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Financial Crisis and Credit Crunch as a Result of Inefficient Financial Intermediation—with Reference to the Asian Financial Crisis

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Abstract

This paper develops a model of private debt financing under inefficient financial intermediation. It suggests a mechanism that can generate the following sequence of events observed in the recent Asian crisis: A period of relatively low capital flow despite a steady improvement in economic fundamentals (capital inflow inertia), followed by a fast buildup of capital inflow, and ended with a large capital outflow and domestic credit crunch. Unlike other models requiring large movements in fundamentals or asset prices to explain a financial crisis, this model can exhibit large credit/capital flow swings with moderate changes in the economic and market environment.

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Summary

This paper develops a new model of private debt financing with an inefficient financial system at its core, where inefficiency is characterized by costly loan monitoring. In this context, the model suggests a mechanism that generates the following sequence of events: a period of low capital inflow despite high rates of economic growth (capital inflow inertia), as observed in the take-off era in the Asian tiger economies, followed by a sudden acceleration of capital inflow (as seen in the 1990s), and then by a crisis, which is defined as a large reduction in the amount of loans intermediated by the financial system, i.e., a large capital outflow or credit crunch.

Most existing models of financial crises require large movements in economic fundamentals or in asset markets (such as bubbles). In our model, such large movements can be further exacerbated due to credit rationing. Moreover, under certain conditions, financial crisis can occur even when economic fundamentals and market sentiment change only slightly. Unlike most credit rationing models, our results do not hinge on the assumption of asymmetric information.

The model provides guidance about the appropriate policy responses to an imminent crisis by focusing on two important elements: the *Safety Buffer*, which is a measure of economic vulnerability, and *the size of the Crash*, which measures the severity of the crisis. We use comparative statics to analyze how changes in asset values and fundamental strengths, the lending and borrowing rates, and the risk free rates affect both the safety buffer and the size of the crash.

I. Introduction

The scope and severity of the largely unexpected financial crisis in Asia in 1997 have prompted numerous postmortem commentaries and heated policy debates. In comparison, new work in theoretical modeling of relevant aspects of the crisis has been lagging behind the general media discussions. This paper is an attempt to provide a simple theoretical model to help analyze some key aspects of the crisis.

A. The Asian Financial Crisis: Some Observations

This paper concerns several observations on the Asian financial crisis. The first, and perhaps the most dramatic, is the speed and magnitude of the change in capital flows to the affected countries. According to the data recently released by Institute of International Finance (IIF), private capital flows to the five economies most adversely affected by the Asian financial crisis—Korea, Indonesia, Malaysia, Thailand and the Philippines—have changed from an net inflow of $93 billion in 1996 to a net outflow of $12 billion in 1997. The large and sudden reversal in private capital inflows stands in sharp contrast to the mostly favorable macro fundamentals—even in the cases where some fundamentals were weakening, the changes in fundamental positions were rather mild and non-dramatic compared to the dramatic changes in capital flows.

The second observation is the importance of private sector debt financing in most of the affected countries. Since 1990, among the primary international issues by Asian emerging market countries, loan commitments and trade financing have consistently been the dominating forms of financing, followed by bond issues and somewhat small equity issues.[2] Data for end-1996 show that Korea, Thailand and Indonesia were among the largest borrowers in Asia, while Malaysia and the Philippines were not.[3] In Korea, at the height of the crisis in December 1997, domestic financial institutions' external debt maturing within a year exceeded $100 billion, which was more than 10 times the level of official foreign exchange reserve. In Thailand, short-term offshore borrowing by banks, finance companies and corporations constituted a large portion of the country's capital inflow. In Indonesia, about half of the officially reported $110 billion external debt was believed to be short- to medium-term private sector debt, and an unofficial estimate, based on offshore "tombstone" loan syndication announcements, suggests some $30 billion more private external debts than the official estimate.[4] The heavy offshore borrowings were encouraged by the large interest rate differentials between domestic and offshore loan markets. An exception is Malaysia,

[2] See IMF (1997): *International Capital Markets: Developments, Prospects, and Key Policy Issues,* Table 16, p.77.

[3] See IMF: *World Economic Outlook,* 1997, Table 2, p.7.

[4] See: *Oxford Analytica Brief* October 16, 1997:2.

where the domestic interest rate was kept low and short-term capital inflow was discouraged and, as a result, external debt played a less damaging role.

Bank loans played the most significant role in the crisis. According to the IIF data, commercial bank flows to Asia deteriorated from a $55.5 billion net inflow in 1996 to a $21 billion net outflow in 1997, a total change of $76.5 billion. In comparison, bond flows declined relatively modestly. The five worst-affected Asian countries suffered an outflow of $12 billion in portfolio flows while gaining slightly in foreign direct investment.

The third observation is that large capital inflows had preceded the crisis in the affected countries. More interestingly, the pickup in capital flows to the Asian countries did not occur hand in hand with the fast growth of these economies. Rather, large inflows occurred only long after the successful takeoff of these Asian economies, mainly in the 1990s. However, once the large inflow had started—with no accompanying acceleration of growth in the economies—the buildup of the inflow was rapid and large. In other words, there exists *capital inflow inertia.* Earlier studies have found that the rapid buildup of bank lending was a predictor of subsequent financial crisis (see Sachs, Tornell and Velasco, 1996). In this paper, we will show a theoretical linkage between capital inflow inertia and subsequent financial crisis.

The fourth observation is that, while these Asian countries have managed to put in place the basic banking infrastructure, the operating efficiency has been low due to government directed lending, inadequate supervision, lack of open competition, and lack of transparency in the corporate sector, among other things. In contrast, economies with better developed financial intermediaries, such as Hong Kong and Singapore, have proved to be more resilient to the capital market attacks.[5]

The fifth observation is that bank lending has been drastically reduced, and banks have been more cautious in granting loans. In the case of Japan after the burst of the real estate bubble in the early 1990s, banks have cut credits even to their traditional customers. Similarly, banks in Korea which used to lend indiscriminantly at the hint of government directives now are reluctant to lend, contributing to a serious credit crunch that still plagues the Asian economies.

B. Highlights of the Model

Based on the five observations described in the previous section, we develop a new model of external debt financing. At the core of the model is an inefficient financial system which,

[5] Countries with the least developed financial intermediaries were not able to attract a large amount of foreign private credit in the first place, and were spared of drastic outflows despite strong contagion in the region during the crisis.

together with changes in credit supply conditions, is able to explain the capital inflow inertia as well as the crisis. In the context of our model, a crisis is defined as a *large reduction in the amount of loans intermediated by the financial system, i.e., a large capital outflow, even when the economic fundamentals change only slightly.*

The above definition of a crisis points out what we consider one of the main features of the recent crisis. In fact, the large reversal of capital flows was hard to predict if only the economic fundamentals of the affected countries were considered. This apparent paradox dissapears in our model once the financial system is modelled explicitly.

The model deals with foreign debt intermediated by financial intermediaries. It does not necessarily require that the debt to be "foreign". Since the Asian crisis mainly involved external debt, we use the terms "foreign debt" and "foreign depositor" in our discussion. The focus on debt flows reflects the above-mentioned fact that private debt flows played a more important role than other forms of capital flows in those Asian countries severely affected by the financial crisis.

The *financial intermediary* in the model is an abstraction of the intermediation function of banks and other financial institutions as well as the financing arms of corporate borrowers. Note that the financial intermediary can be either foreign or domestically owned, and they can operate either on-shore or offshore. In the case of Asia, some financial intermediation was performed by domestic banks, some by foreign banks lending locally, and some by the offshore financing arms of corporations. In all cases, they face lack of information disclosure in the domestic corporate sector and various costs associated with doing business in an emerging market. These obstacles are represented by monitoring costs in our model.

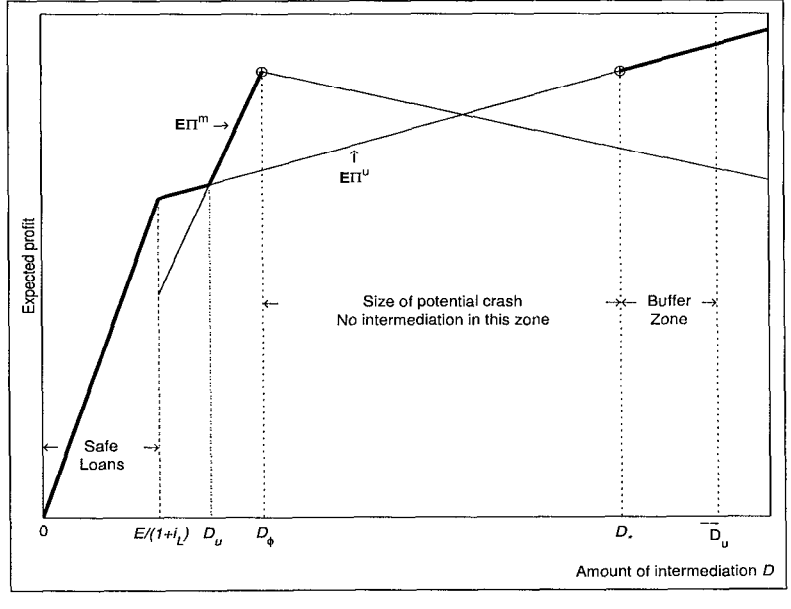
The intermediation function includes the borrowing and lending activities, as well as the *monitoring* of the loans when necessary. Monitoring is defined in a broad sense to include all the activities that can improve the quality of the loans; such activities include screening, due diligence, site visit, and participation in board meetings, etc. The financial intermediary is set in a *closed* capital market in which a positive interest rate differential prevails. Typically, the domestic lending rate is either controlled by the government, or fixed by monopolistic banks which, in reality, are often subject to interest rate ceilings. The intermediary is *inefficient* in the sense that it may choose not to monitor its lending due to, for example, costly and inefficient monitoring technologies. However, the intermediary is *exposed* to foreign credit market in the sense that it has access to and borrows from foreign depositors.[6] Firms borrow from the financial intermediary who in turn borrows from foreign depositors. Firms may succeed or fail in their pursuit of investment opportunities, with the probability of success higher in the case of proper monitoring by the financial intermediary.

[6] Note that exposure or access to international credit markets do not mean that the domestic financial market is *open*. Usually, "open market" reffers to international competition and equalization of domestic and foreign interest rates.

The financial intermediary decides optimally the amount of intermediation and whether to monitor the firms, given the domestic and international interest rates, the salvage value of the firms in the case of bankruptcy, and monitoring costs. Foreign depositors' willingness to lend depends on their expected returns relative to the risk-free rate at their home country.

To highlight the result of the model that is most relevant to the observed large and sudden changes in capital flows, we present a visual preview of the result in Figure 1. The thick lines represent the expected profit to the financial intermediary, with a local maximum at the point D_ϕ, which we will show as the optimal amount of intermediation with monitoring. $\overline{D}_u$ is the maximum supply of credit by the foreign depositor and depends positively upon a measure of the fundamental strength of the economy, which will be shown later. Obviously, if the foreign depositor reduces the credit supply drastically, we will see a drastic reduction in capital inflow as well. In this paper, we focus on the more subtle case in which the changes in foreign credit supply are moderate, but the capital outflow is large. From Figure 1, we can see that the amount of equilibrium intermediation (when demand for credit equals foreign credit supply) can increase, unmonitored, after the switching point D_*. When supply is between D_ϕ and D_*, however, there is no demand for financial intermediation in this region because the expected profit is below the local maximum, and the intermediary's demand is only D_ϕ. So when $\overline{D}_u$ is even marginally below D_*, the size of capital outflow is as large as $D_* - D_\phi$. As we will show, various macroeconomic parameters can affect the supply of foreign credits, as well as the value of D_*,which may lead to a sudden capital outflow of the size $D_* - D_\phi$. More precisely, as pointed out by Wyplosz (1998), this sudden capital outflow is a once-off stock change.

Figure 1: Economy with crisis potential



The moral of the paper is as follows: Financial crisis, in the form of a sudden and large

reversal of private debt inflow, can be a direct result of inefficiencies in the financial sector. The large shifts of financial flows can be traced to the following causes: i) a discontinuous credit demand schedule of the intermediary, ii) the shift in the foreign credit supply, and iii) the combination of the two. When the existing credit supply and demand equilibrium is not far above the switching point D_*, then even a small change in the economic environment can set off a crisis by reducing the supply of foreign credit $\overline{D}_u$ to a level below the demand switching point D_*. In other words, there exists a minimum level of economic fundamental strength that can sustain the amount of capital inflow above D_*. However, if the fundamental strength is not far above this minimum sustainable level, the economy will be vulnerable to shifts in market sentiment and even a small deterioration of fundamentals. Although the reversal of capital inflow may not significantly affect the profit of the financial intermediary, it may severely affect the social welfare which is not explicitly dealt with in this paper. For example, a sharp reduction in the amount of capital inflow may represent a large reduction in productive activities and an increase in unemployment, even with constant returns to scale production technology. It is therefore important for a country to avoid these dangerous situations in its course towards financial development and in the management of capital flows. In certain circumstances, policy instruments can be used to reduce and smooth the shifts in capital flows. The policy instruments include interest rates, measures that affect the economic fundamentals, financial sector reform, capital controls and prudential regulation. The first two will be discussed in this paper, while the rest is discussed in Chan-Lau and Chen (1998).[7]

C. A Literature Review

Most existing theoretical models of financial crisis generally fall into four categories: fundamentals-based models, expectations-based models, multiple equilibria models, and moral hazard models. Since our approach is less related to these models, we only provide a brief review of them below. For a more detailed literature review and the development of the crisis, see Radelet and Sachs (1998a,b) and Corsetti, Pesenti and Roubini (1998).

Fundamentals-based models use changes in fundamentals to derive financial crisis. Theoretically, it is often challenging to produce a large discrete financial flow change from a set

[7] We have not treated explicitly the welfare costs of the crisis. Nonetheless, the size of the capital outflow measures implicitly the costs in terms of fewer projects being financed, and in consequence, a reduction of domestic output. According to Caprio and Klingebiel (1996), the costs of past banking crisis in industrialized countries were in the range of 3% to 17% of GDP; while in developing countries the costs were as high as 25% of GDP. Honohan (1996) estimates that the costs of banking crises since 1980 is nearly a quarter of a trillion dollars. In addition, see Agénor and Aizenman (1998) for a theoretical analysis.

of relatively smooth fundamental variables, although there has been some progress in predicting crisis using composite fundamental variables empirically (Kaminsky and Reinhart, 1996; Kaminsky, Lizondo and Reinhart, 1997; Kaminsky, 1998).

Expectations-based models include models with expectations of future values, as in models of bubbles (Allen and Gale, 1998), models of self-fulfilling expectations (Obstfeld, 1996), and models with expectations of other market participants' actions, as in the liquidity crisis model of Diamond and Dibvig (1983) (and in the open-economy extensions by Chang and Velasco,1997, and Goldfjan and Valdes 1997), where each agent bases his decision whether to withdraw his bank deposit on his expectation of other agents' actions, and a coordination failure can then result in a total panic, i.e., a bank run.

Multiple equilibria models can produce the existence of equally probable equilibria in the same economic environment (Masson, 1998), and can therefore explain the discrete change in financial flows during a crisis as a switch between two equilibria. Usually, such models do not offer direct explanations on how and why the economy shifts from one equilibrium to another.

Moral hazard models with government guarantees have been used extensively in the studies of the U.S. savings and loans crisis (Shoven, Smart and Waldfogel, 1992), and recently by Krugman (1998a, 1998b) in the context of the Asian crisis. Some critics have argued that governments may have provided explicit and implicit guarantees to depositors taking risks in Asia, hence the moral hazard problem.

Though differing completely in model construction, our approach shares a similar spirit with a separate strand of literature. This literature models capital flows in the context of expected return maximization under imperfect financial market conditions. Recent examples include Razin, Sadka and Yuen (1996), and Chen and Khan (1997). In particular, Chen and Khan study portfolio flows to emerging markets which are inefficient and are used as an incentive instrument in corporate governance designed to encourage optimal investment behavior of the firms. It can derive large swings in portfolio equity flows even with a slight change in the growth outlook and/or in the efficiency of the financial market. Such swings are found to be most likely when a country's growth outlook and the efficiency of the financial market are in a moderate range relative to each other, e.g., medium growth potential with a half-baked equity market.

The rest of the paper is organized as follows: Section II presents the details of the model. Section III conducts comparative statics and show how changes in domestic fundamentals, foreign depositors' sentiment, and interest rates affect the outcome of the crisis. It also discusses the issue of financial reform in light of the model. Section IV contains concluding remarks.

II. The Model

There are three different risk neutral representative agents in the model: a depositor (investor), a financial intermediary and a domestic entrepreneur (the firm). The model is centered around the optimal decisions of the financial intermediary in the face of various behavioral configurations of the other two agents.

The domestic entrepreneur owns illiquid assets with terminal value E and the rights to a risky project. The value E can be interpreted as the equity value, the net worth, or the salvage value of the entrepreneur's existing assets, evaluated at the current period when borrowing decision is made. In the aggregate sense, it represents the market valuation of the country's asset, which can be empirically proxied by fundamental variables. The value of E is assumed to be non-random and known to all participants. Because of liquidity constraints, the entrepreneur has to borrow from the intermediary at the gross rate $1 + i_L$ if he wants to pursue the risky project. The return of the project, if successful, is enough to pay back the principal plus the interest. If unsuccessful, however, the project returns 0. The probability of success of the project depends on whether the entrepreneur supplies a high or a low level of effort. In the former case, the probability of success is p_H and p_L in the latter, with $p_H > p_L$. To motivate the monitoring role of financial intermediaries, it is assumed that if the entrepreneur is monitored by the intermediary, he will supply a high level of effort, and if not monitored, he will supply a low level of effort.[8]

The intermediary obtains the funds by borrowing from the foreign depositor at the gross interest rate $1 + i_B$. Under the condition of a closed or inefficient domestic market, the intermediary can profit from the interest rate spread $\Delta i = i_L - i_B$. For now, assume that i_L and i_B are taken as given by the intermediary. To guarantee that non-monitoring is profitable, we need the next assumption:

Assumption 1 $p_L(1 + i_L) \geq 1 + i_B$.

The debt contract between the entrepreneur and the intermediary specifies the following contingent payoffs to the intermediary if the amount borrowed is D:

$$\begin{cases} D(1+i_L) & \text{if the project is succesful or } D(1+i_L) < E \\ E & \text{if the project fails and } D(1+i_L) > E \end{cases}$$

[8] In order to focus on the intermediary, the model does not go into the details of the entrepreneur's incentives problem. We simply assume that monitoring generates better performance, which can be seen as a reduced form of the standard mechanism design problem.

In addition, the intermediary's monitoring cost is characterized by

$$C(D) = \begin{cases} \phi & \text{if } D < D_\phi = E/(1+i_L) + E_\phi,\ E_\phi \text{ constant} \\ \phi + \beta(D - D_\phi) & \text{if } D > D_\phi \end{cases} \tag{1}$$

The cost is a function of the size of the loan, the entrepreneur's asset E, the efficiency of the monitoring technology, which is measured by the parameter $\beta > 0$ and by a fixed cost $\phi > 0$. The fixed cost supports a given level of intermediation, E_ϕ, without further costs to the intermediary. The case of constant monitoring cost is obtained when $\beta = 0$. In general, the efficiency of the intermediary is related to the variable cost, as measured by β, and the fixed cost, as measured by ϕ. Therefore, the intermediary can monitor projects requiring a loan size less than D_ϕ by paying a fixed cost of ϕ.[9] When the loan size is above D_ϕ the monitoring cost increases proportionally in the size of the loan D. Because monitoring is costly, it is not always in the best interest of the intermediary to monitor.

A. The Supply of Foreign Capital

The intermediary cannot borrow without bound from foreign depositors, since foreign depositors' willingness to lend depends on whether their expected return is as high as investing the money in an alternative risk-free asset in their home country.

We begin with the case in which monitoring is performed by the intermediary, so that the probability of a successful project is p_H. When the project is successful, or when the equity value is high enough to pay back the loan, i.e., $E > D(1+i_B)$, the foreign depositor obtains a gross return $1 + i_B$. Otherwise, he obtains a gross return $E/D < (1 + i_B)$, that is, the intermediary takes over the entrepreneur's equity and transfers it to the foreign depositor. Note that here we have made the simplifying assumption that the intermediary has no equity itself.[10] In this case, the expected return of the foreign depositor must be at least equal to

[9] Fixed costs are associated to expenses in facilities and equipment and full-time personnel while variable costs include running and administrative costs. See Kolari and Zardkoohi (1987) for a detailed analysis of the costs of banking.

[10] The zero-equity assumption for the intermediary makes our definition of financial intermediary narrower than real-world intitutions such as banks with their own capital. Therefore, issues such as bank bankrutpcy are not associated with the financial intermediary in our model, but can be interpreted as part of the firm's problem. In practice, banks facing bankruptcy proceedings when their equity was eroded during a crisis may be forced to cut their lending rather than choose to reduce their lending as in our model. In our model, this can be interpreted as the foreign investor, acting through the intermediary to force the firm to use its equity to pay back the debt.

the foreign risk-free rate i_f:

$$p_H(1+i_B)+(1-p_H)\frac{E}{D}\geq 1+i_f.$$

When this condition holds with equality, it determines an upper bound $\overline{D}_m(E)$ of foreign lending to the intermediary

$$\overline{D}_m(E)=\frac{(1-p_H)E}{1+i_f-p_H(1+i_B)}. \tag{2}$$

The subscript m denotes that monitoring is performed. The latter equation makes sense under the following assumption:

Assumption 2 *Given i_f, i_B satisfies the following inequalities: i) $1+i_f > p_H(1+i_B)$ and ii) $i_B \geq i_f$.*

Property i) is needed to guarantee that the maximum loan amount available to the financial intermediary is positive for positive E and is increasing in the amount of domestic net worth. Property ii) simply means that the return offered by the intermediary must be at least equal to the risk-free rate. In the case that $i_B = i_f$, the maximum amount of foreign lending is equal to $E/(1+i_B)$.

Similarly, the maximum amount that can be borrowed by the intermediary when the latter does not monitor the project is given by

$$\overline{D}_u(E)=\frac{(1-p_L)E}{1+i_f-p_L(1+i_B)}, \tag{3}$$

where the subscript u denotes that no monitoring is performed. The next lemma establishes the fact that foreign depositors are willing to lend more if they know that the intermediary is monitoring the domestic firms because the probability of success is higher.

Lemma 1 *Under assumption 2 and given the same E, $\overline{D}_m \geq \overline{D}_u$.*

Proof. Define the function $f(p)=\frac{1-p}{A-Bp}$. Then, $f'(p)=\frac{-(A-Bp)-(1-p)(-B)}{(A-Bp)^2}=\frac{B-A}{(A-Bp)^2}$. Replacing $B=1+i_B$ and $A=1+i_f$ and using ii) in Assumption 2, $f'(p)>0$. ■

Corollary 1 $\overline{D}_m \geq \overline{D}_u \geq E/(1+i_f)$.

The next lemma emphasizes the substitution effect between investing in the domestic economy and the risk-free asset.

Lemma 2 *Given p_L and p_H, the following relationships hold:*

1. $\frac{\partial \overline{D}_u}{\partial i_f} < 0$, $\frac{\partial \overline{D}_m}{\partial i_f} < 0$,
2. $\frac{\partial \overline{D}_u}{\partial i_B} > 0$, $\frac{\partial \overline{D}_m}{\partial i_B} > 0$.

An increase in the risk-free interest rate i_f makes the risk-free asset more attractive and hence reduces foreign depositors' demand for intermediary deposits. On the other hand, an increase in i_B has the opposite effect, since now the return on intermediary deposits increases. In addition, both $\overline{D}_u$ and $\overline{D}_m$ increase when E increases.

Finally, we would like to know how $\overline{D}_u$ and $\overline{D}_m$ are affected by changes in p_L and p_H, which are key determinants of expectations about the overall domestic investment opportunities. In particular, an increase in the probability of success should increase foreigners' demand for domestic assets, as the next lemma states.

Lemma 3 *Given i_L, i_B and i_f, $\frac{\partial \overline{D}_m}{\partial p_H} > 0$ and $\frac{\partial \overline{D}_u}{\partial p_L} > 0$.*

Proof. Follows from the definitions of $\overline{D}_u$ and $\overline{D}_m$ and that $i_L > i_B \geq i_f$. ■

B. The Decision to Monitor

It is clear that there is no need to monitor the entrepreneur if $E > D(1 + i_L)$ since the value of his equity exceeds the value of his liabilities. However, when the entrepreneur is leveraged, that is, when $E < D(1+i_L)$, the case becomes more complex. If the intermediary monitors and the project is successful, its profits are equal to

$$(1 + i_L)D - (1 + i_B)D - \max\{\phi, \phi + \beta(D - D_\phi)\} \equiv \Delta i D - \max\{\phi, \phi + \beta(D - D_\phi)\},$$

where $\Delta i \equiv i_L - i_B$. In case of failure, the profit is given by

$$E - \min\{(1 + i_B)D, E\} - \max\{\phi, \phi + \beta(D - D_\phi)\}$$

Therefore, the financial intermediary's expected profits depend on the size of the loan and are equal to

$$\mathbf{E}\Pi^m(D) = \begin{cases} p_H \Delta i D + (1-p_H)[E-(1+i_B)D] - \max\{\phi, \phi+\beta(D-D_\phi)\} & \text{if } D(1+i_B) < E \\ p_H \Delta i D - \max\{\phi, \phi+\beta(D-D_\phi)\} & \text{if } D(1+i_B) > E \end{cases}$$

where the superscript m denotes the case where monitoring is performed by the intermediary. The next assumption and lemma shows that we should be concerned only with the case in which $D(1+i_B) > E$.

Assumption 3 $E_\phi/E > \Delta i/(1+i_B)(1+i_L)$

This assumption is equivalent to $D_\phi > E/(1+i_B)$, so that in the range relevant to our analysis, $D(1+i_B) > E$ if the foreign credit supply is above $E/(1+i_B)$. The next lemma establishes this fact.

Lemma 4 $\overline{D}_m(E) \geq E/(1+i_B)$

Proof. From the definition of $\overline{D}_m$ in equation (2), the above inequality holds if $i_B \geq i_f$, which must be true because otherwise the foreign depositor is better off investing in the risk-free asset.■

Therefore, the financial intermediary's expected profit if the entrepreneur is monitored is equal to

$$\mathbf{E}\Pi^m(D) \equiv p_H \Delta i D - \max\{\phi, \phi+\beta(D-D_\phi)\}. \tag{4}$$

Similarly, we can show that the expected profit of the intermediary when there is no monitoring is equal to

$$\mathbf{E}\Pi^u(D) \equiv p_L \Delta i D, \tag{5}$$

where the superscript u denotes the case in which there is no monitoring. The decision to monitor depends on whether the expected profit under monitoring exceeds those obtained by not monitoring, or equivalently, whether the following expected profit differential is positive or not:

$$\Delta\mathbf{E}\Pi(D) \equiv \mathbf{E}\Pi^m(D) - \mathbf{E}\Pi^u(D) = \Delta p \Delta i D - \max[\phi, \phi+\beta(D-D_\phi)], \tag{6}$$

where $\Delta p \equiv p_H - p_L$. Note that this relationship is meaningful only when loans are risky, i.e. $E < D(1+i_L)$.

The optimal decision of the intermediary is given by the following proposition:

Proposition 1 ***Existence of a crisis potential.*** *Given the sunk cost ϕ and the variable cost β, there exists a crisis potential only if*

$$\phi \leq \Delta p \Delta i D_{\phi}; \tag{7}$$

$$\beta \geq p_H \Delta i. \tag{8}$$

In addition, the optimal strategy of the intermediary is to:

- *Intermediate the amount $\overline{D}_u(E)$ without monitoring when $\overline{D}_m(E) < D_u$, where $D_u < D_{\phi}$ satisfies $\boldsymbol{E}\Pi^m(D_u) = \boldsymbol{E}\Pi^u(D_u)$.*
- *Intermediate the amount $\min\left\{\overline{D}_m(E), D_{\phi}\right\}$ with monitoring when $\overline{D}_m(E) \geq D_u$ and $\overline{D}_u(E) < D_*$,where D_* satisfies $\boldsymbol{E}\Pi^m(D_{\phi}) = \boldsymbol{E}\Pi^u(D_*)$.*
- *Intermediate the amount $\overline{D}_u(E)$ without monitoring when $\overline{D}_u(E) \geq D_*$.*

Therefore, there exists a discontinuity in capital inflow if $D \in (D_{\phi}, D_*)$.

Remark 1 *The condition (7) implies that the fixed cost of monitoring is relatively low, while condition (8) suggests that the variable cost is relatively high. This corresponds to a financial sector in which the basic banking infrastructure is more or less in place (such as bank branches, computer systems, etc.), but the operating costs are high due to problems in the regulatory framework, asymmetric information, among other things. Arguably, the financial sector in the affected Asian countries falls into this category.*

Proof.

Condition (7) states that when the loan size is equal to D_{ϕ}, $\mathbf{E}\Pi^m(D_{\phi}) \geq \mathbf{E}\Pi^u(D_{\phi})$ and we can show that there exists D_u in $[E/(1+i_L), D_{\phi}]$ such that $\mathbf{E}\Pi^m(D) \geq \mathbf{E}\Pi^u(D)$ when D is in $[D_u, D_{\phi}]$. In fact, when $\phi \leq \Delta p(1+i_L)E_{\phi}$, $\mathbf{E}\Pi^m(D_{\phi}) \geq \mathbf{E}\Pi^u(D_{\phi})$ but at $D = E/(1+i_L)$, $\mathbf{E}\Pi^m \leq \mathbf{E}\Pi^u$. By the mean-value theorem, continuity and monotonicity of $\Delta\mathbf{E}\Pi$ imply that there exists a unique D_u in $(E/(1+i_L), D)$ such that $\Delta\mathbf{E}\Pi(D_{\phi}) = 0$ or $\mathbf{E}\Pi^m(D_u) = \mathbf{E}\Pi^u(D_u)$, so that $\Delta\mathbf{E}\Pi > 0$ when $D > D_u$. Condition (8) implies not only that the marginal gain from monitoring is less than the marginal cost, but that this gain is negative. Therefore, the expected profit obtained by monitoring the entrepreneur has a maximum value when the loan size is equal to D_{ϕ}. Since $\mathbf{E}\Pi^u$ is continuous and increasing, we can apply the mean value theorem to show that there exists $D_* > D_{\phi}$ such that $\mathbf{E}\Pi^m(D_{\phi}) = \mathbf{E}\Pi^u(D_*)$ and that $\mathbf{E}\Pi^u(D) = \mathbf{E}\Pi^m(D)$ when $D > D_*$. When $\overline{D}_m$ available to the intermediary is below D_u, the best strategy is not to monitor and, therefore, to borrow $\overline{D}_u$, since $\mathbf{E}\Pi^u$ is increasing in D. If $\overline{D}_m > D_{\phi}$ but $\overline{D}_u < D_*$, the intermediary chooses to maximize its profits by borrowing only D_{ϕ}. If $\overline{D}_m \in [D_u, D_{\phi})$, then it borrows $\overline{D}_m$. Finally, if $\overline{D}_u < D_*$, then it is optimal to borrow up to $\overline{D}_u$.■

Corollary 2 *When the economy experiences a steady growth and increasingly strong fundamentals that results in a steady expansion of foreign credit supply, $\overline{D}_u$, there may still be no pickup in capital inflow until the economy is so strong that the foreign credit supply limit $\overline{D}_u$ reaches the threshold point D_*, then capital inflow jumps sharply, hence the capital inflow inertia.*

Therefore, the capital inflow inertia arises from the same mechanism that can generate and, perhaps precedes, a crisis. In addition, the properties of D_u and D_* are given by the next corollary.

Corollary 3 *D_u and D_* satisfy the following properties:*

1.

$$D_u = \frac{\phi}{\Delta p \Delta i}, \tag{9}$$

$$\frac{\partial D_u}{\partial \phi} > 0, \tag{10}$$

$$\frac{\partial D_u}{\partial i_L} < 0, \frac{\partial D_u}{\partial i_B} > 0, \frac{\partial D_u}{\partial \Delta i} < 0, \tag{11}$$

$$\frac{\partial D_u}{\partial p_H} < 0, \frac{\partial D_u}{\partial p_L} > 0, \frac{\partial D_u}{\partial \Delta p} < 0. \tag{12}$$

2.

$$D_* = \frac{p_H \Delta i D_\phi - \phi}{p_L \Delta i}, \tag{13}$$

$$\frac{\partial D_*}{\partial E} > 0, \frac{\partial D_*}{\partial \phi} < 0, \tag{14}$$

$$\frac{\partial D_*}{\partial i_B} < 0, \frac{\partial D_*}{\partial \Delta i} > 0, \tag{15}$$

$$\frac{\partial D_*}{\partial p_H} > 0, \frac{\partial D_*}{\partial p_L} < 0, \tag{16}$$

$$\frac{\partial D_*}{\partial i_L} > 0 \Longleftrightarrow p_H E \left[\Delta i/(1+i_L)\right]^2 < \phi \leq \Delta p \Delta i D_\phi. \tag{17}$$

In addition, $\partial D_*/\partial i_L > 0$ in equation (17) requires that E_ϕ satisfies

$$\frac{E_\phi}{E} > \left(\frac{p_H}{\Delta p}\frac{\Delta i}{(1+i_L)} - 1\right)\frac{1}{1+i_L}, \tag{18}$$

otherwise, $\partial D_*/\partial i_L < 0$.

Note that conditions (7) and (8) define a range for the values of Δi and i_L, the latter an implicit function of D_ϕ, as shown in (17) and (1). For interest rates values outside this range, we are in situations where the economy is not subject to a potential crisis. These economies are discussed in a companion paper, Chan-Lau and Chen (1998).

The domestic economy and the world economic environment described above can be parameterized as $\mathcal{E}(p_L, p_H, i_L, i_B, \phi, \beta, E_\phi; i_f, E)$. Given a fixed set of parameters, Proposition 1 states that for certain parameter values, there exists the possibility of a large discrete change in capital flows, i.e., an inertia and a crisis. For other parameter values, we can rule out the occurrence of a crisis, as discussed in the companion paper cited above.

Figure 1 illustrates the profit functions of the financial intermediary under monitoring and non-monitoring regimes ($\mathbf{E}\Pi^m$ and $\mathbf{E}\Pi^u$ respectively), the foreign credit supply limit $\overline{D}_u$. The existence of the discrete jump between the optimal (and somewhat low) level of monitored intermediation and the high level of unmonitored intermediation represents the potential of sharp changes in capital flows when the economy crosses the switching point between monitored and non-monitored intermediation, D_*. For example, assume that $\overline{D}_u$ is slightly higher than D_*. Hence, the intermediary finances a project with size $\overline{D}_u$. Now suppose that there is a slight deterioration in depositors' expectations about the health of the economy, as represented by a small decrease in p_L or in the asset value E, such that now $\overline{D}_u$ is below D_*. The small change in expectations precipitates a drastic contraction of the amount of loans from the original level above D_* to the much lower level D_ϕ. Clearly, the opposite phenomenon is also likely, a sudden increase in loans from D_ϕ to D above D_*. This sudden jump in capital inflow could conceivably take a long time if the underlying fundamentals improve gradually such that the foreign supply limit takes time to move across the interval (D_ϕ to D above D_*), hence the observed *capital inflow inertia* and large reversal of capital inflow are two sides of the same coin. This provides an interesting analytic framework to explain the observed boom-and-bust cycles that characterize the Latin America debt crisis in the eighties as well as the currently ongoing crisis in Asia.

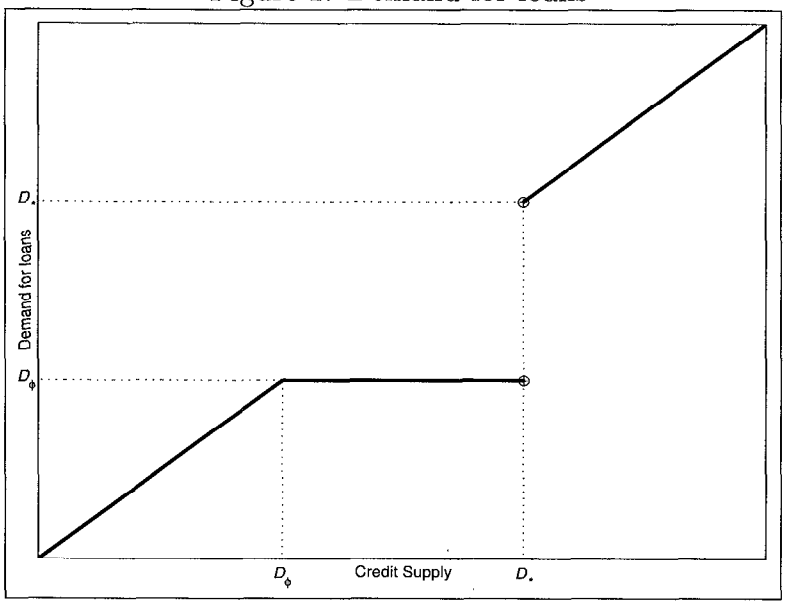
Figure 2 presents the result from another perspective. It shows discontinuous jump when the demand for loans falls short of the available supply of credit.

III. Comparative statics and policy responses to a financial crisis

The focus of our analysis is the crisis. In particular, we are concerned about small changes in the foreign credit supply in the immediate vicinity above the switching point D_*. In this case, the economy is subject to a "hard landing" if foreign depositors' willingness to lend declines, such that $\overline{D}_u$ falls below the switching point D_*. When the economy is on the verge of a collapse, $\overline{D}_u = D_*$ and the magnitude of the impending capital outflow is given by

$$D_* - D_\phi = \frac{\Delta p}{p_L} D_\phi - \frac{\phi}{p_L \Delta i} \tag{19}$$

Figure 2: Demand for loans



Therefore, an adequate policy response would preferably be one that increases the *safety buffer* as measured by $\overline{D}_u - D_*$, so that the economy is safe from the crisis. In the case that a crisis is already underway, a desirable policy response would be to reduce the *size of the crash*, $D_* - D_\phi$. We will show below how this can be achieved through changes in various parameters, some of which can sometimes be controlled by policy authorities.

A. Asset Values/Fundamental Strengths

Consider the case that E is subject to a negative shock. This could occur, for example, when the asset value declines due to, say, a collapsing real estate or equity market. In a broader sense, we can regard E as a proxy for the economy's asset value, which can be further related to the strength of its economic fundamentals. In fact, it is a parameter of the model that is open to broad interpretations. The valuation of E is what matters in the agents' decision process. So changes in agents' perception of the country's fundamental strength, or in market valuations can play a significant role. Further, when the safety buffer is thin, even a small change could trigger a crisis.

According to our model, when E decreases, D_* decreases, but $\overline{D}_u$ also decreases. The following lemma shows that the safety buffer $\overline{D}_u - D_*$ decreases, though the magnitude of the capital outflow $D_* - D_\phi$ remains unchanged.

Lemma 5 *The safety buffer $\overline{D}_u - D_*$ is an increasing function of E.*

Proof: By definition,

$$\overline{D}_u - D_* = \left[\frac{1-p_L}{1+i_f-p_L(1+i_B)} - \frac{p_H}{p_L(1+i_L)}\right] E + \phi - \frac{p_H}{p_L}E_\phi,$$

so it is necessary to show that

$$\frac{1-p_L}{1+i_f-p_L(1+i_B)} > \frac{p_H}{p_L(1+i_L)},$$

or equivalently, that

$$p_L(1+i_L)(1-p_L) > p_H\left[1+i_f-p_L(1+i_B)\right].$$

Because $i_B > i_f$ and recalling Assumption 1, we have that

$$p_H\left[1+i_f-p_L(1+i_B)\right] < p_H(1-p_L)(1+i_B) < p_L(1+i_L)(1-p_L).$$

■

So negative shocks to E increases the likelihood of a crisis. Policies to boost the country's perceived fundamental strength are therefore helpful in preventing the crisis.

In addition to E which reflects the value of *existing* assets, a country's economic fundamentals are also affected by the value of its future investment opportunities, if such opportunities are pursued. In our model, the investment opportunities are measured by the probabilities of success of the entrepreneur's projects, p_H and p_L. From Lemma 2, we know that when these probabilities are higher, the foreign credit supplies are higher. However, an increase in p_H increases D_*, as observed in Corollary 2, equation (16), since it increases the slope of $\mathbf{E}\Pi^m$ and hence, the value of $\mathbf{E}\Pi^m(D_\phi)$. Thus, this increase in p_H increases the size of the crash if it occurs. An increase in p_L has the opposite effect.

B. Intermediary's Lending Rate

We now examine the role of the domestic interest rate, i_L. For convenience, assume that the foreign borrowing rate is constant. Also, we assume for now that i_L is independent of other parameters in the model, including E. On the one hand, from equation (19), an increase in the domestic rate i_L reduces the size of the potential crash, $D_* - D_\phi$, during a crisis, other things being equal. On the other hand, if i_L satisfies

$$p_H E\left[\Delta i/(1+i_L)\right]^2 < \phi,$$

then D_* increases in i_L and it can trigger the crisis by narrowing the buffer zone. Otherwise, the domestic lending rate can be used to help avoid the crisis or reduce the impact of the

crisis. Care should be taken to verify in which range the interest rate lies, so that the authorities can decide whether they should raise or lower the interest rate to help mitigate the crisis. When the interest rate is moved outside the range implied by the conditions as defined in proposition 1, the economy will be shifted to non-crisis regimes, which are analyzed further in Chan-Lau and Chen (1998).

In reality, changes in interest rates can affect other parameters in the model as well, especially the valuation of E. On the one hand, a temporary hike in domestic interest rate may attract capital inflow and improve market confidence, thereby increase E. On the hand, a sustained high level of interest rate may be seen to hurt the corporate sector and reduce the valuation of E. While it is not the purpose of the paper to evaluate the interest rate policy during the Asian crisis—empirical data are needed for that purpose—we want to point out that our model provides a convenient tool to examine the effects of the interest rate policy in a well defined theoretical framework.

C. Intermediary's Borrowing Rate

Let's turn now to the effects of changes in the financial intermediary's borrowing rate, i_B. In practice, it can be viewed as the risk-free rate plus a country premium.

By Lemma 2, a higher borrowing rate i_B makes investing in the domestic economy more attractive to foreign depositors and therefore increases the amount they are willing to lend $\overline{D}_u$. By Corollary 2, D_* is decreasing in i_B and D_ϕ remains invariant. So with a higher borrowing rate i_B, $\overline{D}_u - D_*$ increases and $D_* - D_\phi$ decreases, both working against the crisis scenario and making the country less vulnerable. However, there is a limit to the rise in this rate, because there is an upper bound for the borrowing rate as per Assumption 2. In practice, like the domestic interest rate, the foreign credit market borrowing rate is also not an isolated matter. It can affect a country's debt service burden and corporate solvency, etc., thereby changing the fundamental valuation parameter E.

D. The Risk-Free Rate

If the (risk-free) interest rate in the capital-rich countries increase, i_f, investing in the risky emerging market becomes less attractive. In our model, this is shown as a lower value of $\overline{D}_u$. Since D_* remains unaffected, $\overline{D}_u - D_*$ decreases in i_f and making a crisis more likely.

In reality, there has been clear evidence that the rise and fall of interest rates in capital-rich countries, or the threat of a change in the rates, have been linked to fluctuations in capital flows to emerging markets. In fact, some analyses have attributed the concern on the possibility of an upward adjustment of the U.S. interest rate by the Federal Reserve as a possible cause of capital outflows from emerging markets (See for example, IMF: World

Economic Outlook, 1997). In the same vein, the decision by the U.S. Federal Reserve not to raise interest rates may have been a blessing to the Asian economies in crisis.

IV. Concluding Remarks

Our model differs from conventional models of financial crisis in two ways. First, it relies only on simple and basic cost-revenue calculations of financial intermediaries and foreign depositors. In fact, the results are derived without assumptions such as bubbles and moral hazard, although such additional assumptions can be added to the model to generate richer results. For example, one can add an asset valuation bubble into the valuation of E, and help trigger a crisis when the bubble bursts. Secondly, the model produces a pair of indifference points from the standpoint of the financial intermediary, namely, D_* and D_m,with a discrete change of capital flow between them. While this feature is found in typical multiple equilibria models, our model is decidedly different in that it is able to pinpoint when and why a jump between the two points occurs. Also, the model suggests a mechanism that can generate the following sequence of events as the economy grows.

In the first stage, the model suggests that following the initial take-off, capital inflow does not keep pace with the rapid economic growth for a long period of time. In the case of the Asian "tiger economies," fast growth continued for one or two decades while the scale of capital inflows did not catch up until later (capital inflow inertia). This is because that even when foreign credit supply increases in tandem with economic growth, before reaching the no-monitoring threshold, the intermediary will not intermediate all the credit due to costly monitoring.

In the second stage, the economy and foreign credit supply have grown beyond the no-monitoring threshold, then there is a surge in capital inflow due to the switch from credit rationing to unmonitored intermediation. This happened in the Asian countries in the 1990's.

In the third stage, if an adverse shock pushes the foreign credit supply below the threshold, there will be a financial crisis in the form of large capital outflow in the external front, and a credit crunch in the domestic front.[11]

This paper was motivated by the current Asian financial crisis. As such, in the presentation of the model, we refer to the financial intermediary as a "domestic" institution, and

[11] We have chosen not to model the exchange rate crash directly in the model. The exchange rate crash observed in the Asian crisis is more related to domestic financial institutions and corporations in the affected countries trying to cover their *existing* unhedged external obligations after confidence in the currency had been shaken. Our model is about *new* borrowings under a given exchange market rather than the stock of debt resulted from previous borrowing.

creditors as "foreign" depositors. However, for the model to work, it does not matter what the nationalities of these agents are. For example, the "domestic" intermediary could be an off-shore institution, or a foreign bank operating between foreign creditors and corporate borrowers. Similarly, the "foreign" investor could be a domestic creditor, in which case, the financial crisis will be a domestic one (e.g., the Savings and Loans crisis in the United States).

The financial intermediary in the model captures the essence of an inefficient financial system, which is at the core the Asian financial crisis. In particular, such a system is characterized by somewhat established banking infrastructure but high operating inefficiencies. Such systems are shown to give rise to both capital inflow inertia and a sudden large capital outflow. This analysis sheds new light on the recent financial crisis in Asia, and it also offers a tool to analyze policy responses to the crisis. An important implication of the model is that in the course of developing a country's financial system, there exists a stage in which the economy could be subject to the possibility of a financial crisis, and such a crisis is usually preceded by a period of large capital inflow (unless countered by other policy measures). Policy responses include avoiding staying midway in a financial reform for too long, ensuring solid domestic fundamentals, and carefully monitoring and optimally influencing, if possible, domestic and international credit market interest rates.

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