial intermediaries, rather than self-investing. Unlike in the traditional setup, the financial intermediaries act as firms maximizing profits. The possibility of moral hazard problems will be discussed in the later section.

2.1 Households

Each household lives for three periods: young, middle-aged and old. Everyone is born identical with one unit of labor as endowment when young, but nothing when middle-aged and when old, and values only consumption in middle-age $(c_{2,t+1})$ and old $(c_{3,t+2})$ age. Therefore, each young would devote its labour endowment to earning wages and deposit all income into financial intermediaries, which offer both short-run and long-run accounts for all individuals. The household would decide how to allocate income between different types of accounts before turning middle-aged. There are short-run (SR thereafter) accounts, which take one period to mature, and long-run (LR thereafter)

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[2]Therefore, the economy with financial intermediaires is more efficient and more productive then the economy without financial intermediaries [Champ, Freeman and Haslag (2011), Bencivenga and Smith (1991)].

accounts, which take two periods to mature. Among SR accounts, there are two types: saving accounts and investment (so called money market) accounts. More details will be provided later.

After turning middle-aged, each indivisual learns its type. There are two types, an investor or an entrepreneur. With an exogenous probability λ $(1 - \lambda)$, the individual turns into an investor (entrepreneur) at middle-age. Each middle-aged household can be only one type, which is private information to the individual only, and this remains unchanged thereafter. The distribution of types, however, is public information. The investors and entrepreneurs are different in two aspects: in skills and in their way of spending withdrawals from their short-term accounts. More specifically, the entrepreneurs own the skills of obtaining funds to finance projects, and of operating firms to start production. Accordingly, the entrepreneurs would spend withdrawals on operating firms, while the investors would spend their withdrawals on reinvestment. The utility function is in the form of:

$$U(c_{2,t+1}, c_{3,t+2}) = -\frac{(c_{2,t+1} + \sigma^i c_{3,t+2})^{-\phi}}{\phi}, \text{where } i = I, E \tag{1}$$

where σ^i represents the degree of patience of the individual, depending on its own type, and $0 < \sigma^I < \sigma^E < 1$ indicates that investors (I) are assumed less patient than entrepreneurs (E). After learning about its own type, the middle-aged household would visit the financial intermediaries to withdraw from their matured SR accounts and spend in thier chosen way. When old, the entrepreneurs receive net profits, and the investors receive returns from their reinvestments which they used for consumption.

The rates of return from different accounts at maturing are different. Consider an account opening at period t. A saving account offers the net interest rate $\left(i_t^D\right)$ at period $t+1$; an investment account offers the net return rate $\left(i_{t+1}^E\right)$ at period $t + 1$; a LR account, as shown in Figures five and six, offers the net interest rate $\left(i_t^{LRD}\right)$ at period $t + 2$, or the net interest rate $\left(i_t^{EL}\right)$ at period $t+1$ will be provided if the account is liquidated prematurely, $i_t^{EL} < \left(i_{t+1}^E, i_t^D\right) < i_t^{LRD}$. Since both the saving account and LR account are demand deposits, the interest rates i_t^D, i_t^{LRD}, and i_t^{EL} are pre-determined by the financial intermediaries at the time of deposit. The net interest rate $\left(i_{t+1}^E\right)$, however, is a floating rate, which is determined by the equity market clearing condition.

At date t, each young allocates its income among all types of account, as shown in Figure one.

The allocation is as follows: a fraction α_t^S (< 1) is placed in the SR account and a fraction $\left(1 - \alpha_t^S\right)$ is placed in long term account. Among the funds in SR accounts, a fraction α_t^I (< 1) is placed in the investment accounts and the rest $\left(1 - \alpha_t^I\right)$ is placed in the saving accounts. At date $t+1$, each young becomes middel-ages, and withdraws their SR accounts, receiveing W_{t+1}^M:

$$W_{t+1}^M \equiv \left(1 + i_t^D\right) \alpha_t^S \left(1 - \alpha_t^I\right) w_t + \left(1 + i_{t+1}^E\right) \alpha_t^S \alpha_t^I w_t \tag{2}$$

2.1.1 Investors

After receiving W_t^M at period t, the middle-aged of generation $t - 1$ would behave according to their own types, as shown in Figure two. For the investor, the problem is to maximize utility $\left(c_{2,t}^I + \sigma^I c_{3,t+1}^I\right)$ by choosing whether to reinvest (RI), which country to reinvest in, and whether to liquidate the LR accounts prematurely (EL). It is assumed that the investors would focus on one country to reinvest in, and that if the average rate of return is the same in both countries, the investor would re-invest in the domestic country, about which more is known. An investor who decides to invest in domestic (foreign) country, would place α_t^{IM} $\left(\alpha_t^{IM*}\right)$ fraction of his/her total re-investment in investment accounts, and the rest, the fraction $\left(1 - \alpha_t^{IM}\right)$ $\left(1 - \alpha_t^{IM*}\right)$ in saving accounts.

After consumption $c_{2,t}^I$, an investor's decisions on reinvestment and early liquidation would provide the following returns for old-age consumption:

Table 1: The payoff for an investor

	options		newly created wealth at each date after consumption $c_{2,t}^I$
	RI	EL	W_{t+1}^{IM}
1	yes	no	$R_t^{IM} \left(W_t^M - c_{2,t}^I\right) + \left(1 + i_{t-1}^{LRD}\right) \left(1 - \alpha_{t-1}^S\right) w_{t-1}$
2	no	no	$\left(W_t^M - c_{2,t}^I\right) + \left(1 + i_{t-1}^{LRD}\right) \left(1 - \alpha_{t-1}^S\right) w_{t-1}$
3	no	yes	$\left(W_t^M - c_{2,t}^I\right) + \left(1 + i_{t-1}^{EL}\right) \left(1 - \alpha_{t-1}^S\right) w_{t-1}$
4	yes	yes	$R_t^{IM} \left[\left(W_t^M - c_{2,t}^I\right) + \left(1 + i_{t-1}^{EL}\right) \left(1 - \alpha_{t-1}^S\right) w_{t-1}\right]$

where $R_t^{IM} \equiv \left[\left(1 + i_t^D\right) \left(1 - \alpha_t^{IM}\right) + \left(1 + i_{t+1}^E\right) \alpha_t^{IM}\right]$. Note that all households always have a storage option, which provides a gross rate of return 1, if not re-investing via financial intermediaries.

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The old consume $c_{3,t+1}^I = W_{t+1}^{IM}$. Based on the above table, given $c_{2,t}^I$, an investor prefers reinvestment (RI) if $R_t^{IM} \sigma^I > 1$, and prefers not to liquidate LR account prematurely (non-EL) if there is no uncertainty to receive i_{t-1}^{LRD} at period $t+1$.

2.2 Firms and Debt Contracts

The entrepreneurs, who own special skills, are the ones capable of operating firms. Take a middle-aged entrepreneur of generation $t-1$ as an example. After learning its own type and withdrawing from SR accounts at period t, this entrepreneur must transform part of its W_t^M into capital goods to start production. The transformation from output goods to capital goods (K) is assumed to be one-to-one. Production requires both capital goods (K_t) and labour (L_t) as inputs, and takes one period to complete. The production is in the Cobb-Douglas form with constant returns to scale: $Y_{t+1} = A_t K_t^\theta L_t^{1-\theta}, 0 < \theta < 1$, where A_t represents production technology, and Y_{t+1} represents total output goods produced at period $t+1$.

Additional to inputs, it takes sunk costs q_t to operate a firm, and all labour wages have to be paid by the end of period $t+1$. That is before the completion of the production at period $t+2$. Therefore, the entrepreneur must spend a minimum $q_{t+1} + w_{t+1}L_{t+1} + K_{t+1}$ to start the production. Since $q_t + w_t L_t + K_t > W_t^M$, any entrepreneur who plans to operate a firm must borrow to start production. There are two resources available for entrepreneurs to obtain funds. One resource is to file an application to financial intermediaries to get a loan (the debt market). The other is to issue equities in the equity market. It is assumed that entrepreneurs raise funds in the domestic credit markets only. This is because the cost of acquiring information about foreign entrepreneurs before providing funds could be very high, so that the entrepreneurs usually have more difficulties raising funds in the foreign country. The one-period production in this model implies that only short-term funds are acquired, not long term funds.

2.2.1 Debt Finance

To acquire a loan from the financial intermediaries, an entrepreneur needs to provide collateral (B_t), which will not be returned until the loan is repaid. The amount of loan demanded by an

entrepreneur is:

$$b_t^D = q_t + w_t L_t - \left(W_t^M - c_{2,t}^E - K_t - B_t \right), \tag{3}$$

where $c_{2,t}^E$ represents the entrepreneur's middle-aged consumption before production. In the debt market, the source of loanable funds is limited to the sum of depositors' saving accounts at period t, so there exists credit rationing in the debt market. That means that only a fraction $\left(\beta^D \right)$ of entrepreneurs can obtain loans from the financial intermediaries. Let S_t denote the total deposits in the saving accounts at period t. As shown in Figure three, the resource constraint is

$$S_t \geq \beta_t^D \left(1 - \lambda \right) N_t b_t^D, \tag{4}$$

which can be rewritten as $\beta_t^D \leq S_t / \left[\left(1 - \lambda \right) N_t b_t^D \right]$. This shows that the more costly it is to start production, the more severe the credit rationing will be. Entrepreneurs who obtain loans from the financial intermediaries are called debt-finance entrepreneurs. The entrepreneurs who fail to get loans, and must raise funds in the equity market are called equity-finance entrepreneurs.

The loan rate $\left(i_t^{loan} \right)$ is pre-determined by banks at the time when the debt contract is offered. An acceptable debt contract requires $\left(1 + i_t^{loan} \right) b_t^D < Y_{t+1}$. Additionally, the debt contract must take into account the uncertain success rate of production. The uncertainty of production is as follows: production might succeed with an exogenous probability p and generate net profit $Y_{t+1} - \left(1 + i_t^{Loan} \right) b_t$. Failed production, with probability $(1 - p)$ would produce zero output and leave the loan unpaid. The true state of production is observable without cost by the entrepreneur who owns the firm only, but is costly to all other agents. To reduce verification costs and have the true state of production reported, the financial intermediaries must verify the production state when the loan is unpaid. If verification takes place, whether revealing success or failure, the financial intermediaries will take everything away. As a result, all entrepreneurs always report the true state. Therefore, following Bernanke et al (1996), the expected payoff of a debt-finance entrepreneur is

$$E_t \Pi_{t+1}^{DF} = p \left[Y_{t+1} - \left(1 + i_t^{Loan} \right) b_t^D + B_t \right]. \tag{5}$$

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2.2.2 Equity Finance

For the equity-finance entrepreneurs, the available funds are the aggregate investment accounts at period t (I_t). The resource constraint for equity market is:

$$I_t \geq b_t^E (1 - \lambda) \beta^E N_t, \tag{6}$$

where $b_t^E = q_t + w_t L_t - (W_t^M - K_t)$, and $\beta^D + \beta^E \leq 1$. This constraint shows that the amount of entrepreneurs getting equity finance is limited to I_t. Note that since $b_t^E < b_t^D$, in the case of $I_t = S_t$, $\beta^E > \beta^D$. The entrepreneurs who do not get either debt or equity finance would turn to investors. The expected payoff of an equity-finance entrepreneur is:

$$E_t \Pi_{t+1}^{EF} = p \left[Y_{t+1} - \left(1 + E_t i_{t+1}^E \right) b_t^E \right], \tag{7}$$

where i_{t+1}^E is the net rate of return to the equity holders, and it is determined by the equity market at the period $t + 1$, after the production is completed. So the problem faced by a debt-finance entrepreneur is to choose L_t and K_t to maximize equation (5) subject to equation (3). The problem faced by an equity-finance entrepreneur is similar to that of a debt-finance entrepreneur, except for collateral $(B_t = 0)$ and for the rate of return $\left(i_{t+1}^E \right)$.

2.2.3 Equilibrium Capital Gains

The full employment assumption gives the labour market clearing condition, $L_t = 1/(1 - \lambda) \left(\beta_t^D + \beta_t^E \right)$. This gives optimal the capital input, labour demand, and wage rate:

$$\bar{K}_t^{DF} = \frac{1}{(1 - \lambda)(\beta^D + \beta^E)} \left(\frac{A_t \theta}{1 + i_t^{loan}} \right)^{1/(1-\theta)} , \bar{K}_t^{EF} = \frac{1}{(1 - \lambda)(\beta^D + \beta^E)} \left(\frac{A_t \theta}{1 + E_t i_{t+1}^E} \right)^{1/(1-\theta)} ; \tag{8a}$$

$$\bar{L}_t^{DF} = \bar{L}_t^{EF} = \frac{1}{(1 - \lambda)(\beta^D + \beta^E)} \tag{8b}$$

$$\bar{w}_t^{DF} = \theta^{\theta/(1-\theta)}(1 - \theta) \left(\frac{A_t}{1 + i_t^{loan}} \right)^{1/(1-\theta)} , \bar{w}_t^{EF} = \theta^{\theta/(1-\theta)}(1 - \theta) \left(\frac{A_t}{1 + E_t i_{t+1}^E} \right)^{1/(1-\theta)}. \tag{8c}$$

At the time of making decisions on the amount of capital to invest and labour to hire, the entrepreneurs have not yet learned the value of i_{t+1}^E. The equity financed entrepreneurs hence would form expectation $E_t i_{t+1}^E = i_t^{loan}$. Accordingly, the entrepreneurs would invest $K_t^{DF} = K_t^{EF}$, and

$L_t^{DF} = L_t^{EF}$. The full employment assumption gives $w_t^{DF} = w_t^{EF}$, so there will be no wage discrimination and no labour mobility across firms. This gives entrepreneurs capital gains of : $E_t \bar{\Pi}_{t+1}^{DF} = p \left[\bar{Y}_{t+1} - \left(1 + i_t^{Loan} \right) \bar{b}_t^D + B_t \right]$, and $E_t \bar{\Pi}_{t+1}^{DF} = p \left[\bar{Y}_{t+1} - \left(1 + E_t i_{t+1}^E \right) \bar{b}_t^E \right]$, and entrepreneurs would borrow to operate firms if

$$c_{2,t}^E + \sigma^E E_t \bar{\Pi}_{t+1}^{DF} \geq c_{2,t}^I + \sigma^E \left\{ Max \left(W_{t+1}^{IM} \right)_{ij} \right\}; \;\; c_{2,t}^E + \sigma^E E_t \bar{\Pi}_{t+1}^{EF} \geq c_{2,t}^I + \sigma^E \left\{ Max \left(W_{t+1}^{IM} \right)_{ij} \right\}, \;\; (9)$$

,where $\left(W_{t+1}^{IM} \right)_{ij}$, $(i = (RI, Non - RI), \; j = (EL, non - EL))$, represents all possible returns an investor could obtain when old. This indicates that the entrepreneurs would start production only if the expected capital gains are higher than the maximum expected returns of an investor. In other words, if the expected capital gains were less than the returns of an investor, the entrepreneurs would prefer to become investors, rather than start production.

2.3 Financial Intermediaries

As a middleman for both the debt and the equity markets, the financial intermediaries provide depositors various accounts, which serve different purposes. Saving accounts are for the debt market, investment accounts are for the equity market, and long-term accounts are for arbitrary long-term safe assets which do not default. In this model, both saving accounts and long term accounts are demand deposits, which are tied with deposit contracts with pre-determined interest rates. Failing to repay these two types of accounts would result in bank runs. The role of financial intermediaries in the debt market and in the equity market are different. In the debt market, financial intermediaries offer loan contracts to the entrepreneurs, and offer saving accounts to depositors. In the equity market, financial intermediaries serve as a channel to provide the funds in investment accounts to equity-finance entrepreneurs. They also provide returns to the investment account holders on floating interest rates, which are determined by the equity market.

Demand deposits require the financial intermediaries to manage the saving and long term accounts with caution while choosing the interest rates to attract depositors and to maximize their profits. Let $\gamma_t \left(1 - \gamma_t^* \right)$ denote the fraction of domestic (foreign) investors who choose domestic financial intermediaries to reinvest, and let $\chi_t^B \left(\chi_t^H \right)$ be the fraction of the long term accounts in which the financial intermediaries (households) decide to liquidate prematurely, respectively. The

problem faced by the domestic financial intermediaries at date t is to choose i_t^D, i_t^{LRD}, i_t^{loan}, and χ_t^B to maximize the expected payoff $E_t\Pi_{t+1}^B$:

$$E_t\Pi_{t+1}^B = \left\{ \begin{array}{c} \left[S_{t+1} - \beta_{t+1}^D\left(1-\lambda\right)Nb_{t+1}^D\right] \\ + \left[(1-\lambda)\beta_t^D N\left[p\left(1+i_t^{loan}\right)b_t^D + (1-p)B_t\right] - \left(1+i_t^D\right)S_t\right] \\ + \left(\chi_{t+1}^B - \chi_{t+1}^H\right)\left(1-\alpha_t^S\right)\left(1+i_t^{EL}\right)w_tN \\ + \left(1-\alpha_{t-1}^S\right)\left[\left(1-\chi_t^B\right)\left(1+i_{t-1}^{LR}\right) - \left(1-\chi_t^H\right)\left(1+i_{t-1}^{LRD}\right)\right]w_{t-1}N \end{array} \right\}, \qquad (10)$$

where $S_t \equiv \alpha_t^S\left(1-\alpha_t^I\right)w_tN + \left[\lambda + \left(1-\beta^D-\beta^E\right)\right]\gamma_t\left(1-\alpha_t^{IM}\right)N\left(W_t^M - c_{2,t}\right)$

$+(1/e_t)\lambda^*\left(1-\gamma_t^*\right)\left(1-\alpha_{t,FD}^{IM*}\right)N^*\left(W_t^{M*} - c_{2,t}^*\right)$ is the aggregate saving accounts in the financial intermediaries at date t. The first bracket of equation (10) is the saving accounts of the young and the domestic and the foreign investors, who are the loan suppliers to the middle-aged entrepreneurs. The second line shows that the expected returns from loan repayments are used to meet the withdrawals of matured saving accounts. The third line shows early liquidated long term accounts, while the fourth line is the matured long term accounts at date $t+1$. The details of the capital flows are shown in Figures three, four, five and six.

It is assumed that the financial intermediaries manage all accounts exactly for the purpose stated[3]. That is, the newly opened saving accounts provide the new loans and the matured loans repay the matured saving accounts. All newly opened LR accounts will be placed in LR asset investment, and the returns on, or early liquidation of, LR accounts will be used to repay the matured LR accounts or to respond to the early liquidation requests. The financial intermediaries do not re-distribute funds between debt, equity and LR assets. Moreover, all SR assets, both debt and equity, share the same degree of risk, and LR assets' returns are perfectly secured. Therefore, there is no problem with regard to investing in riskier assets by the financial intermediaries. This is similar to the concept of capital requirements for financial intermediaries. The liquidity constraints of the financial intermediaries for matured SR [Figure four] and LR accounts, respectively, are:

$$\left[p\left(1+i_t^{loan}\right)b_t^D + (1-p)B_t\right]\left(1-\lambda\right)\beta_t^D N \geq \left(1+i_t^D\right)S_t, . \qquad (11a)$$

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[3]The possibility of using new deposits or LR accounts to finance the shortage in repaying the demand deposits will be discussed in the next section.

$$\left(\chi_{t+1}^{B} - \chi_{t+1}^{H} \right) \left(1 - \alpha_t^{S} \right) \left(1 + i_t^{EL} \right) w_t N \tag{11b}$$

$$+ \left(1 - \alpha_{t-1}^{S} \right) \left[\left(1 - \chi_t^{B} \right) \left(1 + i_{t-1}^{LR} \right) - \left(1 - \chi_t^{H} \right) \left(1 + i_{t-1}^{LRD} \right) \right] w_{t-1} N \geq 0.$$

In other words, the financial intermediaries suffer liquidity problems when failing to meet these two constraints [equations (11a) and (11b)].

In order to attract both domestic and foreign investors, the domestic financial intermediaries have the incentive to offer a competitive deposit rate, i_t^{D}, which must satisfy the following two constraints:

$$\left(1 + i_t^{D} \right) \left(1 - \alpha_{t,DD}^{IM} \right) + \left(1 + E_t i_{t+1}^{E} \right) \alpha_{t,DD}^{IM} \tag{12a}$$

$$\geq \ (1/e_t) \left[\left(1 + i_t^{D*} \right) \left(1 - \alpha_{t,DF}^{IM} \right) + \left(1 + E_t i_{t+1}^{E*} \right) \alpha_{t,DF}^{IM} \right]$$

$$\left(1 + i_t^{D} \right) \left(1 - \alpha_{t,FD}^{IM*} \right) + \left(1 + E_t i_{t+1}^{E} \right) \alpha_{t,FD}^{IM*} \tag{12b}$$

$$\geq \ (e_t) \left[\left(1 + i_t^{D*} \right) \left(1 - \alpha_{t,FF}^{IM*} \right) + \left(1 + E_t i_{t+1}^{E*} \right) \alpha_{t,FF}^{IM*} \right],$$

where v_t (v_t^*) represents the real value of the domestic (foreign) currency; $e_t \equiv v_t/v_t^*$ represents the real exchange rate at period t. The value of $\alpha_{t,ij}^{IM}$ shows the fraction of reinvestment placed in investment accounts in country j by a country i investor. This is to reflect the possibilities that the portfolio decisions of a foreign investor may differ from that of domestic investors, and that the portfolio decisions made by domestic investors may differ in different countries, based on various return rates in the debt and the equity markets of different countries.

2.4 Equilibrium Rates

By re-arranging equation (11a) and combining with equation (9), one can obtain the range of equilibrium i_t^{loan}:

$$\frac{1}{p} \left[\frac{\left(1 + i_t^{D} \right) S_t}{(1 - \lambda) \beta_t^{D} N} - (1 - p) B_t \right] \tag{13a}$$

$$\leq \ \left(1 + i_t^{loan} \right) \bar{b}_t^{D} \leq p \left(\bar{Y}_{t+1} + B_t \right) - \frac{1}{\sigma^{E}} \left(c_{2,t}^{I} - c_{2,t}^{E} \right) - \max \left(W_{t+1}^{IM} \right)_{ij},$$

where the first inequality shows the minimum i_t^{loan} required to meet demand deposits, and the second inequality shows the upper bound of i_t^{loan}, which would have entrepreneurs willing to operate a firm.

The equilibrium i_t^D can be obtained by using equations (11a), (12a), and (12b):

$$
\max \left\{
\begin{array}{c}
\frac{(1/e_t)\left[\left(1+i_t^{D*}\right)\left(1-\alpha_{t,DF}^{IM}\right)+\left(1+E_t i_{t+1}^{E*}\right)\alpha_{t,DF}^{IM}\right]-\left(1+E_t i_{t+1}^E\right)\alpha_{t,DD}^{IM}}{\left(1-\alpha_{t,DD}^{IM}\right)}, \\
\frac{(e_t)\left[\left(1+i_t^{D*}\right)\left(1-\alpha_{t,FF}^{IM*}\right)+\left(1+E_t i_{t+1}^{E*}\right)\alpha_{t,FF}^{IM*}\right]-\left(1+E_t i_{t+1}^E\right)\alpha_{t,FD}^{IM*}}{\left(1-\alpha_{t,FD}^{IM*}\right)}
\end{array}
\right\} \tag{13b}
$$

$$
\leq \left(1+i_t^D\right) \leq \frac{\left[p\left(1+i_t^{loan}\right)b_t^D+(1-p)B_t\right](1-\lambda)\beta_t^D N}{S_t}.
$$

In the equity market, after supplying funds to equity finance firms at period t, the households would receive i_{t+1}^E at period $t+1$. The realized return rate in the equity market i_{t+1}^E is determined by the resource constraint of the equity market:

$$
I_t\left(1+i_{t+1}^E\right) = p\left(1+E_t i_{t+1}^E\right)(1-\lambda)\beta^E N b_t^E = (1-\lambda)\beta^E N p \psi_t Y_{t+1}^{EF} \tag{14}
$$

where $I_t \equiv \alpha_t^S \alpha_t^I w_t N + \gamma\left[\lambda+\left(1-\beta^D-\beta^E\right)\right]\alpha_t^{IM} N\left(W_t^M - c_{2,t}\right)$

$+(1/e_t)\lambda^*\left(1-\gamma_t^*\right)\alpha_{t,FD}^{IM*} N^*\left(W_t^{M*} - c_{2,t}^*\right)$ shows the aggregate amount in the investment accounts, and ψ_t represents the average fraction of output extracted to repay the equity holders by the equity-finance entrepreneurs who experience successful production. Note that the actual equity rate is equal to the expected return rate to the equity market, $\left(1+i_{t+1}^E\right) = p\left(1+E_t i_{t+1}^E\right) = p\psi_t Y_{t+1}^{EF}/b_t^E$. Rearranging equations (12a)-(12b), and (9) gives the range of equilibrium equity rate:

$$
Max \left\{
\begin{array}{c}
\frac{(1/e_t)\left[\left(1+i_t^{D*}\right)\left(1-\alpha_{t,DF}^{IM}\right)+\left(1+E_t i_{t+1}^{E*}\right)\alpha_{t,DF}^{IM}\right]-\left(1+i_t^D\right)\left(1-\alpha_{t,DD}^{IM}\right)}{\alpha_{t,DD}^{IM}}, \\
\frac{(e_t)\left[\left(1+i_t^{D*}\right)\left(1-\alpha_{t,FF}^{IM*}\right)+\left(1+E_t i_{t+1}^{E*}\right)\alpha_{t,FF}^{IM*}\right]-\left(1+i_t^D\right)\left(1-\alpha_{t,FD}^{IM*}\right)}{\alpha_{t,FD}^{IM*}}
\end{array}
\right\} \tag{15}
$$

$$
\leq \left(1+i_{t+1}^E\right) \leq \frac{1}{\bar{b}_t^E}\left[p\bar{Y}_{t+1}-\frac{1}{\sigma^E}\left(c_{2,t}^I - c_{2,t}^E\right)-\max\left(W_{t+1}^{IM}\right)_{ij}\right],
$$

where the first inequality shows the minimum equity rate required to attract funds from investors, and the second inequality shows the upper bound of equity rate to ensure entrepreneurs willing to operate firms.

3 The Implications for Banking Crises and Sudden Stops

Bank runs occur when repayment of demand deposits cannot be made, that is when liquidity constraints [equations (11a)-(11b)] are not satisfied. Equation (11a) is the liquidity constraint for SR demand deposits, and equation (11b) is the liquidity constraint for LR demand deposits. Failing

to satisfy one of the liquidity constraint may cause the financial intermediaries to use other accounts to finance the shortage. However, if the shortage is too large to be financed by exhausting all other accounts, the financial intermediaries have no option but to bankrupt, due to insolvency.

In particular, the deposits, whether SR saving accounts or LR accounts, are on the liability side of the balance sheets of the financial intermediaries, while the repayment of loans and the returns to the LR asset investment are on the asset side of the balance sheet. Insolvency occurs when the total assets are less than total liabilities, leaving negative net worth in the financial intermediaries.

In this section, I will demonstrate whether bank runs, followed by sudden stops, may depend crucially on the size of the shock, and on the responses of households' expectations on bank runs to the shocks. Moreover, since SRL facilities are often offered to prevent/stop bank runs as well as sudden stops, the role of SRL in preventing banking crises and sudden stops will be discussed in this section.

3.1 Small shocks

The change in depositors' expectatin in response to a shock could put banks in a position to run, regardless of the size of any shock. Suppose a small adverse shock occurs to the domestic country, but it is too small to cause an inability for banks to repay any type of demand deposit after receiving loan repayments, and the returns to LR accounts. If depositors do not panic and withdraw early, there will be no bank runs and sudden stops.

Unfortunately, if the depositors revise their expectation on the likelihood of bank runs in response to the shock, then panic, and rush to the banks to liquidate their accounts before the loans are repaid and before the returns to the accounts arrive, the financial intermediaries will be forced to fully liquidate all LR accounts prematurely $\chi_t^B = \chi_t^H = 1$, but still fail to repay all demand deposits[4]. As a result, insolvency would cause the banks to run and sudden stops would follow. This is the type of bank run demonstrated in Diamond and Dybvig (1983). If such a small shock is an international shock, bank runs and sudden stops would occur to the country in which depositors panic and withdraw early before loans are repaid and the returns to the accounts arrive. In other

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[4]The main reason is because the production may not yet be completed, and the only source to repay the panic depositors is to liquidate prematurely the LR assets, which earns $i_t^{EL} < i_i^D$.

words, a country in which depositors have little faith in banks is easlily affected by small shocks, and more vulnerable to bank runs and sudden stops.

When the main cause of bank runs is the liquidity problem, or mismatching in the timing of returns and repayments to the accounts, the role of SRL facilities serves as an insurance and becomes crucial in alleviating liquidity problems. On the one hand, the amount of lending could be as large as the sum of both SR and LR repayments to the depositors, because this amount is guaranteed to be repaid if the loan repayment and the returns to LR accounts arrive. On the other hand, the availability of sufficient SRL funding could lower the likelihood of depositors changing their expectation on bank runs in response to a small shock, thus preventing bank runs, and sudden stops. Therefore, in the case of sufficiently small shocks, the costs of providing SRL is low, and such SR lending provision can be effective in preventing bank runs and sudden stops.

3.2 Large shocks

In contrast, a large adverse shock is defined as a shock (ε), which would prevent banks from repaying demand deposits after receiving loan repayments and the returns of LR accounts, and may result in bank runs, regardless of whether the depositors change their expectation. In this model, the shock to the economy enters through the reduced success rate (p) of the projects undertaken by entrepreneurs[5]. The occurrence of the shock lowers the projects' success rate to $(p - \varepsilon)$. If this negative shock (ε_t) occurs at the beginning of period t, the banks would have liquidity problems with the SR demand deposits,

$$(p - \varepsilon_t) \left[\left(1 + i_{t-1}^{loan}\right) b_{t-1}^D - B_{t-1} \right] \leq \left[\frac{\left(1 + i_{t-1}^D\right) S_{t-1}}{(1-\lambda)\,\beta^D N} - B_{t-1} \right]. \tag{16}$$

Let ξ_t denote the amount of liquidity in relation of SR demand deposits, $\xi_t \equiv \left[\frac{(1+i_{t-1}^D)S_{t-1}}{(1-\lambda)\beta^D N} - B_{t-1} \right] - (p - \varepsilon_t) \left[\left(1 + i_{t-1}^{loan}\right) b_{t-1}^D - B_{t-1} \right]$. To prevent insolvency, the banks have several ways of responding to the liquidity problem. One is to use new deposits, and the other is to use the LR accounts. However, each has its own difficulties, and may or may not resolve the insolvency problem and prevent bank runs and sudden stops.

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[5]One may consider different ways in which the shocks enter the economy. This does not affect the main conclusion of this model.

3.2.1 Using new deposit to finance the repayment of demand deposits

The shortage of liquidity to cover demand deposits raises the question of whether to use new deposits S_t to finance the repayment of demand deposits. If not, then without access to lending facilities from other sources, bank runs, followed by sudden stops, would be the result. If using new deposits to finance the repayments of demand deposits, then taking the extreme case in which all S_t are used to cover the shortfall in demand deposits repayments, the financial intermediaries can not provide loanable funds. Without loan repayments in the following period, the deposit rate $\left(1 + i_t^D\right)$ which the financial intermediaries can provide, is 0 meaning $i_t^D = -1$, at which no depositors will be willing to deposit. In other words, the value of $i_t^D > 0$ would cause bank runs in the next period, and the value of $i_t^D < 0$ would result in no new deposits, $S_t = 0$.

In the case where a proportion (η_t) of S_t is used to cover the shortfall in liquidity, the financial intermediaries must set a low deposit rate $\left(1 + i_t^D\right) \leq (1 - \eta_t)\left[p\left(1 + i_t^{loan}\right) + (1 - p)B_t/b_t^D\right]$, push up the loan rate, and widen the margin between the loan rate and the deposit rate, $(i_t^{loan} - i_t^D)$. If the adverse shock is exclusive to the domestic country, the sufficiently low domestic deposit rate $i_t^D(< i_t^{D*})$ may promp the middle-aged investors to invest in the foreign country, if they receive repayment of their SR accounts. The decrease in SR saving accounts lowers the available loanable funds, and raises i_t^{loan} even higher, thereby widening the interest rate differential even further. With such a high i_t^{loan}, the profit earned by an entrepreneur shrinks. Once i_t^{loan} is pushed past the upper bound, as indicated in equation (13a), no entrepreneurs would want to borrow from financial intermediaries. Without loan repayment from the firms, the financial intermediaries cannot afford any $i_t^D > 0$. Unfortunately, if offering a competitive deposit rate to compete with the foreign rate and thus attract deposits, the financial intermediaries cannot afford the repayments of the demand deposits in the next period. So the bank runs and sudden stops are postponed for one period.

Therefore, whether using all of part of new deposits to cover the shortage of liquidity, the financial intermediaries face trade offs in choosing i_t^D. If choosing an affordable rate i_t^D, the financial intermediaries may receive few deposits, which would widen the interest rate differential and cause more severe credit rationing. As a result, the high i_t^{loan} reduces entrepreneurs' profits, and

in a more severe case may stop entrepreneurs from obtaining loans and operating firms. However, if choosing a competitive rate similar to the foreign rate, the financial intermediaries will prepare for a run in the next period, since the repayments of demand deposits cannot be made.

3.2.2 Using LR accounts to finance SR demand deposit shortage

The LR accounts are also demand deposits, so the returns to the matured LR accounts must be paid to LR accounts holders. Additional to new deposits, another source to finance the shortage of SR demand deposit is to liquidate the LR accounts $(\chi_t^B > \chi_t^H)$, which are not yet matured at period t and offer $i_t^{EL} < i_t^D$. This means that financial intermediaries are forced to liquidate more than one unit, $(1 + i_t^D)/(1 + i_t^{EL}) > 1$, in order to make up every unit short. Therefore, immediate bank runs at period t would be the result if the liquidation of all LR accounts is insufficient to cover the liquidity problem of the SR demand deposits:

$$\left(1 - \chi_t^B\right)\left(1 - \alpha_{t-1}^S\right)\left(1 + i_{t-1}^{EL}\right)w_{t-1}N < \xi_t, \tag{17}$$

where the left-hand-side represents the total amount the financial intermediaries could receive if liquidating prematurely all LR account, and the right-hand-side shows the amount of liquidity shortage to be covered for SR demand deposits. Note that the returns to LR accounts do not default. It is the return of early liquidation (i_t^{EL}) which has been stated in the deposit contract insufficient to cover the shortfalls that cause bank runs.

If bank runs at period t are not avoidable even after liquidating all LR accounts, all depositors would want to rush to withdraw all their accounts, including by early liquidation $\chi_t^H = 1$, as soon as witnessing the shock. The time to withdraw could be either before or after the loan repayment and the returns to the LR accounts arrive. One question to examine is whether the time to withdraw is crucial to the repayments the depositors might receive. If withdrawals are before the loan repayments and the returns to LR accounts arrive, the financial intermediaries are forced to liquidate all assets, $\chi_t^B = 1$ and still fail to repay demand deposits, whether the SR or the LR accounts. Consequently, the bank fails before the maturity date of accounts, and the depositors may or may not receive repayments, depending on their rank in line to withdraw. This is the type of bank run discussed in Diamond and Dybvig (1983).

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If all withdrawals were after the arrival of returns for LR accounts, the financial intermediaries would have more funds to repay the depositors. Ideally, the financial intermediaries could repay fully the LR account holders and meet demand deposits for LR accounts, but not SR accounts, according to equation (17). Although better off by postponing their withdrawals until the LR returns have arrived, the depositors risk receiving nothing if all others rush to withdraw before the LR returns arrive. The best time to withdraw would be as soon as noticing the large shock, regardless of whether the LR returns have arrived.

In the face of bank runs, the depositors who may or may not receive the repayments of their SR accounts are the middle-aged investors or new entrepreneurs. Without repayments, the investors cannot reinvest, and the entrepreneurs cannot operate firms for production. The bankruptcy of banks prevents the young households and both domestic and foreign middle-aged investors at period t from depositing their income and wealth, which are the sources of loanable funds for the new entrepreneurs. Without the banks as the middlemen for both the debt and the equity markets, private capital flows stop entering th edomestic country and sudden stops are not avoidable.

If early liquidation of LR accounts is sufficient to cover the shortfall in liquidity, $\left(1 - \chi_t^B\right)\left(1 - \alpha_{t-1}^S\right)\left(1 + i_{t-1}^{EL}\right)w_{t-1}N > \xi_t$, does this mean the bank runs have been prevented successfully? Note that the early liquidated LR accounts would mature in the next period, and LR accounts are also demand deposits. Therefore, it will require the financial intermediaries to have sufficient profit $\Pi_{t+1}^B \geq \left(1 - \chi_t^H\right)\left(1 - \alpha_{t-1}^S\right)\left(1 + i_{t-1}^{LRD}\right)w_{t-1}N$ to repay the LR demand deposit at period $t+1$ to ensure that bank runs are actually prevented. If not, bank runs, followed by sudden stops are only postponed one period to $t+1$.

3.2.3 Using SRL facilities and Banks' moral hazard problems

In general, SRL facilities are considered to be effective in preventing bank runs and sudden stops. This could be one of the reasons why several international organizations, such as IMF, have SRL facilities available to its member countries. In this section, I would like to examine how effective the SRL facilities can be in preventing bank runs and sudden stops. Since it is the large shocks that would cause unavoidable bank runs and sudden stops, the discussion will focus on them. In response to large shocks, a sufficient amount of SRL $(SRL_t) > \xi_t$ is needed to prevent immediate

bank runs and sudden stops. The question is for how long the SRL can prevent bank runs and sudden stops.

Lenders often want to lend short-term, but borrowers often want to borrow long term. Whether the adverse shock is temporary or permanent, SRL must be repaid. The name of SR implies that the repayment can be made as soon as possible. Therefore, when to repay and the amount to repay could be crucial for whether SRL take place and whether this might be another trigger for bank runs and sudden stops.

Taking the temporarily adverse shock (ε_t) as an example, it will require the financial interme-diaries to accumulate sufficient profit within a limited amount of time to repay the SRL; otherwise, the financial intermediaries are subject to runs at the time of due payment to the lender, such as IMF. To be more specific, if the due payment to the SRL lender were set at period $t + 2$, the financial intermediaries would experience liquidity problem at period $t + 2$,

$$p\left[\left(1 + i_{t-1}^{loan}\right) b_{t-1}^{D} - B_{t-1}\right] < \left[\frac{\left(1 + i_{t-1}^{D}\right) S_{t-1}}{\left(1 - \lambda\right) \beta N} - B_{t-1}\right] + \left(1 + i_t^{SRL}\right)^2 (SRL_t),$$

where $\left(1 + i_t^{SRL}\right)^2 (SRL_t) > \varepsilon \left[\left(1 + i_{t-1}^{loan}\right) b_{t-1}^{D} - B_{t-1}\right]$, and i_t^{SRL} represents the interest rate to be paid for SRL. Thus, bank runs and sudden stops are postponed to the period $t + 2$ when the repayment of SRL is due.

Knowing that banks will run at period $t + 2$, potential depositors would stop depositing into domestic banks at period $t + 1$, $S_{t+1} = 0$ and stop investing in equity markets via financial in-termediaries. Without deposits and funds for equity market, entrepreneurs cannot get funds to start production at period $t + 1$, so they all behave as investors and invest in the foreign country, $b_{t+1}^{D} = B_{t+1} = 0$, rather than operating firms. Moreover, both investors and entrepreneurs would liquidate all their LR accounts, $\chi_{t+1}^{H} = \chi_{t+1}^{B} = 1$. This suggests that sudden stops might occur at period $t + 1$, one period before the due payment to the SRL lender. The sudden stops at period $t + 1$ would decrease the banks' profits at period $t + 2$ $\left(\Pi_{t+2}^{B}\right)$, even though banks' profit at period $t + 1$ $\left(\Pi_{t+1}^{B}\right)$ can still be positive:

$$\begin{aligned}
\Pi_{t+1}^{B} &= \left\{p\left[\left(1 + i_t^{loan}\right) b_t^{D} - B_t\right] - \left[\frac{\left(1 + i_t^{D}\right) S_t}{\left(1 - \lambda\right) \beta N} - B_t\right]\right\} \\
&+ \left\{\left(1 - \alpha_{t-1}^{S}\right) \left[\left(1 - \chi_t^{B}\right) \left(1 + i_{t-1}^{LR}\right) - \left(1 - \chi_t^{H}\right) \left(1 + i_{t-1}^{LRD}\right)\right] w_{t-1} N\right\},
\end{aligned} \tag{18}$$

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where the first curly bracket represents the profit earned from SR accounts, and the second curly bracket is from LR accounts. As a result, banks would run at period $t+2$, if $\Pi_{t+1}^B < \left(1 + i_t^{SRL}\right)^2 (SRL_t)^6$.

Providing $\Pi_{t+1}^B < \left(1 + i_t^{SRL}\right)^2 (SRL_t)$ and $\Pi_{t+2}^B = 0$, the net worth of the financial intermediaries would turn negative and the financial intermediaries would be forced to run at period $t+2$. This would encourage the banks to abscond with all the profit at hand while the profit is still positive. This is banks' moral hazard problem. The maximum amount of profit to abscond with at period $t+1$ $\left(\Pi_{t+1}^B\right)'$ is the profit after receiving the loan repayments and the returns to the LR accounts and without repaying the accounts:

$$\left(\Pi_{t+1}^B\right)' = \left[p \left(1 + i_{t-1}^{loan}\right) b_{t-1}^D + (1-p)B_{t-1}\right](1-\lambda)\beta N + \left(1 - \alpha_{t-1}^S\right)\left(1 - \chi_t^B\right)\left(1 + i_{t-1}^{LR}\right) w_{t-1} N > \Pi_{t+1}^B. \tag{18a}$$

The possibility that the banks have incentives to abscond at period $t+1$ could discourage potential depositors from depositing in the domestic banks and cause sudden stops at period t, the period when ε_t occurs and when the SRL is provided. Similarly, without deposits and investments in equity markets via financial intermediaries at period t, the banks' profits at period $t+1$, $\left(\Pi_{t+1}^B\right)'' = 0 < \left(1 + i_t^{SRL}\right)^2 (SRL_t)$. This would encourage banks to abscond with all profits at period t–that is, after receiving loan repayments, the returns to the accounts, and SRL at period t. In other words, absconding would occur at the period of the large shock, even though sufficient SRL was provided to meet demand deposits in time. This might be the worst scenario for the institution(s) which provide SRL facilities, and the citizens of the country suffering banking crises and sudden stops.

To avoid a worst case scenario, it is crucial to give banks sufficient time to accumulate enough profits to repay the lending:

$$\sum_{\tau=1}^{j} (1+i)^{j-\tau} \Pi_{t+\tau}^B > \left(1 + i_t^{SRL}\right)^j \xi_t. \tag{19}$$

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[6] By updating equation (18) by one period and replacing the values of the variables at $t+1$ as indicated above, one could obtain $\Pi_{t+2}^B = 0$. This gives $\Pi_{t+1}^B + \Pi_{t+2}^B < \left(1 + i_t^{IMF}\right)^2 \xi_t$, where $\Pi_{t+2}^B = 0$, so banks would run at period $t+2$.

Moreover, the incentive constraint to prevent banks to abscond is very important:

$$\sum_{\tau=j+1}^{\infty} \frac{1}{(1+i)^{\tau}} \Pi_{t+\tau}^{B} + \frac{1}{(1+i)^{j}} \left[\sum_{\tau=1}^{j} (1+i)^{j-\tau} \Pi_{t+\tau}^{B} - \left(1+i_{t}^{SRL}\right)^{j} (SRL_t). \right] \qquad (20)$$

$$\geq \quad \frac{1}{(1+i)^{t+\kappa}} \left(\Pi_{t+\kappa}^{B}\right)' + \sum_{\tau=j+1}^{\kappa-1} \frac{1}{(1+i)^{\tau}} \Pi_{t+\tau}^{B}, \text{ where } \kappa \leq j,$$

where j is the number of periods required for banks to accumulate sufficient profits to repay the lending, and κ is the period when the banks have strong incentives to abscond with all profits. Equation (20) shows that the banks have no incentive to abscond when the present value of the banks' future profits by not absconding (left-hand-side) is no less than that of absconding at period κ (right-hand-side).

4   CONCLUSION & EXTENSIONS

The advantages of the overlapping generations framework allow this paper to investigate the links between banking crises and sudden stops and discuss the effectiveness of SRL provided by international organizations, such as International Monetary Fund (IMF). Consequently, I find several interesting results. First, an adverse shock may or may not trigger bank runs and sudden stops, depending on the size of the shock and the effects of the shocks on depositors' expectation on the likelihood bank runs. When depositors' faith in banks is weak, even small shocks, which do not affect banks' ability to meet demand deposits fully, could cause panics and trigger bank runs and sudden stops. This is where the availability of SRL facilities could be very helpful, as they serve as insurance to prevent bank runs and sudden stops. Second, should there be a liquidity shortage, although it might be the natural response to use new deposits to finance demand deposits, such a response could jeopardize financial intermediaries' positions. That is, by offering a competitive deposit rate to attract new deposits, the financial intermediaries would have to run at the following period. However, if lowering the deposit rate, the financial intermediaries may lose potential depositors.

Third, a large shock, which affects banks' ability to meet demand deposits, would require SRL to prevent immediate bank runs and sudden stops. However, the due payment to the SRL provider

could encourage banks to abscond and leave the demand deposits unpaid, another type of banks' moral hazard problem. This particular moral hazard problem is more likely to occur when the financial intermediaries do not have enough time to accumulate sufficient profits to repay. To prevent this worst scenario for both the depositors and the institutions which provide the SRL facilities, it is important to ensure a reasonable length of time for financial intermediaries to repay the due payment, and to satisfy the incentive constraint in ordre to prevent the moral hazard problems.

There are several limitations of this paper, which can be extended in the future. The direct extension is to allow for capital controls and to discuss the effects of capital account liberalization on bank runs and sudden stops. Other extensions include the direct access of individuals to the credit markets, so that bank runs do not result in closing down all credit markets. Both extensions, however, might raise the concern on the stability of the financial system. To be more specific, they raise the question of whether such openness or restrictions might increase the international contagion effects for the domestic financial system.

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References

Bencivenga, Valerie R., and Bruce D. Smith. (1991). "Financial Intermediation and Endogenous Growth." Review of Economic Studies 58, 195-209.

Bernanke, Ben, Mark Gertler, and Simon Gilchrist. (1996). "The Financial Accelerator and the Flight to Quality." Review of Economics and Statistics 78, 1-15.

Boyed, John H., and Bruce D. Smith. (1997). "Capital Market Imperfections, International Credit Markets, and Non-convergence." Journal of Economic Theory 73, 335-64.

Chang, Chia-Ying. (2010). "Capital Flows, Financial Intermediaries, and Economic Growth." Journal of International and Global Economic Studies 2, 47-60.

Chang, Chia-Ying. (2011). "When the Banking Systems Meet Currencies." SEF working paper, Victoria University of Wellington.

Chevalier, Judith. A., and David S. Sharfstein. (1996). "Capital Market Imperfections and Countercyclical Markups: Theory and Evidence." American Economic Review 86, 703-725.

Diamond, Douglas W., and Phillip H. Dybvig. (1983). "Bank Runs, Deposit Insurance, and Liquidity." Journal of Political Economy 91, 401-19.

Edwards, Sebastan. (2004). "Financial Openness, Sudden Stops, and Current Account Reversals." American Economic Review 94, 59-64.

Eichengreen, Barry. (2004). Capital Flows and Crises. Cambridge, MA: MIT Press.

Eichengreen, Barry, Poonam Gupta, and Ashoka Mody. (2008). "Sudden Stops and IMF Supported Programs." In Financial Markets Volatility and Performance in Emerging Markets, edited by Sebastian Edwards and Marcio G. Garcia, pp. 219-277. Chicago, IL: University of Chicage Press.

Kiyotaki, Norbuhiro, and John Moore. (1997). "Credit Cycles." Journal of Political Economy 105, 211-248.

Tirole, Jean. (2002). Financial Crises, Liquidity, and the International Monetary System. Princeton, NJ: Princeton University Press.

Wallace, Neil. (1996). "Narrow Banking Meets the Diamond-Dybvig Model." Federal Reserve Bank of Minneapolis Quarterly Review 20, 3-13.
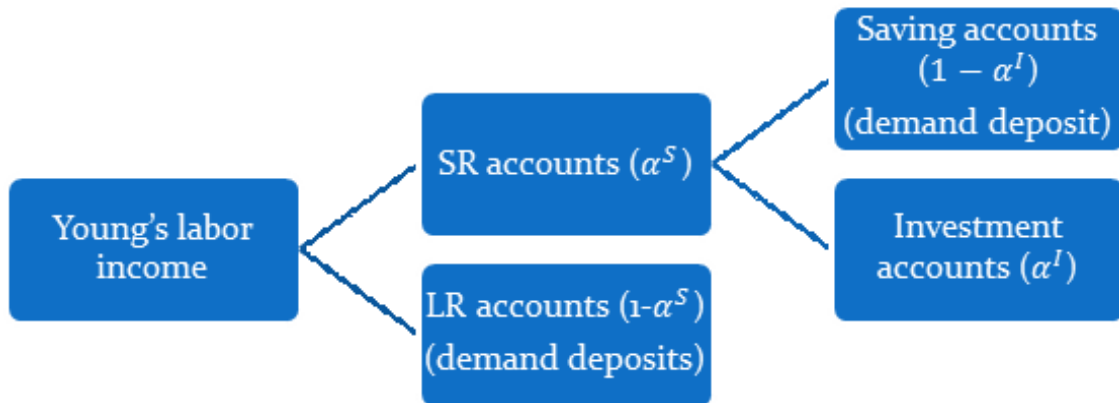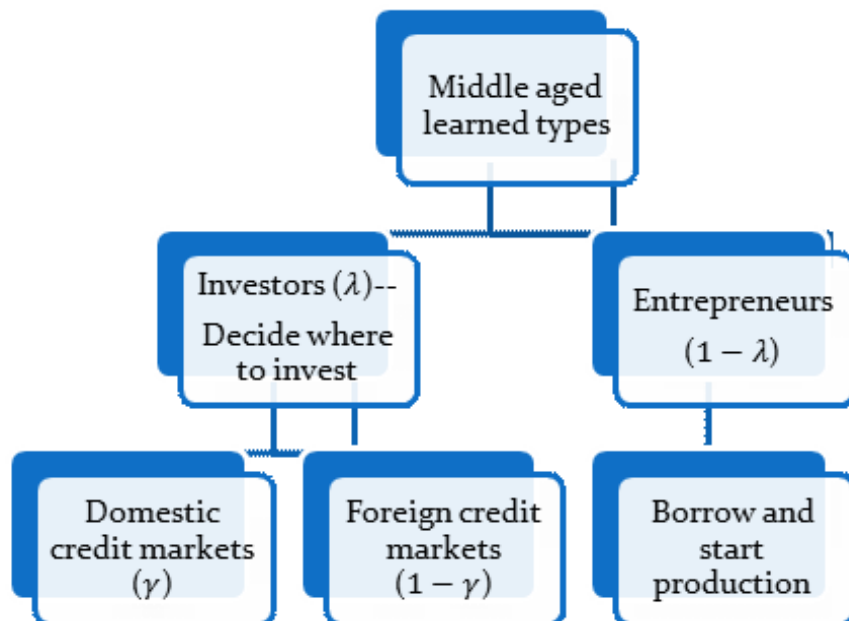
Figure one: the decisions of households
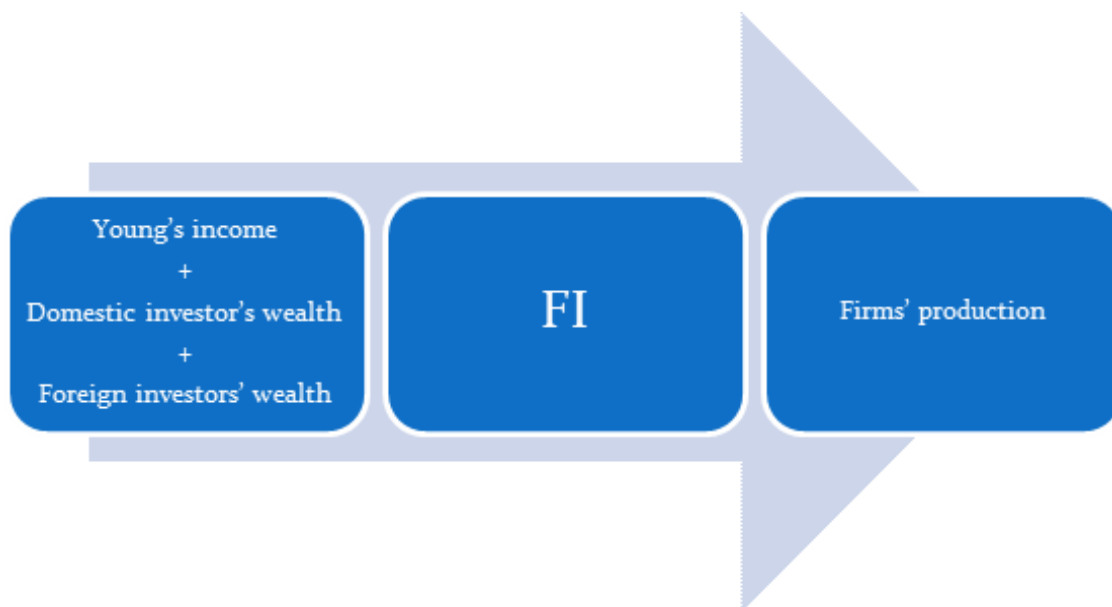

Figure two: the decisions of middle-aged agents
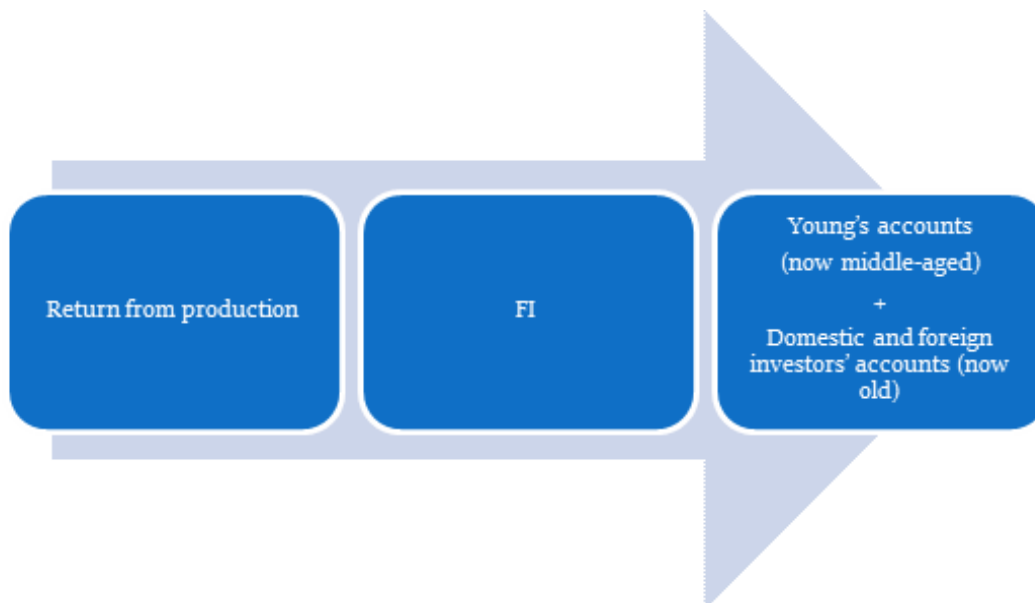
Figure three: the loan market–funds flow to production

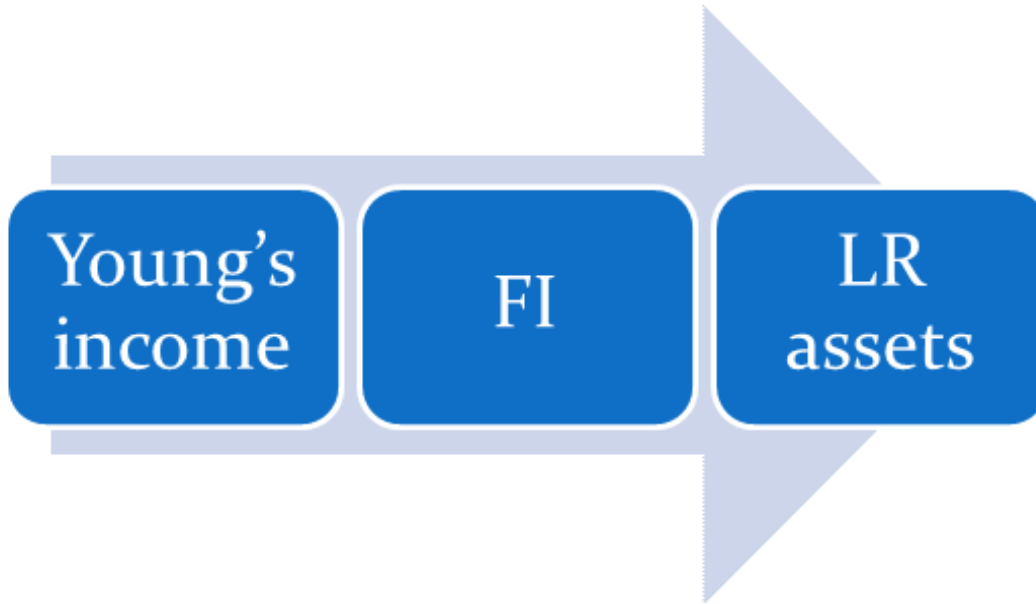Figure four: the loan market–loan repayments flow back to repay demand deposits

Figure five: funds flow to LR asset investment

- Requested by HH=χ^H
- Liquidated by Banks=χ^B
- Returns to HH=$i^{EL} < i^D$
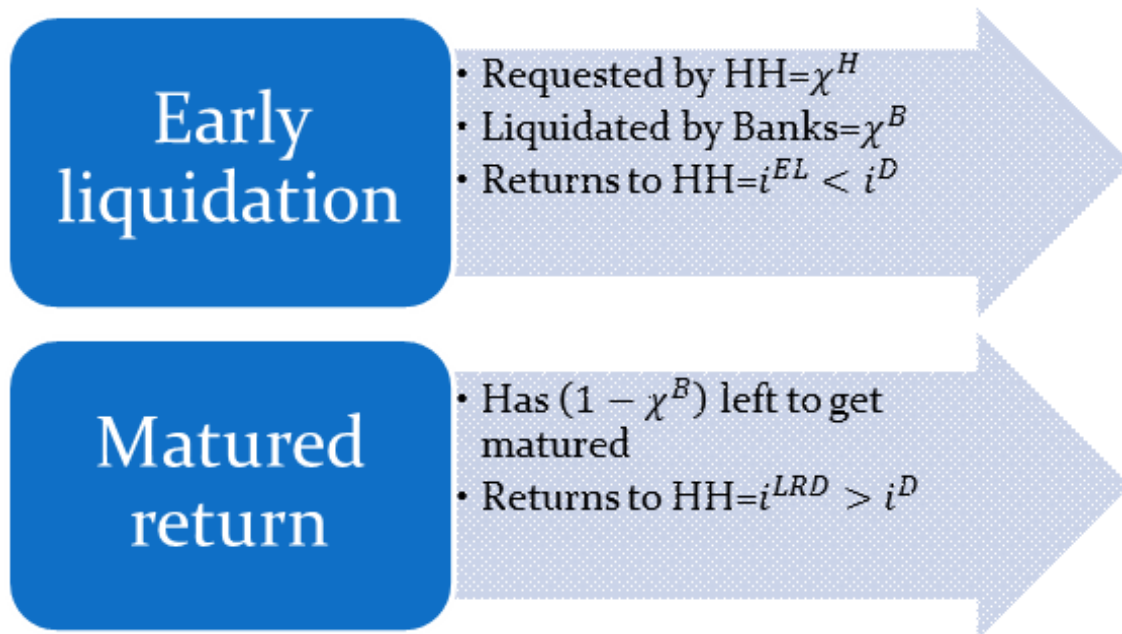
- Has $(1 - \chi^B)$ left to get matured
- Returns to HH=$i^{LRD} > i^D$

Figure six: the returns of LR accounts