

Banking Crisis and Sudden Stops: what could IMF do to assist?

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Abstract: Along the studies suggesting IMF to promote private capital flows, this paper sheds light on the links of banking crisis and sudden stops and provides suggestions which are flexible and more specific for countries in various situations of sudden stops. In this overlapping generation framework in an open economy with international credit markets, both the default risks of firms' loan repayment, and the possibilities of bank runs are considered. As a result, there are good and bad equilibriums, depending on whether bank runs would occur in the lifetime. In the four bad equilibrium discussed in the paper, sudden stops may be unnecessary or unavoidable coincide with the expectation of bank runs, which may or may not occur as expected. There are bad equilibriums in which sudden stops are unnecessary. These are the cases when IMF's assistance could prevent sudden stops, and the repayment to IMF's short-term lending facilities can be guaranteed. In the bad equilibriums when bank runs are unavoidable and when sudden stops cannot be prevented and may last for a long period of time, it could be very costly to assist countries in such equilibrium without certain policies becoming effective. Assisting several countries under this circumstances all together could jeopardize IMF's situation. These findings are consistent with those in [Eichengreen, Gupta and Mody (2006)], and the suggestions for countries in various situations are more specific.

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1 Introduction

One of the main functions of IMF is to assist its membership countries which suffer the interruptions on capital flows (sudden stops). Eichengreen, Gupta and Mody (2006) find that a larger share (around 50%) of sudden stops coincide with banking crisis, not currency crisis. They find that sudden stops has no discernible impact on net FDIs, but its impact on portfolio capital flow is of 2% of GDP by using the three main measures of capital accounts: foreign direct investment, portfolio investments, and other investment. This indicates that the impacts of banking crisis on international capital flows are crucial. It is important to focus not only on the portfolio capital flows but also on the composition of capital flows. The data related to international capital flows, however, are often the net flows, which is difficult to decompose and limit the ability of empirical studies to analyze further. As the banking crisis has occurred frequently, especially after 2007 financial crisis, an analytical/theoretical work is the way to go beyond the net flows and to be able to look insight how banking crisis and the sudden stops are linked together, and to provide flexible and specific assistance to help the countries in need more effectively.

The main assistance provided by IMF for its membership countries is the short-term lending facility. To receive such facility, the countries in need will have to adopt IMF's version of programmes as well as related technical assistance provided by IMF. The short-term lending facility serves as ex-ante insurance for IMF's members. The bright side of such facility is to provide liquidity and to avoid high payments. The down side of such facility is to induce moral hazard and adverse selection problems, and the possibility of IMF's own insolvency due to limited resources. For example, the likelihood of IMF's insolvency is high when there is multilateral assistance required.

The technical assistance provided by IMF and the programme to be adopted in the countries under assistance have also raised concerns. The main reason behind technical assistance and programme adoption is to ensure the repayment of countries under assistance. The concerns are related to the flexibility of the programme, and the programme and the technical assistance shall be tailored for each country's special needs. For example, it is found that IMF seems to premature the capital accounts liberalization of the programmed countries [Joyce and Noy (2008)]. However, it has been well-documented that it is possible that premature capital account liberalization could damage

growth, especially for the countries without sufficient financial deepening and without policies that support such liberalization [van Hulten and Webber (2010), Saidi and Aloui (2010), Tirole (2002)]. Therefore, prematuring capital account liberalization, in some cases, may damage the country's growth and its sustainability, and worsen the country's ability to repay the financial assistance provided by IMF. This may explain part of the doubts on the effectiveness of IMF's program, which is found work best for countries with strong fundamentals [Eichengreen, Guptam and Mody (2006)].

To address these issues, I extend a three-period-lived overlapping generation in an open economy with international credit markets. The role of the financial intermediaries is to serve as middlemen in the debt market and in the equity market. Whether capital would flow into the country depends on the rates of return in the debt and the equity market relative to the other country. It is the capital flows to/from the debt and to/from the equity market forming the total capital flows across countries. The financial intermediaries could run when they fail to meet demand deposits. The financial intermediaries' ability to repay the demand deposit depends on the firms' loan repayment, which is under default risk.

There are good and bad equilibria. In good equilibrium, bank runs are not expected, not in current generations' lifetime, so no assistance from IMF is required. It is the bad equilibrium when bank runs have occurred or are expected occur that required IMF's assistance. In this model, I demonstrate four bad equilibriums, in which sudden stops are unnecessary or non-avoidable, and suggest policies and assistance of IMF that are effective in helping the economy back to the good equilibrium and in preventing IMF from jeopardizing itself. To be more specific, when the bank runs are expected in the future periods, or in the current period but after repayments are made, being the member of IMF and knowing the availability of IMF's short-term lending facilities could be sufficient in preventing bank runs and sudden stops.

In the two cases when the bank runs have occurred and are expected to occur before repaying the accounts, capital account liberalization could worsen the outcome and the costs to assist such countries could be very high. These are the cases in which bank runs and sudden stops are not avoidable. Moreover, when bank runs involving possible moral hazard problems of financial

intermediaires, it will be even more costly for IMF to assist, and it could jeopardize IMF's situation if several countries under such circumstances request assistance. Therefore, it is important for IMF to limit lending facilities to countries under such circumstances, and to provide more technical assistance on policies before assisting further. More details are stated in the later sections.

The paper is organized as follows. Section 2 describes the environment, followed by equilibrium in Section 3. The suggested policies and what IMF could do to assist are discussed in Section 4 before conclusion and possible extension in Section 5.

2 THE MODEL

In this paper, I extend Bencivenga and Smith's (1991) overlapping generation model to an open economy, and allow for capital market imperfections, which are similar to Kiyotaki and Moore (1997, 2002) and Boyd and Smith (1999) to examine the impacts of one country's banking crisis on another country's composition of capital flows. Departing from the basic results, I discuss different cases with regard to capital account liberalization, financial deepening, and multi-countries, then the possible ways to improve the efficiency of international capital markets, and how effective IMF can be potentially by being flexible with its programmes to different countries.

In the world economy, there are two countries, home and foreign countries, which have the same populations, and the populations stay constant over time, $N = N^*$. Each country is composed by households, firms and financial intermediaries, and in each country, the credit market contains both loan and the equity markets. Without losing generality, financial intermediaries are assumed to be the only institutions with the access to invest in the credit market, and to receive returns from it. The exclusive access to the credit market allows the financial intermediaries to serve as middlemen between firms and households since households have income to invest, and firms have to raise funds to produce by requesting loans or by issuing equities. Similar to households and firms, the financial intermediaries are maximizing its own profits. To simplify the model, the possibilities of moral hazard and adverse selection problems are excluded in this paper.

2.1 Households

Each individual is born identical, and lives for three periods: young, middle-aged and old. At different stages of life, each household commits on different activities, which may divide households in different groups. To be more specific, each young is endowed with one unit of labour, and values only the consumption at middle-aged ($c_{2,t+1}$) and at old ($c_{3,t+2}$). At the beginning of middle-aged, each household learns its own type, either an investor or an entrepreneur, but not both. With exogenous probability λ ($1 - \lambda$), the individual turns to an investor (entrepreneur). The investors and entrepreneurs are different in two aspects: the skills and the ways they spend the repayments from their short-term accounts. In particular, the entrepreneurs have the skills to finance projects and to operate firms to start production, but investors don't own such skills. An investor would decide whether to re-invest, and where to re-invest at his middle-aged while an entrepreneur would start raising fund and operating a firm. The information of each household's type remains private. The distribution of types, however, is known by the public. This give the utility function:

$$U(c_{2,t+1}, c_{3,t+2}) = -\frac{(c_{2,t+1} + \sigma^i c_{3,t+2})^{-\phi}}{\phi}, \quad (1)$$

where $\sigma^i = \sigma^I$ for investors, $\sigma^i = \sigma^E$ for entrepreneurs, and $0 < \sigma^I < \sigma^E < 1$. This reflects the possibilities that investors can be less impatient than entrepreneurs. Without having access to the credit market, each household devotes its labour to production when young, earns income and allocates its own income between different accounts offered by the financial intermediaries to finance its own consumption throughout its own lifetime and to maximize its own lifetime utility. At middle-aged, each household gets repayment from the short-term accounts and acts based on his type. At old, while the entrepreneurs receive profits from the firm operation, the investors receive returns from their investments via financial intermediaries.

The financial intermediaries offer all individuals both short-term and long-term accounts. While the short-term accounts take one period to mature, the long-term accounts take two periods to mature. There are two types of short-term accounts: saving and investment accounts, and only one type of long-term accounts: term deposit accounts. For an account opened at period t , an saving account earns the net interest rate (i_t^D) at period $t + 1$, which is pre-determined by the financial intermediaries when opening the account. An investment account earns the net return

rate (i_{t+1}^E) which is determined by the equity market at the beginning of the period $t+1$ and repays to the account owner, prior to each middle-aged learning its own type. A term deposit account earns the net interest rate (i_t^{LR}), which is also pre-determined by the financial intermediaries at period t when opening the account, and the returns will be repaid to the account owner at period $t+2$. An early liquidation of the term deposit account is possible but will be subject to a low liquidation rate i_t^{EL} , which is lowest rate among all accounts at that period, $i_t^{EL} < (i_t^E, i_t^D) < i_t^{LR}$.

At date t , the allocation of each young's income among different accounts offered by the financial intermediaries is as follows. The young places $\alpha_t^S (< 1)$ fraction of income in short-term accounts, in which $\alpha_t^I (< 1)$ fraction is in investment accounts, $(1 - \alpha_t^I)$ in saving accounts, and $(1 - \alpha_t^S)$ in long term accounts. At date t , each of the middle-aged is entitled to receive returns from his short-term accounts W_t^M :

$$W_t^M \equiv (1 + i_{t-1}^D) \alpha_t^S (1 - \alpha_t^I) w_{t-1} + (1 + i_t^E) \alpha_t^S \alpha_t^I w_{t-1} \quad (2)$$

At middle-aged, an investor is interested in re-investment to maximize the utility. Without losing generality, it is assumed that the investors would evaluate the credit markets in both countries, and focus on one country to re-invest, but not both¹. If an investor feels indifferent in reinvestment in both countries, s/he would reinvest in his/her domestic country. An investor, who decides to invest in domestic (foreign) country, would place α_t^{IM} (α_t^{IM*}) fraction of his/her re-investment in investment accounts, and $(1 - \alpha_t^{IM})$ ($1 - \alpha_t^{IM*}$) fraction in saving accounts.

At date t , given $c_{2,t}$, an investor has options whether to reinvest (RI), and whether to liquidate the long term accounts prematurely (EL). The returns of each option is as follows:

¹One may consider relax this assumption and allow investors to invest in both countries, but this does not change the main results of this model.

Table 1: The payoff for an investor

options		newly create wealth at each date after consumption $c_{2,t}$		
RI	EL	W_t^{IM}	W_{t+1}^{IM}	
1	<i>yes</i>	no	0	$R_t^{IM} (W_t^M - c_{2,t}) + (1 + i_{t-1}^{LRD}) (1 - \alpha_t^S) w_{t-1}$
2	no	no	$W_t^M - c_{2,t}$	$(1 + i_{t-1}^{LRD}) (1 - \alpha_t^S) w_{t-1}$
3	no	<i>yes</i>	$W_t^M + (1 + i_{t-1}^{EL}) (1 - \alpha_t^S) w_{t-1} - c_{2,t}$	0
4	<i>yes</i>	<i>yes</i>	0	$R_t^{IM} [W_t^M + (1 + i_{t-1}^{EL}) (1 - \alpha_t^S) w_{t-1} - c_{2,t}]$

where $R_t^{IM} \equiv [(1 + i_t^D) (1 - \alpha_t^{IM}) + (1 + i_{t+1}^E) \alpha_t^{IM}]$. Note that not-to-reinvest means not to reinvest via financial intermediaries, and individuals always have the storage option. So $c_{3,t+1} = W_t^{IM} + W_{t+1}^{IM}$, the sum of newly created wealth after middle-aged consumption $c_{2,t}$. The utility is generated by $c_{2,t} + \sigma^I c_{3,t+1}$. In other words, given $c_{2,t}$, the option chosen by the investor implies that $c_{3,t+1}$ in that particular option is higher than all other options.

2.2 The firms: the production and the roles in credit markets

The firms are operated by entrepreneurs, as they own special skills of transforming output goods to capital goods. These skills are granted to them after realizing their type as entrepreneurs. The transformation between capital goods and output goods is one-to-one. The production requires both capital goods (K_t) and labour (L_t) as inputs, and will take one period to complete. The production is in the Cobb-Douglas form with constant return 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 produced.

It takes sunk cost q_t to operate a firm, and the variable cost, wage, has to be paid by the end of date t , when is slightly prior to the completion time of the production, early date $t + 1$. In other words, an entrepreneur will have to prepare $q_t + w_t L_t$ at minimum to start the production, which is larger than an entrepreneur's wealth at date t (W_t^M). All entrepreneurs, who wish to operate a firm, will have to borrow

$$b_t^D = q_t + w_t L_t - (W_t^M - K_t - B_t), \quad (3)$$

where B_t is the collateral required to obtain loan, which is subtracted from the entrepreneur's wealth and will be returned after loan repayment is repaid. There are two ways an entrepreneur could

borrow the fund. One way is to obtain loan from financial intermediaries in the debt market, and the other is to raise fund by issuing equities in the equity market. It is assumed that both ways are limited to domestic credit markets, the debt market and the equity market. One-period production implies that it is short-term fund the entrepreneurs require, not long term fund.

In the debt market, the source of loanable fund is limited to the sum of depositors' saving accounts at date t . There exists credit rationing in the economy. That is, only a fraction (β) of entrepreneurs could obtain the loan from the financial intermediaries, called debt-finance entrepreneurs. The rest $(1 - \beta)$ of entrepreneurs will have to raise fund in the equity market, called equity-finance entrepreneurs. The debt contract is offered by the financial intermediaries with determined loan rate i_t^{loan} . An acceptable contract requires

$$\left(1 + i_t^{loan}\right) b_t \leq Y_{t+1}. \quad (4)$$

There is uncertainty on the success of the production. With the probability p ($1 - p$), the production succeeds (fails). A successful production would generate profit $Y_{t+1} - (1 + i_t^{Loan}) b_t$ for an entrepreneur, but a failed production will produce zero output and leave the loan unpaid. The true state of the production is observable costlessly by the entrepreneur who owns the firm. All agents other than entrepreneurs will have to pay to verify the true state of the production. To reduce the verification costs, the financial intermediaries will verify the production state only in the case of any non-repaid loan. Once do the verification occur, the financial intermediaries will take all final output away. Therefore all entrepreneurs always report the true state. Moreover, it is assumed that all capital goods used in production depreciate at the rate δ . Therefore, the entrepreneur has the residual of capital goods $(1 - \delta) K_t < (1 + i_t^{loan}) b_t$ which cannot be sold, but can be self-consumed. Therefore, the expected payoff of a debt-finance entrepreneur is

$$E_t \Pi_{t+1}^{DF} = p [Y_{t+1} - (1 + i_t^{Loan}) b_t + B_t + (1 - \delta) K_t] + (1 - p) (1 - \delta) K_t. \quad (5)$$

The equity market differ from the debt market in several aspects. There is no collateral requirement, and no credit rationing for entrepreneurs in the equity market. Also, the return rate to the equity-holders (i_{t+1}^E) is determined by the equity market at the period of production

completion. This gives the expected payoff of a equity-finance entrepreneur:

$$E_t \Pi_{t+1}^{EF} = p [Y_{t+1} - (1 + E_t i_{t+1}^E) b_t^E + (1 - \delta) K_t] + (1 - p) (1 - \delta) K_t. \quad (6)$$

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 debt-finance entrepreneur, except for $B_t = 0$, and for i_t^{Loan} replaced by i_{t+1}^E , so the amount to borrow by an equity-finance entrepreneur $b_t^E = q_t + w_t L_t - (W_t^M - K_t)$ is less than that of a debt-finance entrepreneur (b_t^D)

The full employment assumption gives the labour market clearing condition, $L_t = 1/(1 - \lambda)$. This gives .

$$K_t^{DF} = \frac{1}{1 - \lambda} \left[\frac{A_t \theta p}{i_t^{loan} + \delta} \right]^{1/(1-\theta)}, K_t^{EF} = \frac{1}{1 - \lambda} \left[\frac{A_t \theta p}{E_t i_{t+1}^E + \delta} \right]^{1/(1-\theta)} \quad (7)$$

$$L_t^{DF} = \frac{1}{1 - \lambda} \left[\frac{A_t (1 - \theta)}{(1 + i_t^{loan}) w_t^{DF}} \right]^{1/\theta} \left[\frac{A_t \theta p}{i_t^{loan} + \delta} \right]^{1/(1-\theta)}, \quad (8)$$

$$L_t^{EF} = \frac{1}{1 - \lambda} \left[\frac{A_t (1 - \theta)}{(1 + E_t i_{t+1}^E) w_t^{DF}} \right]^{1/\theta} \left[\frac{A_t \theta p}{E_t i_{t+1}^E + \delta} \right]^{1/(1-\theta)}$$

$$w_t^{DF} = \left[\frac{A_t (1 - \theta)}{(1 + i_t^{loan})} \right] \left[\frac{A_t \theta p}{i_t^{loan} + \delta} \right]^{\theta/(1-\theta)}, w_t^{EF} = \left[\frac{A_t (1 - \theta)}{(1 + E_t i_{t+1}^E)} \right] \left[\frac{A_t \theta p}{E_t i_{t+1}^E + \delta} \right]^{\theta/(1-\theta)}. \quad (9)$$

Note that the wage has to be paid at date t before realizing i_{t+1}^E for equity entrepreneurs. So the equity financed entrepreneurs would form expectations of i_{t+1}^E , $E_t i_{t+1}^E$, when hiring workers. In the case of $E_t i_{t+1}^E = i_t^{loan}$, the values $w_t^{DF} = w_t^{EF}$, $K_t^{DF} = K_t^{EF}$, and $L_t^{DF} = L_t^{EF}$. This is the case when no labour mobility occurs and when all inputs are identical across firms. By substituting equations (7)-(9) to equations (5) and (6), one could obtain entrepreneurs' expected capital gains in operating firms. Note that if the expected capital gains of an entrepreneur, whether via debt-or equity-finance, are sufficiently high, then all entrepreneurs would borrow to operate firms. That is when $\sigma^E E_t \Pi_{t+1}^{DF} \geq c_{2,t} + \sigma^E (W_t^{IM} + W_{t+1}^{IM})_{ij}$, and $\sigma^E E_t \Pi_{t+1}^{EF} \geq c_{2,t} + \sigma^E (W_t^{IM} + W_{t+1}^{IM})_{ij}$, where $i = (i, 0) = (RI, Non - RI)$, and $j = (1, 0) = (EL, non - EL)$.

2.3 The credit markets

The two credit markets are, the debt and the equity markets, where financial intermediaries play an important role in both. The saving accounts provided by the financial intermediaries are for the debt market, and the investment accounts are for the equity market. Based on the assumptions of this model, it is the saving accounts and the long term accounts the demand deposits, which would have the financial intermediaries subject to run. The role of financial intermediaries in the debt market is to offer the entrepreneurs the loan contracts, and to offer the young households and the investors the deposit contracts for the saving accounts and the long term accounts. The role of financial intermediaries in the equity market, however, is simply to serve as a channel to provide the fund in the investment accounts to the equity market for equity-finance entrepreneurs.

Due to the demand deposits, the financial intermediaries would manage the saving and the long term accounts with caution while choosing the return rate to attract depositors and to maximize their profits. Let $\gamma_t (1 - \gamma_t^*)$ denote the fraction of domestic (foreign) investors, who choose domestic financial intermediaries to reinvest, let χ_t^B and χ_t^H be the fraction of the long term accounts in which the financial intermediaries and the households decide to liquidate immaturity, 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 $E_t \Pi_t^B$:

$$E_t \Pi_t^B = \left\{ \begin{array}{l} [S_t - \beta (1 - \lambda) N b_t] \\ + [(1 - \lambda) \beta N [p (1 + i_{t-1}^{loan}) b_{t-1}^D + (1 - p) B_{t-1}] - (1 + i_{t-1}^D) S_{t-1}] \\ + (\chi_t^B - \chi_t^H) (1 - \alpha_{t-2}^S) (1 + i_{t-1}^{EL}) w_{t-1} N \\ + (1 - \alpha_{t-2}^S) [(1 - \chi_{t-1}^B) (1 + i_{t-2}^{LR}) - (1 - \chi_{t-1}^H) (1 + i_{t-2}^{LRD})] w_{t-2} N \end{array} \right\}, \quad (10)$$

where $S_t \equiv \alpha_t^S (1 - \alpha_t^I) w_t N + \lambda \gamma_t (1 - \alpha_t^{IM}) N (W_t^M - c_{2,t}) + (1/e_t) \lambda^* (1 - \gamma_t^*) (1 - \alpha_{t,FD}^{IM*}) N^* (W_t^{M*} - c_{2,t}^*)$ is the aggregate saving account in the financial intermediaries at date t . The first term is the saving accounts of the young's and the domestic and the foreign investors, which are loan out to the middle-aged entrepreneurs. The second term is both the loan repayment and the collateral from unpaid loan, which are used to repay the depositors's matured saving accounts. The third term is early liquidated long term accounts, and the fourth is the matured long term accounts at date t . The details of the capital flows are shown in Figure 2.

There are several strategies the financial intermediaries adopting in managing various accounts. As the strategies is not the focus, I will keep it as simple as possible in this model. That is, to have the newly opened saving accounts to finance the new loan, to have the matured loan to finance the matured saving accounts, and to have the returns and the early liquidation of the long term accounts to finance the mature long term accounts and to serve as backup in case of any shortage in repaying the matured saving accounts and long-term accounts. Since all newly open long term accounts will be located into long term investment, the term $(1 - \alpha_t^S) w_t N$ cancel out each other in equation (10). Based on this strategy, the liquidity constraints of the financial intermediaries are:

$$S_t \geq \beta (1 - \lambda) N b_t^D, \quad (11)$$

$$\left[p \left(1 + i_{t-1}^{loan} \right) b_{t-1}^D + (1 - p) B_{t-1} \right] (1 - \lambda) \beta N \geq (1 + i_{t-1}^D) S_{t-1}, \quad (12)$$

$$\begin{aligned} & (\chi_t^B - \chi_t^H) (1 - \alpha_{t-2}^S) (1 + i_{t-1}^{EL}) w_{t-1} N \\ & + (1 - \alpha_{t-2}^S) \left[(1 - \chi_{t-1}^B) (1 + i_{t-2}^{LR}) - (1 - \chi_{t-1}^H) (1 + i_{t-2}^{LRD}) \right] w_{t-2} N \\ & \geq 0 \end{aligned} \quad (13)$$

where equations (11)-(13) are for newly opened saving accounts, for matured saving accounts, and for matured long term accounts, respectively.

Let $e_t \equiv v_t/v_t^*$ denote the real exchange rate at period t , where v_t (v_t^*) represents the real value of the domestic (foreign) currency. The incentive constraints to attract both domestic and foreign investors are:

$$\begin{aligned} (1 + i_t^D) (1 - \alpha_{t,DD}^{IM}) + (1 + E_t i_{t+1}^E) \alpha_{t,DD}^{IM} & \geq (1/e_t) \left[(1 + i_t^{D*}) (1 - \alpha_{t,DF}^{IM*}) + (1 + E_t i_{t+1}^{E*}) \alpha_{t,DF}^{IM*} \right] \\ (1 + i_t^D) (1 - \alpha_{t,FD}^{IM*}) + (1 + E_t i_{t+1}^E) \alpha_{t,FD}^{IM*} & \geq (e_t) \left[(1 + i_t^{D*}) (1 - \alpha_{t,FF}^{IM}) + (1 + E_t i_{t+1}^{E*}) \alpha_{t,FF}^{IM} \right] \end{aligned} \quad (14)$$

Note that the foreign investors' portfolio decisions on reinvestment may differ from that of domestic investors. Similarly, based on different return rates of the debt and the equity markets in the foreign country, the domestic investors' portfolio decisions may be different in the foreign country.

At date t , the debt market clearing condition is when equality holds in equation (11), and the equity market clearing condition is

$$I_t = b_t^E (1 - \lambda) (1 - \beta), \quad (17)$$

where $I_t \equiv \alpha_t^S \alpha_t^I w_t N + \gamma \lambda \alpha_t^{IM} N (W_t^M - c_{2,t}) + (1/e_t) \lambda^* (1 - \gamma_t^*) \alpha_t^{IM*} N^* (W_t^{M*} - c_{2,t}^*)$ shows the aggregate amount in the investment accounts. The equity market at date $t+1$ after receiving returns from the equity-finance entrepreneurs determines i_{t+1}^E . In order to attract fund investing in the equity market, $E_t i_{t+1}^E$ has to be sufficiently high. Meanwhile, the expected payoff of equity-finance entrepreneurs have to be as better off as the debt-finance entrepreneurs.

$$\begin{aligned} I_t (1 + i_{t+1}^E) &= p(1 - \lambda)(1 - \beta) (\psi_t Y_{t+1}^{EF}) \\ &\geq (1 + i_t^D) S_t, \end{aligned} \tag{18}$$

where ψ_t represents the fraction of output extracted to repay the equity holders by the equity-finance entrepreneurs who experience successful production.

3 EQUILIBRIUM

There are good equilibria and bad equilibria in this model. The good equilibrium is when bank runs are not expected to occur, at least not in the lifetime of the current generations, and the bad equilibrium is when bank runs either occurred or are expected to occur during the lifetime of the current generations. In good equilibrium, IMF's assistance is not required. It is the economy in bad equilibrium when might require the assistance from IMF. In this model, there are several bad equilibrium, which may cause unnecessary or unavoidable sudden stops. I will describe each equilibrium in this section, and leave the discussion of what IMF could possibly do to assist to the next section.

Good Equilibrium In good equilibrium, both saving accounts and the long term accounts will be paid off. According to Table 2, option 3 is worse than option 4 and option 2, which is worse than option 1 if $R_t^{IM} \geq 1$. Therefore, all investors choose option 1 (reinvestment, no early liquidation) $\chi_t^H = 0$ when $(1 + i^{LRD}) \geq R^{IM} (1 + i_{t-1}^{EL})$, and $(1 + i^{LRD}) \geq R^{IM*} (1 + i_{t-1}^{EL})$. As a result, $\chi_t^B = 0$, and $i^{LRD} = i^{LR}$ [equation (13)] to ensure i^{LRD} is sufficiently high and to discourage premature liquidation. Equation(12), (14), and (18) give

$$(1 + i^{loan}) \geq \left[\frac{(1 + i^D) S}{(1 - \lambda) \beta N} - (1 - p) B \right] / p b^D, \tag{19}$$

$$(1 + i_t^D) \geq \frac{\left\{ (1/e_t) \left[(1 + i_t^{D*}) \left(1 - \alpha_{t,DF}^{IM*} \right) + (1 + E_t i_{t+1}^{E*}) \alpha_{t,DF}^{IM*} \right] - (1 + E_t i_{t+1}^E) \alpha_{t,DD}^{IM} \right\}}{\left(1 - \alpha_{t,DD}^{IM} \right)}, \quad (20)$$

$$(1 + i_{t+1}^E) = \frac{p(1 - \lambda)(1 - \beta)(\psi_t Y_{t+1}^{EF})}{I_t} \geq (1 + i_t^D) \left(\frac{S_t}{I_t} \right). \quad (21)$$

Since the amount of profit, which the equity finance entrepreneurs would share to their equity-holders, is limited, the more investment in the equity market may reduce the rate of returns i_{t+1}^E despite $b_t^E < b_t^D$.

Bad equilibrium A: bank runs have occurred unexpected In the bad equilibrium, bank runs either have occurred or are expected to occur. In the case when bank runs have occurred, as the financial intermediaries are the middlemen for both the debt and the equity market in this model, the banks runs may cause both the debt and the equity market closed down. If bank runs occurred before repaying the short-term accounts to depositors, the middle aged entrepreneurs cannot operate new firms to hire the young, the young have no income to deposit, and the investors have no fund to reinvest. This is probably the one of worst scenarios as everyone is worse off, except the entrepreneurs payoffs may remain the same or higher depending on whether the loan is repaid. This is the moral hazard problems of financial intermediaries. In this case, sudden stops is not avoidable, and could last for a long period of time.

Bad equilibrium B: bank runs are expected at the current period and after repayments are made In the bad equilibrium when bank runs are expected at the current period, the depositors would rush to the financial intermediaries to withdraw. If this expectation of bank runs is after the middle aged receive the repayments of their short-term accounts, the middle aged investors would then choose option 3, liquidate all their long terms accounts, $\chi^H = \chi^B = 1$ and reinvest in the foreign financial intermediaries.

In this case, the middle aged investors are worse off than good equilibrium. The middle-aged entrepreneurs would not operate firms² and invest like the investors, and are even worse off. When

²One may argue that the entrepreneurs could still operate firms. However, the expectation of bank runs at any time could mean bank runs after the financial intermediaries receiving the collaterals or equities but before obtaining the loan or the fund. Therefore, in general, the entrepreneurs would prefer not operating the firms.

firms are not operated, the young have nowhere to offer labour supply and earn income, and will the ones suffer the most. The old entrepreneurs utility may remains the same, as the expectation is after the completion of production. In this case, however, as long as the financial intermediaries follow its strategy strictly—only liquidate long-term accounts upon household request, $\chi^H = \chi^B$, there may not be bank runs as expected. However, following by the panic of the middle-aged investors and entrepreneurs, unnecessary sudden stops may occur. Such sudden stops, although unnecessary, may have long term effects on the current young generation, who have nothing to begin with when turning middle aged, either becoming investors or entrepreneurs.

Bad Equilibrium C: bank runs are expected at the current period and before repayments are made When bank runs are expected at the current period and before the completion of production by the old entrepreneurs, the panic may result in bank runs right away, as the case stated in Diamond and Dybvig (1983) and most studies on bank runs. This is when the financial intermediaries have not yet got loan repayments and have to liquidate the long term accounts prematurely to respond to withdrawals, which is insufficient, and the expectation of bank runs would come true, only a matter of time. The existence foreign investors are joining the line, and would speed up bank runs. The results would be similar to that demonstrated in Diamond and Dybvig (1983).

Depending on the rank in line, the agents may or may not get the repayments. Even if getting the repayments, as the withdrawals occur before the mature time of the short term accounts, the rate of return is far less than one. The joining of foreign investors would reduce the expected repayment even further. Thus, the expected repayment in this open economy is worse than that in the closed economy and the economy without capital account liberalization. The middle-aged investors and entrepreneurs are worse off than the case of bad equilibrium B. Both the debt market and the equity market would shut down, and sudden stops are not avoidable. The old entrepreneurs may be better off since nowhere to repay loan or equity holders and $(1 + i_{t-1}^{loan}) b_{t-1}^D > B_{t-1}$. Compared to bad equilibrium B, operating firms becomes more costly for entrepreneurs in this case, and without the debt and the equity markets, the entrepreneurs would reinvest in the foreign country like investors. Therefore, no production, no work, and no income for the young. The unavoidable sudden stops

may have long term impacts for the economy.

Bad equilibrium D: bank runs are expected at the future period(s) When bank runs are expected in the next period $t + 1$, the direct impact is the current young will keep the income in the storage. The middle-aged investors would take all repayments to invest in the foreign country if $R^{IM} \geq 1$. There will be no loanable fund to provide to the entrepreneurs, and no entrepreneurs would seek the financial intermediaries for loan. The role of financial intermediaries as middlemen has been abandoned after the repayments to the depositors in this case, but the good news is no bank runs as a result.

In this case, the possibility for both the debt and the equity markets to exist would require the entrepreneurs and the young to locate each other and to construct contracts or to issue equities directly. However, as discussed in the literature of banking theory, the dual monitoring costs and search costs would increase. So the expected payoff for both the entrepreneurs and the young are worse than that in the good equilibrium, and there may be sudden stops in the coming period $t + 1$ but only temporary. However, in this case, the entrepreneurs are operating firms, which provide income to the young, so the outcome although not as good as good equilibrium, but is better than bad equilibrium A, B, and C.

4 POLICIES and WHAT IMF COULD DO TO ASSIST

It is only the economy in bad equilibrium that would require the assistance from IMF. In the previous section, I discuss four bad equilibrium, in which sudden stops might occur, whether temporary, unnecessary, or non-avoidable. In this section, I will focus on the cases that really require IMF's assistance followed by the ways that may be more effective without jeopardize IMF's state.

As the economy in bad equilibrium D is the mildest case, I will start at this case and move back to equilibrium C, B and A. In bad equilibrium D, the economy still functions well and no bank runs occur as expected. The only concern is that the expectation of bank runs in the future period causes individuals abandon the financial intermediaries as middlemen. What is required is the ways to reverse the expectations of bank runs. One of them is having the membership of IMF,

which acts as the ex-ante insurance. With the availability of IMF's short-term lending facilities, the individuals of the country may not expect bank runs. IMF may not need to actual lend to the country to prevent sudden stops.

For countries in bad equilibrium B, despite no bank runs, it is the distrust on the financial intermediaries that causes entrepreneurs not operating firms and unnecessary sudden stops, which may have long term impacts on the current young and the economy. What is required in this case is the policies and assistance from IMF that could restore individual's trust on financial intermediaries. The policies that could be effective in this case are to ensure the financial intermediaries follow the strategy strictly—no premature liquidation without depositor's request, and to prevent moral hazard problems of financial intermediaries. To be more specific, in this case, it is important to have policies that regulate financial intermediaries to provide funds to the entrepreneurs after obtaining the collateral. Having such policies in the package plus the short-term lending facilities provided by IMF, the entrepreneurs would operate firms, which could provide jobs to the young, and the economy could be back to the good equilibrium, and sudden stops are prevented. In this case, even if the short-term lending facilities is used, it will be mild and the repayment to IMF is guaranteed.

The countries in bad equilibrium C are worse than those in equilibrium B. In equilibrium C, bank runs do occur and sudden stops are not avoidable. The entrepreneurs are either having no repayment or have far less repayment from their short-term accounts, so if they do want to operate firms, they cannot do so since nothing to provide as collateral and no debt or equity market to locate the fund. So the economy ends up without firms, jobs and income for the young. What is required to have policies that have records of the loan contracts and enforceable by the authorities, should the bank runs, and the policies that prevent moral hazard problems of the financial intermediaries. In particular, the policies that would enforce the financial intermediaries return loan repayment to the saving account depositors before bank runs. In this case, IMF's assistance is required as such policies may not be sufficient, since both the debt and the equity markets closed down after bank runs. The assistance required by IMF is not only to construct policies required but also to provide liquidity to the entrepreneurs via the short term lending facilities to operate firms, which can provide jobs to the young. After young having jobs and income, the policies that help entrepreneurs and

people who own the fund to locate each other and start rebuilding the debt and equity markets without financial intermediaries, then moved to the economy with financial intermediaries. The cost involved could be large and risky, and it may take a long period of time to restore the debt the equity markets. If there are several countries in this equilibrium request such assistance from IMF, this is when IMF could jeopardize itself.

The countries in bad equilibrium A is even worse than the countries in equilibrium C as the repayments to middle-aged is zero. The main cause of this bad equilibrium is the moral hazard problems of the financial intermediaries, so all policies suggested for equilibrium C would apply here. The costs via short-term lending facilities to assist such countries could be far more that involved in assisting countries in equilibrium C. Without the policies starting working well, the lending to such countries could be endless, and the repayment may not guaranteed. What IMF could do in response to the request from such countries could be to insist policies legislated and enforced, to provide liquidity to a certain point, and not to continue lending until the policies becoming effective.

5 CONCLUSION & EXTENSIONS

The advantages of overlapping generation framework allow this paper to look insight the links of banking crisis and sudden stops and provided flexible and specific suggestions which could help the IMF and the countries in need. IN particular, when the bank runs are expected any time after repayments to the accounts, being the member of IMF and knowing the availability of IMF's short-term lending facilities could be sufficient in preventing bank runs and sudden stops. However, when the bank runs have occurred and are expected to occur before repaying the accounts, capital account liberalization could worsen the outcome, and the costs to assist such countries could be very high. In these two cases, both bank runs and sudden stops are not avoidable. Moreover, when bank runs involving possible moral hazard problems of financial intermediaries, it will be even more costly for IMF to assist, and it could jeopardize IMF's situation if several countries under such circumstances request assistance. Therefore, it is important for IMF to limit lending facilities to countries under such circumstances, and to provide more technical assistance on policies before

assisting further.

There are several limitation of this paper, which can be extended in the future. The direct extension is to release the direct access to the equity market to individuals, so bank runs won't result in equity market to close down as well. Such relaxation, on one hand, may promote private capital flows in the case of bank runs. On this other hand, it may increase the fragility of equity market, especially for countries with capital account liberalization. This may require an analytical work to address these concerns.

References

- Bencivenga, Valerie R., and Bruce D. Smith (1991), "Financial Intermediation and Endogenous Growth", *Review of Economic Studies*, Vol. 58(2), 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), 1-15.
- Boyed, John H., and Bruce D. Smith (1997), "Capital Market Imperfections, International Credit Markets, and Non-convergence", *Journal of Economic Theory*, Vol. 73, 335-64.
- Champ, Bruce, Bruce D. Smith, and Stephen D. Williamson (1996), "Currency Elasticity and Banking Panics: Theory and Evidence", *Canadian Journal of Economics*, Vol. 29(4), 828-64.
- Chang, Chia-Ying (2010), "Capital Flows, Financial Intermediaries, and Economic Growth", *Journal of International and Global Economic Studies*, Vol. 2(2), 47-60.
- Chang, Chia-Ying (2011), "When the Banking Systems Meet Currencies", working paper, Victoria University of Wellington.
- Chang, Roberto, and Andres Velasco (2000), "Financial Fragility and the Exchange Rate Regime", *Journal of Economic Theory*, Vol. 92(1), 1-34.
- Chang, Roberto, and Andres Velasco (2000), "Banks, Debt Maturity, and Financial Crises", *Journal of International Economics*, Vol. 51(1), 169-94.
- Chang, Roberto, and Andres Velasco (2001), "A Model of Financial Crises in Emerging Markets", *Quarterly Journal of Economics*, Vol. 116(2), 489-517.
- Chevalier, J. A., and D. 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*, Vol. 91(3), 401-19.

Diamond, Douglas W., and Phillip H. Dybvig (1986), "Banking Theory, Deposit Insurance, and Bank Regulation", *Journal of Business*, Vol. 59(1), 55-68.

Eichengreen, Barry (2004), *Capital Flows and Crises*, MIT Press

Eicher, Theo S. and Stephen Turnovsky (1999), "International Capital Markets and Non-scale Growth", *Review of International Economics*, Vol. 7(2), 171-88.

van Hulten, Andrew and Michael Webber (2010) "Do Developing Countries Need 'Good' Institutions and Policies and Deep Financial Markets to Benefit from Capital Account Liberalization?", *Journal of Economic Geography*, Vol 10 (2), pp. 283-319

Huybens, Elisabeth, and Bruce D. Smith (1998), "Financial Market Frictions, Monetary Policy, and Capital Accumulation in a Small Open Economy", *Journal of Economic Theory*, Vol. 81, 353-400.

Joyce, Joseph, and Ilan Noy (2008), "The IMF and the Liberalization of Capital Flows", *Review of International Economics*, Vol. 16(3), 413-30.

Kiyotaki, Nobuhiro, and John Moore (1997), "Credit Cycles", *Journal of Political Economy*, 1997, Vol. 105(2), 211-248.

Kiyotaki, Nobuhiro, and John Moore (2002), "Balance-Sheet Contagion", *American Economic Review*, 2002, Vol. 92(2), 46-65.

Obstfeld, Maurice, and Alan Taylor (2004), *Global Capital Markets: Integration, Crisis and Growth*, Cambridge Press.

Saidi, Hichem, and Chaker Aloui (2010), "Capital Account Liberalization and Economic Growth: GMM Systems Analysis", *International Journal of Economics and Finance*, Vol. 2 (5), pp. 122-31.

Schreft, Stacey, and Bruce D. Smith (1997), "Money, Banking and Capital Formation", *Journal of Economic Theory*, Vol. 73, 157-82.

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

Wallace, Neil (1996), "Narrow Banking Meets the Diamond-Dybvig Model", Federal Reserve Bank of Minneapolis Quarterly Review, Vol. 20(1), 3-13.

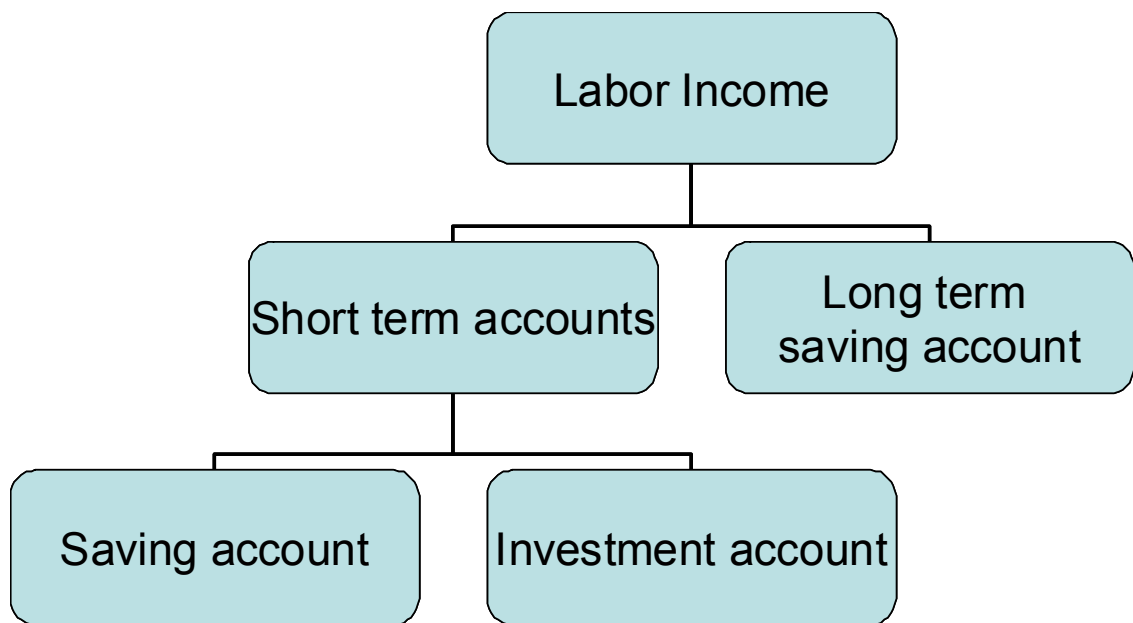


Figure one: the decisions of households

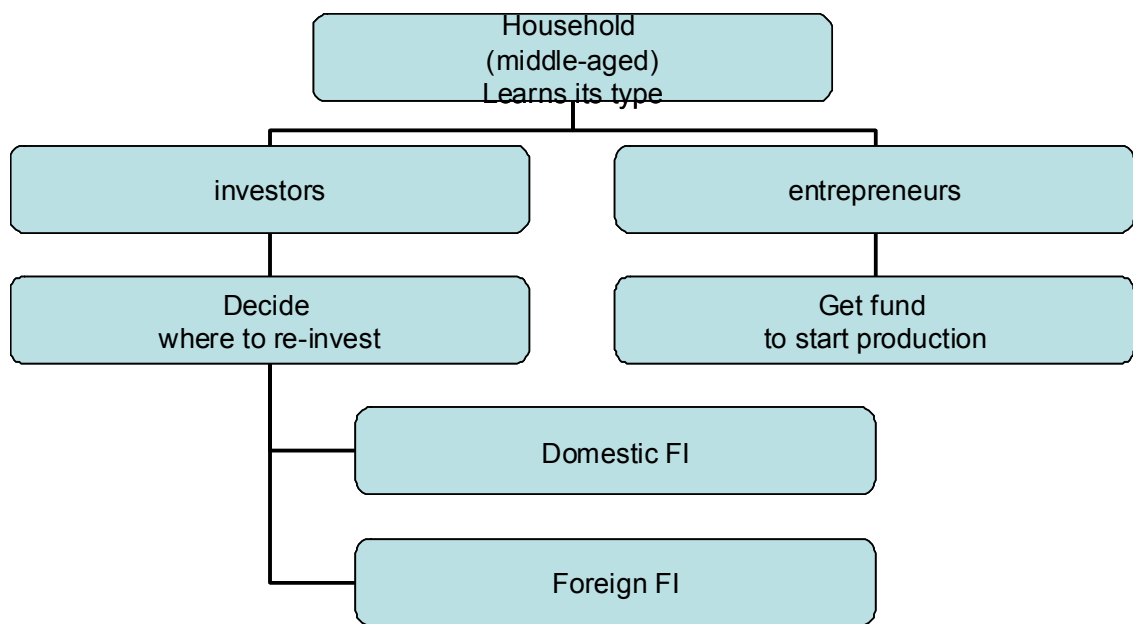


Figure two: the decisions of investors

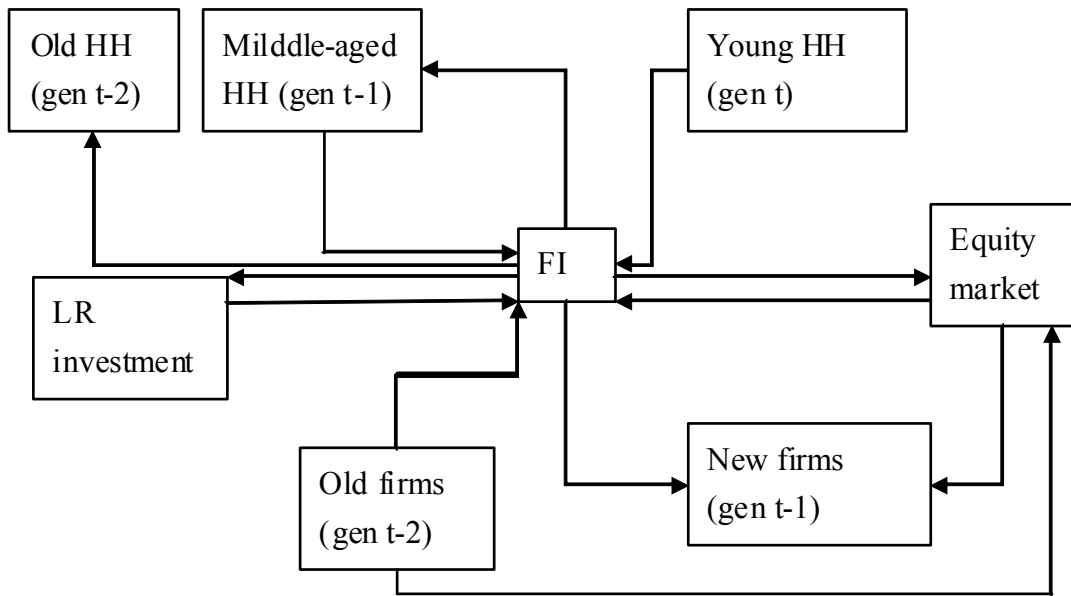


Figure three: the flows of fund