Financing Decisions of Firms and Central Bank Policy

Ai-Ting Goh
Jacques Olivier

Abstract

This paper aims to explain the sharp rise in unhedged foreign borrowing by South East Asian corporations in the few years prior to the crisis despite remarkably little change in fundamentals. The crucial element of our story is the strategic interaction between firms and the central bank, which gives rise to multiple equilibria: when firms use foreign borrowing, they raise the cost of devaluation to the central bank, which in turn makes foreign borrowing more attractive. Consequently, a small shock to fundamentals may have a large and permanent effect on the equilibrium composition of firms' borrowing.

Keywords: Foreign borrowing; Asian crisis

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1 Ai-Ting Goh is affiliated to the Université catholique de Louvain, IRES and the National University of Singapore. Jacques Olivier to the HEC School of Management and to CEPR. We would like to thank Bernard Dumas and Uli Hege for helpful discussions on related topics, participants to seminars at ESSEC, Namur, and the Université catholique de Louvain for valuable comments on an earlier draft. The first author is grateful for the financial support from the Belgian French Community's program 'Action de Recherches Concertée' 99/04-235. The second author gratefully acknowledges financial support from a HEC research grant. The usual disclaimer applies. Please send all correspondence to Ai Ting Goh, Département des Sciences Economiques, Université Catholique de Louvain, 3 Place Montesquieu, 1348 Louvain La Neuve, Belgium; e-mail: goh@ires.ucl.ac.be
I) Introduction

A few years after the onset of speculative attacks against Asian currencies and the subsequent economic crisis, much remains to be understood about the reasons for the attacks and for the magnitude of the crisis. Arguably, the single most important factor aggravating the crisis has been the enormous amount of foreign currency denominated borrowing by local corporations and financial institutions prior to the crisis. Table 1 shows that foreign bank lending to Asian banks and corporations had been steadily rising prior to the crisis, constituted mostly of short term loans, and frequently exceeded the total level of the country's reserves of foreign currencies. According to IMF, external financing (including bond financing) for Asian countries has tripled between 1992 and 1996. Furthermore, the bulk of this exposure to foreign currency risk remained unhedged. Unhedged exposure to currency risk is central to many theories of the Asian crisis and has indeed contributed to the amplification of the crisis in at least two ways. First, and most obviously, it led to a much increased debt burden of Asian banks and corporations after the devaluation of local currencies. Second, it was conducive of a Diamond-Dybvig (1983) type of liquidity crisis as short run liabilities exceeded short term assets and lenders refused to roll over the loans.

At this date, two explanations for the huge exposure to currency risk of Asian firms have been suggested. The first explanation simply is that local firms underestimated the risk of devaluation. For instance, the IMF International Capital Markets Report

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2 See e.g. Figure 12, p.30, 1997 IMF International Capital Markets Report.
3 According to the IMF, the limited development of currency derivative markets in these countries has been a deliberate policy choice as local authorities feared that currency futures and options could be a vehicle for taking speculative positions and could increase exchange rate volatility (see e.g., IMF International Capital Markets Report, 1998, pp. 77). See also Burnside, Eichenbaum and Rebelo (2000) for reference to further evidence.
4 See e.g. Aghion, Bacchetta and Banerjee (2000), Chang and Velasco (1999) and Krugman (1999)
(1998) states that: "large interest rate differentials [between local and foreign borrowing] created a strong incentive for external borrowing, especially when firms regarded the authorities' ability to sustain their exchange rate arrangements as credible". However, this argument is not entirely convincing. First, from a theoretical standpoint, the existence of a spread between domestic and foreign interest rates is incompatible with the principle of no arbitrage unless agents actually anticipate that a devaluation may take place with positive probability. Second, the spread between domestic and foreign interest rates reached a peak in 1990/1991 while the sharp increase in foreign borrowing took place only in the mid-90's after the magnitude of the spread had already gone down. Third, most of the financial liberalization in the region took place before 1990 so that the local firms could have already taken advantage of the large spreads in the early 90's. Finally, the evolution of credit ratings of Asian credit risk during the 90's suggests little change in the way the risk of Asian borrowers was perceived on international financial markets. In short, there is little evidence of any change in fundamentals large enough to motivate a surge in unhedged foreign borrowing in Asia during the mid-90's.

A second, more appealing, explanation for the exposure to currency risk of Asian firms relies on moral hazard considerations, according to which banks or corporations borrowed externally on the basis of implicit or explicit guarantees by the state. This argument was first brought forward by Krugman (1998). However, at the same time, Radelet and Sachs (1998) pointed out several weaknesses of the moral hazard story: first, one would expect banks to be more often protected by bail-out promises than non-bank corporations. Yet, we observe that the bulk of foreign lending in Asia was

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5 For these two points, see e.g. Johnston, Darbar and Echeverria (1997)
6 See e.g. 67th and 68th Annual Reports of the BIS
aimed at non-bank corporations (with the exception of South Korea). Second, even the evidence among non-bank corporations is inconsistent with the moral hazard story as many firms that were too small or unrelated to the government to expect ex-post bail out were able to and did obtain foreign financing prior to the crisis. Finally, from an ex-post point of view, we observe that many of the firms that borrowed abroad have already gone into bankruptcy or are currently facing bankruptcy.

We suggest in this paper that the surge in the exposure to currency risk by Asian corporations may have been the equilibrium outcome of strategic interactions between firms and the central bank even in the absence of explicit or implicit promises of bail-out. We support this suggestion through a model where firms' financing choices and the central bank's decision to defend the currency are jointly determined. Firms decide upon the optimal amount of foreign financing for a fixed size investment project depending on their expectations of the risk of devaluation. We assume that the cost of financing born by local firms enters negatively into the central bank's objective function. The central bank decides whether it should devalue by comparing the cost of raising domestic interest rates to defend the currency with the cost of devaluation. If firms expect that the central bank has strong incentives to defend the currency, they choose to finance their projects with mostly foreign borrowing, thus raising the cost of devaluation to the central bank and the incentives for other firms to use foreign borrowing. This creates a complementarity between the decisions of the different local firms. An implication is the possibility of multiple equilibria, characterized by vastly different financing decisions of firms. A jump from a low to a high foreign borrowing equilibrium may be caused by even a small change in fundamentals. The impact on

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7 See Table 1
foreign borrowing will be especially large when firms behave strategically and realize the role their financing decisions play in the central bank's decision-making. Hence, high foreign borrowing may have arisen in South East Asia because of a slightly different moral hazard problem from the one emphasized in the existing literature, i.e. because of firms trying to change the ex-ante incentives of the central bank to devalue rather than expecting "ex-post" bail-out in case of a devaluation.

Note that our explanation of the high level of foreign currency denominated debt incurred by the South East Asian firms does not rely on firms systematically underestimating the risk of devaluation. On the contrary, the decisions of the firms are motivated by a full understanding of the trade-offs faced by the central bank. It is widely recognized that, in the recent Asian crisis as well as in other crises, central banks were confronted with a difficult policy dilemma (see for instance Corsetti et. al. 1998 or Dornbush 1998). On the one hand, the weak economy and the collapse of the real estate and asset prices, which weakened the banking sector's portfolio, made raising interest rates very costly. On the other hand, keeping interest rates low at the cost of a devaluation of the local currency would cause the bankruptcy of the many firms that had incurred significant foreign debt. In the case of Thailand, the central bank committed substantial reserves to the defense of the currency and raised the interest rate before finally giving up the peg. In this paper, we postulate, first, that central banks were, as far as possible, trying to minimize the losses incurred by local firms borrowing on foreign capital markets and, second, that these agents perfectly understood their importance for the local authorities.

We are not alone in viewing the high level of foreign borrowing in Asia as an equilibrium phenomenon. A much related paper to ours is Burnside, Eichenbaum and
Rebelo (2000) who argue, as we do, that Asian institutions voluntarily exposed themselves to currency risk as an optimal response to incentives provided by the central bank. However, our analysis differs from theirs in two dimensions. First, they suggest that the incentives provided by the central bank took the form of ex-post bail-out guarantees, which is subject to the Radelet and Sachs (1998) critiques mentioned earlier. Second, while their model can explain a high level of exposure of Asian firms to currency risk prior to the crisis, it cannot explain why that level changed so dramatically between 1992 and 1996 despite remarkably little change in the economic, financial and political environment in Asia during that period.

The rest of the paper is organized as follows: Section II describes the basic model. Section III solves for the equilibrium with competitive firms. Section IV analyzes the impact of the presence of strategic agents on the equilibrium. Section V concludes.

II) The Model

The model is a two-period model with two types of optimizing agents: \( n \) firm managers who try to find the optimal mix of foreign and domestic borrowing to finance a fixed size investment project, and the central bank that must decide on whether to defend a fixed exchange rate. As we wish to focus on the interplay between the optimal decisions of these two types of agents while keeping the model tractable, we do not explicitly model the optimization problem of other agents in the economy, namely, foreign investors and local firms that do not have access to foreign capital markets. However, and as will become apparent later in the paper, we impose only mild assumptions about reduced form specifications of the behavior of these agents.
Firm managers try to minimize the utility cost of financing a project of a fixed size. The utility function of the firm managers is assumed to be quadratic so that they behave in a risk-averse fashion. The financing decision involves the choice between two instruments, foreign or domestic borrowing, which are infinitely divisible. The domestic interest rate is fixed (endogenously) by the central bank at the beginning of each period, before firms make their financing decisions. Domestic borrowing is riskless. Foreign borrowing however, entails a currency risk associated with the possibility that the central bank may choose to devalue when the economy is hit by a stochastic shock to the demand for foreign reserves.

The other agent in the economy is the central bank. The central bank is able to maintain the fixed exchange rate through adjusting domestic interest rates. At the beginning of each period, the economy is subjected to a shock to the demand for the central bank's reserves. It is assumed that, ceteris paribus, the demand for foreign currency reserves is strictly decreasing in the domestic interest rate. Hence, it is equivalent to think of the shock to the demand for the central bank reserves as a shock to the domestic interest rate which the central bank needs to set to maintain the fixed exchange rate. Should the cost of maintaining the fixed exchange rate prove to be too large, the central bank can give up the peg, in which case the currency is devalued by a

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8 We thus follow Obstfeld (1994) in modeling the central bank's decision problem as a trade-off between the cost of high interest rate (to maintain the fixed exchange rate) and the cost of opting out of the fixed exchange rate system.

9 Since our objective is not to explain what triggered the Asian crisis but rather to understand financing decisions that occurred before the crisis, we shall not take a stand as to the origins of a shock large enough to force the central bank to devalue. It may either originate from a shock to fundamentals as in first generation models of currency crises (Krugman, 1979) or, more likely in the Asian crisis case, from a shift in expectations moving the economy to a new equilibrium (e.g. Obstfeld, 1994).

10 Note that this interest rate is fixed before firms make their financing decisions. Hence, we are implicitly assuming that borrowing of local firms is negligible compared to the overall demand for central bank reserves.
fixed percentage. In deciding whether to maintain the peg or not, the central bank has to trade off between two opposing costs. On the one hand, high domestic interest rates (are exogenously assumed to) have a negative impact on the domestic economy. On the other hand, devaluation hurts firms that financed part of their projects with foreign loans. The larger the fraction of the projects which is financed by foreign currency loans the greater the cost of devaluation to the central bank. The central bank thus chooses to opt out when the costs imposed by the level of interest rate necessary to support the peg outweigh the cost of the increased burden of external debt on firms in the event of devaluation.

We first summarize the timing of events before describing the firms' and the central bank's problem in more details:

**Timing**

**Period 0**

Beginning of period:

a) Realization of a stochastic shock to the demand for foreign reserves.

b) The central bank decides on whether to devalue or not and thus determines the level of the current period domestic interest rate $r^d_0$.

c) Firms decide on the amount of foreign borrowing at rate $r^f_0$ and of the amount of domestic borrowing at rate $r^d_0$.

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11 For instance, and of relevance in the South East Asian case, by raising the cost of borrowing for firms or agents that do not have access to foreign capital markets.
End of period:
Firms receive borrowed funds and use them for their (fixed sized) investment project.

**Period 1**

Beginning of period:

a) Realization of a stochastic shock to the demand for foreign reserves.

b) The central bank decides on whether to devalue or not and thus determines the level of the current period domestic interest rate $r_1^d$.

End of period:
Investment projects pay off and firms reimburse their debt and the world ends.

**Firms' Financing Decision**

Each representative firm must finance an investment project of a fixed size, which we normalize to 1. At time 0, the firm chooses the optimal proportion of domestic versus foreign financing by solving the following problem:

$$
\text{Min}_{f \in [0,1]} E_0 [C(f; \varepsilon) + \frac{A}{2} (C(f; \varepsilon))^2]
$$  \(1\)

where $C(f; \varepsilon)$ is the cost of financing the project if a fraction $f$ of the project is financed through foreign currency denominated loans. The quadratic term in problem (1) captures the risk aversion of the firm managers with $A$ indicating the coefficient of risk aversion. $C(f; \varepsilon)$ is given by:

$$
C(f; \varepsilon) = f (1 + r_0^w) \varepsilon - f + (1 - f) r_0^d
$$  \(2\)
where $\varepsilon = \frac{e_1}{e_0}$, and $e_0$ and $e_1$ are the exchange rates (domestic currency per unit of foreign currency) prevailing in the first and second period, respectively. Note that $e_0$ and $r_0^d$ are determined before the firm makes its financing decision and are thus taken as exogenous by the firm. For convenience and without loss of generality, we normalize the foreign interest rate, $r_0^w$, to zero. As a consequence, the correct interpretation of $r_0^d$ in our model is that of a spread of domestic interest rates over foreign interest rates. We also make the following assumption about the activity of firms:

**Assumption 1**

Firms are not allowed to lend money, neither on foreign nor on local markets so that: $f \in [0,1]$.

Finally, we make the following important remark:

**Remark 1**

Firm's decisions remain unchanged at the equilibrium if we introduce a futures market on foreign currency.

*Remark 1* holds because futures contracts are a redundant asset given the assets already available in the economy. By the principle of no arbitrage, it must be strictly equivalent at the equilibrium to borrow in foreign currency and hedge the exposure to.

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12 Since we have not assumed limited liability there is no reason for the interest rate charged by the lender to be contingent on the firm's decision. In a setting with limited liability, one could defend the same assumption on the grounds that $f$ is not directly observable by the lender.
currency risk or to borrow domestically. Hence, one can think of the decision variable \( f \) as either foreign borrowing given that no derivative market exists or, equivalently, as the share of borrowing that the firm has optimally decided to keep unhedged to currency risk if currency derivatives are available.

**The Central Bank's Problem**

At the beginning of the second period, a random shock to the central bank's reserves occurs. We may interpret the shock as a speculative attack on the currency. If the central bank chooses to maintain the current exchange rate it has to raise the interest rate to a level sufficient to attract foreign investment into the country. We note by \( d_r^1 \) the level of domestic interest rates necessary to maintain the fixed exchange rate at \( t=1 \). \( d_r^1 \) is a random variable whose realization is known at the beginning of time 1, before the central bank gets to decide on whether to devalue or not. We denote the level of domestic interest rates in case of a devaluation by \( r^* \). For simplicity and without any impact on the results, \( r^* \) is supposed to be deterministic and constant.

Given \( d_r^1 \) and \( r^* \), the objective of the central bank at the beginning of period \( t=1 \) is to minimize the following loss function:

\[
L(r^*, d_r^1) = \min_{\{1,1+,\ldots,1\}} \sum_{i=1}^{n} w_i [C(f_i; \epsilon) + \frac{A}{2}(C(f_i; \epsilon))^2] + g(r_i^d) \tag{3}
\]

s.t.

\[
\begin{align*}
\epsilon &= 1 + \nu \quad \Rightarrow \quad r_i^d = r^* \\
\epsilon &= 1 \quad \Rightarrow \quad r_i^d = d_i^1
\end{align*}
\]
where \( v \) is the proportionate change in the exchange rate in the second period in case of a devaluation and where the function \( g(r) \) captures the cost of high domestic interest rates.

Note that the central bank's objective function explicitly contains the firms' financing cost. The \( w_i \)s are weights which reflect the degree of influence each of these firms has on the central bank policy. We also assume the following about the function \( g \):

\[
g' > 0, \quad g'' > 0, \quad g(0) = 0, \quad \lim_{r \to r_u} g(r) = \infty
\]

That is, we assume that the cost of high interest rates to the rest of the economy is increasing and convex in the level of domestic interest rates. The third assumption is a normalization done without any loss of generality. The last assumption ensures that there are some levels of high interest rates that are too costly to adopt, regardless of the financing decisions of firms that have access to foreign debt markets. This in turn ensures that the probability of devaluation is strictly greater than zero regardless of the firms' actions.

We make the following assumption with regard to the distribution of \( \tilde{r}_1^d \):

**Assumption 2**

The distribution of the random shock is such that the interest rate necessary to maintain the current exchange rate, \( \tilde{r}_1^d \), is uniformly distributed on an interval \([0, r_u]\).

Finally, we make the following assumptions about the size of the devaluation:
**Assumption 3**

The size of the devaluation if the central bank chooses to give up its peg, \( \nu \), is a function of \( r_0^d \) only.

**Assumption 4**

\[ \nu (r_0^d) > r_0^d \quad \text{and} \quad \nu (r_0^d) < 2r_0^d \]

*Assumption 3* is a simplifying assumption which does not affect the results but allows for simple closed form solutions. The first part of *Assumption 4* is a necessary and sufficient condition to prevent arbitrage opportunities; the second part guarantees that the reaction functions of both types of agents are well-behaved.

We are now ready to solve the model in the case where firms are too small to influence the central bank's policy.

**III) The Competitive Equilibrium**

In this section, we assume that no firm manager realizes the impact that his financing decision has on the central bank policy. Instead, firm managers behave competitively taking the central bank's policy as given. We solve the model by backward induction, first solving the central bank's problem, then the firms' financing decisions.

From problem (3), we find that the cost for the central bank to devalue is:
while the cost to maintain the fixed exchange rate is given by:

\[
\sum_{i=1}^{n} w_i \left\{ (1 - f_i) r_o^d + \frac{A}{2} (1 - f_i) r_0^d \right\}^2 + g(r^*)
\]

Since \( g \) is an increasing function of interest rates, the optimal decision of the central bank is to devalue if and only if the interest rate necessary to maintain the peg, \( \bar{r}_i^d \), is larger than the opting-out interest rate, \( r_m \), where \( r_m \) is implicitly determined by the following equation:

\[
\sum_{i=1}^{n} w_i \left\{ (1 - f_i) r_o^d + \frac{A}{2} (1 - f_i) r_0^d \right\}^2 + g(r^*) = \sum_{i=1}^{n} w_i \left\{ (1 - f_i) r_o^d + \frac{A}{2} (1 - f_i) r_0^d \right\}^2 + g(r_m)
\]

Using the fact that all firms are identical and that there is a unique maximum to the firm's problem, (4) can be rewritten as follows:

\[
r_m = g^{-1} \left( g(r^*) + \omega \left\{ \hat{f} \hat{v} + \frac{A}{2} (\hat{f} \hat{v}^2 + 2f (1 - f) \hat{v} r_0^d) \right\} \right)
\]

where \( f_i = f_j = f \) and \( \omega = \sum_{i=1}^{n} w_i \).

Equation (5) describes the reaction function of the central bank to the firms' financing decisions. The following lemma, proved in the appendix, derives some useful properties of that reaction function:
Lemma 1

The central bank's opting out interest rate \( r_m \) has the following properties:

i) \( r_m(0) = r^* \)

ii) \( r_m(1) < r_u \)

iii) \( r_m'(f) > 0 \)

iv) \( r_m''(f) < 0 \)

Proof: see Appendix

Remark 2: Assumption 2 implies that the probability of devaluation is then given by:

\[
\frac{r_u - r_m}{r_u}.
\]

We now solve the firm's problem taking \( r_m \) and, hence, the probability of devaluation as given. Using the previous remark, we can rewrite problem (1) as:

\[
\text{Min}_{f\in[0,1]} \left\{ \frac{r_m}{r_u} \left\{ (1-f)r_0^d + \frac{A}{2} (1-f)^2 r_0^d \right\} + \left( \frac{r_u - r_m}{r_u} \right) \left\{ [fV + (1-f)r_0^d] + \frac{A}{2} [fV + (1-f)r_0^d]^2 \right\} \right\}
\]

Solving problem (6), we get:

Lemma 2

i) The firm's optimum amount of foreign borrowing \( f(r_m) \) is given by:

\[
f(r_m) = \min \left\{ 1, \max \left\{ 0, f^*(r_m) \right\} \right\}
\]  where
\[
 f^* (r_m) = 1 + A r_0^d \frac{r_m r_0^d}{r_u} \frac{r_u}{r_m} \frac{r_u - r_m}{r_u} (\nu - r_0^d) \\
 A \frac{r_m r_0^d}{r_u} + \frac{r_u - r_m}{r_u} (\nu - r_0^d)^2 
\]

(7)

\[ ii) f^*(r_m) > 0 \] (8)

\[ iii) f^{*''}(r_m) < 0 \] (9)

Proof: See Appendix.

Putting together Lemma 1 and Lemma 2 we find that the amount of foreign borrowing by a competitive firm is increasing in the central bank's opting out interest rate which is itself increasing in the amount of foreign borrowing by firms. This implies a complementarity between the financing decisions of the different local firms. If, for whatever reasons, a firm decides to borrow funds abroad, it raises the incentives for the central bank to defend the currency, which in turn makes it more attractive for other local firms to use foreign borrowing. We suggest that this complementarity may be one of the determinants of the observed high foreign borrowing across the board in Asian countries. Some initial foreign borrowing may have been caused, either by misperception of risk or by promises of bail-out as suggested in the existing literature, or by strategic behavior of cronies trying to influence central bank's decisions as we suggest later in the paper. The complementarity between the decisions of the different firms will then guarantee that other firms will optimally "imitate" the cronies, thus explaining one of the puzzles of the high South East Asian foreign borrowing: if the financing decisions of larger firms were motivated by moral hazard considerations, why did smaller firms also suddenly choose to expose themselves to currency risk?
We now put together the reaction functions of both firms and central bank to solve for the equilibrium of the economy with competitive agents. An equilibrium is a solution to the equation $f(r_n(f)) = \hat{f}$. Lemmas 1 and 2 imply that $f^*(r_n(f))$ is a strictly increasing concave function. This property and some straightforward computations in the appendix allows us to derive the following proposition:

**Proposition 1**

i) There exists a unique equilibrium with positive foreign borrowing iff:

$$r^* > r_u \frac{v - r_0^d}{v}.$$ 

ii) Suppose $r^* \leq r_u \frac{v - r_0^d}{v}$

Then no foreign borrowing is an equilibrium. Furthermore, there may also exist 0, 1 or 2 other equilibria with positive foreign borrowing.

Proof: See Appendix.

Proposition 1 contains a number of results. First, and as we conjectured earlier in the paper, the complementarity between the financing decisions of the different local firms can be the source of multiple equilibria. As economists, we have little to say about which of different possible equilibria occurs in real life, so we shall not comment any further on this part of Proposition 1 except to mention the possibility for strategic firm managers to coordinate on the equilibrium that gives them the highest utility. In general, one would expect that equilibrium to be the one with the most foreign borrowing as it allows firms with access to foreign capital markets to exploit to the maximum the spread between domestic and foreign interest rates. Of course, that
equilibrium is also the equilibrium where firms or agents that do not have access to foreign capital markets suffer the most as the central bank will be willing to raise domestic interest rates to a higher level than in equilibria with a lower level of foreign borrowing by local corporations.

However, the central result in Proposition 1 is that even small changes in fundamentals may move the economy from a situation where "no foreign borrowing" is a possible equilibrium (case ii of Proposition 1, described in Figure 1) to a situation where "high foreign borrowing" is the only possible equilibrium (case i of Proposition 1, described in Figure 2). The variable that plays the key role in determining the number of possible equilibria is $t_0^d - \nu \left(1 - \frac{r^*}{r_u}\right)$, which can be interpreted as a spread between domestic and foreign interest rates, adjusted for the risk of devaluation. High foreign borrowing is the unique equilibrium if and only if the risk-adjusted spread is positive. Hence, if the economy starts at the low foreign borrowing equilibrium a small shock to fundamentals may have a discontinuous effect on the equilibrium composition of firms borrowing if it pushes up the risk-adjusted spread to the positive region. Furthermore, it can easily be seen that the high foreign borrowing equilibrium is stable so that even a temporary shock to the risk-adjusted spread may have a permanent impact on foreign borrowing. Thus we view Proposition 1 as providing an essential clue to the last two main puzzles of Asian foreign borrowing: first, why did it start picking up in the early 90's despite little change in the fundamentals and, second, why did it keep growing despite a sharp decline in the

13 Since the world interest rate has been normalized to 0, $t_0^d$ measures the spread between domestic and foreign interest rates. $\nu$ measures the percentage capital loss in the event of devaluation while $\left(1 - \frac{r^*}{r_u}\right)$ measures the probability of devaluation in case of no foreign borrowing.
spread of domestic vs. foreign interest rates?

In next section, we finally investigate how strategic behavior on the part of firm managers can exacerbate the impact of a small shock to fundamentals on the equilibrium composition of firms' borrowing.

IV) The Economy with Strategic Firm Managers

The maximization problem of a strategic firm manager is given by:

$$\min_{f \in [0,1]} \left\{ \frac{r_u(f_i, \bar{f})}{r_u} \left\{ (1 - f_i) r_0^d + \frac{A}{2} [(1 - f_i) r_0^d]^2 \right\} + \frac{r_u - r_m(f_i, \bar{f})}{r_u} \left\{ [f_i \nu + (1 - f_i) r_0^d] + \frac{A}{2} [f_i \nu + (1 - f_i) r_0^d]^2 \right\} \right\}$$  \hspace{1cm} (10)

where $\bar{f}$ is the vector of financing choices of all firms that have a positive weight in the central bank's objective function. We look at the (symmetric) Nash equilibrium of a game where all firms move simultaneously so that firm $i$ takes $\bar{f}$ as given.

The first order condition of the firm's minimization problem is given by:

$$A f_i \left( \frac{r_m}{r_u} r_0^d + \frac{r_u - r_m}{r_u} (\nu - r_0^d)^2 \right) - (1 + A r_0^d) \left( \frac{r_m}{r_u} r_0^d - \frac{r_u - r_m}{r_u} (\nu - r_0^d) \right) - \frac{\partial r_m}{\partial f_i} \left\{ \frac{A}{2} [f_i \nu + (1 - f_i) r_0^d]^2 \right\} = 0$$  \hspace{1cm} (11)

where:

$$\frac{\partial r_m}{\partial f_i} = w_i \frac{\nu + A [f_i \nu^2 + (1 - 2 f_i) r_0^d \nu]}{g'(r_m)} > 0$$
Since the second order condition is satisfied for the competitive firm's problem, we know by continuity that the second order condition for problem (10) is satisfied in a neighborhood of \( w_i = 0 \). Furthermore, by implicitly differentiating (11), we can find the change in the firm's optimal amount of foreign borrowing as the firm's influence on the central bank's decision, \( w_i \), increases. It is straightforward to show that this derivative is positive around \( w_i = 0 \). In other words, strategic firms borrow more abroad than competitive firms, and the more important they are for the central bank, the more they expose themselves to currency risk. Since the central bank's reaction function is unchanged compared to the previous section, the consequence of strategic behavior on the part of the local firm is to shift up the concave curves in Figures 1 and 2. This in turn yields the following proposition:

**Proposition 2**

A larger weight of firms, \( w_i \), in the central bank's objective function implies the following:

- a milder condition on risk adjusted spread for "high foreign borrowing" to be the only equilibrium
- a higher proportion of unhedged foreign borrowing, \( f \), at the "high foreign borrowing" equilibrium
- a larger difference between unhedged foreign borrowing at the "low foreign borrowing" equilibrium and unhedged foreign borrowing at the "high foreign borrowing" equilibrium

**Proposition 2** shows that strategic behavior on the part of firms exacerbate the issues we raised in the previous section. The point is of special relevance for the Asian
crisis due to the presence of a small number of large firms that were able to get financing on foreign capital markets and that had a special weight in the government or the central bank's objective function (the so called "cronies"). By simply realizing their importance for the local authorities, these firms had the incentives to strategically increase their foreign borrowing. Other firms then followed suit given the complementarity between firms' financing decision we pointed out in the previous section. Thus, the presence of implicit or explicit government guarantees to bail out firms in case of a devaluation is not necessary to explain the high foreign borrowing of firms in South East Asia. The simple fact that some firms realized that their financing decisions could change the central bank's decision regarding devaluation is sufficient for that purpose.

V) CONCLUSION

In this paper, we develop a simple static model of the choice by a firm between foreign and domestic financing in the presence of a risk of devaluation. We showed the existence of a strategic complementarity between financing decisions of firms and central bank policy, which can generate multiple equilibria. As a consequence, a small temporary shock to fundamentals may have a large permanent impact on the equilibrium composition of firms borrowing. Finally, strategic behavior on the part of firms' managers exacerbates the impact on foreign borrowing.

We conclude from these results that the large amount of foreign borrowing observed in South East Asia may be due to an unusual moral hazard problem, i.e. to firms trying to change the ex-ante incentives of the central bank to devalue rather than to firms expecting ex-post bail-out in case of a devaluation. A final remark though is
that the two types of moral hazard problems are not mutually exclusive. Even if guarantees of ex-post bail-out cannot explain the bulk of the surge in foreign borrowing in Asia in the mid 90's, they certainly played a role at least as far as the banking sector is concerned. Hence, we view the argument of this paper as complementary, and not substitutable, to those of the existing literature.
References


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Krugman, P. (1998) "What happened to Asia?", mimeo, MIT


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Appendix

Proof of Lemma 1

i) Substituting $f=0$ into equation (5), it is immediate that:

$$r_m(0) = r^*$$

ii) is immediate from the assumption that $\lim_{r \to r_0} g(r) = \infty$ and the fact that

$$g(r^*) + \omega (\nu + \frac{A}{2} \nu^2) < \infty$$

iii) From equation (5), we can find the derivative of $r_m$ w.r.t. $f$ to get:

$$r_m'(f) = \omega \frac{\nu + A(f \nu^2 + (1 - 2f) \nu r_0^d)}{g^2 \left[ g(r^*) + \omega (f \nu^2 + \frac{A}{2} \nu^2 + 2f(1 - f) \nu r_0^d) \right]}$$

(A1)

Note that the denominator is positive since $g'(r)>0$. Let $N$ be the numerator.

$$N \equiv \nu (1 + Ar_0^d) + Af \nu (\nu - 2r_0^d).$$

(A2)

Since $(\nu - 2r_0^d) < 0$ by assumption 4, we note that $N'(f)<0$.

$$N \geq N(1) = \nu (1 + Ar_0^d) + Af \nu (\nu - 2r_0^d)$$

$$= \nu + Af (\nu - r_0^d) > 0$$

(A3)

since by assumption 4, $(\nu - r_0^d) > 0$.

iv) Differentiating (A1), we have:

$$r_m''(f) = \omega \frac{Av (\nu - 2r_0^d) g'(g^{-1}) - \frac{g''(g^{-1})}{g'(g^{-1})} N^2}{\left[ g'(g^{-1}) \right]^2}$$

(A4)

where $N$ is given by (A2). It is clear from (A4) that since $(\nu - 2r_0^d) < 0$, $r_m''(f)<0$.

QED

Proof of Lemma 2
i) The first order condition for the firm's problem is given by:

\[
\frac{r_m}{r_u} \left\{ -r_0^d - A(1 - f^*)(r_0^d)^2 \right\} + \left( \frac{r_u - r_m}{r_u} \right) \left[ (v - r_0^d) + A [f^*v + (1 - f^*)r_0^d](v - r_0^d) \right] = 0
\]

(A5)

\[
\Rightarrow f^*(r_m) = \frac{1 + Ar_0^d}{A} r_u \frac{r_u r_0^d - (r_u - r_m)(v - r_0^d)}{r_u (r_0^d)^2 + (r_u - r_m)(v - r_0^d)^2}
\]

(A6)

If \( f^*(r_m) > 1 \), then the optimal amount of foreign borrowing is equal to 1. If \( f^*(r_m) < 0 \), then the optimal amount of foreign borrowing is equal to 0. Hence the optimal amount of foreign borrowing is given by:

\[
f(r_m) = \min \left[ 1, \max \left( 0, f^*(r_m) \right) \right]
\]

ii) Differentiating (A6) w.r.t. \( r_m \) we have:

\[
\frac{d}{dr_m} f^*(r_m) = \frac{1 + Ar_0^d}{A} \frac{r_0^d r_u v}{r_m (r_0^d)^2 + (r_u - r_m)(v - r_0^d)^2}
\]

(A7)

Since \( (v - r_0^d) > 0 \) by assumption 4, we get:

\[
f^*(r_m) > 0.
\]

Similarly, \( (v - r_0^d) < r_0^d \) by assumption 4, hence:

\[
f^*''(r_m) < 0. \quad \text{QED}
\]

Proof of Proposition 1

(i) Suppose that:
Then \( f = 0 \) is not an equilibrium.

**Case 1:** There is no \( F \in (0, 1) \) such that \( f^*(r_m(F)) - F = 0 \). Hence there is no equilibrium in \((0, 1)\). However, by continuity, we have:

\[ f^*(r_m(1)) > 1 \]

and hence \( f = 1 \) is an equilibrium.

**Case 2:** There is a \( F \in (0, 1) \) such that \( f^*(r_m(F)) - F = 0 \). Hence, \( f = F \) is an equilibrium. However, notice that the function \( f^*(r_m(f)) - f \) is concave, is positive for \( f = 0 \) and is equal to zero for some \( f = F > 0 \). Hence, both the function and its derivative take negative values for all \( f > F \). Hence, there is no other equilibrium.

(ii) Suppose \( r^* < r_u \left( \frac{V - r_0^d}{V} \right) \), then \( f = 0 \) is an equilibrium.

**Case 1:** There is no \( F \in (0, 1) \) such that \( f^*(r_m(F)) - F = 0 \). Hence there is no equilibrium in \((0, 1)\).

**Case 2:** There is a \( F \in (0, 1) \) such that \( f^*(r_m(F)) - F = 0 \). Let \( F_I \) be the smallest such number. Then \( F_I \) is an equilibrium and the derivative of \( f^*(r_m(f)) - f \) is non negative at \( F_I \). If \( F_I = 1 \), then there is no other equilibrium. If \( F_I < 1 \) and the derivative at \( F_I \) is equal to 0, then by strict concavity, both the function \( f^*(r_m(f)) - f \) and its derivative take negative values for all \( f > F_I \) and there is no other equilibrium. If \( F_I < 1 \) and the
derivative at $F_1$ is positive, the same argument as for case (i) implies that there exists exactly one other equilibrium. 

(iii) Suppose $r^* = r_u \frac{(v - r^d)}{v}$, then $f = 0$ is an equilibrium and the same arguments as above imply that there exists 0 or 1 other equilibrium. QED
Figure 1  Competitive Firm Managers: the multiple equilibria case

\[ b = 1 + Ar^d_0 \frac{r^*_u}{r^*_u - (r^*_u - r^*_u)(V - l_0^d)} \]

\[ \frac{r^*_u}{r^*_u - (r^*_u - r^*_u)(V - l_0^d)} \]

\[ \frac{r^*_u}{r^*_u - (r^*_u - r^*_u)(V - l_0^d)^2} \]

\[ \otimes \text{ : Equilibrium} \]
Figure 2 Competitive Firm Managers: The unique equilibrium case

\[ d = \frac{1 + Ar_0^d}{A} \frac{r^* r_0^d}{r_u} \frac{(r_u - r^*)}{r_u} (V - r_0^d) \]

\[ \frac{r^* r_0^d}{r_u} \frac{r_0^d}{r_u} \frac{(r_u - r^*)}{r_u} (V - r_0^d)^2 \]

\[ \otimes \quad : \text{Equilibrium} \]
Table 1 International Claims Held by Foreign Banks- Distributed by Maturity and Sector

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<th>Short Term ≤ 1 yr</th>
<th>Banks</th>
<th>Public sector</th>
<th>Non-bank private</th>
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<td>In billions of US dollars</td>
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