Hyperbola of external debt: A Lesson from the Asian Crisis

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Abstract

With an observation of the stylized facts of the crisis-hit Asian countries, the paper presents the 'hyperbola of external debt' hypothesis contending that there may exist a threshold hyperbola warning a prospective occurrence of currency crisis. The empirical evidence show that given the financial fragility and others, a composite indicator for making diagnosis on the healthiness of the external debt position of a country is roughly the product, {the ratio of total external debt to GDP (%) – 10%}{the ratio of short-term external debt to total external debt (%) – 10%}.

JEL Classification: F34

Key Words: Asian Crisis, External Debt, Liquidity Crisis

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1. Introduction

It is now a unanimous consensus that one of the critical factors leading up to the Asian crisis was the upsurge in the international capital inflow towards Asian countries since the early 1990s, particularly during 1994 to 1996. Indeed, while the private capital inflow towards five crisis-hit Asian countries had tremendously increased to more than 100 billion dollars in 1996 from some 40 billion dollars in 1994, this inflow has abruptly dropped 100 billion dollars to 0.2 billion dollars in 1997 and even turned to negative, outflow of 27.6 billion dollars in 1998 (see IIF, 1999). With this sudden reversal of private capital inflow, many countries have been ailed initially by the liquidity crisis and then by the banking crisis, which has further led to the collapse of the link between the saving and investment, resulting in the dramatic improvement of the current account balance at the expense of the domestic depression.

Observing those painful adjustments, many researchers have pointed out the importance of the management of capital inflow towards the emerging market economies in the age of globalization, whereas there seem little explanation and empirical evidence of the mechanism that links the mismanagement to the sudden collapse of the investor's confidence.[1] The purpose of this paper is to investigate how the mismanagement of the

[1] There are several main streams to explain the Asian financial crisis. The first and initially most influential view was the argument based on the moral hazard coupled with the government intervention (see Burnside et.al., 1998; Corsetti et.al., 1998a, b; Dooley, 1997; Krugman, 1998a, among others). The second view, which is closely related to the first argument and may be called 'mishandled liberalization argument', has argued that many Asian countries had made several false steps towards the financial liberalization (see Chang, 1998; Chang et al., 1998; Mckinnon and Pill, 1996; Wade, 1998a, b, among others). The third view, which has been exerting more and more pervasive influences on the current tide of opinion, reflecting the global unfolding of the crisis encompassing the developed countries as well as the emerging markets economies, emphasizes the lender's liabilities (see Chang and Velasco, 1998a, b; Radelet and Sachs, 1998a, b). Finally, there is an argument to underscore the harmful effect of the large swing of the yen-dollar exchange rate within

capital inflows is related to the crisis, focusing on the instability due to the external debt structure of a country.

Specifically, we will provide a new idea, 'hyperbola of external debt' hypothesis, which emphasizes the importance of the due diligence of both the size *and* composition of the external debt. This hypothesis came from a close observation of the external debt structure of the afflicted Asian countries. For example, Korea has been notorious for her extraordinarily high dependence on the short-term external debt, 57% of total external debt as of end-1996, with the external debt standing at the relatively low level, 34% of GDP in 1996, which was much smaller than that in the mid-1980s (50%). However, one can easily find other countries whose reliance on the short-term external debt is comparable or even higher, and representatives were Czech Republic (50%), South Africa (57%), Taiwan (73%) and Botswana (96%) as of end-1996. On the other hand, Indonesia has been concerned about its heavy external indebtedness, whereas there are many countries such as, say, Côte d'Ivoire, Jordan and Ghana, whose external debt is much larger than that of Indonesia even though restricting ourselves to the emerging market economies. It turns out that we need at least two dimensional approach and we try to construct a useful indicator warning an emerging crisis by using two ratios, the ratio of total external debt to GDP (or GNP) and the ratio of short-term external debt to total external debt. Our exclusive focus on these two ratios obviously has several advantages. First, these are so ready to construct that many researchers have extensively utilized them to make diagnosis on the healthiness of the external debt

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the backdrop of the then virtually US dollar pegging exchange rate system of Asian countries (see e.g.,

structure of a country. Second, two ratios succinctly capture the past history of the size and composition of the capital inflows in terms of the stock dimension, although crude in that these omit the equity capital. Third, we can easily construct the two dimensional diagram in terms of these two indices to obtain a visual diagnosis.

With those simple indices, an observation of the historical pattern of the external debt structure of the afflicted Asian countries reveals that while the unfolding of the external debt structure had been quite diverse across the countries, there was a common feature in the 1990s: the combination of those two ratios had moved together towards north-east direction in the two dimensional diagram, or at least having no negative covariance structure. This pattern was particularly distinctive for Thailand and Korea, and the pattern of Indonesia and Malaysia was similar in that the locus of the external debt structure in terms of these two ratios was characterized by the horizontal movement with different levels of total indebtedness. (see Aoki and Min, 1999)

This casual observation led us to establish the 'hyperbola of external debt' hypothesis which contends that there may exist a threshold curve on the two dimensional diagram warning a prospective occurrence of currency crisis.[2] A crude intuition behind the hypothesis would be as follows: Suppose that for some reason, the country's external debt increases. This higher external debt while keeping the ratio of short-term external debt intact would naturally raise some concerns about the solvency and the possibility of explosive debt burden due to the exchange rate depreciation, and thus it is necessary to

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Ito et al., 1998).

[2] The empirical study on the role of external debt in explaining currency crises has been to date rather unsuccessful. See Kaminsky et al. (1998, pp.12) for the summary of the preceding empirical studies.

reduce the dependence on the short-term external debt in order to alleviate these risks. Otherwise the country might have to face a risk of an abrupt change in the investor's confidence and the sudden reversal of capital inflows. Moreover, the higher is the external debt, the less is the need for this reduction in the short-term debt, simply because the short-term external debt has already been reduced substantially.

With this conjecture, in the subsequent section, we first provide a possible theoretical underpinning for our hyperbola hypothesis. To do so, we construct a simple model explicitly incorporating the external borrowing constraint that may be a key feature for many developing countries, and investigate consequences of a particular external debt structure within an environment characterized by the precarious returns on the past investment depending on the external shocks. Specifically, we show that the real exchange rate could depreciate excessively in response to the adverse external shocks in conjunction with the over-contraction of the economy. Section 3 shows an empirical evidence supporting our hypothesis by exploiting the recent episode of Asian crisis followed by conclusion and policy implications.

2. An Economic Modeling of the Hyperbola Hypothesis

2.1. A Simple Model

To tie down the idea, we construct a simple model following the line of Radelet and Sachs (1998a, b) and Chang and Velasco (1998a, b) which underscored the importance of liquidity crisis initially facing many Asian countries. However, we adopt somewhat

different approach from the preceding literature which rely on the theory of bank-run à la Diamond and Dibvig (1983). We instead focus on the critical role played by the margin requirement that was a key source triggering the global financial turmoil in recent years, within the circumstance of the fragile returns on the past investment that may be caused by the abrupt changes in the external economic environment. [3]

Imagine a small open economy which specializes in producing 'home goods' and imports 'foreign goods'. The country opens the capital account and faces the given world gross real interest rate denoted by $R(>1)$. The competitive forces prevail. We choose foreign goods as a numeraire, and assume that domestic residents can only borrow off-shore in terms of foreign goods, which may correspond to the external borrowing denominated in foreign currency, although our model does not encompass the money. In order to highlight the case of Asian crisis, we exclusively focus on the private external debt in what follows.[4]

There are three periods. In period 0 (or a boom period), the firms undertook an investment project, and the country owed the external debt by;

$$D_0 = P_1 + \frac{P_2}{R} \tag{1}$$

to finance the investment as of the beginning of period 1, where P_1 is the promised debt obligation due in period 1 and P_2 is the promised debt obligation due in period 2. For brevity, we refer to P_1 as the short-term debt and to P_2 as the long-term debt,

[3] See Aiyagari and Gertler (1998) for the similar argument focusing on the capital markets. Krugman (1999) also shows the possibility of self-fulfilling crisis along this line.
[4] Calvo (1996) and Cole and Kehoe (1996) have analyzed the issues associated with the maturity

respectively. We assume that the maturity structure per se is exogenous since our major concern is to investigate the consequences of a particular structure of external debt.

While there is uncertainty regarding the future as of period 0, the state of the world completely turns out in period 1, and thus we do not need to be involved in the uncertainty afterwards. As a result of the investment undertaken in period 0, the economy can produce home goods by Y_1 in period 1 and by Y_2 in period 2, and for simplicity we assume that theses are given. Our model thus amounts to virtually two period model insofar as we restrict ourselves to the development of the economy after period 0.

Reflecting the fact that most of crisis-ailing countries in Asia removed government interventions including debt repayment guarantee along with financial market liberalization before the crisis, we incorporate the borrowing constraint into the model. Assume that as a result of rollover of the short-term external debt in period 1, the country has owned the external debt by;

$$D_1 = Q + \frac{P_2}{R} \tag{2}$$

as of the end of period 1, where Q is the amount of rollover in period 1 which could encompass a new borrowing. Since raising the interest rate is not an effective measure to prevent the moral hazard on the part of borrowers due to the adverse selection effect of the higher interest rate, we assume that the gross real interest rate applied to the rolled-over lending is equal to R.

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structure of public debt in the context of Mexican and Latin American crises.

Borrowers have two options after the rollover contract was struck, whereas creditors cannot prevent them from choosing an option that may do harm on creditors' interest, due to imperfect information and/or incomplete contract. The first option is to continue the current project which gives rise to home goods of Y_2 in period 2 with certainty. The alternative second option available to borrowers is to adopt the diversion project that produces home goods of Y_2^H in period 2 with probability of r $(1 > r > 0)$ and produces nothing with the remaining probability $1-r$, and we assume that the diversion project is socially inefficient, namely, $Y_2^H > Y_2 > rY_2^H (> 0)$.

To prevent the moral hazard on the part of borrowers, creditors in general react by setting a credit line. Define the relative price of home goods in terms of foreign goods (i.e., the terms of trade) in period t (t=1, 2) by p_t. Alternatively, we may refer to this relative price as the 'real exchange rate', and we express the higher (lower) value of p_t as the appreciation (depreciation) of the real exchange rate. Since the incentive compatibility condition under the limited liability rule is stated as $p_2Y_2 - RD_1 \geq r \cdot \{p_2Y_2^H - RD_1\}$, we can rewrite this equation to yield;

$$D_1 \leq k\frac{p_2Y_2}{R} \tag{3}$$

where $k = \{1 - r(Y_2^H / Y_2)\}/(1-r)$ and $1 > k > 0$ by assumption. This borrowing constraint has an intuitive appeal: Since p_2Y_2 / R can be interpreted as the asset value of the borrowers' income generating power in the future, equation (3) implies that creditors are willing to lend only up to a fraction of collaterable asset. Note that while we here adopt Diamond's (1991, pp.728) debt capacity approach, this is not the only way to

generate the borrowing constraint like equation (3).[5] We also note that the moral hazard could take place for the long-term external debt, and therefore we have to assume $P_2 \leq kp_2Y_2$ for the analysis to be meaningful.

Assume, for the sake of simplicity, the log-linear utility function; $U = \ln C_1 + \beta \ln C_2 \quad (1 > \beta > 0)$, where C_t is the aggregate consumption in period *t* and β is the gross subjective discount factor. Letting C_t^H be the home good consumption in period *t* and C_t^F be the foreign good consumption in period *t*, we also specify the Armington aggregator as $C_t = (C_t^H)^{\mu}(C_t^F)^{1-\mu} \quad (1 > \mu > 0)$.

The household decides the optimal consumption patterns so as to maximize the utility function subject to the intertemporal budget constraint and the external borrowing constraint given by equation (3). In this optimization, we assume that when $Q < 0$, the household invests abroad with the given world real interest rate.

Consider first the case in which the borrowing constraint does not bind. Define the relative price of composite goods in terms of foreign goods by $q_t = p_t^{\mu}$. Also define the wealth by:

$$W = p_1Y_1 + \frac{p_2Y_2}{R} - D_0 \tag{4}$$

Simple computations give rise to the optimal consumption patterns:

$$q_1C_1 = \frac{1}{1+\beta}W \tag{5a}$$

[5] See Hart and Moore (1994, 1998) and Kiyotaki and Moore (1997) for the incomplete contract approach, Bernanke and Gertler (1989) for the costly state verification approach, among others.

$$\frac{q_2 C_2}{R} = \frac{\beta}{1+\beta} W \tag{5b}$$

$$p_t C_t^H = \mu q_t C_t \tag{5c}$$

Note that the last equation holds regardless of whether the borrowing constraint binds or not. Letting X_1 be the given exports of home goods in period 1 and X_2 be the discounted value of the given exports in period 2, respectively,[6] the model can be completed by the market equilibrium conditions:

$$p_1 Y_1 = \mu q_1 C_1 + X_1 \tag{6a}$$

$$p_2 Y_2 = \mu q_2 C_2 + R X_2 \tag{6b}$$

Define the new variables by $y_1 = p_1 Y_1$ and $y_2 = p_2 Y_2 / R$. These indicate the real GDP in terms of foreign goods and can be thought of as surrogates for the real exchange rates under the assumption of given outputs and world real interest rate. Substituting (4) and (5) into (6), together with some manipulations, yields the following reduced form expression for the real GDP:

$$y_1 = \frac{1}{1-\mu}\{(1-\frac{\mu\beta}{1+\beta})X_1 + \frac{\mu}{1+\beta}X_2 - \frac{\mu}{1+\beta}D_0\} \tag{7a}$$

$$y_2 = \frac{1}{1-\mu}\{\frac{\mu\beta}{1+\beta}X_1 + (1-\frac{\mu}{1+\beta})X_2 - \frac{\mu\beta}{1+\beta}D_0\} \tag{7b}$$

Quite interestingly, our model has a Keynesian flavor. For example, the trade multiplier associated with the current exports can be computed as:

[6] Assuming the utility function with unitary elasticity and the given foreign aggregate consumption in terms of foreign goods, the foreign demand for home goods in terms of foreign goods may be thought of as given.

$$\frac{\partial y_1}{\partial X_1} = \frac{1}{1-\mu}(1-\frac{\mu\beta}{1+\beta}) > 1 \tag{8}$$

Since the higher exports increase the real GDP via the improvement of the terms of trade or the real exchange rate appreciation, this further stimulates the consumption and thus the multiplier should be larger than unity. We can also use (7) to write;

$$W = \frac{1}{1-\mu}(X_1 + X_2 - D_0) \tag{9}$$

which implies that the solvency requires the condition $X_1+X_2>D_0$. Although we assume this solvency condition in what follows, this tells us an unequivocal importance of exports for the country to be solvent.

2.2. Adverse External Shocks and the Overreaction of the Real Exchange Rate

Developing countries are in general vulnerable to the adverse external shocks such as stagnant exports due to the recession of developed countries and the large swing of exchange rates among them, abrupt deterioration of the terms of trade due to the adverse market conditions in commodities, and the hikes in the world interest rates. In what follows, we will investigate how the economy behaves in response to the adverse external shocks.

To do so, suppose that exports in period 1 suddenly drop. With this adverse external shock, the economy may be confronted with the external borrowing constraint. To see this, we first note that the required amount of rollover in period 1 is expressed as;

$$Q = P_1 - (y_1 - q_1 C_1) \tag{10}$$

where the second parenthesized term on the right hand side represents the trade balance or 'cash flow' in period 1 for the economy as a whole. Exploiting eqs.(5) (7) and (9), it can easily be verified that the trade balance becomes:

$$B(\equiv y_1 - q_1 C_1) = \frac{\beta}{1+\beta} X_1 - \frac{1}{1+\beta} X_2 + \frac{1}{1+\beta} D_0 \tag{11}$$

This in turn implies that the decrease in exports in period 1 leads to the deterioration of the trade balance or the reduction of the cash flow available for the reimbursement of the short-term external debt currently due. Assume that the decrease in exports leads to the inadequacy of the cash flow, $P_1 > B$. Consequently, the economy needs a rollover of the short-term external debt due in period 1 and may even require a new money. But the economy also faces the borrowing constraint;

$$D_1 = D_0 - B \leq k y_2 \tag{12}$$

where we should note that the decrease in the current exports also reduces the debt capacity per se because this at the same time depreciates the future real exchange rate through the intertemporal consumption smoothing. In what follows, when this borrowing constraint binds, we call that the economy faces a 'liquidity crisis' because the required rollover of the short-term external debt becomes impossible by the refusal of creditors.

Define by X_1^C the critical value of exports in period 1 that satisfies the above borrowing constraint with equality. A simple computation yields:

$$X_1^C = D_0 + \{1 - \frac{k(1+\beta)}{1-\mu+k\mu}\}\frac{X_2}{\beta} \tag{13}$$

We can thus conclude that the borrowing constraint should bind when $X_1 < X_1^C$.

With the borrowing constraint binding, the levels of consumption are forcedly compressed to;

$$q_1^* C_1^* = y_1^* + ky_2^* - D_0 \tag{14a}$$

$$\frac{q_2^* C_2^*}{R} = y_2^* - ky_2^* \tag{14b}$$

where the superscript (*) stands for the variables associated with the economy in which the borrowing constraint binds. We can therefore substitute (14) into (6) to yield:

$$y_1^* = \frac{1}{1-\mu}X_1 + \frac{\mu}{1-\mu}(ky_2^* - D_0) \tag{15a}$$

$$y_2^* = \frac{1}{1-\mu+k\mu}X_2 \tag{15b}$$

It is straightforward to verify that;

$$\frac{\partial y_1^*}{\partial X_1} = \frac{1}{1-\mu} > \frac{\partial y_1}{\partial X_1} = \frac{1}{1-\mu}(1 - \frac{\mu\beta}{1+\beta}) > 1,$$

and thus we obtain the following conclusion:

Proposition: **If the current exports fall below the critical vale X_1^C, even though this is temporary, the real exchange rate excessively depreciates compared with the case in which there is no market friction, and the real GDP contracts excessively.**

Moreover, the higher is the marginal propensity to consume home goods μ, and the higher is the marginal propensity to save $\beta/(1+\beta)$, the more overreacts the real exchange rate.

Interpreting the overreaction of exchange rate as a currency crisis, our model amounts to explaining a pattern of currency crisis in developing countries in which the currency depreciation is usually accompanied by the economic contraction.[7]

Figure 1 portrays the basic story. Here, the vertical axis measures the real GDP or real exchange rate in period 1 and the horizontal axis measures the current exports. The line AA indicates the relationship between the real GDP and the current exports in the absence of the borrowing constraint, and the line BB represents the relationship when the borrowing constraint binds. The critical value of exports X_1^C corresponds to the intersection of two lines, and the actual relationship between two variables can be shown by the lower portion of these two lines. As may clearly be seen, when the level of exports in period 1 falls below the critical value, the real GDP or real exchange rate decreases excessively.

Intuition behind this result is simple and may be explained as follows: Suppose that due to, say, a large swing of exchange rates among developed countries, the country's exports abruptly decrease below the critical level. This adverse external shock deteriorates the terms of trade facing this country, and thereby reducing the real GDP or

[7] Incorporating the investment activity into the model would produce more dramatic results such as virtuous and vicious circles, abrupt turnaround of the cycles or boom-bust cycle triggered even by the self-fulfilling expectations, let alone the adverse external shocks, although we do not go further. For

equivalently increasing the external debt burden due to a capital loss. But owing to the intertemporal consumption smoothing, the country's current consumption would not decrease to a same extent and therefore the trade balance worsens. Consequently, the country may be confronted with the difficulty servicing the short-term external debt currently due and may even need a new money. In the presence of the borrowing constraint, however, the rollover of the short-term external debt may be refused by the international creditors on account of the moral hazard consideration, and thus the refusal of rollover precipitates the forced compression of the expenditure and thereby further depreciating the real exchange rate. In other words, the social role of international finance does not function precisely when the country most urgently needs it.

2.3. Hyperbola Hypothesis

Under what conditions is then the liquidity crisis likely to occur? To see this, consider the problem from the viewpoint of period 0 when the country owes the external debt but faces the uncertainty for the future. Since the probability of the occurrence of crisis in period 0 is given by $\Pr ob\{X_1 < X_1^C\}$, taking, say, 50% as a threshold probability, the condition under which a crisis could take place with probability of at least 50% is stated as;

$$\Pr ob\{X_1 < D_0 + AX_2\} \geq 0.5,$$

where $A = \{1 - k(1+\beta)/\beta(1-\mu+k\mu)\}$. Define the minimum external debt that satisfies this inequality by D_{Min}. Obviously, this critical external debt is an increasing

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the related topics, see Krugman (1999).

function of the threshold probability. Accordingly, the condition under which a crisis occurs with probability of at least 50% is given by $D_0 \geq D_{Min}$.

On the other hand, the relationship $P_1 > B$ that implies the inadequacy of cash flow is necessary for a crisis to occur. Define the ratio of the short-term external debt to total external debt by $s = P_1/D_0$. We can use equation (11) to rewrite this as;

$$(s - \frac{1}{1+\beta})D_0 > \frac{\beta}{1+\beta}X_1 - \frac{1}{1+\beta}X_2,$$

where the right hand side of the above inequality implies the trade balance in the absence of the external debt. The necessary condition for a crisis to occur with probability of at least, say, 50% is therefore;

$$\Pr ob\{(s - \frac{1}{1+\beta})D_0 > \frac{\beta}{1+\beta}X_1 - \frac{1}{1+\beta}X_2\} \geq 0.5.$$

Define the critical value of $[s - 1/(1+\beta)]D_0$ that satisfies this condition with equality by B_{Min}, and assume that $B_{Min} > 0$. The necessary condition for a crisis to occur with probability of at least 50% can then be stated as;

$$(s - \frac{1}{1+\beta})D_0 \geq B_{Min}.$$

Figure 2 summarizes the foregoing argument. The rectangular hyperbola SS represents the relationship between two variables that satisfies the above equation with equality, and the horizontal line indicates the critical level of the external debt D_{Min}. It is then obvious that the northern part of the bold curve enclosed by SS and horizontal line at D_{Min} represents a zone in which a crisis could occur with probability of at least 50%,

and this zone may be called 'crisis zone'.[8] It is also obvious that the crisis zone associated with the higher threshold probability should be located farther towards north-east. As may easily be seen, the lower border of a crisis zone could be approximated by the hyperbola at least for the empirical purpose.

3. Empirical Evidence

3.1. Estimation Model

The theory developed in the last section points to an important empirical implication that in order to make diagnosis on the healthiness of the external debt of a country, one should exploit not individual indicators separately but a composite indicator approximated by the product of two indicators, $(D_0 - \delta_1)(s - \delta_0)$, where $\delta_i s$ are some parameters. In this section, we investigate whether this theoretical prediction is really vindicated by the actual data.

To do so, we estimate the regression equation;

$$Crisis = \alpha + \delta_0\{Debt - \delta_1\}\{RSTDebt - \delta_2\} + Others + u \qquad (16)$$

where *Crisis* is some index for crisis, *Debt* is the ratio of total external debt to GDP, *RSTDebt* is the ratio of short-term external debt to total external debt, *Others* are control variables, and *u* is the disturbance term which is orthogonal to the independent variables. We applied non-linear least square method to estimate parameters exploiting the standard

[8] We borrowed this name from Cole and Kehoe (1996), although our model does not encompass any

foreign exchange pressure index.[9] We focus on episode of Asian crisis from mid-1997 onwards and exploit the cross-section data covering 50 emerging market economies that exhaustively encompass the definition by IFC.[10]

The crisis index was constructed as a weighted average of the rate of change in exchange rate vis-à-vis the US dollar and the negative rate of change in foreign reserves excluding gold. We calculated the rate of change in exchange rate as percentage rate of deviation of the actual exchange rate in the last month from the extrapolative value using the trend over the past two and half years prior to July 1997, with a view to controlling over-estimation of the rate of changes in exchange rates due to different exchange rate system and inflation. Following the usual weighting method, we utilized the degree of precision (inverse of the variance) calculated over the same period as weights, but the usual caveats apply.[11] We chose two alternatives as the interval: the first is the period

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room for self-fulfilling crisis.

[9] See Eichengreen et al. 1996; Esquivel and Larraín, 1998; Frankel and Rose, 1996; Fratzscher, 1998; Furman and Stiglitz, 1998; Kaminsky and Reinhart, 1999; Kaminsky et al., 1998; Milesi-Ferretti and Razin, 1998; Sachs et al., 1996; Tornell, 1999. We also note that the result of Probit modeling was blurred because of non-linearity, multicolinearity with the linearization, and the inability to differentiate the degree of severity of hardship across countries.

[10] IFC identifies 51 countries as the emerging market economies including frontier markets as of 1999. We excluded Greece and Portugal on account of the absence of the comparable external debt statistics, and Nigeria due to the paucity of the relevant economic data. We added to this sample two economies, Hong Kong SAR and Singapore, because they are the important economies comprising East Asia. We also note that while we stick to the 50 country sample to overcome a weakness of the previous studies, i.e., the small sample property (see Furman and Stiglitz, 1998), eliminating the transitional economies in Eastern Europe would not change the results reported below significantly.

[11] There are a couple of caveats associated with the calculation method of crisis index. First, since the usual method based on the degree of precision generated an extremely high weight associated with the exchange rate change for several countries, we also tried an alternative crisis index given by $0.5\times$ {rate of change in exchange rate/its standard deviation}$+0.5\times$ {negative rate of change in forex reserves/its standard deviation}, whose conditional variance is equal to unity. The explanatory power and statistical significance of our model proved successful a fortiori. We decided, however, to stick to the traditional approach because of its popularity and our intention of reporting the results with the *least* explanatory power. Second, we were forced to ignore the interest rate variable due to the paucity of the comparable data. On account of this, it is likely that we have failed to construct an effective index for several countries, particularly Hong Kong SAR.

during June 1997 just prior to the onset of the Asian crisis to January 1998 when the depreciation of Asian currencies has almost bottomed out except Indonesian ruphia, and the second is the period during June 1997 to June 1998. For Indonesia, the crisis index proved to be extraordinarily high: Indonesian rupiah exchange rate vis-à-vis the US dollar has been obviously an outlier since December 1997, largely due to the mounting concerns on the political and social instability. To deal with this problem, we inserted the Indonesian dummy, although the estimates are not reported for brevity.

Most of data for *Debt* and *RSTDebt* came from the Joint Statistics on the external debt by BIS/IMF/OECD/World Bank with some complementary information (see Appendix for the data sources and calculation methods). We should, however, notice that while the Joint Statistics is deemed best statistics currently available, this does not cover the off-balance sheet exposure arising from the derivative transactions in which US based financial institutions seem to have heavily been involved (see IMF, 1998; Kregel, 1998; World Bank, 1999).

Control variable includes the change in the ratio of claims on private sector by banking sector to GDP during a period 1993 to June 1997, $\Delta Credit$, to capture the financial fragility, which was an important feature of Asian crisis in conjunction with the boom-bust cycle of investment. The choice of the interval was based on the fact that 1993 was the year just prior to the recurrence of invest boom in East Asia during 1994 to 1996 accompanied by the upsurge in capital inflow towards this region.[12]

[12] Alternatively, one might prefer the period during the late 1980s to mid-1997 with a view to the fact that many Asian countries have launched the financial liberalization since the late 1980s. We also tried this alternative interval with the smaller sample, but the results were similar.

3.2. Estimation Results

Table 1 and table 2 summarize the estimation results, where table 1 contains the results for the interval during June 1997 to January 1998, and table 2 the results for the interval during June 1997 to June 1998, respectively. Equations (1) and (4) show the estimation results based on the gross external debt, whereas equations (2) and (5) are based on the external debt excluding the liabilities on the multilateral institutions (IBRD, IDA and IMF) and the official bilateral loans by DAC creditors in order to address the differences in debt rescheduling difficulties. Equations (3) and (6) address the issue that the short-term external debt is gross value, not allowing for international reserves. In estimating equations (3) and (6), we eliminated ten countries from the sample because their net external debt were negative.[13] When the heteroscedasticity in residual was significant, we reported t-values with White correction.

The estimation results show that the credit aggregate variable is statistically significant irrespective of the choice of the external debt concept and interval, which implies that domestic lending boom pervaded in East Asia before the onset of crisis was a key factor leading up to the following banking crisis-cum-debt overhang of corporate sector.

More importantly, our hyperbola specification proves very successful for the gross external debt (eqs.(1) and (4)), although mixed for the net external debt. Indeed, the

[13] They are Botswana, Croatia, Czech Republic, Estonia, Hong Kong SAR, Latvia, Singapore,

estimation results show that the estimated parameters are all positive and statistically significant at the conventional level, and thus confirm that our hyperbola specification is helpful to explain the Asian crisis.[14] Interestingly, the estimated parameters indicate that given the financial fragility, a country with the gross external debt of more than around 10% of GDP and the short-term external debt of more than around 10% of total external debt should be careful in managing the external debt in that the accumulation of the external debt beyond these thresholds might build up a source leading to a sudden change in the international investor's confidence.

As emphasized in the theoretical part of the paper, the adverse external shocks could trigger a crisis.[15] To address this, we incorporate the variables associated with the exports and real exchange rates. Specifically, we extended control variables as in (17) in order to capture the direct impact of stagnant exports or real exchange rate appreciation (γ_0) and the relevance of the reserve adequacy in the presence of the adverse external shock (γ_1) which we have failed to verify directly in the previous estimation (see eqs.(3) and (6) in table 1 and 2);

$$Others = \{\gamma_0 + \gamma_1 \times STD / FR\} \times Egrowth \qquad (17a)$$

Slovakia, Slovenia and Taiwan.

[14] If $\delta_1 = \delta_2 = 0$, the hyperbola term would degenerate into a single indicator, the ratio of short-term external debt to GDP. What we would like to emphasize is, however, the presence of the non-linear relationship between two ratios.

[15] An abrupt drop of exports since 1996 in conjunction with the closely related turnaround of the yen-dollar exchange rate since mid-1995 was one of the critical external shocks for the East Asian countries, although the role of the devaluation of Chinese yuan in 1994 is elusive and still a matter of debate (see e.g., Fernaldo, Edison and Loungani, 1998). In particular, it can be statistically verified that the prolonged yen appreciation against the US dollar over a decade since the mid-1980s within the backdrop of the then substantially pegged exchange rate system adopted by the East Asian

$$Others = \{\gamma_0^{'} + \gamma_1^{'} \times STD / FR\} \times REXR95 \quad (17b)$$

where *Egrowth*, defined as { average annual growth rate of exports in US dollar over the period 1990-95 – annual growth rate of exports in US dollar in 1996 }×the ratio of exports to GDP in 1996, is the variable indicating the magnitude of the severity of the drop in exports before the crisis. *REXR95* is the change in the real effective exchange rate on a CPI basis during the period 1995 to the second quarter of 1997 with the higher value indicating the real appreciation. The real exchange rate index (1995=100) was constructed against the US dollar, Japanese yen and Deutsche mark exploiting the trade share in 1995, where the trade share for EU15 was exploited for the weight of Deutsche mark. *STD*/*FR*, defined as the ratio of short-term external debt to foreign reserves as of the end of June 1997, indicates the degree of reserve adequacy.

Meanwhile, some researchers have pointed out the importance of the contagious effects of the currency crises or the competitive devaluation drive with the feature of regional concentration (see e.g., Esquivel and Larraín, 1998; Fratzscher, 1998; Glick and Rose, 1998). As a matter of fact, the actual sources for triggering a crisis may not be restricted to the adverse external shocks like as in the cases of Indonesia and Philippines whose exports were relatively buoyant even in 1996. To address this, following Glick and Rose (1998), we also inserted as an additional explanatory variable *Tlink* defined by;

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countries had been a major driving force for the high export growth in this region.

$$Tlink = 100 \times \{ \sum_{k \neq 0,i} \frac{X_0^k + X_i^k}{X_0 + X_i} (1 - \frac{\left| x_0^k - x_i^k \right|}{x_0^k + x_i^k}) + \frac{X_0^i + X_i^0}{X_0 + X_i} (1 - \frac{\left| x_0^i - x_i^0 \right|}{x_0^i + x_i^0}) \} \quad ,$$

where the subscripts *0* and *i* refer to Thailand and the country concerned, respectively, X_i is the total exports of country *i*, X_i^k is the exports of country *i* to country *k*, and the lower case letter x_i^k represents the ratio of the bilateral export flow from country *i* to country *k* to total exports of country *i*. The implication of this index is to measure the degree of indirect competitiveness in the third country *k* between Thailand and country *i* (the first term in the parenthesis on the right hand side) and the degree of direct one in bilateral trade (the second term). We calculated this index as of 1996 on the basis of 64 countries and regions for destination, and set the index value for Thailand equal to zero.

Table 3 shows the estimation results. Several interesting points emerge. First, the direct effects of stagnant exports or real exchange rate appreciation are statistically insignificant, as confirmed by Radelet and Sachs (1998) and others. This is not surprising because the stagnant exports and/or the real exchange rate appreciation per se would not necessarily be accompanied by the crisis without other sources for the vulnerability. More interesting is the finding that focusing on the period during June 1997 to January 1998 when the currency depreciation of the Asian countries was most ferocious, the estimated parameter associated with the product term of *Egrowth* and *STD*/*FR* is positive and statistically significant. This seems to provide an evidence for the vulnerability to the adverse export shock, particularly when a country does not have adequate foreign

reserves. On the other hand, the effect of the real exchange rate that could be a culprit of the stagnant exports in 1996 was blurred. For this respect, one should remind the fact that there were many countries whose real exchange rates had appreciated much more than those of afflicted Asian countries had done.[16] Finally, while the explanatory power of our model declines in the case of extending the interval to June 1998, the contagion effect through the trade linkages proves to be statistically significant across equations as confirmed by other researches.

Figures in table 4 summarize the magnitude of the contribution of explanatory variables using the estimation result (7) in table 3, where the figures associated with *Tlink* was calculated as the original values minus the estimated constant term in order to make clear the differences of this term across countries. For reference, we also calculated the contribution of hyperbola term for Korea using the national data source on the external debt that includes the off-shore borrowing of domestic financial institutions and the borrowing of the foreign branches of domestic financial institutions, because the Joint Statistics still seems to underestimate the external debt for some countries. Table 4

[16] The magnitude of the appreciation of our real effective exchange rate index for the crisis-hit countries during a period 1995 to mid 1997 was around 20% for four ASEAN countries, and 5% for Korea, which were outweighed by those of Kenya (38%), Jamaica (37%), Zimbabwe (26%), Mexico (25%), China (24%) and Hong Kong SAR (21%), let alone those of the transitional economies in Eastern Europe. Chinn (1998) reports that the magnitude of the overvaluation of currencies for the Asian countries before the onset of crisis was modest, and Corsetti et al. (1998b) also refer to a similar point. For the related topics, see Goldfajn and Valdes (1998) who show that when the magnitude of overvaluation of the real exchange rate exceeds 25%, the probability of hard landing via the nominal devaluation is 86% and that when the magnitude of overvaluation exceeds 35%, the hard landing is all but unavoidable. However, it may be fair to say that the role of real exchange rate is still debatable. For one thing, our real exchange rate index was constructed against only three major currencies with trade share weight, which may ignore the third country effect. For the other thing, while our real exchange rate index is based on the price index, it may be desirable to try an alternative index based on the unit labor costs with a view to an apparent fact that the real wages had exploded beyond the productivity growth in some countries, say, Thailand. Also see Ito et al. (1998) for the related topics.

highlights the importance of the hyperbola term for the afflicted countries, particularly for Indonesia, Korea and Thailand. On the contrary, the hyperbola term for Taiwan exhibits large negative value, which indicates that even if ignoring the role of ample foreign reserves, Taiwan's external debt position had been healthy despite its high dependence on the short-term external debt. Secondly, the contribution of credit aggregates is relatively high for all affected Asian countries except Indonesia,[17] particularly for Malaysia and Thailand. Thirdly, the contribution of stagnant exports is diverse: While the magnitude of contribution of stagnant exports is relatively large for Korea, Thailand and, to a lesser extent, Malaysia, those of Indonesia and Philippines are small as expected. This in turn implies that the factors and their magnitude leading to the crisis were different country by country. Fourthly, the values of the hyperbola term for Chile and Colombia which became famous for the controls on the short-term capital inflows are relatively small compared with those of Indonesia, Korea and Thailand, and these countries did not experience any significant domestic lending boom.[18] Finally, the contribution of *Tlink* appears with considerable magnitude for Asian countries as expected,[19] and this trade linkage effect accounts for a large part of relatively high crisis index for Taiwan and Singapore.

Figure 3 is the scattered diagram of the external debt structure actually used in the

[17] This feature for Indonesia depends to a much extent on the choice of interval in constructing the change in credit aggregates. As a matter of fact, if one chose the year before 1988 (the year of launching the second financial reforms) as the base year, the contribution of credit aggregates would appear more significantly.

[18] See Edwards (1998) who emphasizes the importance of the healthiness of domestic banking sector in the context of Chile's experience.

[19] The relatively high values of *Tlink* for Brazil and Saudi Arabia seem responsible for the product mix.

estimation, where the black circles indicate the East Asian countries. In this figure, the dashed curve is a possible threshold, which was drawn by exploiting the estimation equation (7) so as to satisfy the relationship 600={*Debt*-13.44}{*RSTDebt*-10.83}, although somewhat arbitrary. For reference, we also draw two points for Korea; Korea(1) pertains to the original Joint statistics, whereas Korea(2) is based on the Korea's national data source. As may been seen, the external debt structure for Thailand, Indonesia and Korea were obviously unusual in that they were located in the upper region of the drawn hyperbola.

4. Conclusion

The paper has shown a new idea of 'hyperbola of external debt' hypothesis as underpinning a mechanism that links the external debt management to the Asian financial crisis. To tie down this idea, we have constructed a simple model and suggested that we should exploit a composite indicator comprising two ratios, namely, the product of the ratio of external debt to GDP and the ratio of short-term external debt to total external debt with some adjustment for thresholds, in order to make diagnosis on the healthiness of the external debt position of a country. This composite indicator crudely, yet succinctly captures the size and composition of capital inflows in terms of stock dimension.

With this theoretical prediction, the empirical analysis indicated that given the financial fragility and others, a useful indicator is roughly constructed as the product, {ratio of external debt to GDP (%) – 10%}{ratio of short-term external debt to total

external debt (%) – 10%}. The policy implication of this result is that a country should not allow the external debt to accumulate too excessively beyond some thresholds and the value of the composite indicator to persistently rise, particularly in the presence of financial fragility and other disturbing factors.

However, the determinants of the external debt structure per se have yet to be explored, which could be diverse country by country as naturally implied in Figure 3. This is the subject for the future research.

Appendix: Data Sources and Calculations

1. *Crisis Index*: The data were taken from IMF, *International Financial Statistics* CD-ROM, February 1999. For Taiwan, we exploited Bank of China, *Financial Statistics*. The list of sample countries is given in Table 4.

2. *Debt*, *RSTDebt*: The data were taken from BIS, IMF, OECD and the World Bank, *Joint BIS-IMF-OECD-World Bank Statistics on External Debt,* March 1999. OECD, *External Debt Statistics: Resource Flows, Debt Stocks and Debt Service, 1986-1997,* 1998 was used for Hong Kong SAR and Singapore because the external debt data released in Joint Statistics includes off-shore banking transactions for these economies.

For Korea, we used data released from Korea's Ministry of Finance and Economy, *External Liabilities and Assets of Korea: End 1998*, February 2, 1999, as a complementary information. For the calculation of the ratio of external debt to GDP, we used the average exchange rates to convert the GDP denominated in local currency units into the dollar equivalence. The data for GDP and exchange rates were taken from IMF, *International Financial Statistics* and the World Bank, *Global Development Finance* 1999.

3. Δ*Credit*: We used the banking survey data (monetary survey + other banking institutions) as the figures for claims on private sector by banking sector with a view to the importance of other banking institutions for several Asian countries. However, we were forced to exploit the monetary survey data for Bangladesh, Botswana, Bulgaria, Colombia, Côte d'Ivoire, Croatia, Czech Republic, India, Indonesia, Israel, Mauritius, Pakistan, Poland, Romania, Russia, Slovakia, Slovenia, Sri Lanka due to the lack of the relevant data. The data were taken from IMF, *International Financial Statistics* and Bank of China, *Financial Statistics* (line 32d and line 42d). For Korea, we should pay a special attention to the trust account of commercial banks which is classified as other banking institutions in IFS and non-banking financial institutions in Korea, respectively. There is a discontinuity of the credit aggregate statistics for Taiwan, but this proved insignificant.

4. Trade data: The data to construct *Egrowth*, *REXR95* and *Tlink* were taken from IMF,

Direction of Trade Statistics, 1996 and 1998. We reallocated China's exports towards Hong Kong SAR using the destination statistics for Hong Kong's re-exports and calculated Hong Kong's exports as the sum of domestic exports and the margins associated with the re-exports using the estimated margin of 25 percent. Analogously, exports for Singapore were calculated as the sum of domestic exports and margins for re-exports using the estimated margin ratio reported in IMF Staff Country Report No.98/52, May 1998. The intra-trade between Singapore and Indonesia was computed by exploiting the Indonesia's trade statistics with an adjustment using the CIF factor reported in IFS.

5. *REXR95*: The data to construct the real effective exchange rate index were taken from IMF, *International Financial Statistics* and Bank of China, *Financial Statistics*.

6. *STD/FR*: We exploited the BIS statistics on the international bank loans as of the end of June 1997 as the short-term external debt. The data source is BIS, *The Maturity, Sectoral and Nationality Distribution of International Bank Lending*. Since this data includes the off-shore banking transactions for Hong Kong SAR and Singapore, we exploited the OECD data as of the end of December 1996 for these economies. For the international reserves, we basically relied on the IFS's data, whereas allowing for the data reliability, we exploited the net foreign reserves netting out the forward obligations for Thailand and the usable foreign reserves netting out the official dollar deposit on the overseas branches of domestic financial institutions for Korea.

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Table 1 Estimation Results

Explanatory Variables	June 1997 to January 1998 (1)	(2)	(3)
Constant	0.71023	-5.77002	18.7043
	(0.197)	(-1.171)	(2.180**)
Δ *Credit*	0.63955	0.65732	1.00663
	(2.525**)	(2.420**)	(2.632**)
δ_0	0.04034	0.03285	0.01129
	(4.177***)	(3.013***)	(1.886*)
δ_1	8.60562	1.18532	-1.01584
	(2.946***)	(2.150**)	(-0.306)
δ_2	12.5430	13.0252	10.6272
	(6.912***)	(2.122**)	(0.735)
$adjR^2$	0.867	0.853	0.826
[$adjR^2$ excl. I'nesia]	[0.544]	[0.495]	[0.402]
White [p-values]	0.010	0.001	0.000
NOB	50	50	40

Notes: Indonesian dummy was inserted, though the estimates are not reported. Eq.(1) exploited the gross external debt, and eq.(2) was based on the external debt excluding multilateral claims by IBRD, IDA and IMF, and official bilateral loans by DAC countries. Eq.(3) is the result exploiting external debt netting out the international reserves excluding gold, where we omitted Botswana, Croatia, Czech Republic, Estonia, Hong Kong SAR, Latvia, Singapore, Slovakia, Slovenia and Taiwan because their net external debt position were negative. Figures in parentheses below $adjR^2$ indicate the adjusted R-squares when dropping Indonesia from the sample, and *White* is the White statistics for heteroscedasticity in residuals (p-values are reported). *NOB* is the number of observations and t-values are in parentheses.

*** significant at 1%

** significant at 5%

* significant at 10%

Table 2 Estimation Results

	June 1997 to June 1998		
Explanatory Variables	(4)	(5)	(6)
Constant	2.22617 (0.581)	-1.84693 (-0.449)	15.9601 (2.079**)
Δ *Credit*	0.68725 (2.260**)	0.69786 (2.286**)	0.90058 (2.890***)
δ_0	0.00194 (2.348**)	0.01231 (1.563*)	0.00364 (0.984)
δ_1	9.19680 (1.703*)	0.64953 (0.501)	-11.3549 (-0.778)
δ_2	13.0713 (3.251***)	4.95715 (0.349)	40.3471 (0.797)
$adjR^2$	0.939	0.936	0.941
[$adjR^2$ excl. I'nesia]	[0.439]	[0.416]	[0.444]
White [p-values]	0.006	0.003	0.001
NOB	50	50	40

Notes: Indonesian dummy was inserted, though the estimates are not reported. Eq.(4) exploited the gross external debt, and eq.(5) was based on the external debt excluding multilateral claims by IBRD, IDA and IMF, and official bilateral loans by DAC countries. Eq.(6) is the result exploiting external debt netting out the international reserves excluding gold, where we omitted Botswana, Croatia, Czech Republic, Estonia, Hong Kong SAR, Latvia, Singapore, Slovakia, Slovenia and Taiwan because their net external debt position were negative. Figures in parentheses below $adjR^2$ indicate the adjusted R-squares when dropping Indonesia from the sample, and *White* is the White statistics for heteroscedasticity in residuals (p-values are reported). *NOB* is the number of observations and t-values are in parentheses.

*** significant at 1%

** significant at 5%

* significant at 10%

Table 3 The Role of External Shocks and Trade Linkages

	Gross External Debt			
	June 1997 to Jan. 1998		June 1997 to June 1998	
Explanatory Variables	(7)	(8)	(9)	(10)
Constant	-4.83619 (-0.801)	-6.13954 (-0.940)	-2.42389 (-0.445)	-4.74985 (-0.782)
Δ *Credit*	0.50751 (2.386**)	0.57941 (2.691**)	0.63654 (2.210**)	0.63453 (2.351**)
δ_0	0.02612 (2.062**)	0.03247 (2.352**)	0.01674 (1.483)	0.01558 (1.327)
δ_1	13.4371 (2.747***)	9.95160 (2.835***)	17.8582 (1.921*)	12.7596 (1.832*)
δ_2	10.8319 (2.865***)	11.3288 (4.299***)	11.8445 (2.008*)	9.69696 (2.064**)
Egrowth ×*unity*	-0.28220 (-1.662)		-0.34638 (-1.961*)	
×*STD/FR*	1.50821 (2.165**)		0.51984 (0.890)	
REXR95 ×*unity*		-0.03396 (-0.189)		-0.01704 (-0.075)
×*STD/FR*		0.21653 (0.693)		0.10238 (0.425)
Tlink	0.28910 (1.936*)	0.22825 (1.690*)	0.24925 (1.910*)	0.24086 (2.199**)
$adjR^2$	0.881	0.871	0.941	0.940
[$adjR^2$ excl. I'nesia]	[0.593]	[0.558]	[0.464]	[0.452]
White [p-values]	0.446	0.035	0.390	0.139
NOB	50	50	50	50

Notes: Indonesia dummy was inserted, though the estimates are not reported. t-values are in

perentheses.

*** significant at 1% ** significant at 5% * significant at 10%

Table 4 Contributing Factors to Crisis Index

Country	Crisis Index	Explained	Δ *Credit*	*Hyperbola*	*Egrowth*	*Tlink*
Asia						
Crisis-Hit Countries						
Indonesia	282.72	43.08	1.78	21.38	1.54	18.38
Korea(1)	80.95	50.15	11.32	17.40	9.40	12.04
Korea(2)	80.95	57.21	11.32	24.46	9.40	12.04
Malaysia	69.78	58.10	17.97	15.38	7.11	17.64
Philippines	58.85	32.95	11.98	11.10	-0.46	10.32
Thailand	104.90	103.98	16.34	40.65	51.83	-4.84
Other Asia						
Bangladesh	2.20	-3.31	3.40	-4.98	-0.10	-1.62
China	-3.05	8.24	-2.49	1.00	0.28	9.45
Hong Kong	-0.08	28.66	13.14	7.72	0.10	7.70
India	5.71	12.65	-0.81	0.24	0.07	13.16
Pakistan	2.63	0.35	-1.83	2.54	-3.69	3.33
Singapore	21.07	13.96	4.52	-0.69	-2.36	12.49
Sri Lanka	0.08	-2.11	0.00	-1.67	0.19	-0.64
Taiwan	17.15	6.00	-0.10	-5.44	0.20	11.34
Latin America						
Argentina	0.00	6.10	0.61	10.18	0.15	-4.84
Brazil	1.73	-16.89	-34.21	4.85	0.16	12.30
Chile	6.55	20.26	0.71	12.56	1.58	5.42
Colombia	14.05	9.42	0.46	6.38	0.53	2.05
Ecuador	2.13	9.82	4.47	6.64	-0.57	-0.72
Jamaica	2.13	5.82	-0.81	8.10	1.53	-2.99
Mexico	-8.09	-0.74	-9.85	9.44	-2.33	2.00
Peru	-1.11	16.06	4.62	11.20	0.14	0.10
T.&Tobago	-0.48	3.96	-5.13	8.44	3.72	-3.08
Venezuela	-5.82	-1.13	-6.70	1.10	-0.74	5.22
Africa						
Botswana	-2.35	-2.59	-3.35	-16.22	9.87	7.12
C. d'Ivoire	2.48	3.69	-6.70	12.29	-1.33	-0.57
Ghana	-1.04	4.29	0.71	3.71	3.06	-3.19
Kenya	10.81	-1.36	1.27	-0.04	0.25	-2.84
Mauritius	7.00	7.12	0.51	10.32	-0.65	-3.05
Morocco	1.96	-7.93	-5.53	0.65	-2.26	-0.78
S. Africa	3.10	13.66	2.94	4.92	-1.32	7.12
Tunisia	1.41	-2.28	-3.45	0.61	1.17	-0.61

	Zimbabwe	56.88	1.80	-1.93	8.78	-2.03	-3.03
Middle East							
	Egypt	-0.06	6.56	7.41	0.76	-0.01	-1.60
	Israel	-5.22	13.03	2.79	0.54	-0.02	9.72
	Jordan	-0.86	1.00	3.45	0.52	0.37	-3.35
	S. Arabia	0.00	7.68	-2.49	-1.92	-3.67	15.75
Europe							
	Bulgaria	-41.88	-16.06	-25.63	10.99	0.54	-1.96
	Croatia	-0.98	-11.02	-7.92	-2.01	1.19	-2.28
	Czech Rep.	7.46	10.61	1.02	4.69	2.88	2.03
	Estonia	-0.37	-2.08	3.25	-2.59	0.75	-3.49
	Hungary	2.23	12.21	-4.62	14.74	0.50	1.59
	Latvia	0.85	-9.82	-5.18	-0.35	-0.29	-4.00
	Lithuania	-7.03	-8.32	-3.96	-0.89	-0.10	-3.38
	Poland	3.10	3.83	0.05	0.34	0.01	3.42
	Romania	-12.04	-4.15	-5.33	1.10	-0.20	0.27
	Russia	-3.36	24.33	5.68	3.61	8.30	6.73
	Slovakia	2.61	7.04	-2.13	4.18	5.92	-0.92
	Slovenia	1.93	0.26	2.13	-1.39	-0.03	-0.45
	Turkey	23.96	12.92	-0.36	7.06	0.53	5.68
	Ukraine	2.91	-10.59	-10.25	0.14	0.24	-0.72

Notes : Equation(7) was exploited to calculate the contribution of individual factors to the crisis index, and *Tlink* indicates the trade linkage component minus the estimated constant term. The hyperbola term of Korea(1) was calculated using the original Joint Statistics on the external debt, whereas that of Korea(2) exploited the Korea's national data source on the external debt which includes the borrowings of the foreign branches of domestic financial institutions and the off-shore borrowing of Korean domestic financial institutions.

Table 5: The Role of Financial Linkages

	Gross External Debt / June 1997 to January 1998			
Explanatory Variables	(11)	(12)	(13)	(14)
Δ Credit	0.52044	0.52274	0.54428	0.52600
	(2.031**)	(2.473**)	(1.960*)	(2.442**)
δ_0	0.02647	0.02727	0.02878	0.02704
	(2.025**)	(2.112**)	(2.181**)	(2.038**)
δ_1	12.1099	13.2703	11.2698	13.3683
	(2.653**)	(2.866***)	(2.588**)	(2.828***)
δ_2	12.5137	10.9389	12.8291	11.1965
	(3.922***)	(3.023***)	(4.194***)	(2.830***)
Egrowth				
×unity	-0.42011	-0.22768	-0.37416	-0.24211
	(-2.552**)	(-1.325)	(-2.315**)	(-1.520)
×STDFR	1.58125	1.36841	1.27002	1.44601
	(2.017**)	(1.861*)	(1.854*)	(2.003*)
Tlink		0.34874		0.32581
		(1.739*)		(1.935*)
Flink	0.23313	-0.10560		
	(1.142)	(-0.454)		
Flink/Japan			0.23200	-0.13978
			(0.678)	(-0.392)
adjR2	0.872	0.879	0.869	0.879

[adjR2 excl. I'nesia]	[0.562]	[0.584]	[0.551]	[0.585]
White [p-values]	0.244	0.540	0.132	0.418
NOB	50	50	50	50

Notes: Constant term and Indonesian dummy were inserted, though the estimates are not reported. t-values are in parentheses.

*** significant at 1% ** significant at 5% * significant at 10%

Figure 1 The Overreaction of Real Exchange Rate

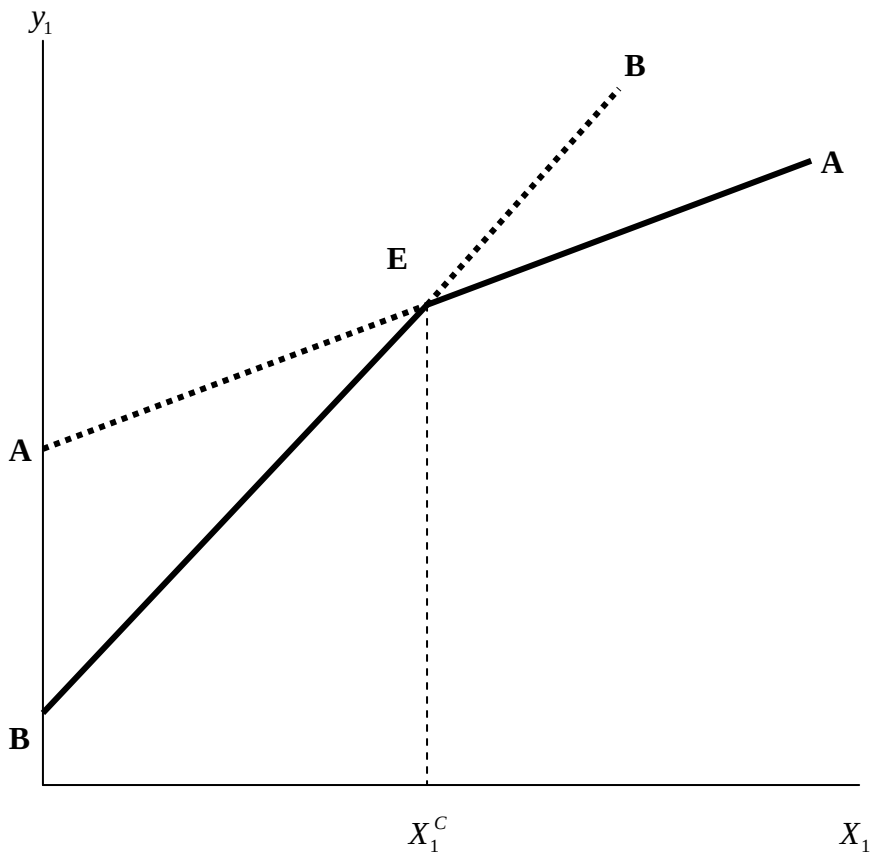


Figure 2 Crisis Zone

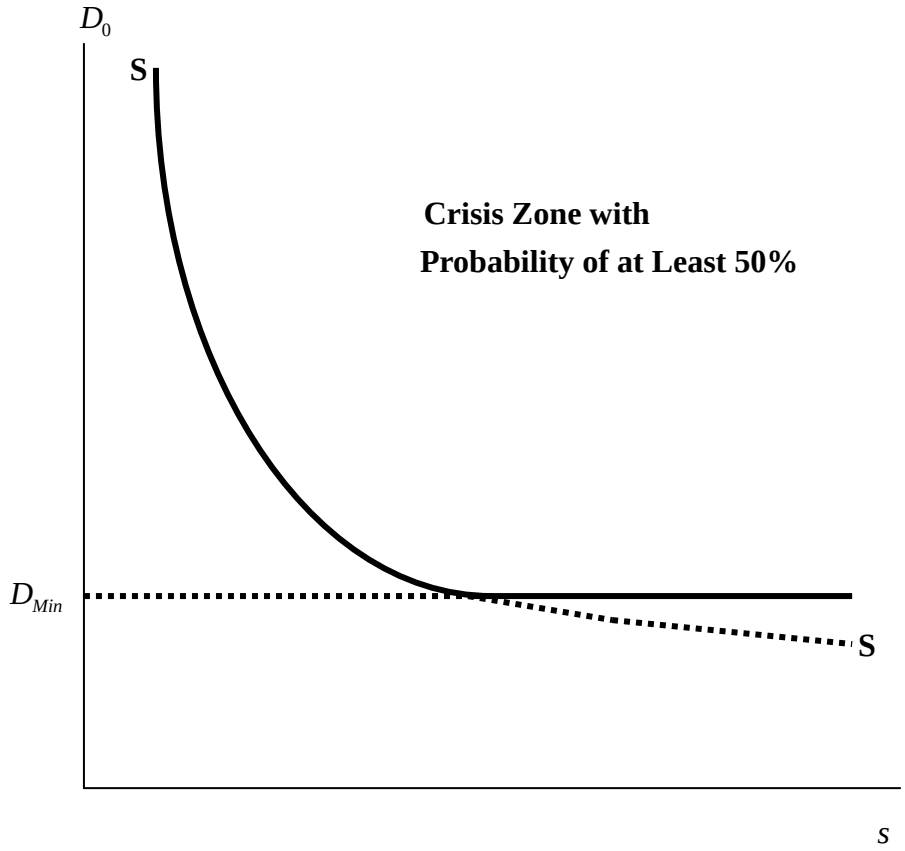
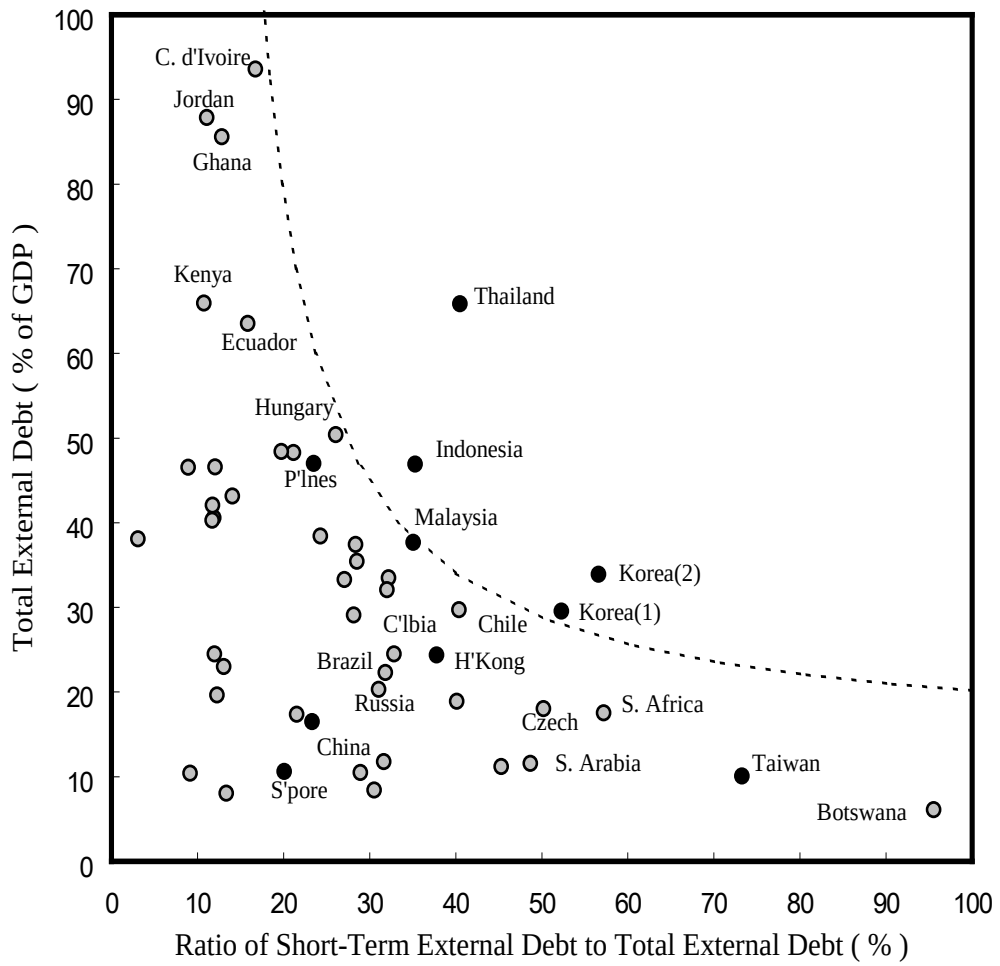


Figure 3 External Debt Structure of 50 Emerging Market Economies in 1996



Notes: Dashed curve indicates the hyperbola exploiting the estimation result (7), which was drawn so as to satisfy the relationship 600={ *Debt* – 13.44 }{ *RSTDebt* – 10.83 }. Korea(1) and Korea(2) are based on the Joint Statistics and the Korean national data source on the external debt, respectively. The black circles indicate the East Asian countries.