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Qiu Fang  
Utah State University

Basudeb Biswas  
Utah State University

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by

QIU FANG

BASUDEB BISWAS

Department of Economics
Utah State University
3530 Old Main Hill
Logan, UT 84322-3530

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Qiu Fang, Research Assistant
Basudeb Biswas, Professor

Department of Economics
Utah State University
3530 Old Main Hill
Logan, UT 84322-3530

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MATURITY STRUCTURE OF FOREIGN DEBTS IN THE PRESENCE OF A POSSIBLE TWIN CRISIS

Qiu Fang and Basudeb Biswas

ABSTRACT

The objective of this paper is to analyze the effect of a probable financial crisis triggered by bank runs and the consequent currency crisis on the optimal choice of maturity structure of foreign debts. Theoretical analyses of the maturity structure suggest some macroeconomic policies that the emerging markets can adopt in the form of financial regulations and exchange rate management. During the transition period from closed or controlled capital market to liberalized capital market, these policies should help the developing countries to prevent the occurrence of crisis.
I. Introduction

The Asian Financial Crisis started in 1997, peaked during 1998 and was followed by dramatic recovery during 1999. The quick recovery of the crisis in the affected countries was as unexpected as the disastrous consequences that were widespread among the eastern Asian countries. Studies on the origin of Asian crisis focus on either economic fundamentals such as current account balances, banking system, political certainty, credibility of governments and commitment to structural reforms (Giancarlo Corsetti, Paolo Pesenti, and Nouriel Roubini, 1999), or self-fulfilling expectations stemmed from international illiquidity (Diamond & Dybvig, 1983; Chang & Velasco, 1999). The Asian crisis, regarded as ‘inevitable’ by some economists, was commonly regarded as the result of internal imperfection of the macroeconomic systems of the affected countries and external shocks. Such imperfection of macroeconomic system was most pronounced in current account balances and in the supervision of financial sectors. Lack of supervision of the financial sectors in some countries resulted in crony capitalism. External shocks refer mainly to “the tendency for international financial markets to overreact to both positive and negative news” and speculative attacks (Wing Thye Woo, Jeffrey D. Sachs and Klaus Schwab, 2000). G. Corsetti, Paolo Pesenti and Nouriel Roubini provide evidence of current account imbalances and weak macroeconomic fundamentals in their study (1999) on causes of Asian financial and currency crisis. It’s shown in their study that “several Asian countries whose currencies collapsed in 1997 had experienced somewhat sizable current account deficits in the 1990s”. In 1996, current account deficit was 4.8% of GDP for Korea, 3.3% for Indonesia, 3.7% for Malaysia, 4.7% for the Philippines and 8.5% for Thailand, most of which reached near the alarming level of 5%, especially for the Thailand case.
In this paper, we focus on such internal problems as risky maturity structure of foreign debt borrowed in international capital market and unmatched structure of long-term illiquid and short-term liquid assets. Some studies on maturity structure of foreign debt (Cooper & Ross, 1998; Chang & Velasco, 2000) have concluded that under certain condition the bank will choose the second best contracts, which involve some risk of runs, in order to achieve higher expected returns from their investment. Cooper & Ross’s analysis focused on the bank’s response to the probability of runs and offered some insights into the design of deposit insurance. Based on their work, Chang and Velasco extend their model (Chang & Velasco 1998) and conclude that ‘if the probability of a run is sufficiently small, banks will deliberately choose an illiquid asset-liability position and expose themselves to run’ (Chang & Velasco, 2000). Both papers focus on the probability of banking crisis and not its consequences.

One feature of Asian crisis of 1997 is that the currency crisis followed the banking crisis, in which most affected countries experienced significant depreciation of domestic currency. The 1997 Asian crisis had devastating effects on Thailand, Indonesia, Malaysia, and Korea. Contractionary monetary policy and a vast overhang of bad debt throughout Asia affected many corporations financially and adversely affected production due to lack of working capital, as banks stopped making new loans because of liquidity squeeze and the risks of corporate bankruptcies. The liquidity crisis was further exacerbated by the accompanying currency crisis (so called twin crises in the literatures as described by Kaminsky, Graciela and Carmen M. Reinhart, with G. Kaminsky, 1999 and Victoria Miller, 1998). A couple of recent studies have discussed the relation between banking and currency problems. Graciela L. Kaminsky and Carmen M. Reinhart found in their study of 26 banking crises and 76 currency crises that “most often, the beginning of banking-sector problems predate the balance of payment crisis and knowing that a banking crisis was underway helps predict a future currency crisis”. However they also find that banking crises are not necessarily the immediate cause of currency crisis. Other studies, such as Chang & Velasco (1999), McKinnon and Pill (1996, 1998), emphasize that the joint occurrence of “twin crises” may be the consequence of certain common factors, like international illiquidity (Chang & Velasco, 1999) and financial liberalization combined with moral hazard incentives that induce banks to take on particularly risky portfolios (Mckinnon and Pill, 1998).

To analyze Asian crisis, we extend the model of Chang and Velasco (2000) by way of introducing risky long term asset and exchange rate risk. In the augmented model, maturity structure of foreign debt is determined endogenously with the possibility of financial crisis or bank run and the consequent currency crisis. Even if the probability of a banking crisis or run is
very small, the consequences could approach a level of significant magnitude in the presence of self-fulfilling expectations and the effort to defend the fixed exchange rate system. With the exchange rate risk included in the model, possible currency crisis will worsen the economy in the event of foreign creditor runs and the situation becomes even more serious because huge amount of debt are denominated in foreign currency. In this case, the maturity structure of debts is chosen in a way that the exposure to the crisis is minimized.

The paper is organized as follows. Part A of section II lays out the model with probability of financial crisis, and derives its implication with probability of crisis given exogenously. Part B of section II introduces risky long term asset in the model to endogenize the probability of financial crisis. Allocations leading to a run equilibrium and a no-run equilibrium are analyzed to illustrate the point that the way the bank writes the contract—the amount of payment promised to households for each unit of deposit they deposit in the bank—will have direct impact on the probability of the bank’s being in crisis. And the conditions under which the bank may choose the allocation subject itself to the run are also analyzed. Section III expands the framework to model the currency crisis by including expectation about the future movement of the exchange rate. In this section, there is discussion about bank’s choice of allocation in the face of banking crisis and currency crisis. Section IV discusses some policy implications for countries which have liberalized international flow of capital. This is the case for emerging market economies. The solution of the model should offer some measures on prevention of crisis and measure to cope with the risks involved in international capital market. Section V concludes and gives suggestions on possible extensions of the model.

Section II. The model of financial crisis


As in Roberto Chang & Andres Velasco’s paper, a three-period small open economy with a single, perishable consumption good in each period is modeled in our theoretical framework. There is one representative bank (credit intermediary) and a continuum, normalized to one, of identical individual households, who are endowed with 1 unit of consumption good at the initial period of time. The bank is of mutual type. Households are depositors as well as shareholders of the bank. In the initial period of time, the bank accepts deposits from household and it also borrows from foreign creditors both short-term and long-term debt, it invests in domestic long-term illiquid asset and holds short-run liquid asset for period one’s debt payment and deposit withdrawal from households. In second period, T=1 , the bank continues to borrow from foreign
creditor and can get the fund only if its credibility still stands intact and it has to pay back the first period short-term debt and satisfy the withdrawal from household. In period two, the bank pays back both short-term and long-term debts, satisfies withdrawals from household and gets paid back its long-term investment.

The representative household is of either patient type or impatient type. An impatient household withdraws in period one, while a patient one waits until period two to withdraw its deposit and in addition, share with bank whatever left after paying back all the debts. The probability of the household of being impatient is denoted by $\lambda$, with the amount of $x$ being withdrawn. $x$ is written in the contract which the bank offers to the depositors as the amount promised by the bank for each unit of deposit made at the initial period of time. The probability of the household of being patient is denoted by $1-\lambda$, with the amount of $y$ being withdrawn. The incentive constraint ($y \geq x$) will be sufficient to guarantee the truth telling of different types of consumers. There will be more about this incentive constraint in later sections.

The social planner’s objective is to maximize the utility of the household subject to the bank’s lending and borrowing constrains. The solution of utility maximization problem will result in the optimal choice of the promise of payment to the impatient consumers and long-term investment and the maturity structure of foreign debts by the bank. In the absence of a bank run, the objective function is:

$$\lambda U(x) + (1-\lambda) U(y)$$

(1)

Suppose the probability of a run or a financial crisis is denoted by $p$. Everyone will be eager to withdraw deposits from the bank and everyone will turn out to be impatient when there is a run on the bank. And since the service under the condition of a run is available on the “first come first serve” basis, the household would be able to withdraw from the bank the amount of $x$ with a probability of $q$, which depends on the amount of available liquid asset held by the bank and the amount of existing total liabilities of the bank. The depositor’s objective could be rewritten as following, where $q$ will be defined later. Since in this paper, the social planner’s objective is to maximize the household’s utility with respect to the budget constraints of the bank, the household could be regarded as a shareholder of the bank as well. Therefore, the household not only has claims (in terms of deposits) on the bank but also responsible for liabilities of the bank.

$$pq U(x) + (1-p) [\lambda U(x) + (1-\lambda) U(y)]$$

(2)

The budget constrains faced by the bank (or the social planner) are almost the same as that in Chang & Velasco’s paper (2000) (except the second-period-of-time constraint). The initial
endowment, deposits made by household, is just 1 by assumption. In initial period of time, \( T=0 \), the bank borrows short-term foreign debt, \( d_{01} \), and long-term foreign debt, \( d_{02} \), from international capital market. And the bank is willing to compensate the creditor for the possible crisis by paying a non-zero interest the long-term loans because under the circumstances of a crisis virtually the long-term loans are all under default while the short-term loans and the depositor still has a chance to get paid back. Interest rate on short-term debt bank borrowing from foreign creditors is assumed to be zero. Investment on the long-term domestic asset is denoted by \( k \). At the initial period, the bank also decides how much liquid asset, \( b_0 \), it will hold for debt payment and withdrawal in next period. The budget constraint in this period is defined as:

\[
1 + d_{01} + d_{02} \geq b_0 + k \tag{3}
\]

In the second period, \( T=1 \), bank will decide the amount of short-term foreign debt to be borrowed, \( d_{12} \), and holdings of liquid asset, \( b_1 \), as well. In the context of an open economy, one of the reason that bank exists is that it transforms the illiquid asset into liquid consumption services by borrowing short term debt as an intermediary of that transformation. Without the ability of borrowing at the second period of time, the bank will have to carry sufficient amount of \( b_0 \) to satisfy both consumption needs and debt services in period \( T=1 \). Consumption need could be satisfied by carrying \( \lambda x \). However the amount of short-term borrowing in period 0, if any, could only be honored if the bank has the exact amount of liquid asset on hand. This gives the bank no incentive to borrow the short-term debt in the initial period of time when no credit available in next period. Since the bank’s objective is to maximize the households’ utility consistent with a probability of a run in the objective function, it will also consider the probability of a run in its budget constraint. We assume that \( d_{12} \) will always be positive. However, the availability of borrowed funds in period 1 depends on the probability of a run. This is consistent with the observation of the actual behavior of the bank. It was well documented that firms tend to borrow aggressively whenever it’s in financial difficulties. In the context of a bank, bank will tend to borrow aggressively if it encounters difficulties in repaying the debt and satisfy withdrawal in the second period of time. Therefore the following budget constraints differ slightly from those in Chang & Velasco’s model. And we shall see that this simple adjustment makes a lot of differences in our solution. Therefore, in second period \( T=1 \), the bank will continue to borrow short-term debt from foreign creditors, \( d_{12} \), however the availability if contingent on the probability of a run; it will pay back the short-term debt
borrowed in the initial period, \( d_{0t} \), and satisfy the withdrawal from impatient consumers, \( \lambda x \).

The bank’s budget constraint at period \( T = 1 \) is defined as below:

\[
 b_0 + (1-p) d_{12} \geq \lambda x + b_1 + d_{01} \tag{4}
\]

In the last period, \( T = 2 \), the bank pays back all the short-term borrowed in second period of time and long-term debt and get back it’s long term investment \( R_k \), where \( R = (1 + r) \). The household will withdraw an amount of \( y \) if it turns out to be patient (with probability of \( 1 - \lambda \)). The bank’s budget constrain at this period is defined as:

\[
 R_k + b_l \geq (1-\lambda) y + d_{02} + (1-p) d_{12} \tag{5}
\]

In this section, a couple of assumptions are made: First, we assumed zero interest rates on deposit for consumers; Second, zero interest on both short-term debt and long-term debt in this part, later a positive interest rate on long-term debt will be added in to compensate for the risk of complete default faced by the creditor making long-term loans to the bank. Second, in this part the probability of crisis is treated as exogenously given. Third, utility function satisfies all the classical assumptions. Fourth, both depositors and foreign creditors must respect sequential service constraints in period 1 and 2 on a first come-first serve basis. The probability of the household being able to withdraw \( x \) at period 1, \( q \), conditioned on a crisis happening is defined as follows:

\[
 q = \frac{r_k + b_0}{d_{01} + x} \tag{6}
\]

Finally, the household withdraw in either period 1 or period 2 is used for consumption exclusively, no asset holding in terms of domestic currency or foreign currency will be discussed in this paper. The portfolio of asset holding will be the concern of the bank only.

Without the possibility of a run in the framework, the social planner’s objective is just to maximize (1) subject to (3)-(7). With a probability of a run (financial crisis) in our framework, \( p_f \), the objective turns into maximization of (2) subject to adjusted budget constrains (3)-(5) and (6)-(7) as specified below: In addition to the above budget constrains, there are two other borrowing limit constrains, which eliminates the possibility of Ponzi scheme (same as in Roberto Chang & Andres Velasco’s paper):

\[
 d_{01} + d_{02} \leq f_1 \tag{6}
\]

\[
 (1-p)d_{12} + d_{02} \leq f_2 \tag{7}
\]

\[
 r_k + b_0 < x + d_{01} \tag{8}
\]

**Proposition 1.** Under the assumption stated above, the first order conditions of the maximization problem show that if the bank is going to borrow anything at the initial period of
time, it is going to borrow only long term debt. Therefore, the bank's optimal maturity structure of foreign debt consistent with the possibility of a crisis should be $d_{01} = 0$, $d_{02} = f_1$; and if the probability of crisis is very close to zero, $b_1$ and $b_0$ will all be zero. The bank will borrow any short term debt in the initial period of time only if the probability of crisis is equal to zero.

The intuition is simple. If short-term and long-term debt cost the same (so far interest rates on both types of debt are assumed to be zero), there is no incentive for the bank to borrow short-term debt, which it has to pay back in second period of time. The bank can borrow the long-term debt up to its credit limit, $f_1$ and invest it in the long-term asset and pay it back until the investment matures, earning a profit of $r_k$. This proposition also implies that $f_2 \geq f_1$, which means borrowing limit in second period of time should be at least as large as that of the first period of time. When the bank can honor its debt services in the period $T=1$, its borrowing limit is increased because of the increased value of collateral (long term investment could be held until maturity which gives back a total return of $R_k$. The initial endowment, $1$ has increased its value to $1 + r_k$, increased by the amount of $r_k$). The proof of this proposition is attached in the Appendix.

In this section, since there is no risk involved in long term investment, and also expectation of exchange rate is not considered. There is no need for the bank to carry liquid asset in the period $T=1$, which implies that $b_1=0$, no matter whether the bank run is happening or not. If the bank run is happening, there won't be any foreign reserves left for the last period of time, which means $b_1$ is zero. If the bank run is not happening, the long-term investment matures in the last period of time $T=2$, and the bank will be able to satisfy its liabilities by using the total return of the long term investment, without the need of carrying any liquid foreign reserves in period $T=1$. Therefore $b_1=0$ will always be the equilibrium outcome no matter what. The argument is valid only in the context of this part, however, when we include risky long term investment and expectation on exchange rate in the model, the situation becomes more complicated and $b_1=0$ will no long be the case always.

Including a positive interest rate, $p$, compensating for the risk of default faced by long term debt lenders, the budget constraint (5) turns into:

$$R_k + b_1 \geq (1-\lambda) y + (1+p) d_{02} + (1-p) d_{12} \quad (5)'$$

Maximization problem turns into maximization of objective function (2) subject to the constraints (3)-(4), (5)' and (6)-(7). We only assume positive interest compensation for
complete default, compensation for partial default is ignored. Therefore the assumption of zero
interest rates on deposit as well as short term debt is still maintained\(^1\).

**Proposition 2:** With a positive interest rate, \( p \), compensating long-term debt for the possible
default when run happens, the bank will borrow only long term debt if the probability of a run is
big enough: \( p > \frac{\rho \mu_2}{q_{d_0} U(x)} \). And we know the optimal allocation \( \{x, y, d_{o1}, d_{o2}, b_0, b_1, k\} \) and
also the Lagrange multipliers \( \{\mu_0, \mu_1, \mu_2, \theta_1, \theta_2\} \) will be all solved in terms of exogenous
variables \( (p, r, \lambda, \rho, f) \), therefore the expression in the right-hand-side in the optimal solution
could also be expressed in terms of \( (p, r, \lambda, \rho, f) \). Therefore, a critical value of \( p \) could be solved
by rearrange the inequality expressed in terms of \( \lambda \) and \( \rho \): \( p^*(r, \lambda, \rho, f) \). Beyond the critical value
of \( p \), the bank will only borrow long-term debt in the initial period of time.

With an interest rate, \( \rho \), in the framework, the long-term debt is more costly than the short-
term debt. Under this circumstance, the bank will borrow short-term debt only if probability of
crisis is low enough. However, when the probability of a run is big enough, the bank will only
borrow long-term debt to avoid excessive liquidity pressures. And with a positive interest rate
compensation for long term debt, we are able to solve out a critical value of probability
expressed in terms of other exogenous variables. Beyond this critical value, \( p^* \), the probability
of crisis is regarded as too large and the bank will only borrow long term debt in spite of the
higher cost.

**Part B. Risky Long-term Investment**

In this part, we extend the model by including a risk component of the return on long-term
investment. As in Chang & Velasco’s paper, we agree that the illiquidity condition, defined in
(8) is necessary for the bank run; however, it’s not sufficient. The probability of crisis (run)
must be based on certain additional information. This ‘vulnerability’ to the banking run, an
simple idea vividly defined by Dornbusch (1997) as “if something goes wrong, then suddenly a
lot goes wrong”, yet is an idea very difficult to pin down. Although in papers like Diamond and
Dybvig (1983) and Obstfeld (1995), they were able to locate vulnerability in multiple equilibria
(good equilibrium and bad equilibrium) in a way that “if they expect a good outcome (no bank
run, no currency crisis) then they may do things which bring this good outcome about, but if
they expect a bad outcome (bank run, currency crisis) then they may do things which bring this
bad outcome about”, we argue that a simple self-fulfilling expectation is not convincing enough to explain the run on a bank with healthy investment, especially when the bank constructs its allocation to satisfy different types of consumers (patient ones and impatient ones) exactly the way that it won’t be able to satisfy the withdrawals if all consumers go to the bank at T=1. Put it in a simple way, in the case of non-risky long term investment, the bank has access to the information about the proportion of impatient consumers, and it will only carry limited amount of liquid asset to satisfy this group of consumers. Patient consumers know that bank will be able to pay them more if they are truthful about their type, because they know that as long as the bank carries the long-term investment to maturity, their claims will be honored. There would be no incentive for patient consumers to run on the bank, which will only end them being worse off. Every consumer will withdraw according to their true type. Only when there is certain risk involved in period 2 withdrawal, the patient consumers will consider withdraw earlier, ending up in a run situation. The increasing non-performing loan, decreased price of real estate somehow all served as alarming signals to patient consumers warning them that they might not be able to get more than impatient consumers. In Chang and Velasco’s paper, they implicitly treat $y > x$ as the incentive constraint, which is checked by the optimal allocation of $(x, y)$. However, in this paper, we assume that $y$ is determined by the final positions of the bank, and could be less than $x$ because of the risk component in the long-term investment. Along this line, we are able to construct the probability of a banking crisis (run) based on the information on the risk involved in long-term investment. With the risky aspect of long-term investment involved in the framework, we are able to look into some fundamental factors influencing the bank’s decision on its maturity structure of foreign debt. In the context of Asian crisis, among the weak fundamentals playing roles in landing the economy in troubled water, one of them is current account imbalance. Although the current account imbalance was viewed as one of the fundamentals which played key roles in weakening the economy. Rakshit (2002) does not regard current account deficits as necessarily a bad thing. For example, the current account deficits of Thailand, unlike those in Mexico, played a positive role in strengthening rather than impairing the macroeconomic fundamentals of the country (Rakshit, 2002). However, in spite of the fact that current account deficits in Thailand was accompanied by a compatible increase in the investment ratio and capital formation and the deployment of capital was much more efficient in Thailand (compared with Mexico during 1990-95), the capacity of debt services eventually relies on the ability to generate an export surplus in the long run. Although it was observed that the export-GDP ratio in Thailand showed a steady growth, from 34.1% in 1990 to
41.8% in 1995, The gap between imports and exports was widening with the trade deficit as a ratio of GDP surging from 4.96% in 1992 to 6.8% in 1995 (Rakshit, 2002).

The other fundamental factor as the potential causes of Asian crises is financial fragility, most often in terms of poorly supervised and regulated financial system and increased non-performing loans ratio accompanied by a lending boom right before the onset of the crisis (IMF 1998; OECD 1998). For the case of Thailand, the quantitative jump of loans, as a ratio of GDP, to the private sector from 39% to 123% between 1992-96 (Rakshit, 2002), which was most recorded in real estate loans, marked the beginning of sharp rise in the non-performing loans of banks and other financial institutions. Signs of overinvestment and slowdown in demand in the real estate market were clear as early as 1993. The fall in the prices of real estate together with the unbalanced structure of Thailand’s foreign debt (a preponderance of short-term borrowing, by early 1997, it reached a level of $60 billion out of $90 billion outstanding external loans (Mihir, 2002)) pushed the majority of the financial firms over the edge into serious trouble, thereby undermining the international creditors’ confidence in Thai’s economy. As a result of that, foreign creditors stopped rolling over the debt, forcing the economy into an international liquidity crisis.

In this section, we introduce an in-deterministic component to the return on long-term investment, ε, which is assumed to be uniformly distributed within [0, 1] (for simplicity) to capture the idea of risky assets (in the context of Asian crisis, the low efficiency over-investment in the real estate market, lack of capacity to generate export surplus, increased non-performing loans by the banking sectors and other financial institutions). The return on long-term investment, R, therefore consists of a deterministic part, r, and an in-deterministic part, ε, defined as follows:

\[ R = r + ε \] (18)

The least the bank can get back from the long-term investment is \( r k \), the value of the long-term investment if liquidated at \( T=1 \), while the most the bank can get back is \((1+r)k\). And the realization of \( ε \) is treated as exogenously given by its distribution. With this uniformly distributed random variable introduced in the framework, we could endogenize the probability of a financial crisis by using this additional information. Based on budget constraints (4) & (5), holding in equality, \( y \) could be expressed in terms of \( x, k, R, b_1, d_{02} \), as

\[ y = \frac{b_0 + Rk - d_{01} - d_{02} - λx}{1 - λ} \].

Probability of a run is defined as \( p = \text{Prob}\{y<x\} \).

\[ p = \text{Prob}\{y<x\} = \text{Prob}\{\frac{b_0 + Rk - d_{01} - d_{02} - λx}{1 - λ} < x\} \]
= \text{Prob. } \{ \varepsilon < \frac{[x + d_{02} + d_{01} - b_0]}{k} - r \} \\
= F\{ \frac{[x + d_{02} + d_{01} - b_0]}{k} - r \} \\
= \frac{[x + d_{02} + d_{01} - b_0]}{k} - r \text{, because } \varepsilon \text{ follows uniform distribution in } [0,1].

Therefore, \( p = \frac{[x + d_{02} + d_{01} - b_0]}{k} - r \) \quad (19)

Equation (19) expressed the probability of crisis in terms of the choice variables of the bank's objective, therefore will be endogenously determined when the optimal allocation of \( \{ x, y, d_{01}, d_{02}, b_0, b_1, k \} \) is solved for the bank's problem. With the probability of a run endogenized in the objective function, the utility maximization problem faced by the bank becomes very complicated. However, we should be able to get some insights on bank's optimal allocation facing risky long-term investment. We know that, the optimal allocation of the bank will be solved in terms of exogenous variables \( \{ \varepsilon, r, \lambda, f \} \), therefore the equation (19) could be rewritten as follows:

\[
\text{Prob. } \{ \varepsilon < \frac{[x + d_{02} + d_{01} - b_0 - rk]}{k} \} \\
= \text{Prob. } \{ \varepsilon < \frac{[x(\varepsilon, r, \lambda, f_1, f_2) + d_{02}(\varepsilon, r, \lambda, f_1, f_2) + d_{01}(\varepsilon, r, \lambda, f_1, f_2) - b_0(\varepsilon, r, \lambda, f_1, f_2) - rk(\varepsilon, r, \lambda, f_1, f_2)]}{k(\varepsilon, r, \lambda, f_1, f_2)} \} \\
= \text{Prob. } \{ \varepsilon < \Lambda(\varepsilon, r, \lambda, f_1, f_2) \} \\
= \Lambda(\varepsilon, r, \lambda, f_1, f_2), \text{ where } \Lambda(\varepsilon, r, \lambda, f_1, f_2) \text{ will be the probability of a run, and the optimal allocation } \{ x, y, d_{01}, d_{02}, b_0, b_1, k \}^* \text{ will be all expressed in terms of } \{ \varepsilon, r, \lambda, f_1, f_2 \}, \text{ in which there will be different allocation corresponding to different values of } \Lambda(\varepsilon, r, \lambda, f_1, f_2), \text{ which depends on } r, \lambda, f_1, \text{ and } f_2 \text{ only. The optimal allocation of the bank is changed from being dependent on exogenously given probability of crisis in part A to being dependent on the realization of } \varepsilon \text{ or, in other words, the risk involved in investment in long-term asset.}

However, we ignore the possible mixed strategy equilibrium with probability of crisis \( p \) lying somewhere between 0 and 1 and only focus on the two pure strategy allocations so far, one leading to the banking run crisis (the case when \( P=1 \)) and the other one not (the case when \( P=0 \))^2. The bank's optimal allocation will be chosen by comparison of the two pure strategy equilibria.
Proposition 1 of part A still holds so far without a positive interest rate compensation for the risk of complete default faced by long-term debt lender. Bank will only borrow short-term debt under the stated assumption. However, in this section \( b_1 \) will not be always zero because of the introduced risk involved in the long term investment. Let's look at the two cases when \( p=1 \) and \( p=0 \), with solution allocation denoted as \( V_0 = \{x, y, d_{01}, b_0, b_1, k\}^{*}_{p=0} \) and \( V_1 = \{x, d_{01}, d_{02}, b_0, b_1, k\}^{*}_{p=1} \). And the optimal allocation will be determined by \( \text{Max} \{V_0, V_1\} \).

**Case I, \( p=0 \):**

From (18)-(19) and (3)-(7) and the first order conditions of the maximization problem (in Appendix (10)'-(17)'):

\[
d_{01} = 0, \ d_{02} = f_1, \ x = 1-(1-r)k \leq 1, \ y = \frac{(1+r) - (1-r)k}{1-\lambda} = 1 - (1-r - \frac{\epsilon}{1-\lambda})k \geq x,
\]

\[
V_0 = \text{Max} \ \{\lambda U(x) + (1-\lambda)U(y)\}
\]

\[
= \text{Max} \ \{\lambda [1-(1-r)k] + (1-\lambda)[1-(1-r - \frac{\epsilon}{1-\lambda})k]\} \text{ w.r.t. } k:
\]

FOCs: \(- (1-r)\lambda U'(x) - (1-\lambda) (1-r - \frac{\epsilon}{1-\lambda}) U'(y) \leq 0, \text{ equality if } k=0.\)

Since \( 0<r<1 \), and \( \epsilon \in [0,1] \), when \( \epsilon \) is small enough, the LHS of the first order condition is always smaller than zero, which means \( k \) is equal to zero. Plugging the value back to the \( V_0 \) function, we get \( V_0 = U(1) \) when \( \epsilon \) is small enough.

When the risk involved in long-term investment is big enough, there is no incentive in investing in the long-term assets, bank can do no better than households holding the endowment themselves, with \( x = y = 1 \). It also implies that there might be a chance that a banking-run equilibrium might be superior to the no-banking-run equilibrium in the sense that it offers possible higher payoff.

**Case II, \( p=1 \):**

From (18)-(19), (3)-(4) and (10)'-(17)'(see appendix):

\[
d_{01} = 0, \ d_{02} = f_1, \ x = rk + 1 > 1, \ k = \frac{1+f_1 - \lambda}{\lambda r + 1}, \ b_0 = \lambda x, \ q = \frac{r + rf_1 + rf_1 + rf_1 + rf_1}{\lambda r + 1} \text{ (see detail in appendix)}
\]

\[
V_1 = \text{Max} \ q U(x)
\]

\[
= \frac{r + rf_1 + rf_1 + rf_1 + rf_1}{\lambda r + 1} U\left(\frac{r + rf_1 + 1}{\lambda r + 1}\right), \text{ where } \frac{r + rf_1 + rf_1 + rf_1 + rf_1}{\lambda r + 1} < 1 \text{ yet } \frac{r + rf_1 + 1}{\lambda r + 1} > 1.
\]

There are possibilities that \( V_1 > V_0 \), which makes the bank choose an allocation leading to a banking run.
**Proposition 3**: if the bank write the contract in a way that $x$ is small enough, $1-(1-r)k$, the banking run is not going to happen. However, when the risk involved in long-term asset investment is big enough, the bank can do no better than letting households holding the initial endowment themselves. Under that condition, the bank may choose to write a contract, in which the amount of $x$ promised by the bank is larger than $1$, $rk+1$, and the banking run is going to happen. In that case, the optimal allocation is $x=\frac{r+rf_1+1}{\lambda r+1}$, $d_{01}=0$, $d_{02}=f_1$, $k=\frac{l+f_1-\lambda}{\lambda r+1}$, $b_0=\frac{r\lambda+rf_1\lambda+\lambda}{\lambda r+1}$ and $b_1=0$.

Notice that although $\lambda$ is set to 1 in the first part of the objective function (because all the consumers are regarded as impatient when there is a banking run), in the optimal allocation, $\lambda$ is the natural proportion of impatient households under normal condition (no run) perceived by the bank because types were publicly observable as of period $T=1^3$.

In the absence of an interest compensation for long-term debt, the bank will only borrow long-term debt because it costs no more than the short-term debt. Under the assumption of zero interest rate on both short-term and long-term borrowing, whether the bank is subject to the run has nothing to do with borrowing, because the bank will only borrow long-term debt, therefore it will be exclusively dependent on the promise of payment to the impatient consumers, $x$. Although promise of smaller amount of $x$ will excuse the bank from a run crisis, it may imply lower payoff to the households, because under that condition, the bank can do no better than households holding assets themselves when faced with high investment risk involved in long-term assets. The bank may still choose the allocation subject to a banking run because of possible higher payoff under the stated conditions. The bank will invest the amount of $\frac{1+f_1-\lambda}{\lambda r+1}$ in the long-term asset; carry liquid asset in the initial period of time $b_0$, $\frac{r\lambda+rf_1\lambda+\lambda}{\lambda r+1}$; promise of payment to impatient consumers, $\frac{r+rf_1+1}{\lambda r+1}$. And all the consumers will turn out to be impatient. It might be a little bit awkward to say that the bank may choose an allocation leading to a catastrophe itself. In the case of Asian Financial crisis, it may not be the case because of in spite of the structural weaknesses and fragility in financial sector and low efficient investment in forms of so called "crony capitalism", Asian economies were still viewed as successful miracles. It’s hard to believe that the financial sectors themselves chose
the allocation leading to a disastrous financial crisis. However, we think this explains exactly what happened in Mexico’s crisis during 1990s. Unlike Thailand, current account deficits of Mexico during 1989-94 were not accompanied by a commensurate increase in her investment ratio. It is well documented that the current account deficits of Mexico during that period of time were accompanied by a positive shock in her domestic consumption pattern. And lots of financial institutions in Mexico used foreign borrowing to finance domestic consumption boom instead of investment in working capital. We believe that for Thailand, a deliberate action taken by the bank and other financial institutions leading to a banking run crisis was not the case. For Thailand it is the lack of awareness of exchange risk and government’s failure in defending the fixed parity that further exacerbate the existing financial problems. Without considering the foreign exchange rate risk, the bank took on an allocation too riskier than what it can bear. This point will be further illustrated in section III when we incorporate the currency crisis into the story.

Next, we will again introduce the positive interest rate compensating for the long term debt into the model. The probability of a banking crisis, expressed in equation (19) turns into the following because of the positive interest rate:

\[
p = \frac{x + d_{oi} + (1 + \rho)k - b_0}{k} - r
\]

(19)'

**Proposition 4:** with a positive interest rate compensating the long term creditor, \( \rho \), if the bank write the contract in a way that the amount promised to impatient consumers, \( x \), is small enough \((1-(1-r)k)^2\), the bank will only borrow short term debt at a lower cost, and there won’t be a run on the bank; If the bank write the contract in a way that the amount promised to impatient consumers, \( x \), is large enough, however not necessarily as large as \((rk+1)\), the bank is subject to the banking run, and the bank will only borrow long-term debt. Since after introduced in the positive interest rate on the long term fund, the payoff of run equilibrium depends on \( x \), which is not necessarily larger than 1 in this case, the bank may choose an allocation that leads to no run equilibrium. \( x = (1-(1-r)k) \), \( b_{o1} = f_1, b_{o2} = 0, b_0 > 0 \).

Compared with proposition 3, when there is a positive interest rate compensating for the risk of default faced by long-term debt lender, the long-term fund is more costly than the short-term fund. The bank will borrow short-term debt if the promise of payment to impatient consumers is reasonably small enough. This is intuitive because now the bank’s decision on borrowing fund
will have direct impact on the payoff to the household because of the introduced positive interest rate on long term fund. Only when the bank’s promise on payment to the impatient consumers is small enough, the bank can manage to borrow short-term debt at a lower cost and therefore can afford to pay back the patient consumers a higher amount of payment. And under that allocation, the patient consumers can get a higher payoff, and therefore will be patient to wait until the last period of time. The bank will borrow only long term debt if the promise of payment to impatient consumers is too large (however, it doesn’t have to be as large as \((1+r_k)\) as stated in proposition 3. A promise of payment smaller than \((1+r_k)\) will be enough to lead the bank to the run equilibrium. In that case, the bank will borrow only long term debt and in the meanwhile promise the impatient consumers an amount of payment sufficiently large to bring the bad equilibrium about. Under that circumstance, all the borrowed long-term funds will be defaulted on. All the liquid assets and liquidated long term assets will be used for satisfying the domestic consumer’s withdrawal. However, notice that since the amount of promise doesn’t have to be as large as \((1+r_k)\) to bring the bad equilibrium about, it implies that under this circumstance, a run equilibrium doesn’t necessarily bring higher payoff because of smaller amount of payment, \(x\), promised by the bank’s contract. Therefore, compared with proposition 3, because of the possibility of \(x\) being smaller than 1, and since \(q\) is smaller than 1, the payoff of a run equilibrium is worse than the worst scenario of no run equilibrium (worst because of the assumption of large risk involved in long term investment stated in proposition 3), the bank will choose the allocation that leads to no run equilibrium.

Section III. Modeling financial crisis and currency crisis.

There has been plenty of research done on the relationship between financial crisis and currency crisis. Among the recent writings, Diamond and Dybvig (1983) analyze bank runs. Obstfeld (1995) discusses exchange rate crises. They use very different models to analyze these two different problems. Recently, theoretical linkages between currency and banking crises have been explored by a number of economists. One chain of causation, stressed by Velasco (1987), points to the causal direction from financial-sector problems to the currency collapse. These models blame central banks because they create excessive money to provide help to troubled financial institutions. The creation of too much money results in a currency crisis. Another line of reasoning (Stoker, 1994) starts from balance of payments problems which then lead to a banking crisis.

The linkage between currency crises and banking crises could point in either causal direction. In this paper, along the line of Chang & Velasco, we start from banking crisis which causes
currency crisis, a sharp depreciation of home currency. A possible bank run might give rise to the consequent currency crisis and the expectation of a currency crisis further deepens the problem. Experience from the Asian financial crisis tells us that predating the outburst currency crisis in Asian, there has been lots of problems happening in financial sectors, bankruptcies of banks and financial institutions. Since most of the affected Asian countries adopted pegged exchange rate system during that period of time and were not well prepared for the currency risks in the capital market, when they face adverse balance of payments, the consequence is loss of foreign currency reserves. As a result, there is a decrease in the stock of money and a credit crunch. To counter this problem if the currency is devalued, the situation may be worse. In this section, foreign reserves serve as a source for the foreign debt repayment as well as a source of defending the pegged system of exchange rate, therefore a signal for speculator to indicate whether the pegged system could be defended successfully or not. And it has direct impact on expectation on future movement of exchange rate. Since there is no role of government in our model, the possibilities of government’s bailing out financial institutions is ruled out in this paper. In this section, we explore the possibility of pinpointing the effect of a twin crisis on bank’s optimal choice of allocation. The revised budget constraints when the role of expectations is incorporated in the model are as follows:

$$\pi l + s^0 d_{01} + s^2 d_{02} \geq s^0 b_0 + \pi k$$

$$s^0 b_0 + s^2 (1-p) d_{12} \geq \lambda_1 \pi k + s^2 b_1 + s^2 d_0$$

$$R \pi k + s^2 b_1 \geq (1-\lambda) \pi y + s^2 (1+p) d_{02} + s^2 (1-p) d_{12}$$

where $q$ is defined as $q = \frac{r_n k + s^2 b_0}{s^2 d_{01} + \pi x}$, $s$ is the fixed nominal exchange rate in the pegged system in the initial period of time, and $s^2$ is the expected exchange rate prevailing in next two periods. We argue that the effort in defending the pegged system will fail if the reserves are depleted. Therefore if $b_1=0$, which means foreign reserves are depleted in the period $T=1$, the expectation of exchange rate will be higher than the fixed nominal exchange rate.

A couple of additional assumptions are made in this section: First, exchange rate was given exogenously to simplify the model in the context of pegged exchange rate system, and since there is only one freely traded good, purchasing power parity holds; Second, there is uncertainty in expectation of exchange rate because of the possibility that government will give up defending the pegged system and let the exchange rate float after depleting the foreign reserves during the period $T=1$. 
According to purchasing power parity, \( s \pi^* = \pi \), where \( \pi^* \) is the price of the commodity in terms of foreign currency and it is normalized to be one for simplicity. Therefore \( \pi = s \). The first budget constraint turns out to be unchanged because \( \pi \) and \( s \) cancel each other out. Dividing both sides of the other two budget constraints by \( s \), the above budget constraints turn as follows:

\[
\begin{align*}
\pi l + s d_{01} + s d_{02} &\geq s b_0 + \pi k \quad (3)' \\
\frac{s^e}{\pi} b_0 + \frac{s^e}{\pi} (1-p) d_{12} &\geq \lambda x + \frac{s^e}{\pi} b_1 + \frac{s^e}{\pi} d_{01} \quad (4)' \\
R k + \frac{s^e}{\pi} b_1 &\geq (1-\lambda) y + \frac{s^e}{\pi} (1+p) d_{02} + \frac{s^e}{\pi} (1-p) d_{12} \quad (5)'
\end{align*}
\]

In addition, the asset approach of exchange rate shows that the expectation on the exchange rate must be related to the interest rate, \( \rho \). Therefore, interest rate parity shows that: \( \rho = \rho^* + \frac{s^e - s}{s} \), where \( \rho^* \) is the interest rate on long term borrowing prevailing in the rest of the world, which is assumed to be zero for simplicity.

**Hypothesis 1**: with a positive interest rate compensating long term debt for the risk of default and the expectation of exchange rate in the model, if the probability of crisis is treated as exogenously given, under the stated assumption, the probability of crisis has to be even smaller (compared with the case in part A of section II) the critical value \( p^*(r, \lambda, \rho, f) \) in proposition 2, so the bank will choose the allocation that short-term debt will be borrowed.

When the banks consider that bank runs may lead to a currency crisis, the situation becomes more serious, the tolerance level for bank run becomes lower. We believe that one of the reason that Asian crisis is so devastating is that most of the countries on the pegged or fixed exchange rate system didn’t consider the foreign exchange risk. The banks may choose an allocation and subject themselves to the bank run for a higher expected payoff. However, they may have chosen one, carrying a higher risk of run than they can afford.

When probability of crisis is endogenized in the framework, the probability is defined as follows after introducing the expectation of exchange rate. Since we assume self-fulfilling expectation of exchange rate in this paper, the expectation of the exchange rate will be actual rate prevailing later.
It's not hard to tell that compared with (19)', now the probability of crisis is positively related with the $\frac{s^e}{\pi}$, the expectation of exchange rate, if the amount of foreign reserve $b_0$ is smaller than the amount of $d_{o1}$ and $(1+p)d_{o2}$. This implies that without adequate foreign reserves, the possible following currency crisis will further exacerbate the banking crisis and breaking the economy down to a massive destructive financial crisis.

Hypothesis 2: If $d_{o1}$ is the optimal allocation, then with an endogenized probability of banking run, the bank will choose an allocation which leads to no run equilibrium. The promise of payment to the consumers withdraw at $T=1$ will be small enough $(1-(1-r)k)$. And $b_0>0$, $b_1>0$, which implies that the amount of foreign reserves should be large enough to defend the fixed parity, therefore susceptibility to the currency crisis is also minimized.

With currency crisis modeled in the theoretical framework, when bank takes into consideration the consequences of a banking run crisis, which is embodied in terms of expectation of drastic depreciation of home currency, the bank will choose an allocation in a way that the probability of a banking crisis is minimized. And also the bank will carry large amount of foreign reserves to meet the debt services and withdrawals as well as for the purpose of preventing possible following currency crisis.

Section IV, Policy Implication.

Our model suggests some precautionary steps which developing countries should take when they decide to liberalize their financial system to allow private asset trade with foreigners. First, we suggest a gradual approach to liberalization of capital market. This will give banks and other financial institutions grace period to adjust to the highly mobile capital market. Control on the limit of short-term foreign debt or minimum stay-in-territory requirement of capital inflows could be imposed on foreign direct investment and short-term lending to avoid excessive capital inflow and outflow. Permanent capital controls are needed by both developed and developing economies and for both economic and political reasons (Crotty & Epstein, 1999). One of the reasons that China falls in the category of countries that were not subject to disruptive speculative pressure is the presence of constraints on capital mobility. Second, we suggest an
optimal tax imposed on withdrawal by the consumers. An optimal tax will be sufficient to prevent a bank run although it implies certain social welfare cost. Third, although the foreign reserves are costly to the bank, these are regarded important in preventing the economy from suffering from exacerbated financial crisis. We believe that for developing countries on the way to liberalize their capital market, a balanced current account and capital account is of key importance because the ability of the economy to service its both long term and short term debts eventually relies on the productivity of the working capital in export-generating industries. Fourth, depreciation of home currency caused by bank run will deteriorate the bank’s financial condition when the debts are all denominated in foreign currencies and the bank doesn’t hedge against currency risk. The question lies in the choice of timing of letting the currency float. Should the currency be allowed to float before the liberalization of capital market or after? Looking at Taiwan, Singapore and Hong Kong, regions relatively less affected by the regional turmoil, Taiwan and Singapore decided to let their currency float rather than lose reserves until the last effort of defending the currency; Hong Kong’s ability to maintain the currency parity despite strong speculative attacks was partly attributed to the large pool of foreign reserves. What China is doing right now be a good example of policies against the attack of twin crises. China has been always cautious about opening up capital market. Yet for the reform in exchange rate system, China has adopted a unique way to let the currency float step by step. China has adopted the managed floating system since 1994, and will continue to improve foreign exchange administration and maintain a strong position in balance of payments and exchange rate stability by giving priority to continuing the market-based, managed floating exchange rate system (Dai XiangLong, People’s Daily, Jan. 15, 2002). Whether China will let the RMB freely float will mainly depend on the economic development, and not until then will China consider fully liberalizing its capital market. In addition, China has always maintained a high level of foreign reserves, especially after the Asian crisis in 1997. China’s foreign reserves has reached a level of 200 billion in terms of dollar by 2001, more than enough to pay back the total outstanding foreign debt (170.11 billion U.S. dollars at the end of December 2001, among which medium and long-term debt accounted for 70.3 percent), costly yet necessary for the transition period of time.

Section VI. Conclusions

Regarding bank’s choice of maturity structure of foreign debt, the conclusion derived from the analysis in part A of section II is consistent with Chang and Velasco (2000). When the probability of banking crisis is smaller than some critical value, the bank will take some short
term loans. When exchange rate uncertainty is included in the model the critical value of probability is smaller. The implication is that the bank will have to be more careful about the maturity structure of the foreign debt. It seems the financial sectors of the Asian countries which were most affected did make an allocation riskier than was justified by the economic environment.

In this paper, we focus on the linkage between banking crisis and currency crisis with the banking crisis preceding the currency crisis. However, since the banking and currency crises enter the picture simultaneously in period $T=1$, the model could be adapted to analyze the linkage with currency crisis leading to banking crisis. The model could be extended by way of including a government agency that can bail out financial institutions by money creation.

Footnote:

1 In Chang & Valesco (2000)'s, there is positive interest rate, $\rho_t$, compensating for short term debt as well as the long term debt. ($(1-p)+pq(1+\rho_t)=1$ holds because the expected net return on a short loan is zero under the assumption of risk neutral creditors and zero opportunity cost of funds. In our paper, $\rho_t$ is set to be zero for simplicity and in addition for the reason that foreign creditors are treated equally as the domestic household under the circumstances of a banking crisis. Since there is no positive interest rate compensating for the risk of partial default on the deposit made by households, there is no positive interest rate compensating for the risk of partial default on the short term debt faced by foreign creditors either.

2 See “Bank Runs, Deposit Insurance, and Liquidity” by Douglas W. Diamond, Philip H. Dybvig, in which the mixed strategy equilibria were also ruled out because of none economic senses. In their paper, there are two equilibria, a good equilibrium (no run equilibrium) and a bad one (run equilibrium).


4 The promise of payment to the impatient consumers is smaller than 1, which implies that the payment to the consumers is smaller than the amount that impatient consumers can get if they hold the initial endowment themselves. However, if we look at the amount $(1-r)k$ as the tax the government imposed on the wealth the consumers hold after they withdraw from the bank, it supported Diamond (1983)'s result on the role of government deposit insurance through its tax policy in preventing a run because it never pays to participate in a run.

Appendix:

Proof of proposition 1:
The first order conditions of the social planner’s problem are (3)-(7) with equality and (10)-(16) listed below:

\[(1-p)\lambda U'(x) + pqU'(x) + pq_x U(x) - \mu, \lambda = 0 \quad (10)\]
\[(1-p)U'(y) - \mu_z = 0 \quad (11)\]
\( p U(x) q_{b0} - \mu_0 + \mu_1 \leq 0, \text{ equality if } b_0 > 0 \) \hspace{1cm} (12)

\( p U(x) q_k - \mu_0 + R \mu_2 = 0 \) \hspace{1cm} (13)

\( p U(x) q_{d01} + \mu_0 - \mu_1 - \theta_1 \leq 0, \text{ equality if } d_{01} > 0 \) \hspace{1cm} (14)

\( \mu_0 - \mu_2 - \theta_2 - \theta_1 \leq 0, \text{ equality if } d_{02} > 0 \) \hspace{1cm} (15)

\( \mu_1 - \mu_2 - \theta_2 = 0 \) \hspace{7cm} (16)

\( -\mu_1 + \mu_2 \leq 0, \text{ equality if } b_1 > 0 \) \hspace{7cm} (17)

We assume that the bank will always borrow in the period \( T=1 \). However, the availability of it will depend on the credibility standing of the bank in that period of time. Therefore, (16) should always bind. Equation (16) could be transformed into the following:

\( \theta_2 = \mu_1 - \mu_2 \) \hspace{1cm} (16)

From the left-hand-side of (14) and (15), we could tell that the LHS of (15) will be always larger than that of (14) as long as the probability of a run is not close to zero, because \( q_{d01} \) will always be negative as long as the probability of a run is non-zero. (14) will hold in equality only if \( p \) is zero, in which case the bank will borrow short-term debt in the first period of time. Since \( b_1=0 \), from (17) we know that \( \mu_1 > \mu_2 \). From (15), we can further show that \( \mu_0 > \mu_1 > \mu_2 \) (\( \mu_0 = \mu_1 \) couldn’t hold because if it holds it will contradict with (12)). Therefore, only when \( p \) is very small, \( b_0 \) could be zero, otherwise, \( b_0 \) will always be bigger than zero.

**Proof of proposition 2:**

The proof of this proposition is as straightforward as the first proposition. The LHS of (15) is no longer guaranteed to be larger than that of (14) because of the additional term \( -\rho \mu_2 \), which is non-positive as the first term of LHS of (14), \( p U(x) q_{d01} \). It’s up to these two terms to decide which one is larger. When \( p U(x) q_{d01} < -\rho \mu_2 \), the LHS of (15) again will be larger than that of (14), back to the situation of proposition 1 again: if the bank is going to borrow anything in the initial period of time, it will borrow only long-term debt. Otherwise, if the reverse holds, the bank will only borrow short-term debt because of the lower cost. Only when \( p U(x) q_{d01} = -\rho \mu_2 \) will there be long-term debt and short-term debt together.

**Proof of proposition 3:**

Plugging the probability of banking crises expressed in terms of \( x, d_{01}, d_{02}, b_0 \), and \( k \) (equation 19) back into the objective function (2).

The first order conditions of the utility maximization problem are (3)-(7) holding in equalities and (10)'-(17)' as follows:
\( p_x q U'(x) + pq U'(x) + pq_x U(x) - p_x \left\{ \lambda U(x) + (1 - \lambda) U(y) \right\} + \\
(1 - p) \lambda U'(x) - \mu_1 p_x d_{12} + \mu_2 p_x d_{12} + \theta_2 p_x d_{12} - \mu_1 \lambda = 0 \\
(1 - p) U'(y) - \mu_2 = 0 \quad \text{(10)' } \\

\( p_{b_0} q U(x) + p U(x) q_{b_0} - p_{b_0} \left\{ \lambda U(x) + (1 - \lambda) U(y) \right\} \\
- \mu_0 + \mu_1 - \mu_1 p_{b_0} d_{12} + \mu_2 p_{b_0} d_{12} + \theta_2 p_{b_0} d_{12} \leq 0, \text{ equality if } b_0 > 0 \quad \text{(11)' } \\

\( p_k q U(x) + p U(x) q_k - p_k \left\{ \lambda U(x) + (1 - \lambda) U(y) \right\} - \mu_0 + R \mu_2 \\
- \mu_1 p_k d_{12} + \mu_2 p_k d_{12} + \theta_2 p_k d_{12} = 0 \quad \text{(12)' } \\

\( p_{d_{01}} U(x) q + p U(x) q_{d_{01}} - p_{d_{01}} \left\{ \lambda U(x) + (1 - \lambda) U(y) \right\} + \mu_0 - \mu_1 - \theta_1 \\
- \mu_1 p_{d_{01}} d_{12} + \mu_2 p_{d_{01}} d_{12} + \theta_2 p_{d_{01}} d_{12} \leq 0, \text{ equality if } d_{01} > 0 \quad \text{(13)' } \\

\( p_{d_{02}} U(x) q - p_{d_{02}} \left\{ \lambda U(x) + (1 - \lambda) U(y) \right\} + \mu_0 - \mu_2 - \theta_2 - \theta_1 \\
- \mu_1 p_{d_{02}} d_{12} + \mu_2 p_{d_{02}} d_{12} + \theta_2 p_{d_{02}} d_{12} \leq 0, \text{ equality if } d_{02} > 0 \quad \text{(14)' } \\

\( \mu_1 - \mu_2 - \theta_2 = 0 \quad \text{(15)' } \\
- \mu_1 + \mu_2 \leq 0, \text{ equality if } b_1 > 0 \quad \text{(16)' } \\

From (19), we can tell that \( p_x = p_{d_{01}} = p_{d_{02}} = -p_{b_0} \). Therefore, comparing the LHS of (14)' and (15)', it's still obvious that if (15)' holds in equality, (14)' will not, which implies that if the bank is going to borrow any foreign debt, it is going to borrow only long term debt under the stated assumption of zero interest rates on both of them. Therefore, \( d_{02} = f_1, d_{01} = 0 \).

Since the allocation and the probability of crisis is of one-to-one correspondence, we could derive the allocation by setting \( P = 1 \), and regard that allocation as the one leading to the run equilibrium. And so it is about the no-run equilibrium too. When \( p = 1 \), \( (1-p)d_{12} = 0 \) therefore the actual amount of \( d_{12} \) doesn't matter, in this case \( f_2 \) is equal to \( f_1 \). It is intuitive that under the circumstances of a banking run, there is no possibility for extended credit because the investment is not going to mature and there is no possibility that the value of collateral is increasing. From (19) and (3), when \( p = 1 \), \( x = 1 + rk \). Since when \( p = 1 \), \( b_1 = 0 \), therefore, \( b_0 = \lambda x = \lambda(1 + rk) \). Plug \( b_0 \) and \( x \) back in the budget constraint (3), we can get \( k = \frac{l + f_1 - \lambda}{\lambda r + l} \). Then \( x = 1 + rk = \frac{r + rf_1 + 1}{\lambda r + 1}, b_0 = \lambda x = \lambda \frac{r + rf_1 + 1}{\lambda r + 1} \). And it's obvious that \( q = \frac{r + rf_1 + rf_2 \lambda + \lambda}{\lambda r + 1} \); Plugging the values back into \( V \) function, we get \( V_1 = qU(x) = \frac{r + rf_1 + rf_2 \lambda + \lambda}{\lambda r + 1} U \left( \frac{r + rf_1 + 1}{\lambda r + 1} \right) \).

When \( p = 0 \), \( d_{02} = f_1, d_{01} = 0 \) and \( d_{12} = f_2 - f_1 \). From (19) & (3), it's obvious that \( x = 1 - (1-r) k \); From (3) & (4), we can get \( b_0 = 1 + f_1 - k = b_1 + \lambda x - f_2 + f_1 = b_1 + \lambda(1 - (1-r)k) - f_2 + f_1 \), which implies that \( b_1 = 1- \).
\[ \lambda + (1-r) \lambda k - k + f_2. \] From (5), \[ y = \frac{Rk + b_1 - f_2}{1 - \lambda} = \frac{Rk + (1 - r)(1 - r)\lambda - k}{1 - \lambda} = 1 - (1 - r - \frac{\epsilon}{1 - \lambda})k. \]

Plug the expression of \( x \) and \( y \) in terms of \( k \) back into the objective function, we get \( V_0 = \max \lambda U(x) + (1 - \lambda)U(y) = \max \{ \lambda U[1 - (1 - r)k] + (1 - \lambda)U[1 - (1 - r - \frac{\epsilon}{1 - \lambda})k] \} \)

Notice that since \( x = (1 + rk) \) and \( x = (1 - (1 - r)k) \) are the necessary and sufficient conditions for run equilibrium \( (p = 1) \) and no run equilibrium \( (p = 0) \), by looking at two cases when \( p = 1 \) and \( p = 0 \), we could derive out the allocations which will lead to run equilibrium and no run equilibrium respectively. And then by comparison of the utility level of household derived from the allocation we could determine which one the bank will choose.

**Proof of proposition 4:**
The FOC (15)' changed into (15)'':

\[
p_{d_02} U(x) q - p_{d_02} \{ \lambda U(x) + (1 - \lambda)U(y) \} + \mu_0 - \mu_2 - \rho \mu_2 - \theta_2 - \theta_1 - \mu_1 p_{d_02} d_{12} + \mu_2 p_{d_02} d_{12} + \theta_2 p_{d_02} d_{12} \leq 0, \text{ equality if } d_{02} > 0
\]

From (19)', \( (1 + \rho)p_x = (1 + \rho)p_{d_01} = p_{d_02} = -(1 + \rho)p_{b_0} \)

If \( P = 0 \), the allocation is the same as the case in proposition 3, because the compensation for the long term fund is zero. The worst payoff the bank can achieve is \( U(1) \), the case when there is large risk involved in long term investment. However, for the allocation leading to the run equilibrium, \( x \) is smaller than \( 1 + rk \), because there is an addition term, \(-\rho \mu_2\), in it. \( x \) is equal to \( 1 + rk - \rho \mu_2 \), therefore the maximized payoff the bank can get by choosing a run equilibrium is lower than the no run equilibrium. Therefore, the bank will choose an allocation that leads to no-run equilibrium.

**Reference:**

Krugman, Paul, Jan. 1998, What Happened to Asia
Rakshit, Mihir (2002), The East Asian Currency Crisis, Oxford University Press.
Maturity Structure of Foreign Debts in the Presence of a Possible Twin Crisis

Qiu Fang
Economics Department
Utah State University
Email: qiufang@cc.usu.edu
Phone: 435-797-6339

Basudeb Biswas
Economics Department
Utah State University
Email: biswas@202.cc.usu.edu
Phone: 435-797-2304

Maturity Structure of Foreign Debts in the Presence of a Possible Twin Crisis

Abstract

The objective of this paper is to analyze the effect of a probable financial crisis triggered by bank runs and the consequent currency crisis on the optimal choice of maturity structure of foreign debts. Theoretical analyses of the maturity structure suggest some macroeconomic policies that the emerging markets can adopt in the form of financial regulations and exchange rate management. During the transition period from closed or controlled capital market to liberalized capital market, these policies should help the developing countries to prevent the occurrence of crisis.

I. Introduction

The Asian Financial Crisis started in 1997, peaked during 1998 and was followed by dramatic recovery during 1999. The quick recovery of the crisis in the affected countries was as unexpected as the disastrous consequences that were widespread among the eastern Asian countries. Studies on the origin of Asian crisis focus on either economic fundamentals such as current account balances, banking system, political certainty, credibility of governments and commitment to structural reforms (Giancarlo Corsetti, Paolo Pesenti, and Nouriel Roubini, 1999), or self-fulfilling expectations stemmed from international illiquidity (Diamond & Dybvig, 1983; Chang & Velasco, 1999). The Asian crisis, regarded as 'inevitable' by some economists, was commonly regarded as the result of internal imperfection of the macroeconomic systems of the affected countries and external shocks. Such imperfection of macroeconomic system was most pronounced in current account balances and in the supervision of financial sectors. Lack of supervision of the financial sectors in some countries resulted in crony capitalism. External shocks refer mainly to "the tendency for international financial markets to overreact to both positive and negative news" and speculative attacks (Wing Thye Woo, Jeffrey D. Sachs and Klaus Schwab, 2000). G. Corsetti, Paolo Pesenti and Nouriel Roubini provide evidence of current account imbalances and weak macroeconomic fundamentals in their study (1999) on causes of Asian financial and currency crisis. It's shown in their study that "several Asian countries whose currencies collapsed in 1997 had experienced somewhat sizable current account deficits in the 1990s". In 1996, current account deficit was 4.8% of GDP for Korea, 3.3% for Indonesia, 3.7% for Malaysia, 4.7% for the Philippines and 8.5% for Thailand, most of which reached near the alarming level of 5%, especially for the Thailand case.