Paper tigers? A preliminary assessment of the Asian crisis*

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paper tiger: *a Chinese expression first used by Chairman Mao, a person, country, etc., that appears outwardly powerful or important but is actually weak or ineffective* (Oxford English Dictionary, 2nd edition).

1 Introduction

The purpose of this paper is to provide a preliminary assessment of the evidence on the origins and causes of the 1997-98 Asian crisis. We cast our empirical analysis within a theoretical framework that illustrates the links between policy inconsistencies and financial crises, focusing on the effects of government bail-out guarantees on overinvestment, foreign debt accumulation and current account deficits under a fixed exchange rate regime. Our findings point at significant weaknesses of the fundamentals in the region, consistent with an interpretation of the Asian collapse according to which structural factors caused a progressive and steady deterioration of economic conditions in the crisis countries.

The paper is organized as follows. Section 2 presents a synthetic overview of the structural imbalances in South-East Asia on the eve of the crisis. The micro-founded model of currency crisis in the presence of moral hazard, introduced in Section 3, provides a conceptual and analytical apparatus to interpret the econometric results of Section 4. According to our findings, the likelihood and severity of a currency and financial crisis are related to the magnitude of the current account deficits and the share of non-performing loans; these effects are stronger when a country has weak fundamentals and low foreign exchange rate reserves, as was the case in the Asian region by early 1997. Section 5 concludes.

2 Fundamental imbalances in the Asian crisis

At the end of 1996 Thailand, the Philippines, Malaysia and Korea ran current account deficits of the order of 5% of GDP or higher, while the Indonesian deficit was slightly less sizable.[1] The recent debate on the causes of the 1997-98 events has highlighted a number of country-specific and global factors

[1] In 1996, the current account deficit was 9.1% in Thailand, 5.9% in Malaysia, 5.8% in the Philippines, 4.9% in Korea, 3.4% in Indonesia.

underlying these large external imbalances.[2]

First, several adverse shocks had caused a significant export slowdown from the region. The long period of stagnation of the Japanese economy in the 1990s had contributed to the deterioration of the trade balances; in the months preceding the eruption of the crisis, the hopes for a Japanese recovery were shattered by a sudden decline in economic activity in this country. Sector-specific shocks such as the fall in the demand for semi-conductors in 1996, and adverse terms of trade fluctuations, had also contributed to decelerate export growth in several Asian countries between 1996 and 1997.

Second, the sharp appreciation of the US dollar relative to the Japanese yen and the European currencies since the second half of 1995 had led to deteriorating cost-competitiveness in most Asian countries whose currencies were effectively pegged to the dollar. Competitive pressures were enhanced by the increasing weight of China in total export from the region.[3] Also, expectations of a monetary contraction in the US in the summer of 1997 may have played a role in precipitating the crisis.

Third, to some extent, the external deficits reflected currency misalignment. Based on standard real exchange rate measures, many Asian currencies had appreciated in the 1990s, although the degree of real appreciation had not been as large as in previous episodes of currency collapses (such as Mexico in 1994). The dynamics of the real exchange rate had been asymmet-

[2]The picture that emerges from a broad overview of the available empirical evidence on current account imbalances, foreign indebtedness and structural macroeconomic indicators in Asia is discussed in detail in Corsetti, Pesenti and Roubini (1998a). A partial list of recent discussions of the empirical evidence on the Asian crisis includes Bhattacharya *et al.* (1998), Dornbusch (1998), Feldstein (1998), IMF (1998), and Radelet and Sachs (1998). Internet links to a very large number of contributions on the crisis are available at www.stern.nyu.edu/~nroubini/asia/AsiaHomepage.html.

[3]Whether cost-competitiveness deteriorated in the rest of the region after the 50% devaluation of the Chinese currency in 1994 is still a matter of debate. The thesis that "a large part of China's recent export success reflects the devaluation that occurred in January 1994" and that this "cheap-currency policy" was "one of the factors provoking the crisis in south-east Asia" has been espoused in a *Financial Times* editorial (September 17, 1997) and echoed in the popular press (see for instance *The Economist*, November 22, 1997, or Harun Jailani, "Manage exchange rates, Asean told", *Business Times*, March 17, 1998.) Recent studies (Liu, Noland, Robinson and Wang (1998), Fernald, Edison and Loungani (1998) and IMF (1998)) dismiss the thesis on the basis of several factors, most notably the fact that by 1993 about 80% of Chinese transactions were already settled at the swap market rate, not the official rate, so that the official exchange rate devaluation influenced only about 20% of the foreign exchange transactions.

ric across countries: by 1997 the extent of real appreciation was evident in Malaysia and the Philippines, while in South Korea, Thailand and Indonesia, real exchange rate indicators had not moved significantly relatively to 1990.[4]

Fourth, and most notably, the current account deficits were driven by high rates of investment.[5] While common wisdom holds that borrowing from abroad to finance the accumulation of domestic capital should not raise concerns about external solvency, the evidence for the Asian countries in the mid-1990s highlights that the profitability of new investment projects was low. For instance, in Thailand, Indonesia, Korea and Malaysia the share of non-performing loans before the crisis was above 15%. In Korea, 20 of the largest 30 conglomerates displayed in 1996 a rate of return on invested capital below the cost of capital. By mid-1997, 8 of the 30 largest conglomerates were effectively bankrupt.

At the macroeconomic level, evidence that investment efficiency was already falling before the crisis is provided by the dynamics of the incremental capital output ratio, defined as the ratio between the rate of investment (as percentage of GDP) and the rate of growth of the economy. In all countries but Indonesia and the Philippines, this indicator increased sharply between the two sub-periods 1987-1992 and 1993-1996.

Why did investment rates and capital inflows in Asia remain high even after the negative signals sent by the indicators of profitability? In part, the fall of interest rates in industrial countries (especially in Japan) lowered the cost of capital for firms and motivated large financial flows into the Asian countries. But at the very root of the sustained capital accumulation was the structure of incentives under which the corporate and financial sectors operated in the region. The so-called 'moral hazard' problem in Asia exhibited three different, yet strictly interrelated dimensions at the corporate, financial, and international level.[6]

Political pressures to maintain high rates of economic growth had led to a long tradition of public guarantees to private projects, some of which were effectively undertaken under government direction, directly subsidized,

[4]See Table 1.

[5]Throughout the 1990s, in most of the South-East Asian countries investment rates were above 30% of GDP — rising above 40% in Thailand, Malaysia and China. The exception was the Philippines, where the investment rate ranged from 20% to 25%.

[6]A number of authors have stressed the role of moral hazard in the onset of the Asian crisis. See *e.g.* Fischer (1998), Greenspan (1998), Krugman (1998), and the overview in Corsetti, Pesenti and Roubini (1998a,b).

or supported by policies of directed credit to favored firms and/or industries. Even in the absence of explicit promises of 'bail-out', the production plans and strategies of the corporate sector largely overlooked costs and riskiness of the underlying investment projects. With financial and industrial policy enmeshed within a widespread business sector network of personal and political favoritism, and with governments that appeared willing to intervene in favor of troubled firms, markets operated under the impression that the return on investment was 'insured' against adverse shocks.

The financial counterpart of the 'moral hazard' problem in investment was the strong tendency for national banks to borrow excessively from abroad and lend excessively at home,[7] thus playing a key role in channelling funds toward projects that were marginal if not outright unprofitable from a social point of view. Lax supervision and weak regulation of the financial system, low capital adequacy ratios, lack of incentive-compatible deposit insurance schemes, insufficient expertise in the regulatory institutions, distorted incentives for project selection and monitoring, and outright corrupt lending practices, all contributed to the build-up of severe structural weaknesses in the undercapitalized financial system, whose most visible manifestation was a growing share of non-performing loans.

The distortions generated by such behavior were enhanced by the rapid process of capital account liberalization and financial market deregulation in the region during the 1990s, that had increased the supply-elasticity of funds from abroad. The extensive liberalization of capital markets was consistent with the policy goal of providing a large supply of low-cost funds to national financial institutions and the domestic corporate sector.[8] The same goal motivated exchange rate policies aimed at reducing the volatility of the domestic currency in terms of the US dollar, that translated into low risk premiums on dollar denominated debt.

The international dimension of the moral hazard problem hinged upon the behavior of international banks, that over the period leading to the crisis had lent large amount of funds to the region's domestic intermediaries, with

[7]Between 1990 and 1996, the ratio of bank lending to GDP grew more than 50% in Thailand and the Philippines, by 27% in Malaysia, and around 15% in Korea, Singapore, Hong Kong and Indonesia. For an analysis of these data see Corsetti, Pesenti and Roubini (1998a).

[8]The seminal contribution by Diaz-Alejandro (1985) provides key insights on the dangers of financial deregulation and liberalization. For a recent study of the Asian case along the same lines see McKinnon and Pill (1996).

apparent neglect of the standards for sound risk assessment. Underlying such overlending syndrome may have been the presumption that short-term interbank cross-border liabilities would be effectively guaranteed by either a direct government intervention in favor of the financial debtors, or by an indirect bail-out through IMF support programs in the event of a crisis.

A very large fraction of foreign debt accumulation was in the form of short-term, unhedged, foreign-currency denominated liabilities:[9] by the end of 1996, a share of short-term liabilities in total liabilities above 50% was the norm in the region. Moreover, the ratio of short-term external liabilities to foreign reserves — a widely used indicator of financial fragility — was above 100% in Korea, Indonesia and Thailand.

As a result of the cumulative effects of the fundamental financial and real imbalances considered above, by 1997 the Asian countries appeared quite vulnerable to financial crises, either related to sudden switches in market confidence and sentiments, or driven by deteriorating expectations about the poor state of fundamentals.

3 A theoretical framework

Due to its unprecedented complexities, the analysis and interpretation of the Asian crisis is by no means a straightforward task. A full understanding of the Asian events — it has been recently argued — requires a 'new' theoretical paradigm in the literature on currency and financial crises. In fact, the traditional conceptual and interpretive schemes[10] do not appear, *prima facie*, to fit well the specific characteristics of the 1997-98 crisis, and fall short in a number of dimensions.

A first reason is related to the role of fiscal imbalances. At the core of 'first generation' (or 'exogenous-policy') models of speculative attacks á-la-Krugman (1979) and Flood and Garber (1984), the key factor that explains the loss of reserves leading to a crisis is the acceleration in domestic credit expansion related to the monetization of fiscal deficits. Instead, in the Asian case one may be tempted to consider the budget surpluses (or the limited

[9]FDI was substantial only in Indonesia, Malaysia, and the Philippines (and even in Malaysia the contribution of FDI to current account financing dropped from 100% to 50% in 1995), but very low in Korea and Thailand.

[10]See Buiter, Corsetti and Pesenti (1998a), Calvo (1998), Calvo and Vegh (1998), Cavallari and Corsetti (1996) and Flood and Marion (1998) for recent surveys.

deficits) of the 1990s as pervasive evidence against the fiscal origins of the 1997 currency crises.

'Second generation' (or 'endogenous-policy') models of currency crisis appear similarly powerless to explain the logic of the Asian events. In these models, governments rationally choose — on the basis of their assessment of costs and benefits in terms of social welfare — whether or not to maintain a fixed rate regime. A crisis can be driven by a worsening of domestic economic fundamentals, or can be the result of self-validating shifts in expectations in the presence of multiple equilibria,[11] provided that the fundamentals are weak enough to push the economy in the region of parameters where self-validating shifts in market expectations can occur as rational events. The indicators of weak macroeconomic performance typically considered in the literature focus on output growth, employment, and inflation. But in the Asian economies, GDP growth rates were very high into 1997, and unemployment and inflation rates quite low.

The above criticism of the existing literature is certainly valid. Nevertheless, a 'third-generation' model of currency and financial crises cannot afford to overlook the many insights on the logic of crises offered by the traditional explanatory schemes. As a contribution to the development of the analytical literature on the implications and lessons of the Asian crisis, in the following pages we suggest an interpretive scheme that, while revisiting the classical models, brings forward new elements of particular relevance for the analysis of the 1997 events.[12]

Specifically, at the root of our model is the consideration that bail-out interventions can take different forms, but ultimately have a fiscal nature and

[11] See among others Obstfeld (1994), and Cole and Kehoe (1996). If investors conjecture that a country's government will eventually devalue its currency, their speculative behavior raises the opportunity cost of defending the fixed parity (for instance, by forcing a rise in short-term interest rates), thus triggering a crisis in a self-fulfilling way. Note that multiple equilibria can arise even in 'first-generation' models (see for instance Obstfeld (1986)). Somewhat confusingly, the literature occasionally identifies 'first-generation' models with unique equilibria, and 'second-generation' models with multiple equilibria. A classification of the models based on exogenous versus endogenous policies provides a more accurate taxonomy.

[12] Recent empirical and analytical work suggests the importance of modeling banking and currency 'twin' crises as interrelated phenomena (see Velasco (1987), Kaminsky and Reinhart (1997), Goldfajn and Valdes (1997), Kumhof (1997), Chang and Velasco (1988a,b)). Our model contributes to this literature by focusing on the common fiscal roots of twin crises.

directly affect the distribution of income and wealth: an implicit system of bail-out insurance is equivalent to a stock of contingent public liabilities that are not reflected by debt and deficit figures until the crisis occurs. These liabilities may be manageable in the presence of firm-specific, or even mild sector-specific shocks. They become a concern in the presence of cumulated sizeable macroeconomic shocks (such as the prolonged slump in Japan, a strong dollar appreciation, negative terms of trade shocks and persistent negative productivity shocks), that fully reveal the financial fragility associated to excessive investment and risk taking.

While fiscal deficits before a crisis are low, the implicit and/or explicit bail-outs represent a serious burden on the *future* fiscal balances, a burden whose order of magnitude in the Asian countries has been estimated around 10-20% of GDP.[13] A financial and currency crisis could be understood as a consequence of the anticipated bail-out costs and distributional conflicts on who should bear these costs, that generate expectations of a partial monetization of future fiscal deficits and a fall in economic activity induced by the required fiscal and external adjustment.[14]

3.1 The setup

Consider a small open economy specialized in the production of a traded good Y. The production function is

$$Y_t = \tilde{A}_t K_t^{\alpha} H_t^{\beta} L_t^{1-\alpha-\beta}$$

where K is physical capital, H are intermediate services provided by skilled labor, L is unskilled labor and $\tilde{A}$ is a technology parameter. In this and the next sections we assume that both skilled and unskilled labor is inelastically supplied, and adopt the normalization $L = H = 1$. Later we discuss an extension of the model that analyzes the role of H in a crisis.

[13] See the empirical section of our paper.

[14] In order to maintain both focus and tractability, the model in this contribution necessarily abstracts from a number of factors that are relevant in a comprehensive reading of the Asian crisis. Namely, we do not explicitly model the real exchange rate and its role in determining the domestic burden of external debt. By the same token, we do not address contagion and issues related to the systemic dimension of the crisis. Systemic models of currency crises and competitive real depreciations are presented in Buiter, Corsetti and Pesenti (1998a,b) and Corsetti, Pesenti and Roubini (1998b).

The production technology is stochastic, say

$$\tilde{A}_t = \begin{cases} A+\sigma & \text{with probability } 1/2 \\ \\ A-\sigma & \text{with probability } 1/2 \end{cases} .$$

As regards the timing of the variables, agents determine the level of capital K_t (in place at time t) at time $t-1$, before the shock $\tilde{A}_t$ is realized and observed.

The country is comprised of three types of agents: the country 'élite', the rest of the country and the government. The *élite* (ELI) encompasses the country's financial intermediaries, the only agents in the economy with access to foreign capital markets, and the only providers of skilled labor inputs.[15] Unskilled labor incomes are the only source of wealth for the rest of the country; there is no capital market whereas these agents can borrow against future incomes.

The élite borrows foreign-currency funds from abroad, denoted D, at the constant rate r, provides managerial services and lends capital K to the country's firms, owned by the élite itself, so that its aggregate budget constraint is

$$(K_{t+1}-K_t)-(D_{t+1}-D_t)\frac{\mathcal{E}_t}{P_t} = Y_t - W_t$$
$$-r\frac{\mathcal{E}_t}{P_t}D_t - C_t^{ELI} - T_t^{ELI} - \frac{M_t^{ELI}-M_{t-1}^{ELI}}{P_t}$$

where W are labor costs in real terms (net of the remuneration of skilled labor), C^{ELI} is the élite's consumption, T^{ELI} are net taxes paid by the élite to the government, M^{ELI} is nominal money holdings,[16] P is the domestic price level, and $\mathcal{E}$ is the nominal exchange rate (domestic currency per unit of foreign currency). Arbitrage in the goods market guarantees that purchasing power parity holds:

$$P_t = \mathcal{E}_t,$$

[15] Similarly, Krugman (1998) refers to a class of *minister's nephews*.

[16] The time-subscripts adopted here follow the notational conventions suggested by Obstfeld and Rogoff (1996): the élite enters period t with a stock of capital equal to K_t, a stock of external debt equal to D_t, but a stock of money holdings equal to M_{t-1}^{ELI}. This convention regarding the time-subscript of the money stock is maintained throughout the paper.

where the foreign price level is assumed to be constant and normalized to one. The standard transversality condition applies.[17] Consistently with evidence on the Asian crisis, we assume that firms are undercapitalized, namely, the initial capital stock of the nation is financed through external borrowing.

Real money balances provide liquidity services that enter the utility function of the élite (formally, we parameterize the instantaneous utility from real balances as $\chi \ln (M_t/P_t)$, with $\chi > 0$). The élite agents are risk neutral[18] and their rate of time preference is equal to the world interest rate r, so that their expected utility is given by

$$E_t \sum_{s=t}^{\infty} \frac{1}{(1+r)^{s-t}} \left[Y_s - W_s - (K_{s+1} - K_s) - T_s^{ELI} \right.$$

$$\left. - (1+r) D_s + D_{s+1} - \left(M_s^{ELI} - M_{s-1}^{ELI} \right) / P_s + \chi \ln \left(M_s^{ELI} / P_s \right) \right]$$

The élite agents maximize their expected utility with respect to capital K and money holdings M^{ELI}.[19] Accounting for the possibility of distortionary net taxes, the élite's wealth/utility is maximized with respect to K when

$$E_t \frac{\partial Y_{t+1}}{\partial K_{t+1}} - E_t \frac{\partial \sum_{s=0}^{\infty} T_{t+1+s}^{ELI} / (1+r)^s}{\partial K_{t+1}} = r \tag{1}$$

In the above expression we allow for the possibility that agents act under the presumption that current investment decisions affect the stream of net taxes from $t+1$ onwards — as is the case when tax-related rights and obligations are expected to be settled over time.

The optimal demand for money by the élite is

$$\frac{M_t^{ELI}}{P_t} = \chi \frac{1 + i_{t+1}}{i_{t+1}}$$

[17] Namely, the intertemporal budget constraint for the élite is

$$E_t \sum_{s=t}^{\infty} \left(\frac{1}{1+r} \right)^{s-t} (C_s + K_{s+1} - K_s) = - (1+r) D_t$$

$$+ E_t \sum_{s=t}^{\infty} \left(\frac{1}{1+r} \right)^{s-t} \left[Y_s - W_s - T_s^{ELI} - \left(M_s^{ELI} - M_{s-1}^{ELI} \right) / P_s \right]$$

[18] Under the assumption that the entire capital stock is leveraged, throughout the paper we assume that, in each period, the consumption of risk-neutral élite agents is equal to the income they receive by providing skilled labor H.

[19] Debt accumulation is determined residually.

where i_{t+1} denotes the domestic nominal interest rate, defined according to the uncovered interest parity relation as

$$1 + i_{t+1} = (1 + r) E_t \left(\frac{\mathcal{E}_{t+1}}{\mathcal{E}_t} \right) = (1 + r) E_t \left(\frac{P_{t+1}}{P_t} \right).$$

Under a fixed exchange rate regime, the domestic interest rate is equal to the foreign (nominal and real) interest rate r.

In the *rest of the country* (ROC), the aggregate budget constraint is

$$W_t = C_t^{ROC} + T_t^{ROC} + \frac{M_t^{ROC} - M_{t-1}^{ROC}}{P_t}$$

where C^{ROC} is consumption, T^{ROC} net taxes and $\left(M_t^{ROC} - M_{t-1}^{ROC} \right) / P_t$ the seigniorage tax. We model net taxes on the rest of the country as a fraction η of real wages, where the tax rate is bounded from above by some constant $\bar{\eta}$:

$$T_t^{ROC} = \eta_t W_t, \qquad 0 \leq \eta_t \leq \bar{\eta} < 1.$$

The labor market is competitive, so that $W = \partial Y / \partial L = (1 - \alpha - \beta) Y$. Money demand in the rest of the country is determined by a cash-in-advance constraint:[20]

$$M_{t-1}^{ROC} = P_t C_t^{ROC}$$

which implies $M_t^{ROC} / P_t = (1 - \eta_t) (1 - \alpha - \beta) Y_t$.

The government's only role in this model is to implement a redistributive policy across agents and to manage its stock of foreign reserves R, denominated in foreign currency:[21]

$$T_t^{ELI} + T_t^{ROC} + \frac{M_t - M_{t-1}}{P_t} + r \frac{\mathcal{E}_t}{P_t} R_t = \frac{\mathcal{E}_t}{P_t} (R_{t+1} - R_t)$$

where $M = M^{ELI} + M^{ROC}$.[22] Note that aggregate money demand is a

[20] The cash-in-advance constraint is consistent with the idea that agents in the rest of the country do not have access to financial markets, so that their money demand is interest inelastic.

[21] See section 3.3.2 below.

[22] The intertemporal budget constraint for the government is

$$0 = (1 + r) R_t + E_t \sum_{s=t}^{\infty} \left(\frac{1}{1 + r} \right)^{s-t} \left[T_s^{ELI} + T_s^{ROC} + (M_s - M_{s-1}) / P_s \right]$$

function of income and the nominal interest rate:

$$\frac{M_t}{P_t} = \chi \frac{1 + i_{t+1}}{i_{t+1}} + (1 - \alpha - \beta)(1 - \eta_t)\tilde{A}_t K_t^{\alpha}.$$

If the exchange rate is expected to be maintained fixed at the level $\overline{\mathcal{E}}$ between time t and $t+1$, for a constant tax rate η and a constant stock of capital, seigniorage revenues are on average equal to zero:

$$\frac{M_t - M_{t-1}}{\overline{\mathcal{E}}} = (1 - \alpha - \beta)(1 - \eta)\left(\tilde{A}_t - \tilde{A}_{t-1}\right) K^{\alpha}.$$

Aggregating the three budget constraints above we obtain the current account relation

$$-(D_{t+1} - R_{t+1}) + (D_t - R_t) = Y_t - r(D_t - R_t) - C_t - (K_{t+1} - K_t)$$

where $C = C^{ROC} + C^{ELI}$ denotes aggregate consumption. In a steady state, the previous expression yields

$$C = AK^{\alpha} - r(D - R). \tag{2}$$

In the particular case of lump-sum taxes and subsidies[23] the optimal capital stock $\bar{K}$ is such that $r\bar{K} \equiv \alpha A \bar{K}^{\alpha}$. To realize that $\bar{K}$ represents a social optimum, note that it is also the level that maximizes the country steady-state consumption C level in equation (2), when the entire stock of capital is financed through net external borrowing ($\bar{K} = D$).

3.2 Moral hazard, overinvestment and excessive external debt

Suppose that agents' investment decisions incorporate the expectation that the fiscal authorities will guarantee a rate of return on domestic financial investment equal to the international rate of return. To be rational, such expectation must be based on two elements: first, an explicit or tacit commitment by the government to back the financial debt incurred by firms in financing their production plans; second, the consistency of this commitment with the requirement of solvency.

[23] So that $E_t \partial T^{ELI}_{t+1+s} / \partial K_{t+1} = 0$ in equation (1).

Formally, assume that starting at time t_0 and up to some time $t_{\max}$, the élite anticipates a stream of transfers from the government such that

$$E_t \sum_{s=t_0+1}^{\infty} \left(\frac{1}{1+r}\right)^{s-t_0} \left(-T_s^{ELI}\right) = \sum_{s=t_0+1}^{t_{\max}} \left(\frac{1}{1+r}\right)^{s-t_0} \theta_s K_s \qquad (3)$$

where by definition $E_t \partial \left[\sum_{s=0}^{\infty} T_{t+1+s}^{ELI} / (1+r)^s\right] / \partial K_{t+1} = -\theta_{t+1}$. Over the period $(t_0, t_{\max}]$, firms' debt is perceived as 'insured' by the government against adverse contingencies: in 'good' times ($\tilde{A} = A + \sigma$) the government is not expected to intervene, while in 'bad' times ($\tilde{A} = A - \sigma$) firms expect from the government an amount of 'bail-out' subsidies θK equal to the difference between the cost of funds and the 'bad' payoff.[24]

Since the government insurance is only implicit, say $T^{ELI} = 0$ before $t_{\max}$, the payment of these subsidies is not contemporaneous to the realization of negative productivity shocks. Instead, the transfer payments are delayed over time, beyond $t_{\max}$. Yet the present discounted value of expected transfers (left hand side of (3)) is equal to the cumulative value of the bail-out implicit interventions (right hand side of (3)).

Taking into account such expected subsidies, the élite firms will choose the desired level of capital as follows:

$$K_t \;=\; \left(\frac{\alpha\,(A+\sigma)}{r}\right)^{\frac{1}{1-\alpha}} \equiv \hat{K} \qquad\qquad t_0 < t \leq t_{\max}.$$

Observe that, as long as firms act under the presumption that the subsidy policy is in place, the level of capital $\hat{K}$ is higher than the efficient level $\bar{K}$ obtained in the absence of bail-out promises:

$$\bar{K} = \left(\frac{\alpha A}{r}\right)^{\frac{1}{1-\alpha}}$$

In Krugman (1998) terminology, such scenario corresponds to 'overinvestment' driven by 'Pangloss values'.

[24] In equilibrium the bail-out subsidy per unit of capital is

$$\theta_{t+1} = \alpha \left(A + \sigma - \tilde{A}_{t+1}\right) K_{t+1}^{\alpha-1} = r - \frac{\alpha Y_{t+1}}{K_{t+1}}.$$

In addition to overinvestment, the subsidy policy also causes excessive external indebtedness. Specifically, consider a country that starts off at time t_0 with a steady-state level of external debt $D = \bar{K}$. At any point between t_0 and $t_{\max}$, for a given path of money demand, the difference between external debt with subsidies, denoted by $\hat{D}$, and external debt without subsidies, denoted by $\bar{D}$, is

$$\hat{D}_{t+1} - \bar{D}_{t+1} = \hat{K} - \bar{K} +$$

$$\sum_{s=t_0+1}^{t} \left[\alpha\left(A + \sigma - \tilde{A}_s\right)\hat{K}^{\alpha} - \alpha\left(A - \tilde{A}_s\right)\bar{K}^{\alpha}\right](1+r)^{t-s} \tag{4}$$

Interpreting the previous expression, recall that a negative shock to production (a bad realization of $\tilde{A}$) is not offset by a contemporaneous government subsidy of the same size ($T^{ELI} = 0$ during this period). With implicit government guarantees, firms will be able to finance their losses by borrowing in the international financial markets against future bail-out revenue, so that current external private debt is expected to translate into future public liabilities.[25]

The component of external debt corresponding to the implicit bail-out promises, F, is defined as:[26]

$$F_{t+1} = \sum_{s=t_0+1}^{t} \left[\alpha\left(A + \sigma - \tilde{A}_s\right)\hat{K}^{\alpha}\right](1+r)^{t-s} \tag{5}$$

The above equation shows that, other things being equal, F_{t+1} will be higher the worse is the sequence of 'bad' shocks, and the higher is the 'excessive' capital level $\hat{K}$.

Note that a large and increasing stock of foreign liabilities, driven by F, can coexist with a path of balanced government budget, or even of budget

[25] In the literature, the recourse to foreign borrowing to cover profit losses in excess of public transfers is referred to as *evergreening* — see for instance Kumhof (1997).

[26] Between t_0 and $t_{\max}$, total external debt is equal to the stock of capital, the cumulative seigniorage revenues extracted from the élite, and the implicit fiscal burden related to the bailout promises

$$D_{t+1} = K_{t+1} + \sum_{s=t_0}^{t} \left(\frac{M_s^{ELI} - M_{s-1}^{ELI}}{P_s}\right)(1+r)^{t-s} + F_{t+1}$$

Note that at time t, F_{t+1} is predetermined, while capital and seigniorage depends on current portfolio decisions by the élite.

surplus — a feature that is consistent with the evidence on the Asian crisis. In fact, the expressions in squared brackets in the above equations (4) and (5) are non-negative under any state of nature. Thus, between t_0 and $t_{\max}$, both the wedge between the two debt levels $\hat{D} - \bar{D}$ and the implicit fiscal burden F increase over time at a rate faster than r.

It should be stressed that, in the presence of moral hazard distortions, a process of financial liberalization can contribute to increase the level of capital accumulation and foreign indebtedness. A simple way to see this is to model capital controls as a tax on foreign borrowing, say ϕ, such that the cost of borrowing is equal to $r(1+\phi)$. Then, with a perfectly elastic supply of international funds, the financial intermediaries of the élite would equate the *cum-tax* cost of borrowing to the (guaranteed) return on capital:

$$r(1+\phi) = \alpha(A+\sigma)K^{\alpha-1}$$

corresponding to a lower investment rate relative to $\hat{K}$. In this sense, capital liberalization (the removal of ϕ) exacerbates the 'moral hazard' problem stemming from the implicit government guarantees.[27]

3.3 The dynamics of a crisis

3.3.1 'Show me the money'

What determines $t_{\max}$, i.e. the duration of the implicit bail-out period? In principle, the regime is sustainable as long as the government solvency constraint is satisfied. More realistically, the sustainability of the regime is subordinated to the creditors' willingness to lend.[28] Consistently, we assume that foreign creditors are willing to refinance domestic firms against expected future government guarantees only insofar as the country's collateral, i.e. the stock of foreign official reserves, remains above some minimum threshold expressed as a fraction of F, say γ.

When R reaches this threshold, foreign creditors not only refuse to finance new losses: they also refuse to roll-over the outstanding stock of debt, unless the élite comes up with enough resources to service its external liabilities fully and permanently. This 'show me the money' condition does not imply

[27] See Díaz-Alejandro (1985) for an early formulation of this issue. Corsetti and Roubini (1997) analyze how political distortions may lead to excessive fiscal deficits and external debt accumulation.

[28] See *e.g.* Milesi-Ferretti and Razin (1996).

that the élite is forced to repay F at once — rather, the élite is no longer allowed to finance its interest bill with additional external borrowing.[29]

Formally, $t_{\max}$ is the first time at which

$$R_{t_{\max}+1} = \gamma F_{t_{\max}+1} \qquad 0 < \gamma < 1 \tag{6}$$

At time $t_{\max}$, the élite 'presents the bill' to the government. Ruling out a default scenario, in which agents' expectations are not validated *ex post*, the government must undertake the appropriate fiscal measures to back the claim by the élite. Starting from $t_{\max+1}$, the actual transfer of resources from the government to the élite, $-T^{ELI}$, begins, and the return on *new* financial investment in the country ceases to be perceived as implicitly insured. In other words, $t_{\max}$ is the point at which the financial sector goes into a crisis and the government starts to bail-out explicitly domestic financial institutions, determining a sharp current account adjustment.

As shown in Appendix 1, at time $t_{\max}$, the public sector budget constraint can be written as

$$(1-\gamma)(1+r)F_{t_{\max}+1} - \frac{1+r}{r}\bar{\eta}(1-\alpha-\beta)A\bar{K}^{\alpha} =$$

$$= E_{t_{\max}} \sum_{s=t_{\max}+1}^{\infty} \left(\frac{1}{1+r}\right)^{s-t_{\max}-1} \left(\frac{M_s - M_{s-1}}{P_s}\right) \tag{7}$$

The left hand side of the above expression includes the outstanding implicit liabilities of the government, net of reserves, minus the discounted value of anticipated tax revenue flows from the rest of the country (that depend on the post-subsidy capital level $\bar{K}$). The right hand side includes the discounted value of seigniorage revenue.

The key implication of the above budget constraint is that the lower boundary on the anticipated permanent rate of money creation from $t_{\max}$ onward is determined residually, as a positive function of the outstanding stock of implicit government liabilities, and a negative function of the reserves to debt ratio and the maximum tax rate. If $\bar{\eta}$ (that is, if the ability of the government to extract fiscal resources from the rest of the country) is low

[29]The threshold γ captures the realistic feature that there is an upper limit to the creditors' willingness to let the borrowers 'evergreen' their losses. While the assumption of an exogenously given γ is common in other models of evergreening in the literature (see *e.g.* Kumhof (1997) and Velasco (1987)), this parameter could be determined endogenously in a more general setting.

relative to F (that is, the size of the outstanding imbalance of the élite), when the subsidy policy is discontinued at time $t_{\max}$ agents revise their expectations of a monetary expansion, say, they expect the following process of money growth:

$$E_t M_{t+1} = (1+\mu)\, M_t \qquad t \geq t_{\max}$$

where μ, the average growth rate of money supply, is an increasing function of $F_{t_{\max}+1}$. Algebraic details are presented in Appendix 1.

3.3.2 An inconsistent policy trio

We can now delve into the analysis of the dynamics of a crisis. The maintained assumptions that are of particular interest for the interpretation of the Asian events can be summarized as follows. Starting from t_0, the government pegs the nominal exchange rate at the level $\mathcal{E}_t = \overline{\mathcal{E}}$. Second, it does not raise taxes on the rest of the country, in order to build up foreign reserves against future liabilities. Third, it does *not* make a credible announcement that the firms' debt will not be bailed-out.[30] These three policies represent an 'inconsistent trio', which is not sustainable in the long run.

To see this, recall that, in a fixed exchange rate regime, revenue from seigniorage is, on average, zero. As there are no taxes on the rest of the country ($\eta = 0$), and current transfers to firms T^{ELI} are zero as well, from t_0 onward international reserves grow at the average rate r. At the same time, due to moral hazard, private firms overinvest and keep refinancing current losses in the international private markets, counting on a future government bail-out that the government has not explicitly denied. In this case F grows at a rate faster than r. Thus, sooner or later, the stock of reserves will fall below the threshold γF, triggering the 'show me the money' condition. This is a situation that, in analogy to Grilli (1986), can be referred to as the 'natural collapse' of the implicit bail-out policy.

[30] With an implicit subsidy policy, the wealth of the élite and the value of the firms are both boosted, at the expenses of the wealth of the rest of the country. Because of the wedge in the valuation of firms, no agent in the economy will be able to act as a financial intermediary and compete with the existing financial firms, unless she benefits from the same privileges as the élite. These considerations suggest some preliminary answers to why would a government implicitly back the external liabilities of the firms: preference towards capital accumulation and growth corresponds to a targeted pattern of income and wealth distribution between élite and rest of the country.

At the time of the natural collapse, the financial sector goes into a crisis, the government takes over the bad loans and the elimination of the subsidy guarantee leads to a fall in the capital stock and output — so that a crisis corresponds to an economic recession. What happens to the exchange rate at the time of the natural collapse? Unless the government is able to raise sufficiently large revenues from taxing the rest of the country, money starts to grow at a positive rate μ, generating expectations of exchange rate depreciation and driving a sizeable wedge between the domestic and the international nominal interest rates. Moreover, to the extent that new investment subsidies are ruled out, the capital stock and output will drop, driving down money demand: the natural collapse clearly coincides with the abandonment of the peg and a strong depreciation of the exchange rate.

But this is why, with rational expectations, the economy will never reach the point of a natural collapse of the implicit subsidy policy, at which there would be an anticipated jump in the currency price. In each period agents can attack the currency and force the government to give up its investment objective by bringing down R/F to its lower limit γ. Rational agents will never find it optimal to attack the currency too soon, when the stock of outstanding liabilities is still too small relative to the country's future tax revenue: in this case, the need for seigniorage revenue is contained, and the anticipated rate of post-attack money growth μ is correspondingly negligeable.[31] The attack will take place as soon as the fundamentals are weak enough, that is, when the stock of external debt backed by the government is sufficiently high to induce expectations of a sustained permanent money expansion. Yet, the crisis will happen well before the point of 'natural collapse'. It should be stressed that the speculative attack in our model takes the form of both an attack on the monetary balances (as in the traditional stock-shift reshuffle of money and foreign reserves) and an attack on the foreign liabilities of the financial and corporate sector (the international creditors withdraw the loans triggering a financial crisis).

Note that at the time $t_{\max}$, when the government discontinues its bail-out policy and starts to repay the stock of past liabilities, the money demand from the élite falls due to the increase in the interest rate $i_{t_{\max}+1}$, reflecting expectations of exchange rate depreciation. However, demand for money

[31] Under these conditions, an attack would not cause the currency to depreciate (even after allowing for the effect of the drop in output on money demand) and therefore will never happen in a rational-expectations equilibrium.

from the rest of the country is still high, as it depends on the existing moral hazard-induced high level of capital and output $\hat{K}$. It is only in the following period ($t_{\max+1}$) that external debt, capital, output and ROC money demand all drop, triggering a further depreciation of the exchange rate besides the one induced by high money growth.

The above scenario of financial collapse, currency attacks, economic recession, and large explicit fiscal imbalances, captures in a highly stylized yet coherent way the events that have characterized the onset and aftermath of the 1997-98 crisis in several Asian economies.

3.3.3 Welfare, political risk and liquidity crises

An important implication of the analysis in the previous section is the role of financial markets to force the economic system out of an inefficient equilibrium before the occurrence of the natural collapse of the implicit subsidy policy. Other things being equal, an early dismantling of the public guarantees on investment increases net welfare for the country as a whole, by reducing the extent of overinvestment. From this point of view, the crisis is but a manifestation of a rapid convergence to a sustainable and efficient market equilibrium — a point stressed by Krugman (1998). It should not be overlooked, however, that the crisis coincides with a sizeable redistribution of resources from the rest of the country to the élite. At the new efficient level of investment, the real income of the rest of the country falls, both because of a lower real wage and a higher tax rate.

Moreover, a comprehensive interpretation of the crisis within the framework of our model should take into account a number of additional features that have a significant impact on economic efficiency. A first realistic extension of our analysis allows for political risk regarding the distribution of the costs of the bail-out. To the extent that the élite anticipates the possibility of being responsible for part of these costs, these agents can attempt to elude taxes and resort to capital flights.

A simple way to model a loss of economic efficiency following a crisis is the following. Recall that the élite agents supply managerial and intermediation services, H. Suppose that, after $t_{\max}$, the income accruing to H is expected to be subject to taxation. However, the élite can transfer H abroad, where it receives an income that is lower than the remuneration at home on a before-tax basis, but higher on an after-tax basis. Then, at $t_{\max}$ political risk can motivate a massive 'flight' of H, lowering capital profitability, domestic

investment, output and real wages below their efficient level. The possibility of a loss of managerial and intermediation services adds uncertainty to the welfare impact of a crisis: by worsening the post-crisis average productivity of capital, a fall in H lowers domestic welfare.

A second amendment to the model consists in allowing for the possibility of a liquidity crisis, stemming from a 'collective action problem' among creditors.[32] The standard way to introduce this possibility is to assume time-to-build and a low liquidation value for installed capital. Consider a scenario in which lenders anticipate that future corporate income will not be sufficient to service outstanding liabilities, and that the real return on loans to the country falls below the international rate. Thus, lenders refuse to roll over the short-term external debt of the country. When short-term debt is sufficiently high relative to the country's reserves (per effect of the implicit bail-out policy discussed above), a liquidity crisis forces an early liquidation of installed capital that validates, ex post, the initial pessimistic expectations.

As the crisis causes production plans to be discontinued, both output and tax revenue fall, increasing the need for money creation. The rate of currency depreciation after the crisis correspondingly increases. Moreover, as the solvency of domestic firms depends on public transfers, a fall in government revenue after the crisis exacerbates the domestic financial distress and concurs in validating the expectations underlying the sudden loss of confidence by international financial markets.

4 Empirical evidence

Our theoretical analysis has highlighted the key role played by a number of macroeconomic factors in the build-up of a currency and financial crisis: excessive investment in low profitability projects, misallocation of resources by banks and other financial intermediaries in the presence of moral hazard, large fiscal costs associated with financial bail-outs, unsustainable current account deficits. In this section we present some preliminary evidence on the relevance of these variables as determinants of the currency crises in Asia. In this respect, we compare the performance of all the Asian countries that were subject to pressures in 1997 with the performance of other emerg-

[32]The standard reference is Diamond and Dybvig (1983). Among recent extensions and applications to the Asian events, see Radelet and Sachs (1998), Corsetti, Pesenti and Roubini (1998b), and Chang and Velasco (1998b).

ing economies, including a few transition economies, for a total sample of 24 countries whose selection has been determined by data availability: Argentina, Brazil, Chile, China, Columbia, Czech Republic, Hong Kong, Hungary, India, Indonesia, Jordan, Korea, Malaysia, Mexico, Pakistan, Peru, Philippines, Poland, Singapore, Sri Lanka, Taiwan, Thailand, Turkey and Venezuela.

4.1 The 'crisis index'

Following the methodology suggested in previous studies,[33] we first construct a 'crisis index' (IND) as a measure of speculative pressure on a country currency. In our study such index is a weighted average of the percentage rate of exchange rate depreciation relative to the US dollar — if such depreciation can be deemed as abnormal, as explained below — and the percentage rate of change in foreign reserves between the end of December 1996 and the end of December 1997.[34]

The logic for the index IND is quite simple. If a currency is attacked, this is signalled either by a depreciation of the currency or by a fall in foreign reserves that prevents a devaluation. While of course an increase in domestic interest rates may also signal a frustrated speculative attack, we choose not to consider interest rates in constructing our crisis index, for two reasons. First, there are no reliable data on national interest rates for the purpose of a comparison across countries. Second, an increase in interest rates in the presence of speculative pressures is highly correlated with non-sterilized foreign exchange intervention leading to a fall in reserves. In IND the weight assigned to the exchange rate is 0.75, and 0.25 is the weight assigned to reserves changes.[35]

[33]Sachs, Tornell and Velasco (1996), Eichengreen, Rose and Wyplosz (1996) and Kaminsky, Lizondo and Reinhart (1998).

[34]Alternative tests with different samples of shorter size provide similar results. Lack of data availability precludes for the time being the possibility of extending the sample to 1998. We plan to consider an extended sample as 1998 data on foreign exchange reserves become available.

[35]For the purpose of carrying out sensitivity analysis, we consider alternative crisis indexes with different weights assigned to the rates of exchange rate depreciation and reserve loss. In $IND2$ the weight assigned to the exchange rate is 0.67, and 0.33 is the weight assigned to reserves changes. In $IND3$ these weights are 0.50 and 0.50. The choice of the weight coefficients turns out not to be crucial to our findings, so that we present in the tables only the results relative to IND where the exchange rate has a relatively higher

In evaluating the crisis index, we need to control for the fact that some countries may have had a trend depreciation in 1997 without being subject to substantial speculative pressures. For example, the fact that the Turkish currency depreciated by over 50% in 1997 should not be interpreted as a signal of 'crisis,' as chronically high inflation rates in Turkey over the 1990s have been associated with 'normally' high depreciation rates.[36] There is no obvious way to purge the sample of the effects of trend depreciations not associated with a crisis. In this study, we take the following approach: if a currency has depreciated in 1997 by less than its average depreciation rate in the 1994-1996 period, we consider this as being part of a trend depreciation and set the 1997 depreciation rate equal to zero in constructing the index.[37] Because of this screening procedure, the other major exclusion — besides Turkey — of a high depreciation country from our sample is represented by Venezuela.

We present the values for IND in Table 1: a large negative value for IND corresponds to a high devaluation rate and/or a large fall in foreign reserves, *i.e.* a more severe currency crisis. As Table 1 shows, the countries that in 1997 appear to have been hit by the most severe crises are, in order, Thailand, Malaysia, Korea, Indonesia, Philippines and the Czech Republic. Among Asian countries, the currencies of Singapore and Taiwan were also moderately devalued in 1997, but these two countries were not subject to such extensive and dramatic financial turmoils as the ones affecting other East Asian countries. Conversely, outside the Asian region the Czech Republic appears as a crisis country as its currency, that had been pegged since 1992, suffered a severe speculative attack in the spring of 1997 leading to a devaluation.[38] Next, we construct indexes of excessive investment and financial fragility, as well as indexes of external imbalance pressures.

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weight. Results with IND2 and IND3 are available upon request.

[36] In spite of its trend depreciation, Turkey exhibited a highly satisfactory economic performance in 1997, with GDP growing over 6% and its stock market being a leading performer among emerging countries.

[37] Other authors use a different approach to the same problem. For example, Sachs, Tornell and Velasco (1996) control for the variance of the exchange rate and reserves in the last 10 years.

[38] The Czech Republic shared many symptoms with the Asian crisis countries: a fixed exchange rate regime maintained for too long, a severe real appreciation, a dramatic worsening of the current account, and a weak banking system with large amounts of non-performing loans.

4.2 Indexes of financial fragility

In previous contributions, such as Sachs, Tornell and Velasco (1996), financial sector fragility is proxied by measures of 'lending boom' by banks and financial institutions. While adopting similar indicators in our analysis, we also attempt to measure the weakness of the banking system directly, by constructing a series of non-performing loans as a share of total assets for 1996 (NPL). This task is complicated by the lack of directly comparable data — Appendix 2 describes in detail our methodology to estimate the series NPL. The variable NPL is reported in Table 1.

Once we have obtained a measure of non-performing loans as a share of total bank assets, we proceed as follows. First, as we are interested in relating the degree of currency/financial crisis to the size of non-performing loans, we need to evaluate a measure of the implicit fiscal costs of financial bail-outs. An appropriate indicator for this purpose is the ratio of non-performing loans to GDP, rather than to banking assets. We calculate such a series, called $NPL3$, by taking the product of NPL times the ratio of commercial banks loans to the private sector as a share of GDP in 1996. This change in the scale of our NPL variable is important because some countries with a large stock of non-performing loans as a share of banking assets (India and Pakistan) have a very low ratio of loans to GDP. In such countries, the potential costs of bailing-out the banking system is smaller relative to countries with a similar NPL, but a much higher ratio of bank lending to GDP.

Second, we interact NPL with an indicator of 'lending boom' similar to the one derived by Sachs, Tornell and Velasco (1996). 'Lending boom' is defined here as the percentage rate of growth of the ratio of commercial bank loans to the private sector relative to GDP in the period 1990-1996. The reason why such a measure is proposed as a proxy for financial fragility is that, when bank lending grows at a rapid pace in a short period of time, the quality of the loans is likely to deteriorate significantly and a large fraction of them may become non-performing.

Some preliminary econometric tests suggested that 'lending boom' alone does not proxy well for the effects of non-performing loans. A better indicator can be obtained by combining the information encompassed by the two variables (lending boom and non-performing loans) in a new indicator, denoted with $NPL2$ and defined as follows: if the sign of the 'lending boom' variable in the 1990s is positive, we assign to $NPL2$ the original value of NPL; if the lending boom in the 1990s is negative, we set $NPL2$ equal to

zero.

The logic of this $NPL2$ variable is straightforward: non-performing loans represent a serious source of tension, and may lead to a currency/financial crisis, only when observed in tandem with excessive bank lending that enhances the fragility and vulnerability of the country. In the absence of a lending boom (i.e. when the growth of private loans as a share of GDP is negative), the consequences of a stock of non-performing loans on the financial health of a country is more limited.

Our econometric tests include both $NPL3$, as a proxy for the fiscal costs of a bank bail-out, and $NPL2$, as a proxy for financial fragility obtained by interacting the rate of non-performing loans with a measure of the lending boom.

4.3 Indexes of current account imbalances

Next, we construct measures of external balance and current account sustainability. One measure is the current account balance as a share of GDP in the 1994-1996 period.[39] The other is a measure of real exchange rate appreciation in the 1990s. The values of both variables are reported in Table 1.

There is no simple way to assess when a current account imbalance is sustainable (*e.g.*, when it is driven by investment in sound projects) and when is not (*e.g.*, when it reflects a structural loss of competitiveness), or to what extent a real appreciation is due to misalignment, as opposed to an appreciation of the fundamental equilibrium real exchange rate.[40] However, it is sensible to argue — and previous historical experience confirms this — that the *combination* of a relatively large current account deficit and a significant real appreciation represents a worrisome and unambiguous signal of unsustainability.

Consistently, we construct a variable, $CA2$, based on the interaction of the

[39]This is a relatively short period, and we could alternatively consider a longer time span such as 1990-96. In the longer sample, however, many countries exhibit large swings in their current account positions, so that the imbalances preceding the crisis are smoothed out in the six-year average. To the extent that short-run imbalances played a role in the currency and financial collapse, a six-year average may miss an important element in the explanation of the crisis.

[40]In fact, some preliminary tests suggested that the current account deficit and real exchange rate, taken insulately, did not have a significant effect on the crisis index.

current account data with the real exchange rate. This variable is constructed as follows: if the rate of real exchange rate appreciation is above a given threshold, $CA2$ is equal to the current account balance (as a share of GDP); if the real appreciation is below the threshold (or there is a real depreciation), $CA2$ is set equal to zero. The $CA2$ variable therefore captures the idea that current account deficits are problematic only to the extent that they are associated with a real appreciation. The threshold for the real exchange rate appreciation is set to two different values: either 10% or 0. In the tables, we present regression results for the 10% threshold, but similar results are obtained for the other threshold.

4.4 Indexes of foreign reserves adequacy and fundamental performance

In our empirical tests, we are interested in considering whether the effects of external imbalances and financial fragility are enhanced by the inadequate availability of foreign exchange reserves and by the performance of other fundamental variables. Our model suggests that the possibility of a currency crisis is higher when reserves are low relative to some measure of domestic liquid assets or short-term foreign debt. To capture the role of reserves availability we construct three different measures.

The first is the ratio of $M1$ to foreign exchange reserves ($M1/RES$), the second is the ratio of $M2$ to foreign reserves ($M2/RES$), the last is the ratio of the foreign debt service burden (i.e. short-term foreign debt plus interest payments on foreign debt) to foreign reserves (STD/RES). The values of these variables are shown in Table 1. In order to test for the robustness of our results to alternative reserve adequacy measures, we will use all these variables in our regressions.

To test for the joint role of weak fundamentals and foreign reserves in determining a currency crisis, we classify the countries in our sample as being *strong* or *weak* as regards these two dimensions. We use a broad classification according to which a country has high foreign exchange reserves if the ratio of M2 to reserves is in the lowest quartile of the sample; the resulting dummy variable for low reserves, $D2^{LR}$, is set equal to one for the countries with a ratio of money to foreign reserves ($M2/RES$) above the bottom quartile of the sample, and set equal to zero if otherwise. Similar dummies are created by replacing $M2/RES$ with $M1/RES$ and STD/RES; such dummy variables

are labelled $D1^{LR}$ and $D3^{LR}$.

We also construct a dummy variable for weak fundamentals, D^{WF}, that takes a value of zero when fundamentals are strong, and zero otherwise. Strong/weak fundamentals are defined as follows: D^{WF} is equal to zero for countries with a corrected current account balance ($CA2$) in the highest quartile of the sample, or with a rate of non-performing loans (corrected for the lending boom, i.e. $NPL2$) in the lowest quartile of the sample; it is equal to one otherwise. Alternatively, D^{WF} is also defined using $NPL3$ rather than $NPL2$.[41]

4.5 Testing for the effects of fundamentals on the likelihood and severity of a crisis

We start by regressing our index variable IND on the corrected measure of current account balance ($CA2$) and the measure of non-performing loans (corrected for the lending boom) $NPL2$. Next, we interact these two explanatory variables with our dummy variables D^{LR} and D^{WF} to test whether the effects are stronger when reserves are low and fundamentals are weak. In column (1) of Table 2, we present the result of a regression of IND on $CA2$ and $NPL2$. Both variables have the expected sign and are statistically significant at the 5% significance level: both a larger current account deficit and a larger rate of non-performing loans increase the crisis index.[42]

In columns (2)-(4) we interact the two regressors with the dummies for low reserves. In this case, the coefficients β_2 and β_3 measure the effects of $CA2$ and $NPL2$ on the crisis index in countries with high reserves ($D^{LR} = 0$). If such coefficients are not significant, then a crisis is not likely to occur if reserves are high. To evaluate the impact of fundamental imbalances on the crisis index in countries with low reserves ($D^{LR} = 1$), consider the sum of the coefficients $\beta_2 + \beta_4$ and $\beta_3 + \beta_5$. If the sum of these coefficients is different from zero, low reserves make it more likely that a country with a small $CA2$ and a large $NPL2$ will suffer a currency crisis. In regressions (2)-(4) the

[41] In this case, D^{WF} is equal to zero for countries with a corrected current account balance ($CA2$) in the highest quartile of the sample, or with a rate of non-performing loans as a share of GDP, *i.e.* $NPL3$, in the lowest quartile of the sample; it is equal to one otherwise.

[42] This result is robust to the use of the alternative crisis indexes $IND2$ and $IND3$ (which assign different weights to exchange rates and foreign reserves). These results are not reported here but available upon request.

coefficients β_2 and β_3 are not significant. However, the Wald tests indicate that the hypotheses $\beta_2+\beta_4=0$ and $\beta_3+\beta_5=0$ can be rejected at the 1% and 10% significance levels (their *p-values* are 0.005 and 0.09 respectively) for the case where we use the reserve dummy $D2^{LR}$, based on $M2$ data. Similar or better results are obtained when we use the other two low-reserves dummies, $D1^{LR}$ and $D3^{LR}$. These results suggest that the effects of current account deficits and non-performing loans on the crisis index are larger when reserves are low.

Next, in Table 3 we test whether the effects of low reserves on the crisis index depend on structural fundamental weaknesses. In column (1) of Table 3 we add another regressor to the ones of column (2) in Table 2, namely an interaction regressor equal to $CA2$ times $D2^{LR}$ times D^{WF}. In this case the sum of the coefficients $\beta_2+\beta_4+\beta_6$ captures the effects of current accounts deficits on the crisis index in countries with low reserves and weak fundamentals. If $\beta_2+\beta_4+\beta_6$ is positive and different from zero while $\beta_2+\beta_4$ is not significantly different from zero, this means that a crisis is more likely and severe when a high deficit country presents a combination of weak fundamentals and weak reserves, while a crisis is less likely and severe if, despite low reserves, the high deficit country has strong fundamentals. The results show that $\beta_2+\beta_4+\beta_6$ is indeed positive. The Wald tests suggests that $\beta_2+\beta_4+\beta_6$ is different from zero at the 1% significance level (as the *p-value* is 0.009) while $\beta_2+\beta_4$ is not significantly different from zero.[43] This result implies that large current account imbalances make a crisis more severe only if fundamentals are weak *and* reserves are low.

In column (2) of Table 3 we consider a similar test for the role of non-performing loans. Here we add another regressor to the ones of column (2) in Table 2, that is an interaction regressor equal to $NPL2$ times $D2^{LR}$ times D^{WF}. Thus, the sum of the coefficients $\beta_3+\beta_5+\beta_7$ captures the effects of non-performing loans on the crisis index in countries with low reserves and weak fundamentals. If $\beta_3+\beta_5+\beta_7$ is negative and different from zero while $\beta_3+\beta_5$ is not significantly different from zero, this means that a crisis is more severe if non-performing loans are large in countries with weak fundamentals and weak reserves, while a crisis is not more likely nor severe in countries with strong fundamentals and weak reserves. The result shows that $\beta_3+\beta_5+\beta_7$ is indeed negative. Also, the Wald tests suggests that $\beta_3+\beta_5+\beta_7$ is different

[43]Note also that the coefficient on $NPL2$ (β_3) is still significantly different from zero in this regression.

from zero at the 5% significance level (as the *p-value* is 0.017) while $\beta_3 + \beta_5$ is not significantly different from zero. These results imply that large non-performing loans make a crisis more severe only if fundamentals are weak and reserves are low.

Finally, in column (3) of Table 3, we consider interactions of both $CA2$ and $NPL2$ with the dummies for weak fundamentals and low reserves. The results for $NPL3$ are similar to those in column (2): a crisis is more severe with high non-performing loans when both fundamentals and reserves are weak. For the current account, instead, we fail to reject the hypothesis that both $\beta_2 + \beta_4 + \beta_6$ and $\beta_2 + \beta_4$ are equal to zero. Formal tests (such as the Variance Inflation Test) suggest that this is due to a strong multicollinearity between '$CA2$ times $D2^{LR}$ times D^{WF}' and '$NPL2$ times $D2^{LR}$ times D^{WF}': when they both appear in a regression, the effects of $CA2$ are swamped by those of $NPL2$.

In summary, the results of Tables 2 and 3 suggest that a crisis is more severe when current account deficits are larger and when the share of non-performing loans is bigger; these effects are stronger when a country has weak fundamentals and low foreign exchange rate reserves.

Next, in Tables 4 and 5 we perform regressions similar to those in Tables 2 and 3, but we substitute $NPL2$ with $NPL3$ that represents non-performing loans as a share of GDP; this is a proxy for the implicit fiscal costs of a banking sector bail-out by the government. The results are very similar and even *stronger* than those obtained in Tables 2-3 with $NPL2$ (the non-performing loans ratio corrected for the lending boom). First, as Table 4 column (1) shows, both $NPL3$ and $CA2$ are strongly significant (at the 5% level and 1% level respectively) in explaining the crisis index: a bigger fiscal cost of bailing out the banking system and larger current account deficits increase the severity of a currency crisis. Columns (2)-(4) of Table 4 confirm that the effects of current account deficits are more relevant when reserves are low: the *p-values* on the Wald tests for $\beta_2 + \beta_4 = 0$ are 0.001, 0.002 and 0.016 respectively in columns (2), (3) and (4) with the three different measures of low reserves.

The results on non-performing loans $NPL3$ in columns (2)-(4) of Table 4 are quite interesting. We can usually reject the hypothesis that $\beta_3 + \beta_5 = 0$ (i.e. that non-performing loans are more important for a crisis in low reserves countries) only at the 10% level. However, in columns (2) and (3) the coefficient on $NPL3$, i.e. β_3, remains of the right sign and statistically significant on its own at the 5% confidence level, suggesting that non-performing loans

as a share of GDP affect the crisis index regardless of whether reserves are low or high.

In Table 5 we present results of regressions equivalent to those in Table 3 where we now use $NPL3$ instead of $NPL2$. The results are similar to those obtained in Table 3, but for one caveat discussed below. First, current account deficits matter if both reserves and fundamentals are weak, as follows from the Wald test on $\beta_2 + \beta_4 + \beta_6 = 0$ in column (1). Second, the failure to reject $\beta_2 + \beta_4 + \beta_6 = 0$ in column (3) is again due to multicollinearity between '$CA2$ times $D2^{LR}$ times D^{WF}' and '$NPL3$ times $D2^{LR}$ times D^{WF}'. Third, tests on $\beta_3 + \beta_5 + \beta_7 = 0$ in columns (2) and (3) suggest that non-performing loans have a strong effect on the crisis index when fundamentals are weak and reserves are low. However, and this is the caveat, non-performing loans have an independent effect on the intensity of the crisis even when reserves and fundamentals are not weak. In fact, the coefficient on $NPL3$, i.e. β_3, remains of the right sign and is statistically significant at the 5% confidence level on its own: this suggests that high non-performing loans as a share of GDP have a strong effect on the size of a crisis regardless of whether reserves are low or fundamentals are weak.

To test for the robustness of our results we perform a number of other tests. First, we use two other indicators of crisis that give more weight to reserve losses relative to exchange rate depreciation. Our qualitative results remain the same. As reported in Tables 2-5, the results are also robust to the use of three alternative definitions of low reserves. Next, we test whether the significance of $CA2$ is sensitive to the threshold for the real exchange rate appreciation; instead of a 10% trigger we use a 0% trigger and obtain the same qualitative results. The significance of the two non-performing loans measures $NPL2$ and $NPL3$ is also invariant with respect to modification of the definitions of these variables.[44]

Finally, we attempt to test whether direct measures of the productivity of capital have explanatory power for the crisis. We derive a measure of the incremental capital-output ratio ($ICOR$) for the 1993-1996 and test for its significance in our basic regressions. The $ICOR$ variable is generally not significant. However, we find that a modification of the $ICOR$ is significant in some regressions. We define a new $ICOR$ variable, $ICOR2$, that is equal to the original one when the lending boom variable is positive, and is equal to zero when the lending boom is negative. The idea here is that

[44] All these results are avaialble upon request.

low profitable investment is problematic only when there is a lending boom and excessive credit growth; a country with low profitability of capital but without excessive credit growth is at low risk. We therefore run the following regression:

$$\begin{array}{rcccccccc} IND & = & 11.3 & - & 2.21 & NPL3 & - & 2.94 & ICOR2 \qquad R^2 = 0.48 \\ & & (5.28) & & (0.77) & & & (1.25) & \end{array}$$

In the regression above both the $NPL3$ variable and the $ICOR2$ variable have the expected sign and are statistically significant: in particular, a lower profitability of capital, measured by a higher $ICOR$, is associated with a more severe currency crisis.

In sum, we found evidence that a number of economic fundamentals affect the probability of a crisis and its severity. A measure of external imbalance, the current account deficit interacted with the degree of real appreciation is highly significant; a measure of the fiscal costs of financial bail-outs (non-performing loans as a share of GDP) is strongly significant; a measure of non-performing loans interacted with a measure of lending boom is also very significant. Such effects are also found to be stronger in countries with low reserves and in countries with weak economic fundamentals. However, the measure of banking system bail-out cost appears to be significant even after controlling for weak reserves and weak fundamentals. Finally, a measure of the productivity of investment is not generally significant, besides some particular specifications.

5 Conclusions

Our theoretical and empirical analysis suggests that the Asian currency and economic crisis was rooted in the inconsistency of policies aimed at simultaneously sustaining growth, investment and risk-taking, maintaining stable exchange rates, liberalizing domestic and international capital flows, and providing guarantees to underregulated financial institutions. Over the 1990s, in the absence of developed securities markets in the region, such policies translated into large current account imbalances, mostly financed through the intermediation of the banking system. The liberalization of capital markets exacerbated the distortions deriving from implicit and explicit public guarantees, leading firms and financial institutions to borrow and invest excessively.

Banks borrowed heavily in foreign currency, and their debt positions were often short-term and unhedged, as borrowers acted on the presumption that the exchange rates would remain stable, and they would be bailed-out if things went wrong. When indeed things did go wrong and a series of domestic and external shocks revealed the low profitability of past investments, the shaky foundations of investment strategies in the region emerged, and currency and financial crises appeared inextricably intertwined.

While the decades of economic growth and development in the region make clear that there were no 'paper tigers' among the East Asian countries, our analysis of the sudden and dramatic collapse of currencies, asset prices and economic activity in 1997 suggests that severe structural weaknesses in the financial and corporate sectors had been masked by policies of overinvestment and public guarantees. So, if the Asian tigers were not made of paper, their foundations were nevertheless quite fragile.

Further research will shed light on the many open issues left in understanding and modeling the causes of the crisis, its international propagation, and its long-run welfare implications. As suggested in a companion paper (Corsetti, Pesenti and Roubini (1998b)), a partial list of such questions includes: the modeling of real depreciations and their effects on the real burden of foreign debt, through the disruptive increase of short-term foreign liabilities by domestic firms and banks; a thorough analysis of self-fulfilling liquidity crises, under scenarios in which the sudden reversal of short-term capital flows — related to political risk associated with the distributional costs of the financial bail-outs — transforms the current account imbalances into a large-scale financial crisis; and the contagious elements of the crisis, including the 'beggar-thy-neighbor' spiral of competitive devaluations and speculative attacks in the region. We leave to future contributions the formal extension of our framework to the analytical consideration of these open issues.

Appendix 1

At time $t_{\max}$, with $R_{t_{\max}+1} = \gamma F_{t_{\max}+1}$, the expected budget constraint of the government is

$$0 = (1+r)\,\gamma F_{t_{\max}+1}$$
$$+E_{t_{\max}} \sum_{s=t_{\max}+1}^{\infty} \left(\frac{1}{1+r}\right)^{s-t_{\max}-1} \left(T_s^{ELI} + T_s^{ROC} + \frac{M_s - M_{s-1}}{P_s}\right)$$

The present discounted value of T_s^{ELI} is equal to the current level of foreign debt backed by implicit government guarantees, that is:

$$E_{t_{\max}} \sum_{s=t_{\max}+1}^{\infty} \left(\frac{1}{1+r}\right)^{s-t_{\max}-1} T_s^{ELI} = -F_{t_{\max}+1}\,(1+r)$$

$$= -\,(1+r) \sum_{\tau=t_0+1}^{t_{\max}} \left[\alpha\left(A + \sigma - \tilde{A}_\tau\right)\hat{K}^{\alpha}\right](1+r)^{t_{\max}-\tau}.$$

The (maximum) present discounted value of T_s^{ROC} is equal to

$$E_{t_{\max}} \sum_{s=t_{\max}+1}^{\infty} \left(\frac{1}{1+r}\right)^{s-t_{\max}-1} T_s^{ROC} =$$

$$E_{t_{\max}} \sum_{s=t_{\max}+1}^{\infty} \left(\frac{1}{1+r}\right)^{s-t_{\max}-1} \bar{\eta} W_s = \frac{1+r}{r}\bar{\eta}\,(1-\alpha-\beta)\,A\bar{K}^{\alpha}$$

The present discounted value of seigniorage is

$$E_{t_{\max}} \sum_{s=t_{\max}+1}^{\infty} \left(\frac{1}{1+r}\right)^{s-t_{\max}-1} \left(\frac{M_s - M_{s-1}}{P_s}\right) =$$

$$\frac{(1+r)\,(1+\mu)}{(1+r)\,(1+\mu)-\mu}\left[\chi\frac{1+r}{r}\frac{1+\mu}{\mu} + A\,(1-\alpha-\beta)\,(1-\eta)\,\bar{K}^{\alpha}\right]$$
$$-E_{t_{\max}}\frac{M_{t_{\max}}}{\mathcal{E}_{t_{\max}}}\frac{\mathcal{E}_{t_{\max}}}{\mathcal{E}_{t_{\max}+1}}$$

To obtain the previous expression, observe that if money grows at the average rate μ from $t_{\max}+1$ onward, so does the price level (and the exchange rate). In fact, if the exchange rate grows at the rate ξ so that $E_t\mathcal{E}_{t+1} = (1+\xi)\,\mathcal{E}_t$, expected money demand is

$$E_t\frac{M_{t+1}}{\mathcal{E}_{t+1}} = \chi\frac{1+r}{r}\frac{1+\xi}{\xi} + A\,(1-\alpha-\beta)\,(1-\eta)\,\bar{K}^{\alpha} \quad t \geq t_{\max}+1$$

and since the right hand side is a constant, it follows that $\xi = \mu$.

Note however that the expected exchange rate depreciation between $t_{\max}$ and $t_{\max}+1$ can be different from μ even though money is expected to grow at the rate μ during that period. The reason is that at time $t_{\max}+1$ there is a fall in the demand for money of the *ROC* due to the adjustment of the desired capital stock and the implied output contraction.

To determine $M_{t_{\max}}$, first observe that

$$M_{t_{\max}-1} = \overline{\mathcal{E}}\left[\chi\frac{1+r}{r} + (1-\alpha-\beta)(1-\eta)\tilde{A}_{t_{\max}-1}\hat{K}^{\alpha}\right]$$

Then, recall that after a speculative attack

$$M_{t_{\max}} = M_{t_{\max}-1} + \overline{\mathcal{E}}\left(\gamma F_{t_{\max}+1} - R_t\right)$$

Note that the drop in money supply is equal to the drop of reserves evaluated at the fixed exchange rate $\overline{\mathcal{E}}$. In a stochastic setup, the post-attack exchange rate at time $t_{\max}$ can differ from $\overline{\mathcal{E}}$, provided that $E_{t\max-1}\mathcal{E}_{t_{\max}} \leq \overline{\mathcal{E}}$:

$$E_{t\max-1}\mathcal{E}_{t_{\max}} = E_{t\max-1}\frac{M_{t_{\max}}}{\chi\frac{1+r}{r}\frac{E_{t_{\max}}\mathcal{E}_{t_{\max}+1}}{E_{t_{\max}}\mathcal{E}_{t_{\max}+1}-\mathcal{E}_{t_{\max}}} + A\hat{K}^{\alpha}} \leq \overline{\mathcal{E}}$$

Since $M_{t_{\max}+1} = (1+\mu)M_{t_{\max}}$, the last condition that defines the timing of a speculative attack is

$$E_{t_{\max}}\mathcal{E}_{t_{\max}+1} = \frac{(1+\mu)M_{t_{\max}}}{\chi\frac{1+r}{r}\frac{1+\mu}{\mu} + A\bar{K}^{\alpha}} \geq \overline{\mathcal{E}}.$$

Appendix 2

In this appendix we describe in more detail the construction of the variables used in the empirical analysis.

Crisis index (IND)

The index is a weighted average of the percentage rate of exchange rate depreciation relative to the US dollar and the percentage rate of change in foreign reserves between the end of December 1996 and the end of December 1997, as explained in the text. A large negative value for IND corresponds to a high devaluation rate and/or a large fall in foreign reserves, *i.e.* a more severe currency crisis. All data are from the International Financial Statistics of the IMF (IFS-IMF).

Real exchange rate appreciation (RER)

This variable measures the percentage rate of change of the real exchange rate between the end of 1996 and an average over the 1988-1990 period. This is a trade-weighted real exchange rate measure based on wholesale price indexes, using trade weights of OECD countries (excluding Mexico and Korea). For the three transition countries where the real exchange rate exhibited very large fluctuations in the early transition years, the appreciation is calculated between 1996 and 1992. For Argentina, where the real exchange rate experienced very large swings in the hyperinflation period of 1998-1990, the real exchange rate is computed between 1996 and the end of 1990 (rather than the 1988-90 average).

Corrected current account deficit as a share of GDP (CA2)

We first computed the average current account deficit as a share of GDP in the 1994-96 period; data are from IFS-IMF. Next, we corrected these data to account for real appreciation of the currencies. $CA2$ is constructed as follows: if the rate of real exchange rate appreciation is above 10%, the current account balance (as a share of GDP) takes its original value in the data; if the real appreciation is below 10%, the current account value is set to be equal to zero.

Lending boom (LB)

This variable is the rate of growth between 1990 and 1996 of the ratio between the claims on the private sector of the deposit money banks (line 22d in IFS-IMF) and nominal GDP. All data are from IFS-IMF. In the case of transition economies — Czech Republic, Hungary and Poland — whereas either data since 1990 are not available or the ratio was very unstable in early transition years, we took 1992 as the starting date rather than 1990.

Non-performing loans as a share of total bank assets (NPL).

Since there are no homogeneous series for non-performing loans, we constructed a series based on several sources. For most of the Asian countries in our sample (Korea, Indonesia, Hong Kong, Taiwan, Malaysia, Thailand) there are two available estimates for 1996; one from the 1997 BIS Annual Report and the other from Jardine Fleming. Both are biased estimates: the former underestimates the amount of non-performing loans before the onset of the crisis (for example Korean non-performing loans are estimated to be only 0.8% at the end of 1996) while the latter is based on data from the third quarter of 1997, when the amount of non-performing loans starts to capture the effects of the devaluation of the currencies on the financial conditions of banks and corporate sector (for example, Korean non-performing loans are estimated to be 16% at the time). As the former data are obviously underestimated and the latter probably capture the early effects of the crisis, we take the average of the two figures as a reasonable estimate of the non-performing loans before the onset of the crisis, *i.e.* end 1996-early 1997. For the remaining countries, we proceed as follows: for India, Argentina, Brazil, Chile, Colombia, Mexico, Peru, Venezuela we use the estimates for 1996 in the BIS 1997 Annual Report. For China, Singapore and the Philippines, we use estimates from Jardine Fleming. For the other countries in the sample,we rely on information derived from the IMF country reports. Our estimates do not appear to be systematically biased towards the countries that suffered a crisis in 1997. Note in fact that non-crisis countries such as Mexico, China, India and Pakistan all show a very large fraction of non-performing loans (over 10% of total loans).

Fiscal cost of the bailout of the banking system as a share of GDP (NPL3)

This variable is computed as follows. We take the estimate of the non-performing loans as a share of banks assets (NPL) derived above and we multiply it by the ratio to GDP of claims on the private sector by deposit money banks at the end of 1996. The latter variable is computed from IFS-IMF data.

Corrected non-performing loans (NPL2)

In deriving $NPL2$, we interact the lending boom variable with the non-performing loans variable by taking the NPL variable as defined above and modifying it as follows: if the sign of the lending boom in the 1990s was positive, we assign to NPL its original value; if the lending boom in the 1990s was negative, we assign a value of zero to NPL for that particular country. The resulting modified NPL variable is $NPL2$.

Reserve adequacy ratios

We compute three ratios for reserve adequacy at the end of 1996. The first is the ratio of $M1$ to foreign exchange reserves ($M1/RES$), the second is the ratio of $M2$ to foreign reserves ($M2/RES$); the third is the ratio of the foreign debt service burden (*i.e.* short-term foreign debt plus interest payments on foreign debt) to foreign reserves (STD/RES). Foreign exchange reserve data are from the IFS-IMF (line 1l.d). Data on short term debt and interest payments on foreign debt are from Datastream.

Incremental Capital-Output Ratio (ICOR).

This variable is computed for the 1993-96 period using IFS-IMF national income data on investment and GDP.

Taiwan

Taiwan is not included in the IMF data base. Our data for Taiwan are from Datastream that relies on Taiwan national data sources.

References

[1] Bhattacharya, Amar, Stijn Claessens, Swati Ghosh, Leonardo Hernandez and Pedro Alba (1998). "Volatility and contagion in a financially-integrated world: lessons from East Asia's recent experience," paper presented at the CEPR/World Bank conference "Financial crises: contagion and market volatility," London, 8-9 May.

[2] Buiter, Willem, Giancarlo Corsetti and Paolo Pesenti (1998 a). *Financial markets and European monetary cooperation. The lessons of the 1992-93 Exchange Rate Mechanism crisis.* Cambridge, UK: Cambridge University Press.

[3] Buiter, Willem, Giancarlo Corsetti and Paolo Pesenti (1998 b). "Interpreting the ERM crisis: country-specific and systemic issues," *Princeton Studies in International Finance* No.84, March.

[4] Calvo, Guillermo (1998). "Varieties of capital market crises," in G.E. Calvo and M. King (eds.) *The debt burden and its consequences for monetary policy*, London: Macmillan, forthcoming.

[5] Calvo, Guillermo and Carlos Vegh (1998). "Inflation stabilization and balance of payments crises in developing countries," forthcoming in John Taylor and Michael Woodford (eds.), *Handbook of Macroeconomics*, Amsterdam: North-Holland.

[6] Cavallari, Lilia and Giancarlo Corsetti (1996), "Policy-Making and Speculative Attacks in Models of Exchange Rate Crises: a Synthesis", Working paper of the Economic Growth Center at Yale University.

[7] Chang, Roberto and Andres Velasco (1998a). "Financial fragility and the exchange rate regime." National Bureau of Economic Research Working Paper No.6469, March.

[8] Chang, Roberto and Andres Velasco (1998b). "Financial crises in emerging markets: a canonical model," mimeo, May.

[9] Cole, Harold and Timothy Kehoe (1996). "A self-fulfilling model of Mexico's 1994-1995 debt crisis." *Journal of International Economics*, 41, 309-330.

[10] Corsetti, Giancarlo, Paolo Pesenti and Nouriel Roubini (1998a). "What caused the Asian currency and financial crisis? Part I: A macroeconomic overview," paper presented at the CEPR/World Bank conference "Financial crises: contagion and market volatility," London, 8-9 May .

[11] Corsetti, Giancarlo, Paolo Pesenti and Nouriel Roubini (1998b). "What caused the Asian currency and financial crisis? Part II: Interpreting and modelling the crisis," paper presented at the CEPR/World Bank conference "Financial crises: contagion and market volatility," London, 8-9 May.

[12] Corsetti, Giancarlo and Nouriel Roubini (1997). "Politically motivated fiscal deficits: policy issues in closed and open economies." *Economics & Politics*, March, pp.27-55.

[13] Diamond, D.W. and P. Dybvig (1983). "Banks runs, deposit insurance, and liquidity." *Journal of Political Economy*, 91, 401-419.

[14] Diaz-Alejandro, Carlos F. (1985) "Good-bye financial repression, hello financial crash," *Journal of Development Economics* 19.

[15] Dornbusch, Rudiger (1998). "Asian crisis themes," mimeo, MIT, February.

[16] Eichengreen, Barry, Andrew K. Rose and Charles Wyplosz (1996). "Contagious currency crises." National Bureau of Economic Research Working Paper No.5681, July.

[17] Feldstein, Martin (1998). "Refocusing the IMF." *Foreign Affairs* 77 (2), March-April.

[18] Fernald, John, Hali Edison and Prakash Loungani (1998). "Was China the first domino? Assessing links between China and the rest of emerging Asia". Federal Reserve Board, International Finance Discussion Paper No.604, March.

[19] Fischer, Stanley (1998). "The Asian crisis, the IMF, and the Japanese economy." Asahi Shimbun symposium "The Asian economic crisis and the role of Japan", Tokyo, April 8.

[20] Flood, Robert and Peter Garber (1984). "Collapsing exchange-rate regimes: some linear examples." *Journal of International Economics* 17: 1-13.

[21] Flood, Robert and Nancy Marion (1998). "Perspectives on the recent currency crisis literature." National Bureau of Economic Research Working Paper No.6380, January.

[22] Goldfajn, Ilan and Rodrigo O. Valdes (1997). "Capital flows and the twin crises: the role of liquidity." International Monetary Fund Working Paper 97/87, July.

[23] Greenspan, Alan (1998). "Remarks before the 34th Annual Conference on Bank Structure and Competition," Federal Reserve Bank of Chicago, May 7.

[24] Grilli, Vittorio (1986). "Buying and selling attacks on fixed exchange rate systems." *Journal of International Economics* 20, pp.143-156.

[25] International Monetary Fund (1998). *World economic outlook*. Washington, DC: International Monetary Fund, April.

[26] Kaminsky, Graciela, Saul Lizondo and Carmen M. Reinhart (1998). "Leading indicators of currency crises." *IMF Staff Papers*, March.

[27] Kaminsky, Graciela and Carmen M. Reinhart (1997). "The twin crises: the causes of banking and balance-of-payments problems," mimeo, Federal Reserve Board.

[28] Krugman, Paul (1979). "A model of balance of payments crises." *Journal of Money, Credit, and Banking* 11: 311-325.

[29] Krugman, Paul (1998) "What happened to Asia?," mimeo, MIT, January.

[30] Kumhof, Michael (1997). "Balance of payment crises: the role of short-term debt," mimeo, University of Maryland.

[31] Liu, Ligang, Marcus Noland, Sherman Robinson, and Zhi Wang (1998). "Asian competitive devaluations," paper prepared for the conference "China's integration into the world economy," Cambridge, Harvard University, January 17.

[32] McKinnon, Ronald and Huw Pill (1996). "Credible liberalization and international capital flows: the 'overborrowing syndrome'," in Takatoshi Ito and Anne O. Kruger (editors), *Financial deregulation and integration in East Asia*, The University of Chicago Press.

[33] Milesi Ferretti, Gian Maria and Assaf Razin (1996). "Current account sustainability." *Princeton Studies in International Finance* No.81, October.

[34] Obstfeld, Maurice (1986). "Rational and self-fulfilling balance of payments crises." *American Economic Review* 76: 676-681.

[35] Obstfeld, Maurice (1994). "The logic of currency crises." *Cahiers Economiques et Monetaires* 43:189-213.

[36] Obstfeld, Maurice and Kenneth Rogoff (1996). *Foundations of international macroeconomics*. Cambridge, MA: MIT Press.

[37] Radelet, Steven and Jeffrey Sachs (1998). "The onset of the East Asian financial crisis," Harvard Institute for International Development, mimeo, February.

[38] Sachs, Jeffrey, Aaron Tornell and Andres Velasco (1996). "Financial crises in emerging markets: the lessons of 1995." *Brookings Papers on Economic Activity* No.1, 147-217.

[39] Velasco, Andres (1987). "Financial and balance of payments crises." *Journal of Development Economics* 27, 263-283.

Table 1. Crisis and Economic Indicators
Percentage change, except where indicated

Country	*Crisis Index (IND)*	*Real Appreciation (RER)*	*Current Account (CA)*	*Lending Boom (LB)*	*Non-Performing Loans (NPL)*	*Reserves Adequacy (M2/RES)*	*Reserves Adequacy (M1/RES)*	*Reserves Adequacy (STD/RES)*
Argentina	4.9	38.6	-1.9	16.5	9.4	351.0	108.2	147.8
Brazil	-0.5	75.8	-2.0	-26.3	5.8	345.9	66.8	78.3
Chile	-1.4	37.5	-1.7	24.1	1.0	188.2	41.9	53.3
China	7.6	4.9	0.8	6.9	14.0	828.9	334.0	26.7
Columbia	-9.1	26.6	-5.0	35.0	4.6	209.4	104.3	73.9
Czech	-19.5	50.7	-4.4	22.7	12.0	356.9	139.5	42.9
Hong Kong	5.7	31.8	-1.6	25.5	3.4	411.9	34.2	20.0
Hungary	-1.6	-38.8	-6.5	-56.5	3.2	167.1	83.3	52.3
India	5.7	-29.1	-1.2	-2.3	17.3	860.0	296.5	37.2
Indonesia	-38.3	17.5	-2.9	9.6	12.9	614.8	114.3	188.9
Jordan	9.8	6.1	-4.5	1.4	6.0	437.8	141.4	33.9
Korea	-38.6	11.1	-2.5	11.2	8.4	665.4	147.6	217.0
Malaysia	-38.8	19.9	-6.4	31.1	9.9	364.8	115.6	45.3
Mexico	10.9	8.9	-2.7	-10.9	12.5	444.8	129.3	142.9
Pakistan	11.4	-2.0	-5.3	-3.7	17.5	3369.9	1822.8	399.0
Peru	0.7	-20.4	-6.2	177.2	5.1	123.6	32.4	61.6
Philippines	-29.8	38.9	-4.6	150.8	14.0	465.6	91.8	849.3
Poland	3.5	30.0	0.9	38.5	6.0	262.3	95.9	14.2
Singapore	-15.7	4.7	16.5	16.7	4.0	103.5	25.0	20.0
Sri Lanka	-1.0	17.7	-5.7	28.4	5.0	236.4	72.9	26.8
Taiwan	-11.4	-7.0	2.9	43.4	3.9	575.1	141.0	22.8
Thailand	-47.8	20.0	-7.2	58.0	13.3	380.5	43.3	121.5
Turkey	4.3	-16.1	-0.1	43.2	0.8	302.6	48.9	76.0
Venezuela	4.9	2.2	6.8	-51.5	3.8	102.4	58.5	28.2

Table 2. Explaining the Crisis Index[a]

Estimated coefficient and summary statistic	*Independent variable*	*(1)*	*(2)* *Regression with M2/RES*	*(3)* *Regression with M1/RES*	*(4)* *Regression with STD2/RES*
β_1	constant	6.877	7.073	7.437	5.324
		(3.755)	(4.094)	(3.956)	(3.552)
β_2	*CA2*	3.768	0.849	2.210	0.569
		(1.254)	(2.869)	(3.677)	(1.971)
β_3	*NPL2*	-1.338	-2.888	-2.805	-0.476
		(0.605)	(2.073)	(1.946)	(0.782)
β_4	$CA2 \times D2^{LR}$		3.613		
			(3.191)		
β_5	$NPL2 \times D2^{LR}$		1.761		
			(2.035)		
β_4	$CA2 \times D1^{LR}$			1.467	
				(3.982)	
β_5	$NPL2 \times D1^{LR}$			1.534	
				(1.929)	
β_4	$CA2 \times D3^{LR}$				3.571
					(2.564)
β_5	$NPL2 \times D3^{LR}$				-0.864
					(0.986)
Summary statistic					
$\bar{R}^2$		0.555	0.541	0.536	0.622
R^2		0.594	0.621	0.616	0.688
Addendum: Wald tests					
Null hypothesis		*p values*	*p values*	*p values*	*p values*
$\beta_2 + \beta_4 = 0$			0.005	0.018	0.023
$\beta_3 + \beta_5 = 0$			0.099	0.057	0.091

[a] The dependent variable is the crisis index, *IND1*. See Table 1 and Appendix for definition of variables. Standard errors are shown in parentheses.

Table 3. Explaining the Crisis Index[a]

Estimated coefficient and summary statistic	*Independent Variable*	(1)	(2)	(3)
β_1	constant	-2.861	5.535	5.602
		(2.138)	(3.887)	(4.082)
β_2	*CA2*	0.841	0.762	0.766
		(2.946)	(2.694)	(2.771)
β_3	*NPL2*	-1.338	-2.569	-2.583
		(0.605)	(1.954)	(2.017)
β_4	$CA2 \times D2^{LR}$	2.851	1.118	1.559
		(6.650)	(3.274)	(6.293)
β_5	$NPL2 \times D2^{LR}$	1.769	2.448	2.446
		(2.091)	(1.945)	(2.000)
β_6	$CA2 \times D2^{LR} \times D^{WF}$	0.834		-0.497
		(6.337)		(6.004)
β_7	$NPL2 \times D2^{LR} \times D^{WF}$		-2.120	-2.131
			(1.123)	(1.164)
Summary statistic				
$\bar{R}^2$		0.516	0.596	0.572
R^2		0.621	0.684	0.683
Addendum: Wald tests				
Null hypothesis		*p values*	*p values*	*p values*
$\beta_2 + \beta_4 = 0$		0.547	0.337	0.688
$\beta_2 + \beta_4 + \beta_6 = 0$		0.009		0.388
$\beta_3 + \beta_5 = 0$		0.146	0.883	0.875
$\beta_3 + \beta_5 + \beta_7 = 0$			0.017	0.026

[a] The dependent variable is the crisis index, *IND1*. See Table 1 and Appendix for definition of variables. Standard errors are shown in parentheses.

Table 4. Explaining the Crisis Index[a]

Estimated coefficient And summary Statistic	*Independent variable*		(1) *Regression with M2/RES*	(2) *Regression with M1/RES*	(3) *Regression with STD2/RES*
β_1	constant	6.682	8.142	6.289	5.491
		(3.699)	(3.951)	(3.789)	(3.492)
β_2	*CA2*	4.156	2.288	-1.402	0.845
		(1.158)	(2.394)	(4.511)	(1.963)
β_3	*NPL3*	-1.630	-6.579	-4.817	-0.597
		(0.724)	(3.263)	(2.419)	(0.874)
β_4	$CA2 \times D2^{LR}$		2.594		
			(2.657)		
β_5	$NPL3 \times D2^{LR}$		5.133		
			(3.170)		
β_4	$CA2 \times D1^{LR}$			5.760	
				(4.660)	
β_5	$NPL3 \times D1^{LR}$			3.481	
				(2.497)	
β_4	$CA2 \times D3^{LR}$				3.487
					(2.530)
β_5	$NPL3 \times D3^{LR}$				-1.185
					(1.248)
Summary statistic					
$\bar{R}^2$		0.558	0.578	0.634	0.618
R^2		0.596	0.651	0.557	0.684
Addendum: Wald tests					
Null hypothesis		*p values*	*p values*	*p values*	*p values*
$\beta_2 + \beta_4 = 0$			0.001	0.002	0.016
$\beta_3 + \beta_5 = 0$			0.074	0.105	0.107

[a] The dependent variable is the crisis index, *IND1*. See Table 1 and Appendix for definition of variables. Standard errors are shown in parentheses.

Table 5. Explaining the Crisis Index[a]

Estimated coefficient and summary statistic	*Independent variable*	(1)	(2)	(3)
β_1	constant	9.060	3.754	3.677
		(4.233)	(2.731)	(3.026)
β_2	*CA2*	2.438	1.570	1.557
		(2.439)	(1.577)	(1.633)
β_3	*NPL3*	-6.912	-4.985	-4.957
		(3.347)	(2.164)	(2.263)
β_4	$CA2 \times D2^{LR}$	-7.295	-2.753	-2.085
		(14.900)	(2.033)	(9.972)
β_5	$NPL3 \times D2^{LR}$	5.425	5.287	5.267
		(3.246)	(2.081)	(2.160)
β_6	$CA2 \times D2^{LR} \times D^{WF}$	9.905		-0.685
		(14.676)		(10.005)
β_7	$NPL3 \times D2^{LR} \times D^{WF}$		-5.420	-5.436
			(1.060)	(1.117)
Summary statistic				
$\bar{R}^2$		0.566	0.818	0.808
R^2		0.660	0.858	0.858
Addendum: Wald tests				
Null hypothesis		*p values*	*p values*	*p values*
$\beta_2 + \beta_4 = 0$		0.741	0.424	0.957
$\beta_2 + \beta_4 + \beta_6 = 0$		0.001		0.633
$\beta_3 + \beta_5 = 0$		0.073	0.626	0.445
$\beta_3 + \beta_5 + \beta_7 = 0$			0.000	0.000

[a] The dependent variable is the crisis index, *IND1*. See table 1 and Appendix for definition of variables. Standard errors are shown in parentheses.