Assessing financial vulnerability, an early warning system for emerging markets: Introduction

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Assessing Financial Vulnerability: An Early Warning System for Emerging Markets:
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Introduction

Purpose and motivation

This study analyzes and provides empirical tests of early warning indicators of banking and currency crises in emerging economies. The aim is to identify key empirical regularities in the run-up to banking and currency crises that would enable officials and private market participants to recognize vulnerability to financial crises at an earlier stage. This, in turn, should make it easier to motivate the corrective policy actions that would prevent such crises from actually taking place. Interest in identifying early warning indicators of financial crises has soared of late, stoked primarily by two factors.

First, there is increasing recognition that banking and currency crises can be extremely costly to the countries in which they originate; in addition, these crises often spillover via a variety of international channels to increase the vulnerability of other countries to financial crisis.

According to the IMF's tally, there have been over sixty five developing-country episodes during the 1980-95 period when the banking system's capital was completely or nearly exhausted;[1] the public-sector bail-out costs of resolving banking crises in developing countries during this period has been estimated at around $250 billion.[2] In at least a dozen of these banking crises, the public-sector resolution costs amounted to 10 percent or more of the country's

[1] See Lindgren et al (1997). Other identifications of banking crises over this period can be found in Caprio and Klingebiel (1996), Dimerguc-Kunt and Detraigche (1998), Eichengreen and Rose (1998), Kaminsky and Reinhart (1996), and the IMF (1998c).

[2] See Honohan (1997).

GDP.[3] In the latest additions to the list of severe banking crises, the cost of bank recapitalization for the countries most affected in the ongoing Asian financial crisis is expected to be huge--on the order of 30 percent of GDP for both Thailand and South Korea and 20 percent of GDP for Indonesia and Malaysia.[4]

In addition to the enormous fiscal costs, banking crises exacerbate declines in economic activity, prevent precious national saving from flowing to its most productive use, limit the room for maneuver in the conduct of domestic monetary policy, and increase the chances of undergoing a currency crisis as well.[5] Illustrative of the magnitude of output losses, an IMF (1998c) study, drawing on a sample of 31 developing countries, reports that it typically takes almost three years for output growth to return to trend after the outbreak of a banking crisis and that the cumulative output loss averaged 12 percent.[6] Probably the main reason why the Mexican authorities did not make more aggressive use of interest rate policy after the Colosio assassination is that bad loan problems in the banking system had by then already become serious and they were worried that recourse to higher interest rates would push Mexican banks over the edge; yet failure to increase domestic interest rates in the face of increasing concern on the part of international investors contributed to a rapid decline in international reserves and helped to transform a banking problem into a currency and debt crisis.[7] Drawing on a broader sample of banking and currency crises in emerging economies, there is evidence that banking

[3] See Goldstein (1997) for a list of these severe banking crises. For comparison, the public-sector tab for the U.S. saving and loan crisis is typically estimated at about 2-3 percent of U.S. GDP.

[4] See Eschweiler (1998b).

[5] See Lindgren et al (1996) and Goldstein and Turner (1996).

[6] In Chapter 7, we present our own estimates of how long it takes growth rates of real output to recover after banking and/or currency crises.

[7] See Calvo and Goldstein (1996).

crises typically precede currency crises.[8]

Although the contagion of financial disturbances usually runs from large countries to smaller ones, the Asian financial crisis has shown that severe financial-sector difficulties in even a relatively small economy (namely Thailand) can have wide ranging spillover effects if it acts as a "wake up call" for investors to reassess country risk and if a set of other economies have vulnerabilities similar to those in the economy first affected.[9]

The costs of currency crises have likewise been shown to be significant. Mexico's peso crisis was accompanied in 1995 by a decline in real GDP of 6 percent--its deepest recession in sixty years. During the ERM crises of the fall of 1992 and summer of 1993, on the order of $150 billion was spent on official exchange market intervention in a fruitless effort to stave off the forced devaluation and/or floating of ERM currencies. In emerging Asia, consensus forecasts for 1998 growth issued just prior to the crisis (that is, in May/June 1997) generally stood in the 6-8 percent range. As indicated in Table 1.1, these forecasts have now been subject to unprecedented downward revisions in the midst of the currency, banking, and debt crises enveloping these economies. The IMF (1998c) estimates that emerging economies suffer, on average, an 8 percent cumulative loss in real output (relative to trend) during a severe currency crisis. And like banking crises, currency crises too seem to exhibit contagious behavior. One recent study found that a currency crisis elsewhere in the world increases the probability of a speculative attack by an economically and statistically significant amount even after controlling

[8] See Kaminsky and Reinhart (1996) and IMF (1998). In Chapter ?, we provide further evidence that the presence of a banking crises is one of the better leading indicators of a currency crises in emerging economies.

[9] See Calvo and Reinhart (1996) and Goldstein (1998a). Kaminsky and Reinhart (1998b) provide an analysis of contagion in the Asian crisis that stresses the financial links among these countries--including the sudden withdrawal of funds by a common commercial bank lender or mutual fund investor.

for economic and political fundamentals in the country concerned.[10]

Table 1.1. Real GDP growth forecasts

Country	1996	1997e	1998: as of May 1997	1998: as of December 1998	Change in 1998 forecast
Indonesia	7.8	5.6	7.5	-15.3	-22.8
Thailand	6.4	0.4	7.0	-8.0	-15.0
South Korea	7.1	5.8	6.3	-7.0	-13.3
Malaysia	8.6	7.4	7.9	-7.5	-15.4
Philippines	5.7	5.1	6.4	0.2	-6.2
Hong Kong	4.9	5.4	5.5	- 5.0	-10.5

Source: International Monetary Fund, World Economic Outlook

The more costly it is to clean up after a financial crisis has already occurred, the greater the returns to designing a well-functioning early-warning system.

The **second** reason for the increased interest in early warning indicators of financial crises is that there is accumulating evidence that two of the most closely watched "market indicators" of default and currency risks--namely, interest rate spreads and changes in credit ratings--frequently do not provide much advance warning of currency and banking crises. [11]

[10] Eichengreen et al (1996); see also Calvo and Reinhart (1996) and Kaminsky and Reinhart (1998b).

[11] This issue is explored in some detail in Chapter 4.

Empirical studies of the 1992-93 ERM crisis have typically concluded that market measures of currency risk did not point to the specter of significant devaluations of the weaker ERM currencies before the fact.[12] In the run-up to the Mexican crisis, market signals were again muted or inconsistent. More specifically, measures of default risk on tesobonos (dollar indexed, Mexican government securities) jumped up sharply in April 1994 (after the Colosio assassination) but stayed roughly constant between then and the outbreak of the crisis.[13] From April 1994 on, market measures of currency depreciation on the peso usually were beyond the government's announced rate; nevertheless, this measure of currency risk fluctuated markedly and the gap between market expectations and the official rate was widest in summer of 1994 when the attack came with most ferocity only in late December.[14]

The preliminary evidence now available suggests that the performance of interest spreads and credit ratings was likewise disappointing in the run-up to the Asian financial crisis. Examining interest rate spreads on three-month offshore securities, one study found that these spreads gave no warning of impending difficulties (i.e., were either flat or declining) for Indonesia, Malaysia, and the Philippines and produced only intermittent signals for Thailand.[15] A recent analysis of spreads using local interest rates for South Korea, Thailand, and Malaysia found similarly little indicator of growing crisis vulnerability.[16]

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12 See Rose and Svensson (1994).

13 See Calvo and Goldstein (1996) and Obstfeld and Rogoff (1995).

14 See Obstfeld and Rogoff (1995), Leiderman and Thorne (1996), and Rosenberg (1998).

15 Eschweiler (1997).

16 See Rosenberg (1998).

Sovereign credit ratings (on long-term, foreign-currency debt) issued by the two largest international ratings firms were even less prescient in the Asian crisis.[17] As shown in Table 1.2, there were almost no downgrades for the most severely affected countries in the eighteen month run-up to the crisis. As the **Economist** (1997, p. 68) put it, "... in country after country, it has often been the case of too little, too late." Looking at a larger sample of cases, a recent OECD study was unable to find consistent support for the proposition that sovereign credit ratings act more like a leading than a lagging indicator of market prices (i.e., of interest rate spreads).[18]

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[17] See Radelet and Sachs (1998), World Bank (1998), and Goldstein (1998c). In a recent report, Moody's (1998) argues that its rating record in the East Asian crisis was better than it appears at first sight from ratings changes alone. More specifically, the report argues, inter alia, that Moody's went into the crisis with lower ratings for the crisis countries than the other major ratings agencies (i.e., Standard & Poors and Fitch-IBCA), that it took ratings actions before its main competitors, that its low bank financial strength ratings identified many of the banks that subsequently experienced stress in the crisis countries, that changes in sovereign credit ratings led to a widening of yield spreads in the crisis countries, and that one should examine the sovereign research reports -- not just the ratings -- in looking for early warning signals. At the same time, the report acknowledges that the firm is studying several potential enhancements to their analytical methodology to help improve the predictive power of their sovereign ratings.

[18] Larrain, Reisen, and von Maltzan (1997).

Table 1.2: Performance of Ratings Agencies Prior to Asian Crisis
Moody's and Standard and Poor's Long Term Debt Ratings 1996-1997

		Jan. 15, 1996		**Dec. 2, 1996**		**Jun 24, 1997**		**Dec. 12, 1997**	
		Rating	**Outlook**	**Rating**	**Outlook**	**Rating**	**Outlook**	**Rating**	**Outlook**
MOODY'S Foreign Currency Debt									
Indonesia		Baa3		Baa3		Baa3		Baa3	
Malaysia		A1		A1		A1		A1	
Mexico		Ba2		Ba2		Ba2		Ba2	
Philippines		Ba2		Ba2		Ba2		Ba2	
South Korea		A1		A1	stable			Baa2	negative
Thailand		A2		A2		A2		Baa1	negative
STANDARD AND POOR'S								**October 1997**	
Indonesia	**Foreign Currency Debt**	BBB	stable	BBB	stable	BBB	stable	BBB	negative
	Domestic Currency Debt			A+		A+		A-	negative
Malaysia	**Foreign Currency Debt**	A+	stable	A+	stable	A+	positive	A+	negative
	Domestic Currency Debt	AA+		AA+		AA+		AA+	negative
Philippines	**Foreign Currency Debt**	BB	positive	BB	positive	BB+	positive	BB+	stable
	Domestic Currency Debt	BBB+		BBB+		A-		A-	stable
South Korea	**Foreign Currency Debt**	AA-	stable	AA-	stable				
	Domestic Currency Debt								
Thailand	**Foreign Currency Debt**	A	stable	A	stable	A	stable	BBB	negative
	Domestic Currency Debt			AA		AA		A	negative
Mexico	**Foreign Currency Debt**	BB	negative	BB		BB			
	Domestic Currency Debt	BBB+		BBB+	stable	BBB+	positive		

Note: Rating Systems (from highest to lowest)
Moody's : Aaa, Aa1, Aa2, Aa3, A1, A2, A3, Baa1, Baa2, Baa3, Ba1, Ba2, Ba3
S&P's : AAA, AA+, AA, AA-, A+, A, A-, BBB+, BBB, BBB-, BB+, BB, BB-
Source: Radelet and Sachs (1998)

There are of course several reasons why interest rate spreads or changes in sovereign credit ratings may not anticipate financial crises well. For one thing, market participants may not have timely, accurate, and comprehensive information on the borrower's creditworthiness. Several recent examples underscore the point.[19] Thailand's commitments in the forward exchange market and South Korea's lending of international reserves to commercial banks meant that official figures on gross international reserves gave a misleading (i.e., overoptimistic) view of each country's net usable reserves. Similarly, external foreign-currency denominated debt of Indonesian corporations, along with non-performing bank loans in South Korea, Thailand, Malaysia, and Indonesia turned out to be considerably larger than pre-crisis published official data suggested.[20] Ceteris paribus, if the true size of liquid assets and liabilities were known at an earlier stage, interest rate spreads would have been higher and credit ratings would have been lower than actually observed prior to the Asian crisis; this in turn may well have moderated the sharp change in market sentiment that was associated with the "news" of lower than expected net worth of Asian debtors.

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[19] For further elaboration, see Goldstein (1998a), Corsetti, Pesenti, and Roubini (1998), and BIS (1998).

[20] Along the same lines, Garber (1997) shows that in the run-up to the Mexican peso crisis of 1994-95, off-balance sheet derivative positions on the part of Mexican banks meant that their unhedged foreign-currency exposure was much larger than suggested by either published data or standard prudential ratios.

The other reason why market prices may not signal impending crises is that there are often widely and strongly-held expectations of a bail-out of a troubled borrower by the official sector -- be it national or international. In such cases, interest rate spreads will reflect the creditworthiness of the guarantor -- not that of the borrower. Again, it is not difficult to find recent examples where such expectations could well have impaired market signals. In Asian emerging economies, several authors have argued that implicit and explicit guarantees of the liabilities of financial institutions were important in motivating the large net private capital inflows into the region in the 1990s, while others have emphasized that the disciplined fiscal positions of these countries may have convinced investors that should banks and finance companies experience strains, governments would have the resources to honor their guarantees.[21] In the case of the Mexican peso crisis, it has similarly been argued that after agreeing NAFTA, it would have been very costly for the United States to stand by while Mexico either devalued the peso or defaulted on its external obligations and that expectations of a U.S. bail-out blunted the operation of early-warning signals.[22] And looking eastward, investments in Russian and Ukrainian government securities have in recent years sometimes been known on Wall Street as "the moral hazard play" -- reflecting the expectation that geopolitical factors and security concerns would, when push came to shove, lead to a bail-out of troubled borrowers. Suffice to say that the size and frequency of IMF-led international financial rescue packages -- including commitments of nearly $50 billion for Mexico in 1994-95, over $120 billion for Thailand,

[21] See Krugman (1998), Dooley (1997), and Calomiris (1997) on the role of expected national and international bailouts in motivating capital flows and/or banking crises. Claessens and Glaessner (1997) highlight the link between fiscal positions and the wherewithal to honor explicit and implicit guarantees in the financial sector. Goldstein (1998a) offers a set of proposals on how the "moral hazard" associated with international financial rescue packages might be reduced.

[22] See Leiderman and Thorne (1996) and Calvo and Goldstein (1996).

Indonesia, and South Korea in 1997-98, and over $25 billion for Russia and Ukraine in 1998 -- illustrate that market expectations of official bail-outs cannot be dismissed lightly.

If interest rate spreads and sovereign credit ratings only blow the whistle on financial crises once in a while, increased interest attaches to the question of whether there are other early-warning indicators that history suggests would do a better job, and if so, what are they? This is one of the key questions we address in this study.

Methodology and organization

Our approach to identifying early warning indicators of financial crises in emerging economies reflects a number of decisions about the appropriate methodology for conducting such an empirical exercise. Key elements of our thinking can be summarized in the following seven guidelines.

(i) If one hopes to find a systematic pattern in the origin of financial crises, one needs to look beyond the last prominent crisis (or group of crises) to a larger sample; otherwise there is a risk either that there will be too many potential explanations to discriminate between important and less important factors, or that generalizations and lessons will be drawn that do not necessarily apply across a wider body of experience. In our work, we try to guard against these risks by looking at a sample of 87 currency crises and 29 banking crises that occurred in a sample of 25 emerging economies and smaller industrial countries over the 1970-95 period. Currency crises are defined as extreme values (three standard deviations or more above the mean) of an index of exchange market pressure. This index is a weighted average of percentage changes in the exchange rate and percentage changes in gross international reserves; it captures the notion that currency crises are marked by "large" currency depreciations and/or "large" declines in international reserves.[23] Banking crises are defined as events characterized by a combination of bank runs, mergers, bank closures, and large-scale government intervention/assistance to a group of financial institutions.[24]

Several examples help to illustrate the point. Consider the last two major financial crises of the 1990s: the 1994-95 Mexican peso crisis and the ongoing Asian financial crisis. Was the peso crisis primarily driven by Mexico's large current-account deficit (equal to almost 8 percent of its GDP in 1994), or by the overvaluation of the peso's real exchange rate, or by the maturity and composition of Mexico's external borrowing (too short term and too dependent on portfolio flows), or by the uses to which that foreign borrowing was put (too much for consumption and not enough for investment), or by the already weakened state of the banking system (the share of non-performing loans doubled between mid-1990 and mid-1994), or by bad luck (in the form of unfortunate domestic political developments and an upward turn in the international interest rate cycle), or by failure to correct fast enough earlier slippages in monetary and fiscal policies in the face of market nervousness, or by a growing imbalance between the stock of liquid foreign-currency denominated liabilities and the stock of international reserves, or by an expectation on the part of Mexico's creditors that the United States government would step in to bail-out holders

[23] Since it looks at both changes in nominal exchange rates and changes in international reserves, such an index of exchange market pressure can accommodate both flexible and fixed exchange rate regimes. Because countries sometimes respond to exchange market pressure by altering domestic interest rates, a comprehensive index would also include market interest rates as a third component. Because many of the countries in our sample did not maintain market-determined interest rates for at least some of the sample period, we had to be content with including only exchange rates and international reserves in the index of exchange market pressure.

[24] One advantage of this definition of banking crises is that crises can be identified within a relatively brief period from their occurrence; in contrast, definitions of banking crises that rely on reaching a threshold share of non-performing loans or of government resolution costs as a share of GDP imply a longer time lag since the data on which such definitions depend appear with relatively long publication lags. In any case, as we show in Chapter 2, there is considerable overlap in the dating of banking crises across alternative definitions.

of tesobonos?[25] Analogously, was the Asian financial crisis due to the credit boom experienced by the ASEAN-4 economies (Thailand, Indonesia, Malaysia, and the Philippines), or by a concentration of credit to real estate and equities, or by large maturity and currency mismatches in the composition of external borrowing, or by easy global liquidity conditions, or by capital-account liberalization cum weak financial-sector supervision, or by relatively large current-account deficits and real exchange rate overvaluations in the run-up to the crisis, or by a deteriorating quality of investment, or by increasing competition from China, or by global overproduction in certain industries important to the crisis countries, or by contagion from Thailand?[26] Here, there are simply too many likely suspects to draw generalizations from two episodes --even if they are important episodes. To tell, for example, whether overvalued exchange rates are a better leading indicator of currency crises than are say current-account deficits, we need to run a horse race across a larger number of currency crises.

Equally but operating in the opposite direction, there is a risk of "jumping the gun" by concluding that one factor is a key leading indicator in most crises just because it has been present in a relatively small set of prominent crises. An example is "credit booms" (i.e., expansions of bank credit that are large relative to the growth of the economy) which have been shown to be a precursor of banking crises in Japan, in several Scandinavian countries, and in Latin America.[27] Yet when we compare credit booms as a leading indicator of banking crises to other indicators across a larger group of emerging economies and smaller industrial countries, we

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[25] See Leiderman and Thorne (1996) and Calvo and Goldstein (1996) for an analysis of the Mexican crisis.

[26] These alternative explanations of the Asian crisis are discussed in BIS (1998), Corsetti et al (1997), Goldstein (1998a), Radelet and Sachs (1998), IMF (1997), and World Bank (1998).

[27] See Gavin and Hausman (1996).

find that credit booms are outperformed by a variety of other indicators. Put in other words, credit booms have been a very good leading indicator in some prominent (large-country) banking crises but are not, on average, the best leading indicator in emerging economies more generally. Again, it is helpful to have recourse to a larger sample of crises to sort out competing hypotheses.

(ii) A second guideline in this study is to pay as much attention to banking crises as to currency crises. To this point, most of the existing literature on leading indicators of financial crises relates exclusively to currency crises.[28] Yet the costs of banking crises in developing countries appear to be greater than those of currency crises, banking crises appear to be one of the more important factors generating currency crises, and the determinants and leading indicators of banking crises should be amenable to same type of quantitative analysis as for currency crises.[29] In this study, we analyze banking and currency crises separately, as well as exploring the interactions among them. As it turns out, several of the early warning indicators that show the best performance for currency crises also work well in anticipating banking crises; at the same time, there are enough differences in the early warning process and in the aftermath of crises as between currency and banking crises to justify treating each in its own right.

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[28] See Kaminsky, Lizondo, and Reinhart (1998) for a review of this literature. Among the relatively few studies that include or concentrate on banking crises in emerging economies, we would highlight Caprio and Klingebiel (1996a, 1996b), Demirguc-Kunt and Detragiache (1997), Eichengreen and Rose (1997), Furnam and Stiglitz (1998), Honohan (1996), Gavin and Hausman (1996), Goldstein (1997), Goldstein and Turner (1996), Kaminsky (1998), Kaminsky and Reinhart (1998a, 1998b), Rojas-Suarez (1998), Rojas-Suarez and Weisbrod (1996), Sheng (1996), and Sundararijan and Balino (1991).

[29] Both Kaminsky and Reinhart (1998a) and the IMF (1998c) conclude that the output costs of banking crises in emerging economies typically exceed those for currency crises and that these costs are greater still during what Kaminsky and Reinhart (1996) call "twin crises" (that is, episodes when the country is undergoing simultaneously a banking and currency crisis). We provide further empirical evidence on this issue in Chapter 7.

(iii) A third feature of our approach -- and one that differentiates our work from that of many other researchers -- is that we employ monthly data to analyze banking crises as well as currency crises.[30] Use of monthly (as opposed to annual data) involves a trade-off. On the minus side, because monthly data on the requisite variables for a long time period (1970-98) are available for a smaller number of countries than would be the case for annual data, the decision to go with higher frequency data results in a smaller sample of countries (i.e., 25 countries versus more than 100 countries with annual data). The indicators, as well as its periodicity, and the transformation used are reported in Table 1.3 while the country coverage and sample period are presented in Table 1.4.

[30] For example, the studies of banking crises in emerging markets by Caprio and Klingebiel (1996a, 1996b), Goldstein and Turner (1996), Honohan (1996), and Sundararajan and Balino (1991) are primarily qualitative, while the studies by Demirguc-Kunt and Detragiache (1997), Eichengreen and Rose (1998), and the IMF (1998c) use annual data for their quantitative investigation of the determinants of banking crises.

Table 1.3. Selected leading indicators of banking and currency crises

INDICATOR	TRANSFORMATION	DATA FREQUENCY
REAL OUTPUT	12 month growth rate	Monthly
EQUITY PRICES	12 month growth rate	Monthly
INTERNATIONAL RESERVES	12 month growth rate	Monthly
DOMESTIC/FOREIGN REAL INTEREST RATE DIFFERENTIAL	Level	Monthly
EXCESS REAL M1 BALANCES	Level	Monthly
M2/INTERNATIONAL RESERVES	12 month growth rate	Monthly
BANK DEPOSITS	12 month growth rate	Monthly
M2 MULTIPLIER	12 month growth rate	Monthly
DOMESTIC CREDIT/GDP	12 month growth rate	Monthly
REAL INTEREST RATE ON DEPOSITS	Level	Monthly
LENDING ITEREST RATE/DEPOSIT INTEREST RATE	Level	Monthly
REAL EXCHANGE RATE	Deviation from trend	Monthly
EXPORTS	12 month growth rate	Monthly
IMPORTS	12 month growth rate	Monthly
TERMS OF TRADE	12 month growth rate	Monthly
MOODY’S SOVEREIGN CREDIT RATINGS	1 month change	Monthly
INSTITUTIONAL INVESTOR SOVEREIGN CREDIT RATINGS	Semi annual change	Semi annual
GENERAL GOVERNMENT CONSUMPTION	Annual growth rate	Annual
OVERALL BUDGET DEFICIT/GDP	Level	Annual
NET CREDIT TO THE PUBLIC SECTOR/GDP	Level	Annual
CENTRAL BANK CREDIT TO PUBLIC SECTOR/GDP	Level	Annual
SHORT TERM CAPITAL INFLOWS/GDP	Level	Annual
FOREIGN DIRECT INVESTMENT/GDP	Level	Annual
CURRENT ACCOUNT IMBALANCE/GDP	Level	Annual
CURRENT ACCOUNT IMBALANCE/INVESTMENT	Level	Annual

Source: The authors.

Table 1.4 Country coverage and sample period

Africa:		
South Africa		
Asia:		
Indonesia	Korea	Malaysia
Philippines	Thailand	
Europe and the Middle East:		
Czech Republic	Denmark	Egypt
Finland	Greece	Israel
Norway	Spain	Sweden
Turkey		
Latin America:		
Argentina	Bolivia	Brazil
Chile	Colombia	Mexico
Peru	Uruguay	Venezuela

On the positive side of the ledger, monthly data permit us to learn much more about the timing of early warning indicators, including differences among indicators in the first arrival and persistence of signals. For the purposes of this study -- including the controversial question of whether there were warnings about the Asian financial crisis before the fact -- the advantages of monthly data seemed to outweigh the disadvantages. In the end, we were able to assemble monthly data for about two thirds of our indicator variables; for the remaining third, we had to settle for annual data.

(iv) Yet a fourth element of our approach was to include a relatively wide array of potential early warning indicators. We based this decision on a review of broad recurring themes in the literature on financial crises. These themes encompass: asymmetric information and bank run stories that stress liquidity/currency mismatches and shocks that induce borrowers to run to liquidity or high quality assets; inherent instability and bandwagon theories that emphasize excessive credit creation and unsound finance during the expansion phase of the business cycle; "ready-or-not" financial liberalization stories that focus on the perils of liberalization when banking supervision is weak and when an extensive network of explicit and implicit government guarantees produces an asymmetric pay-off for increased risk taking; first and second-generation models of the vulnerability of fixed exchange rates to speculative attacks; and interactions of various kinds between currency and banking crises.

In operational terms, this eclectic view of the origins of financial crises translates into a set of 25 leading indicator variables that span the real and monetary sectors of the economy, that contain elements of both the current and capital accounts of the balance of payments, that include market variables designed to capture expectations of future events, and that attempt to proxy certain structural changes in the economy (e.g., financial liberalization) that could affect vulnerability to a crisis; see Table 1.4 for the listing of these leading-indicator variables. Note that in contrast to earlier empirical studies of currency and banking crises, the presence of two credit rating variables allows us to explicitly test the performance of credit ratings versus standard "economic fundamentals." Viewing our list of indicators as a group, there is a parallel with the more established, leading-indicator analysis of business cycles where a diverse set of indicators, drawn from different sectors of the economy, has been chosen for their ability to anticipate earlier cycles.[31]

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[31] See Stock and Watson (1989, 1991, 1993) for an analysis of coincident and leading indicators of the U.S. business cycle. Moore (1959) and Zarnowitz (1992) also provide an earlier approach to scoring leading indicators of the business cycle.

(v) Once a set of potential leading indicators or determinants of banking and currency crises has been selected, a way has to be found both to identify the better performing ones among them and to calculate the probability of a crisis. In most of the existing empirical crisis literature, this is done by estimating a multi-variate logit or probit regression model where the dependent variable (in each year or month) takes the value of one if that period is classified as a crisis and the value of zero if there is no crisis. When such a regression is fitted on a pooled set of country data (i.e., a pooled cross-section of time series), the statistical significance of the estimated regression coefficients tell us which indicators are "significant" and which are not, and the predicted value of the dependent variable tells us which time periods or countries carry a higher or lower probability of a crisis.

A fifth characteristic of our approach is that we use a different technique to evaluate individual indicators and to assess crisis vulnerability across countries and over time. Specifically, we adopt the non-parametric "signals approach" pioneered by Kaminsky and Reinhart (1996).[32] The basic premise of this approach is that the economy behaves differently on the eve of financial crises and that this aberrant behavior has a recurrent systemic pattern. For example, currency crises are usually preceded by an overvaluation of the currency, and banking crises tend to follow sharp declines in asset prices. The signals approach is given diagnostic and predictive content by specifying what is meant by an "early" warning, by defining an "optimal threshold" for each indicator, and by choosing one or more diagnostic statistics that measure the probability of experiencing a crisis.

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[32] This approach is described in detail in Kaminsky, Lizondo, and Reinhart (1998).

We set the early warning window for currency crises at 1 to 24 months before the start of the crisis. For banking crises, "early" is defined as a 24 month window beginning 12 months before the start of the crisis and extending 12 months after the start. We chose this less demanding window because banking crises typically last much longer than currency crises and because the peak of the banking crises often occurs quite a while after the onset; see the discussion later in this chapter. As such, even a warning that takes place after a banking crisis starts can be helpful.

By requiring the specification of an explicit early warning window, the signals approach forces one to be quite specific about the timing of early warnings. This is not the case for all other approaches. For example, it has been argued that an asymmetric information approach to financial crises implies that the spread between low and high quality bonds will be a good indicator of whether an economy is experiencing a true financial crisis -- but there is no presumption that this spread should be a leading rather than a contemporaneous indicator.[33] Similarly, many of the regression-based studies of financial crisis are focused on identifying the determinants of banking and currency crises but usually (particularly if annual data are employed) do not explore in any depth if and by how much these determinants lead the onset of crises; as such, they generally do not pay much attention to where (i.e., for which indicators) the first signs of a crisis are likely to surface.

[33] See Mishkin (1996).

We define the optimal threshold for an indicator as the value of the indicator that, once reached, maximizes that indicator's ability to accurately forecast a crisis. This threshold is calculated using an iterative search procedure. Suppose, for example, we want to know the optimal threshold for current-account imbalances preceding currency crises. We start with an arbitrary tail of the distribution for current-account imbalances, say, the 15 percent tail (in each country) that contains the largest ratios of current-account deficits to GDP. We then pool these observations on large current-account deficits across countries. We regard any observation that falls in the 15 percent tail as a signal. Its a "true" signal if a currency crisis occurs within 24 months after the signal was given, and its a false signal or "noise" if no crisis occurs during the early-warning window. We then experiment with different tails (going from 20 to 10 percent) until we find the one, that is, the optimal threshold, that maximizes the number of true signals and minimizes the number of false signals. Too inclusive a threshold will send too much noise; too selective a threshold will miss too many crises. The optimal threshold balances these conflicting considerations by calculating the one that minimizes the noise-to-signal ratio.

Note that while the optimal threshold percentage for a given indicator is the same for all countries, this percentage is likely to translate into a different specific value for each country. Consider the following illustration. Country A has a history of large current-account deficits during the sample period, say, averaging 5 percent of GDP; in contrast, country B has, on average, run a balanced external position. Suppose the optimal threshold for the entire 25-country sample is calculated to be 10 percent. Applying that 10 percent tail to country A's own frequency distribution may yield a critical value for current-account deficits of say, 8 percent of GDP, whereas for country B, the same 10 percent tail may correspond to a critical value on only 3 percent of GDP. Put in other words, the signals approach "custom tailors" the country-specific threshold to the country's own history for that indicator. It also follows that the optimal thresholds (as well as the country-specific critical values) for a given indicator will often differ as between banking and currency crises.

Calculation of the optimal thresholds in terms of noise-to-signal ratios also provides a convenient metric for comparing the performance of the individual indicators themselves. Those indicators with low noise-to-signal ratios are regarded as better early warning indicators of crises than those with higher ones.

Finally, under the signal approach, we can rank the probability of crises both across countries at a point in time and for a given country (or group of countries) over time by calculating the weighted number of indicators that have reached their optimal thresholds (are "flashing"), where the weights (represented by the inverse of the individual noise-to-signal ratios) capture the relative past forecasting track record of the individual indicators.[34] Indicators with good track records receive higher weight in the forecast that those with poorer ones. Ceteris paribus, the greater the incidence of flashing indicators, the higher the presumed probability of a banking or currency crisis. For example, if in mid-1997, we were to find that 18 of 25 indicators were flashing for Thailand versus only 5 of 25 for Brazil, we would conclude that Thailand was more vulnerable to a crisis than Brazil. Analogously, if only 10 of 25 indicators were flashing for Thailand in mid-1993, we would conclude that Thailand was less vulnerable in mid-1993 than it was in mid-1997. Note that by specifying the probability of a crisis as a weighted average of the number of indicators that have reached their optimal thresholds, the signals approach makes it easy computationally to monitor crisis vulnerability. In contrast, the regression-based

[34] While this is one of only many potential "composite" indicators (i.e., ways of combining the information in the individual indicators), Kaminsky (1998) provides evidence that this weighting scheme shows better in-sample and out-of-sample performance than three alternative. Also, note that one can equivalently evaluate the performance of individual indicators by comparing their conditional probabilities of signalling a crisis.

approaches require estimation of the entire model to calculate crisis probabilities; in addition, because these regression-based models are non-linear, it becomes difficult to calculate the contribution of individual indicators to crisis probabilities in cases where the variables are far away from their means.[35]

(vi) Guideline number six is to employ out-of-sample tests to help gauge the usefulness of leading indicators. The in-sample performance of a model may convey a misleading sense of optimism about how well it will perform out of sample. A good case in point is the experience of the 1970s with structural models of exchange rate determination for the major currencies. While these model fit well in sample, subsequent research indicated that their out-of-sample performance was no better --and often worse -- than that of "naive" models (e.g., using the spot rate or the forward rate to predict next period's exchange rate).[36] In this study, we use data from the 1970-95 period to calculate our optimal thresholds for the indicators but we save data from 1996 through end-1997 to assess the out-of-sample performance of the signals approach, including the ability to identify the countries most affected during the Asian financial crisis.

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[35] Of course, ease of application is only one among many criteria for choosing among competing crisis-forecasting methodologies. For example, the signals approach also carries the disadvantage that is less amenable to statistical tests of significance; in addition, some of the restrictions it imposes (e.g., that indicators send a signal only when they reach a threshold) may not be consistent with the data.

[36] See Meese and Rogoff (1982).

(vii) Our seventh and last guideline is to beware of the limitations of this kind of analysis. Because these exercises concentrate on the macroeconomic environment, they are not capable of capturing the kind of political triggers and exogenous events -- such as the Danish referendum on EMU in 1992 or the Colosio assassination in 1994 -- that often have an important influence on the precise timing of speculative attacks. Because high frequency data are not available on most of the institutional characteristics of national banking systems -- ranging from the extent of "connected" and government-directed lending to the adequacy of bank capital and banking supervision -- such exercises can also not be expected to capture some of these longer-term origins of banking crises. Also, because we are not dealing with structural economic models but rather with loose reduced-form relationships, such leading-indicator exercises do not generate much information on why or how the indicators affect the probability of a crisis. For example, a finding that exchange rate overvaluation typically precedes a currency crisis does not tell us whether the exchange rate overvaluation results from a rigidly fixed exchange rate regime that has overstayed its welcome or from a surge of private capital inflows; and it cannot inform us whether the source of vulnerability is a loss of competitiveness for the country's traded goods or a mismatched foreign-currency position on the part of banks or their corporate customers which will result in a banking crisis once the rate is devalued. Nor is the early warning study of financial crises immune from the "Lucas critique:" that is, if a reliable set of early warning indicators were identified empirically, it is possible that policymakers would henceforth behave differently when these indicators were flashing than they did in the past, thereby transforming these variables into early warning indicators of corrective policy action rather than of indicators of financial crisis. While this feedback effect of the indicators on crisis prevention has apparently not been strong enough in the past to eradicate the predictive content of the indicators, there is no guarantee that this feedback effect wouldn't be stronger in the future (particularly if the empirical evidence in favor of robust early warning indicators of crises was subsequently viewed as more persuasive).

Much like the leading-indicator analysis of business cycles, we are engaging here in a mechanical exercise -- albeit one that we think is interesting on a number of fronts. Moreover, it needs to be kept in mind that this research is still in its infancy, with many of the key empirical contributions coming only in the last two to three years. In areas like the modelling of contagion and alternative approaches to out-of-sample forecasting, there hasn't been time to run enough "horse races" to know which approaches work best. For all of these reasons, we see the leading-indicator analysis of financial crises in emerging economies as one among a number of analytical tools for studying financial crises in emerging economies and not as a stand-alone, sure-fire system for predicting where the next crisis will take place. That being said, we also argue that this approach shows promising signs of generating real value added, and that it appears particularly useful as a first screen for gauging the ordinal differences in vulnerability to crises both across countries and over time.

The rest of this study is organized as follows. Chapter 2 takes up in more detail the leading_methodological issues surrounding the forecasting of crisis vulnerability, including the choice of sample countries, the definition of currency and banking crises, the selection of leading-indicators, the specification of the early warning window, and the signals approach to calculating optimal thresholds for indicators and the probability of a crisis.

Chapter 3 presents the main empirical results for the in-sample estimation (1970-95), with a focus on the best-performing monthly and annual indicators, on a comparison of credit ratings and interest rate spreads with indicators of economic "fundamentals," and on the ability of the signals approach to predict accurately earlier currency and banking crises. In Chapter 4, we analyze the track record of rating agencies in forecasting currency and banking crises.

In Chapter 5, we use two overlapping out-of-sample periods (namely beginning-1996 through mid-1997, and beginning-1996 through end-1997) to project which emerging economies were recently the most vulnerable to currency and banking crises. This exercise also permits us to gauge the performance of the model in anticipating the Asian financial crisis. In Chapter 6, we analyze the contagion of financial crises across countries, with particular emphasis on how fundamentals-based contagion is influenced by trade and financial-sector links. The following chapter also examines data on the aftermath of crisis to provide an assessment of how long it will be before the recovery from the Asian crisis takes hold. Finally, Chapter 8 contains some brief concluding remarks, along with suggestions for how the leading-indicator analysis of currency and banking crises in emerging economies might be improved.

Summary of findings

Our empirical findings can be summarized conveniently into twelve main points.

(i) Banking and currency crises in emerging markets do not typically come out of the blue--without any warning. There are recurring patterns of behavior in the period leading up to banking and currency crises. Reflecting this tendency, the better-performing leading indicators anticipate between 50 and 100 percent of the banking and currency crises that occurred over our 25 year sample period. In addition, we find consistently that both the average number of signals and the frequency of extreme signals are much higher during crises than during normal times. At the same time, even the best leading indicators send a significant share of false alarms (on the order of one false alarm for every two to five true signals).[37]

(ii) Using monthly data, banking crises in emerging economies are more difficult to forecast accurately than are currency crises. Within sample, the average noise-to-signal ratio is higher for banking crises than for currency crises, and the model likewise does better out-of-sample in predicting currency crises than banking crises. It is not yet clear why this is so. It may reflect difficulties in dating accurately banking crises, that is, in judging when banking sector distress turns into a crisis and when banking crises end. For example, by our criteria, banking distress in Indonesia and Mexico really began in 1992 (and not in 1997 and 1994, respectively). The absence of high-frequency (monthly or quarterly) data on the institutional characteristics of national banking systems probably also is a factor.

[37] This ratio comes from our estimated "adjusted" noise-to-signal ratios. By "adjusted," we mean ratios that are adjusted for the fact that the number of months in which a false signal could have been issued is different from the number of months that a true signal could have been issued; see Kaminsky, Lizondo, and Reinhart (1998).

(iii) There is wide variation in performance across leading indicators, with the best-performing indicators displaying noise-to-signal ratios that are in the neighborhood of two to three times better than those for the worst-performing ones.[38] In addition, the group of indicators that show the best (in sample) explanatory power also seem, on average, to send the most persistent and earliest signals. Warnings of a crisis usually appear 10 to 18 months prior to the outset.

(iv) For currency crises, the best of the monthly indicators were: appreciation of the real exchange rate (relative to trend), a decline in equity prices, a fall in exports, a high ratio of broad money (M2) to international reserves, a low ratio of international reserves by itself, and excess narrow-money (M1) balances; a recession just misses the top group. Among the annual indicators, the two best performers were both current-account indicators, namely, a large current-account deficit relative to both GDP and investment; see Table 1.5.

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[38] When an indicator has a noise-to-signal ratio above one, crises would be more likely when the indicator was not sending a signal than when it was. Similarly, when an indicator has a conditional probability of less than zero, it means that the probability of a crisis occurring when the indicator is signaling is lower than the <u>un</u>conditional probability of a crisis occurring, that is, merely estimating the probability of a the crisis according to its historical average; for example, if currency crises occur in a third of the months in the sample, the unconditional probability of a crisis is one third.

TABLE 1.5. Currency and banking crises:
Best performing indicators

	CURRENCY CRISES	BANKING CRISES
High-frequency Indicators		
	REAL EXCHANGE RATE	REAL EXCHANGE RATE
	BANKING CRISIS	EQUITY PRICES
	EQUITY PRICES	M2 MULTIPLIER
	EXPORTS	REAL OUTPUT
	M2/INTERNATIONAL RESERVES	EXPORTS
	INTERNATIONAL RESERVES	REAL INTEREST RATE ON DEPOSITS
Low-Frequency Indicators		
	CURRENT ACCOUNT IMBALANCE/GDP	SHORT-TERM CAPITAL INFLOWS/GDP
	CURRENT ACCOUNT IMBALANCE/INVESTMENT	CURRENT ACCOUNT IMBALANCE/INVESTMENT

Source: The authors, Chapters 3-5.

(v) Turning to banking crises, the best (in descending order) of the 15 monthly indicators were: appreciation of the real exchange rate (relative to trend), a decline in equity prices, a rise in the (M2) money multiplier, a decline in real output, a fall in exports, and a rise in the real interest rate. Among the eight annual indicators tested, the best of the pack were a high ratio of short-term capital flows to GDP and a large current-account deficit relative to investment; see Table 1.4.

(vi) While there is a good deal of overlap between the best-performing leading indicators for banking and currency crises, there is enough of a distinction to warrant treating the two separately. To highlight but two noteworthy differences, the two indicators that serve as proxies for financial liberalization -- namely, a rise in the real interest rate and an increase in the money multiplier -- turned out to be more important leading indicators for banking crises than for currency crises, whereas the opposite proved true for the two indicators designed to capture currency and maturity mismatches and excessively expansionary monetary policy -- namely, a high ratio of broad (M2) money balances to international reserves and excess M1 money balances, respectively.

(vii) While our data on sovereign credit ratings cover only a subsample of crises and relate to only two of the major rating firms (Institutional Investor and Moody's Investor Services), we find that changes in sovereign credit ratings have performed considerably worse than the better leading indicators of economic fundamentals in anticipating both currency and banking crises in emerging economies. In addition, we find no empirical support for the view that rating changes have led financial crises in our sample countries rather than reacting to these crises. In a similar vein, we have found that interest rate spreads (i.e., foreign-domestic real interest rate differentials) are not among the best-performing group of leading indicators. Those who are looking to "market prices" for early warning of crises in emerging economies would therefore be advised to focus on the behavior of real exchange rates and of equity prices -- not on credit ratings and interest rate spreads.

(viii) In most banking and currency crises, a high proportion of the (monthly) leading indicators -- on the order of 50-75 percent reach their danger thresholds. Indeed, both in and out-of-sample, we found that fewer than one-sixth of crises occurred with only five or fewer of the (15 monthly) leading indicators flashing. Put in other words, when an emerging economy is lurching toward a financial crisis, many of the wheels come off simultaneously.

(ix) Although we have just scratched the surface on testing our leading indicators out of sample, we are encouraged by the initial results.

We considered two out-of-sample periods: an 18 month period running from the beginning of 1996 to end-June 1997 (just prior to the outbreak of the Asian financial crisis), and a 24 month period running from January 1996 to end-December 1997. Recall that because the indicators lead crises by anywhere from 10 to 18 months, part of the prediction period will lie outside the out-of-sample observation period.

In each period, we concentrated on the ordinal ranking of countries according to their crisis vulnerability. Our preferred measure of vulnerability was an index equal to the weighted average of "good" indicators issuing signals in the out-of-sample period. By "good" indicators, we mean those that had noise-to-signal ratios less than unity during the 1970-95 period (i.e., marginal forecasting probabilities greater than zero); taking the monthly and annual indicators as a group, there were 18 "good" indicators. We used the inverse of the noise-to-signal ratios as weights. We then ranked each of the 25 countries in the sample according to the computed value of this index. The index is meant to capture the probability of a crisis -- not necessarily its severity.

As regards vulnerability to currency crises, the results for the two out-of-sample periods were quite similar. The eight most vulnerable countries (in descending order) for the 1996 to mid-1997 period were as follows: Czech Republic, South Korea, Greece, Thailand, South Africa, Colombia, Turkey, and the Philippines; see Table 1.6. For the somewhat longer 1996 to end-December 1997 period, the list of the eight most vulnerable countries was identical, although their ordinal ranking was slightly different, namely (again in descending order): Czech Republic, Thailand, South Korea, Greece, the Philippines, South Africa, Colombia, and Turkey.

If the most vulnerable list was extended to the top ten, Finland and Malaysia would have been included in the first period, and Norway and Malaysia in the second one.

Table 1.6: Vulnerability to currency crises

January 1996-June 1997				**January 1996-December 1997**			
Country	Weighted Index[1]	Rank	Crisis[2]	Country	Weighted Index[1]	Rank	Crisis[2]
Most Vulnerable							
Czech Republic	24.54	1	*	Czech Republic	24.54	1	*
South Korea	20.55	2	*	Thailand	22.96	2	*
Greece	20.05	3		South Korea	22.31	3	*
Thailand	18.74	4	*	Greece	17.97	4	
South Africa	15.12	5		Philippines	16.18	5	*
Colombia	14.26	6	*	South Africa	15.12	6	
Turkey	14.25	7		Colombia	14.26	7	*
Philippines	14.05	8	*	Turkey	14.25	8	
Least Vulnerable							
Brazil	6.27	18		Denmark	7.53	18	
Peru	6.10	19		Chile	7.30	19	
Egypt	5.39	20		Brazil	6.27	20	
Chile	4.55	21		Peru	6.10	21	
Argentina	4.51	22		Argentina	4.51	22	
Uruguay	1.75	23		Indonesia	3.43	23	*
Mexico	1.47	24		Uruguay	1.75	24	
Indonesia	1.30	25	*	Mexico	1.47	25	

[1] Weighted index is a sum of the weighted signals flashing at any time during the specified period. Monthly and annual indicators are included. Weights are equal to the inverse noise:signal ratios of the respective indicators

[2] An asterisk indicates that the country experience a crisis during the out-of-sample period.

Perhaps the first question to ask is how many of the countries estimated to be most vulnerable to currency crises in the out-of-sample period(s) turned out to have undergone such crises? The answer, as shown in the upper panel of Table 1.6, is almost three quarters of them. According to our index of exchange market pressure, the Czech Republic, Thailand, South Korea, the Philippines, and Colombia all experienced currency crises in 1997 (that is, depreciations or reserve losses that pushed the index of exchange market pressure to three standard deviations or more above its mean). Moreover, while South Africa did not formally make the cut, it could reasonably be classified as a near miss since it experienced a quasi-crisis in June 1998 (a 14 percent devaluation cum a 13 percent decline in reserves that pushed the exchange market pressure index 2.7 standard deviations above its mean). Greece underwent an 11 percent devaluation in March 1998 but since it was accompanied by a large reserve gain, it didn't quite qualify. Malaysia, which just made it into the top-ten most vulnerable group, did have a currency crisis in 1997. So did Norway (in the form of a large reserve loss in late 1997), which made it into the top ten list in the first out-of-sample period but not in the second. The most serious missclassification in the top vulnerability group was Turkey, which was estimated to have medium-high vulnerability (that is, ordinal vulnerability rankings of 7 or 8 out of 25 countries) but did not experience a crisis during or close to the out-of-sample period.

Further information on the out-of-sample performance of the leading indicators of currency crisis can be gleaned by looking for episodes where, to borrow a theme from Sherlock Holmes, the "dogs were not barking," that is, by looking to see how often crises occurred among those countries estimated to have relatively low vulnerability. The lower panel of Table 1.6 indicates the eight countries that were estimated to have relatively low vulnerability to currency crises in 1996-1997. As with the high vulnerability group, the ordinal rankings of countries are very similar across the two out-of-sample periods, with Mexico, Indonesia, and Uruguay heading the least vulnerable list, and with Argentina, Chile, Peru, Brazil, and Egypt rounding out the top eight. Here too, with the important exception of Indonesia, there are relatively few poor forecasts of crises. More specifically, excluding Indonesia, in none of the least vulnerable countries does the calculated index of exchange market pressure reach even two standard deviations above its mean during the out-of-sample period. If we extend the period out farther, Brazil might conceivably be regarded as a miss classification since it does get very close to a currency crisis (with the index hitting 2.9) but that comes quite a bit later, not until September 1998.

But what about Indonesia which after all suffered the most severe currency crisis (beginning in December 1997) among the sample countries during the out-of-sample period? Why did the model miss it so badly?[39] The explanation probably lies in two areas. First, most of the best-performing (higher weight) leading indicators were not flashing in Indonesia's case. For example, in mid-1997 (just before the outbreak of the Thai crisis), the real effective exchange rate of the Indonesian rupiah was only 4 percent above its long-term average --far below its optimal threshold; in a similar vein, neither the decline in equity prices, nor the decline in exports, nor the change in the ratio of M2 money balances to international reserves, had hit their threshold values.[40] Second, at least three of the factors important in the Indonesian crisis are not included in our list of indicators, namely, currency/liquidity mismatches on the part of the corporate sector, regional cross-county contagion effects, and political instabilities (in this case,

[39] It should be recognized that none of the existing early warning models -- including the regression-based models, is able to anticipate the Indonesian crisis.

[40] Indonesia's equity prices did suffer a severe decline but it did not begin until August 1997.

associated with the Suharto regime). In this connection, work reported in Kaminsky and Reinhart (1998b) and extended in Chapter 6 suggests that the withdrawal of a common bank lender (in this case, Japanese banks) had a lot to do with contagion in emerging Asia after the outbreak of the Thai crisis.

The failure of our leading indicators to anticipate the Indonesian crisis should not, however, obscure the fact that of the five countries most adversely affected by the Asian crisis (Thailand, South Korea, Indonesia, Malaysia, and the Philippines), the indicators placed three of the them (Thailand, South Korea, and the Philippines) in the top vulnerability group and another (Malaysia) in the upper third of the country-vulnerability rankings. Given the well-documented failure of private credit ratings and interest rate spreads to anticipate these Asian currency crises (with the possible exception of Thailand), and given that these forecasts are based solely on own-country fundamentals (that is, with no help from contagion variables), this performance on relative-country vulnerabilities is noteworthy. By the same token, the relatively high estimated vulnerability of several of the Asian emerging economies also challenges the oft-heard view that the crisis was driven primarily by investor panic, with little basis in weak country fundamentals.[41]

[41] Using a very similar approach (cum an expanded set of indicators), Kaminsky (1998) presents a time-series of calculated crisis probabilities for the Asian economies and finds that estimated currency-crisis vulnerability increased markedly before the 1997 event in Thailand, and moderately in Malaysia and the Philippines. Again, no such increase in estimated vulnerability was present for Indonesia. Korea was not in her sample. Sachs and Radelet (1998) take the opposing view that the crisis in Asia was mainly attributable to investor panic.

Turning to banking crises, the ordinal rankings of country vulnerability again are quite similar across the two out-of-sample periods, although the correspondence is slightly lower than was the case for currency crises: six of the eight countries estimated to be most vulnerable to banking crises are the same across the two periods. Specifically, for the 1996 to mid-1997 period, the eight most vulnerable countries (again in descending order) were: Czech Republic, Greece, South Korea, Colombia, Finland, Thailand, South Africa, and the Philippines; see Table 1.7. When the out-of-sample period is extended through the end of 1997, South Africa and the Philippines drop out of the top eight (moving to eleventh and ninth, respectively) and are replaced by Norway and Spain. Thus, the rankings for the 1996 to end-1997 period are as follows: Czech Republic, Thailand, Greece, South Korea, Colombia, Norway, Finland, and Spain.

Table 1.7. Vulnerability to Banking Crises

January 1996-June 1997				January 1996-December 1997			
Country	Weighted Index[1]	Rank	Crisis[2]	Country	Weighted Index[1]	Rank	Crisis[2]
Most Vulnerable							
Czech Republic	24.87	1		Czech Republic	24.87	1	
Greece	20.28	2		Thailand	21.72	2	*
South Korea	19.93	3	*	Greece	20.28	3	
Colombia	17.53	4		South Korea	19.93	4	*
Finland	16.12	5		Colombia	17.53	5	
Thailand	14.49	6	*	Norway	17.21	6	
South Africa	12.95	7		Finland	16.12	7	
Philippines	12.52	8		Spain	16.03	8	
Least Vulnerable							
Denmark	6.83	18		Chile	8.86	18	
Venezuela	6.38	19		Argentina	8.51	19	
Brazil	6.08	20		Venezuela	7.85	20	
Mexico	4.45	21		Indonesia	7.68	21	
Chile	4.23	22		Brazil	7.55	22	
Egypt	3.96	23		Denmanrk	6.83	23	
Uruguay	3.88	24		Mexico	4.45	24	
Indonesia	2.84	25		Uruguay	3.88	25	

[1] Weighted index is a sum of the weighted signals flashing at any time during the specified period. Monthly and annual indicators are included. Weights are equal to the inverse noise-to-signal ratios of the respective indicators

[2] An asterisk indicates that the country experience a crisis during the out-of-sample period.

As with the vulnerability rankings for currency crises, it is useful to ask which of the countries estimated to be most vulnerable to banking crises actually suffered that fate during the out-of-sample periods. As suggested earlier, this is intrinsically a tougher question to answer for banking crises (than for currency crises) because the identification and dating of crises are subject to wider margins of error. Recall also that because we our 24 month early-warning window for banking crises covers both the 12 month period preceding the beginning of the crisis as well as the 12 month period following the onset, successful predictions would include some crises that began toward the end of 1995 and some that started no later than early 1998 (as well as those that began in 1996 or 1997).

With these caveats in mind, the picture painted by Table 1.6 can be summarized as follows. Of the eight countries estimated to be most vulnerable in the January 1996 to end-June 1997 sample, two experienced banking crises that fall in our prediction window. Specifically, we consider South Korea's banking crisis to have begun in January 1997 with the loan losses stemming from the bankruptcy of Hanbo Steel; in a similar vein, we date Thailand's banking crisis as starting in May 1996 when the Ministry of Finance took control of Bankgok Bank of Finance (following a run on deposits). A third member of the most vulnerable group, the Czech Republic, also experienced a banking crisis although the timing is not clear cut: the start of the Czech crisis could be dated in August 1996 reflecting the closure of Kreditini Banka; alternatively, one could also defend a much earlier starting date, namely September 1993 when Kreditni was initially placed under supervision.[42] Some researchers (e.g., Kaminsky and Reinhart (1998)) also classify Malaysia and the Philippines as having registered banking crises in 1997. The results for the longer out-of-sample period, shown in the upper panel of Table 1.6, are

[42] The Czech banking crisis was not included in our in-sample test and hence, the model is not calibrated to account for this crisis.

quite similar: the same three countries (South Korea, Thailand, and Czech Republic) make up the list of successful banking-crisis predictions.

What about the group of countries estimated to be least vulnerable to banking crises? As seen in the lower panel of Table 1.6, seven of the eight countries in this category are common to both sample periods, namely, Uruguay, Indonesia, Mexico, Brazil, Venezuela, Denmark, and Chile; Egypt appears only in the shorter period, while Argentina makes the least vulnerable list only in the longer period. For five of the seven countries estimated to be least vulnerable, no banking crisis appears to have taken place during the out-of-sample periods. As was the case with the forecasting of currency crises, Indonesia emerges as a major misclassification, although timing problems cloud somewhat the issue. Many observers would regard the severity of Indonesia's financial-sector problems in 1997 as constituting a “new” banking crisis; others might argue that these difficulties constituted a continuation of the banking problems that began in 1992 with the collapse of Bank Summa. In any case, it is clear that the model was not picking up the increase in Indonesia's vulnerability in 1997. Mexico presents another timing problem. Mexico remained in the throes of a banking crisis throughout the out-of-sample period and thus could be classified as highly vulnerable. At the same time, most studies (e.g., Demirguc-Kunt and Detriache (1997) and IMF (1998b)) regard the Mexican banking crisis as having started at least as early as 1994; here too, the model seems to have difficulty in identifying changes in vulnerability when they occur in the context of the continuation of banking problems.

Looking at both the high and low vulnerability groups, it is clear that the early-warning model is less successful out-of-sample in anticipating banking crises than it is in anticipating currency crises. The problem is not so much that the model misses many banking crises that do occur but rather that it generates too much "noise", that is, it predicts more cases of banking-crisis vulnerability than actually occur. In this connection, it is worth noting that we classify only five or six episodes as meeting our criteria for banking crisis during the out-of-sample period (that is, the period running roughly from late 1995 to early 1998). This list comprises South Korea, Thailand, the Czech Republic, Indonesia, Mexico, and Malaysia.[43] Of these six crisis cases, three of the countries concerned (South Korea, Thailand, and the Czech Republic) were members of our "most vulnerable" group and the three others (Indonesia, Mexico, and Malaysia) were not.[44] This might be considered fair performance. More worrisome is the finding that five of the eight other members of the high vulnerability group did not experience banking crises during the out-of-sample period. Difficulties in forecasting Asian banking crises in 1997 seem to be common to the leading forecasting models -- be they signals-approach models or regression-based models. For example, Demirgic-Kunt and Detragiache (1998), using a multi-variate logit model, report that the conditional probabilities for banking crises in the five most adversely-affected Asian economies were actually below the unconditional crisis probabilities.[45] Similarly, Kaminsky (1998) finds that estimated crisis probabilities are rising sharply in the case of the Thai banking crisis and moderately for the case of the Philippines, but not for either Malaysia or Indonesia.

We conducted a number of experiments to help gauge the robustness of our results on the

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[43] The Malaysian crisis would probably best be regarded as beginning in March 1998 when the central bank announced losses at Sime Bank and elsewhere, and when Malaysian President Mahatir pledged state funds to prop up weak institutions.

[44] Malaysia was ranked fourteenth (out of 25 countries) in the shorter period and tenth in the longer one.

[45] See Furnam and Stiglitz (1998).

ordinal ranking of country vulnerability to currency and banking crises. In one exercise, instead of basing the ordinal vulnerability rankings exclusively on weights derived from the noise-to-signal ratios, we looked at the both the proportion of indicators signaling a crisis and the proportion of the top nine indicators signaling a crisis. In another exercise, we looked at various indicators signaling both banking and currency crises, and calculated "average" vulnerability to banking and currency crises combined. And in yet another set of exercises, we liberalized the optimal thresholds for each of the indicators by 5 percent, thereby making it less likely that we would miss crisis that were unfolding, albeit at the cost of predicting crises that never occurred. While these robustness exercises not surprisingly generated some changes in the ordinal rankings, perhaps the most important finding was that a set of five or six countries -- namely, the Czech Republic, South Korea, South Africa, Greece, Columbia, Thailand, the Philippines, and Malaysia -- consistently remained in the top tier of the vulnerability list. All in all, we regard the out-of-sample performance of the signals approach as encouraging -- particularly as regards anticipating currency crises in the Asian crisis countries.[46] With the exception of Indonesia -- and to a lesser extent Malaysia, the model did well in identifying the countries with relatively high vulnerability. In addition, the model gave strong signals for the Czech Republic, South Africa, Greece, and Colombia which also experienced crises outside the Asian region. The results for banking crises were less impressive. While we would not place much confidence in the precise estimated ordering of vulnerability across countries, we think the signals approach looks promising for making course distinctions between the vulnerability of countries near the

[46] This is consistent with the results of a recent IMF study ((Berg and Pattillo (1998)) that found that the signals model of Kaminsky, Lizondo, and Reinhart (1998) did a better job of predicting the Asian crisis than the models of Frankel and Rose (1996) and of Sachs et al (1996). At the same time, Berg and Pattillo (1998) argue that some of the key assumptions of the signals approach are not supported by empirical tests and that one could obtain better predictions of the Asian crisis by embedding the better-performing indicators of the signals approach within a probit framework.

top of the list and those near the bottom, that is, it may be useful as a "first screen," which can then be followed up by more in-depth country analysis.

Some others are more pessimistic about both the potential and actual out-of-sample performance of signals-based leading-indicator models of currency crises, including their track record in anticipating the Asian financial crisis.[47] The criticisms here include the arguments: that when such models do seemingly perform well, it is often because they rely on "black box" simple contagion variables (e.g., the number of crises that have occurred in the previous period); that the methodology embedded in the signals approach is biased toward overpredicting crises in countries with good histories and this explains its successes in predicting currency crises in Asia; that both in-sample and out-of-sample performance would be better if the good indicator variables were entered linearly (rather than sending a signal only when the indicator crossed its threshold) and if the weights on the individual indicators were estimated by a regression (rather than selected from an iterative noise-to-signal test, one at a time); that the correlation between the severity of observed currency crises and crisis vulnerability predicted by the signals approach was low (at least in 1996); and that (also in 1996) there did not seem to be a marked distinction between the calculated currency crisis vulnerabilities of several non-crisis countries (particularly the Philippines, Brazil, Argentina, and Mexico) and the Asian crisis countries (Thailand and Indonesia).

We take up these criticisms in some detail in Chapter ? Here, it is sufficient to offer the following rebuttal.

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[47] See Berg and Pattillo (1998), the Economist (1998), Furnam and Stiglitz (1998), and the IMF (1998c).

In the two studies (Berg and Pattillo (1998) and Furnam and Stiglitz (1998)) which have explicitly run out-of-sample horse races between the Kaminsky-Reinhart signals model and two other regression-based models of currency crises (namely, the Frankel-Rose (1997) model and the Sachs et al (1997) model), both studies conclude that the signals approach does better.

While we present some new results on cross-country contagion in Chapter 6, the out-of-sample results -- both in earlier Kaminsky-Reinhart studies and in this book -- do not rely at all on cross-country contagion; instead, they reflect only own-country fundamentals.

There is (at least to our knowledge) no empirical evidence to support the view that imposing a common absolute threshold for indicator variables would produce better in-sample and out-of-sample performance than (our procedure) of imposing a common percentile threshold and allowing the absolute threshold to differ across countries; nor, as we have argued earlier, does it seem more reasonable on a priori grounds to impose the one-size-fits-all restriction on countries with different histories; quite the contrary. As for the alleged influence of our procedure in the context of forecasting the Asian financial crisis, one would have thought that if this bias was large, it might have led to a very successful prediction of crises in the Asian countries when some of these same critics find that the signals approach does very poorly in forecasting currency crises in these countries.

Finally and perhaps most importantly, while more work is clearly needed to assess the robustness of the results to different out-of-sample periods (since these differ and seem to generate different outcomes across studies), we do not find that there was little distinction in estimated currency-crisis vulnerabilities between most of the Asian crisis countries on the one hand and some other (Latin American) non-crisis countries on the other. As indicated earlier, we found that Thailand, the Philippines, and Malaysia had higher estimated currency-crisis probabilities in 1996-97 than did Brazil, Argentina, and Mexico -- not the other way around. Thailand was near the top of our vulnerability list -- not near the bottom. Also, it is not obvious that out-of-sample comparisons based on the severity of crises are more meaningful that those (as above) that concentrate on the crisis/no-crisis distinction.

In short, just as we emphasized that it is important not to oversell the potential of early-warning models to predict crises in emerging economies, we think some of the critics are too quick to dismiss the usefulness of these models because of a mixed out-of-sample performance based on runs from a single period. We should also keep in mind the apparent inability of non-model-based forecasts to foresee the Asian crisis. In our view, much more empirical work will need to be done before we can draw reliable conclusions on the out-of-sample performance of the signals approach.

(x) Examining a somewhat more limited sample (20) of small developed and emerging economies over the 1970-98 period, we looked for patterns in the cross-country contagion of currency crises. Our results suggest that (at least historically) contagion has operated more along regional than global lines, that susceptibility to contagion is highly nonlinear (rising dramatically if several core countries are already affected), that it is difficult to discriminate between trade and financial contagion links (because most countries that are linked in trade are also linked in finance), and that two earlier prominent episodes of contagion -- namely Argentina after the Mexican peso crisis and Indonesia after the Thai baht crisis -- are probably best explained in terms of financial linkages (specifically, withdrawal of a common commercial bank lender and the unwinding of cross-market hedging).[48]

[48] Note that in these two contagion episodes, bilateral and third-party trade links with the first-infected country were weak.

(xi) In addition to studying the antecedents of crises we also drew on our data base for information on the aftermath of crises-- with particular attention on assessing the speed with which emerging economies are able to return to "normal" after a currency or banking crises. We defined normal in two alternative ways: first, as a period of "tranquility" that excludes not only the crisis years but also the two-to-three year windows before and after the crisis, and second, as the average of the two years just preceding crises.[49]

[49] More specifically, the "tranquil" period excludes the 24 months before and after currency crises, and the 24 months before and 36 months after banking crises.

One of our most robust findings was that the deleterious effects on economic activity are more lingering for banking crises than for currency crises; for example, whereas it took about two years for economic growth to return to the average of the two pre-crisis years in the aftermath of a currency crisis, that return was not evident even three years after a banking crisis. One possible explanation for this difference is that whereas a currency crisis reduces sharply external sources of funding, a banking crisis curtails access to both external and domestic sources of finance for households and firms, that is, the "credit crunch" is more severe in the wake of banking crises. This more sluggish recovery pattern for banking crises was also evident for exports, imports, and equity prices. For instance, whereas exports recover relatively quickly (8 months) and ahead of the rest of the economy following currency crises, they continue to sink for two years following the onset of a banking crisis. Two other dimensions of the protracted nature of banking crises are that banking crises usually last for about ( ) years and that it takes on the order of a year and half between the onset of a banking crisis and its peak. All of this paints a pessimistic picture for the speed of recovery in the ongoing Asian crisis: not only are the most affected countries in emerging Asia suffering from currency crises that are accompanied by banking crises (what Kaminsky and Reinhart (1996 call "twin crises") but the banking crises themselves are very severe. This suggests that recovery of economic growth in emerging Asia is more likely to resemble the shape of a bathtub than a V.

Our analysis of the aftermath of crises does not lend support to the notion that devaluations in emerging economies generate deflation. Instead, we find that devaluations are inflationary, that the pass-through to prices in incomplete (hence, they lead to real depreciations), and that it takes between two and three years after a devaluation for inflation to return to the average of the two pre-crisis years.

(xii) Last but not least, we offer a number of suggestions for improving early-warning models of currency and banking crises. In our view, four directions for future research merit priority.

First, as hinted at above, more work needs to be done to determine the out-of-sample forecasting properties of these models -- be it signals-approach models or regression-based logit or probit models. In particular, it would be useful to know how robust are "whose next" country rankings of vulnerability to changes in the forecasting period, to different composite indicators, and to the restrictions imposed in the different models (e.g., imposing thresholds versus allowing indicators to enter linearly, imposing absolute thresholds versus common percentile ones, etc). It may turn out, as suggested by Berg and Pattillo (1998), that it is possible to improve performance by combining certain features of the signals approach and the regression-based models (e.g., using the signals approach to select the good indicators and then estimating the weights and crisis probabilities using a regression-based format).

Second, we think there is mileage in bringing other indicators into these horseraces. For example, Kaminsky (1998) has found that the share of short-term debt in total foreign debt as well as a proxy for capital flight (by residents of emerging economies) do quite well in anticipating currency and banking crises within sample. Looking at the run-up to the Asian financial crisis, Furnam and Stiglitz (1998) likewise make a good case for including the ratio of short-term external debt to international reserves as an indicator in future early-warning exercises. If monthly data could be obtained both on real property prices and on the exposure of the banking system to property, those too could prove very helpful.

Yet a third extension would be to bring institutional characteristics of weak banking systems into the forecasting of banking crises. There is a strong presumption that weak accounting, provisioning, and legal frameworks, policy-directed lending, the ownership structure of the banking system (government ownership, foreign ownership, etc), the incidence of connected lending, the extent of diversification, and the incentive-compatibility of the official safety net, all matter for vulnerability to banking crises. Yet it is only very recently that any of these factors have begun to enter the empirical literature.[50]

The main constraint on making use of these institutional characteristics is that one can't get high frequency measurements of them; indeed, for some of these characteristics (e.g., the share of government ownership), its proven difficult to get even annual data that's less than two or three years old. This means that such variables have to be introduced as zero-one dummy variables in a time-series context. There would be more scope to take advantage of such factors in cross-section work, that is, in explaining cross-country differences in the incidence of banking crises over long time periods. Given however the difficulties encountered so far in predicting banking crises out-of-sample, such work should be encouraged, that is, its unlikely that a model based almost solely on macroeconomic and liberalization variables will do the job.

[50] See, for example, Demirgic-kunt and Detragiache (1997) who introduce law enforcement and deposit-insurance variables into their banking crisis model.

Fourth, we think the ongoing work on modelling the nature of cross-country contagion of crises should be extended. One of the lessons of the last few major crises (that is, the Mexican peso crisis cum tequilla effect and the Asian/global financial crisis) is that the channels of cross-country contagion are more numerous and complicated than we thought earlier. Trade links (bilateral and third party), perceived similarities in macroeconomic and financial vulnerability, the dynamics of competitive devaluations, induced effects on primary commodity prices, financial links operating via withdrawal of a common bank or mutual fund lender, liquidity and margin-call effects operating via the regulatory framework, and perceived changes in the rescheduling cum capital-account convertibility regime (such as took place after the Russian unilateral rescheduling/default in August 1998 and the Malaysian imposition of wide-ranging capital controls), each seem to play a part in contagion. We need to find ways to incorporate more of these channels of contagion in our forecasting models.

References

Agenor, Pierre-Richard, Jagdeep S. Bhandari, and Robert P. Flood. 1992. "Speculative Attacks and Models of Balance of Payments Crises." *IMF Staff Papers* 39 (June), 357–94.

Bank of International Settlements. 1998. *The Maturity, Sectoral, and Nationality Distribution of International Bank Lending*. Basle: Bank for International Settlements.

Berg, Andrew, and Catherine Patillo. 1999. "Are Currency Crises Predictable? A Test." forthcoming in *Journal of International Money ad Finance,* (August).

Blanco, Herminio, and Peter M. Garber. 1986. "Recurrent Devaluation and Speculative Attacks on the Mexican Peso." *Journal of Political Economy*, 94 (February), 148–66.

Borensztein, Eduardo, and José de Gregorio. 1998. "Devaluations and Inflation After Currency Crises." Unpublished paper.

Calomiris, Charles, 1997. *The Post Modern Bank Safety Net: Lessons from Developed and Developing Countries.* Washington, DC: American Enterprise Institute.

Calvo, Guillermo A. 1998. "Varieties of Capital-Market Crises." In Guillermo A. Calvo and M. King *The Debt Burden and Its Consequences for Monetary Policy*. New York: MacMillan Press.

Calvo, Guillermo A., Morris Goldstein. 1996. "What Role for the Official Sector? "In Guillermo A. Calvo, Morris Goldstein, and Eduard Hochreiter *Private Capital Flows to Emerging Markets After the Mexican Crisis*, Washington: Institute for International Economics, 233-82.

Calvo, Guillermo A., and Enrique Mendoza. 1996. "Mexico's Balance-of-Payments Crisis: A Chronicle of A Death Foretold," *Journal of International Economics* 41, No. 3/4, (November), 235-264.

Calvo, Sara, and Carmen M. Reinhart. 1996. "Capital Flows to Latin America: Is There Evidence of Contagion Effects?." In Guillermo A. Calvo, Morris Goldstein, and Eduard Hochreiter *Private Capital Flows to Emerging Markets After the Mexican Crisis*, Washington: Institute for International Economics, 151–71.

Cantor, Richard, and Frank Packer. 1996a. "Determinants and Impact of Sovereign Credit

Ratings," *Federal Reserve Bank of New York Economic Policy Review*, (October), 1-15.

Cantor, Richard, and Frank Packer. 1996b. "Sovereign Risk Assessment and Agency Credit Ratings," *European Financial Management*, Vol. 2, 247-56.

Caprio, Gerald, Jr. and, Klingebiel, Daniela. 1996a. "Bank Insolvency: Bad Luck, Bad Policy, or Bad Banking?" in *Annual World Bank Conference on Development Economics*. Washington, DC: The World Bank, 79-104.

Caprio, Gerald, Jr. and, Klingebiel, Daniela. 1996b. "Bank Insolvency: Cross-country Experiences." Unpublished paper.

Claessens, Stijn, and Thomas Glaessner. 1997. "Are Financial Sector Weaknesses Undermining the Asian Miracle? Unpublished paper.

Cooper, Richard. 1971. "Currency Devaluation in Developing Countries." In G. Ranis, *Government and Economic Development*, New Haven: Yale University Press.

Corsetti, Giancarlo, Paolo Pesenti, and Nouriel Poubini. 1997. "What Caused the Asian Currency and Financial Crisis?". Unpublished paper.

Cumby, Robert, and Sweder van Wijnbergen. 1989. "Financial Policy and Speculative Runs with a Crawling Peg: Argentina 1979–81," *Journal of International Economics* 17 (August), 111–27.

Demirguç-Kunt, Asli, and Enrica Detragiache. 1998. "Banking Crises Around the World: Are There Any Common Threads." *IMF Staff Papers,* (March).

Diamond, Douglas, and Phillip Dybvig. 1983. "Bank Runs, Liquidity, and Deposit Insurance." *Journal of Political Economy* 91 (June), 401-19.

Diebold, Francis and Glen Rudebusch. 1989. "Scoring the Leading Indicators." *Journal of Business* 62, No. 3 (July), 369-91.

Dooley, Michael P. 1997. "A Model of Crises in Emerging Markets." National Bureau of Economic Research Working Paper No. 6300. Cambridge: National Bureau of Economic Research

Dornbusch, Rudiger, Ilan Goldfajn, and Rodrigo O. Valdés. 1995. "Currency Crises and Collapses," *Brookings Papers on Economic Activity,* No. 2, 219–95.

Doukas, John. 1989. "Contagion Effect on Sovereign Interest Rate Spreads." *Economic Letters* 29, 237-41.

Edwards, Sebastian. 1986. "Are Devaluations Contractionary?" *Review of Economics and Statistics* 68, 501-08.

Edwards, Sebastian. 1989. *Real Exchange Rates, Devaluation, and Adjustment: Exchange Rate Policy in Developing Countries.* Cambridge, Massachusetts: MIT Press.

Eichengreen, Barry, Andrew Rose, and Charles Wyplosz. 1995. "Exchange Market Mayhem: The Antecedents and Aftermath of Speculative Attacks." *Economic Policy* 21 (October), 249–312.

Eichengreen, Barry, Andrew Rose, and Charles Wyplosz. 1996. "Contagious Currency Crises," National Bureau of Economic Research Working Paper 5681, (July).

Eichengreen, Barry, Andrew Rose. 1997. "Staying Afloat When the Wind Shifts: External Factors and Emerging-Market Banking Crises." Unpublished paper.

Eschweiler. 1997. Did the Market See the Asian Crisis Coming? Unpublished paper.

Fischer, Stanley. 1993. "The Role of Macroeconomic Factors on Growth," *Journal of Monetary Economics* 32 (3), 395-415.

Frankel, Jeffrey A., and Andrew K. Rose. 1996. "Exchange Rate Crises in Emerging Markets." *Journal of International Economics* 41, No. 3/4 (November), 351-68.

Frankel, Jeffrey A., and Sergio L Schmukler 1996. "Crisis, Contagion, and Country Funds: Effects on East Asia and Latin America." In Reuven Glick *Managing Capital Flows and Exchange Rates: Perspectives from the Pacific Basin*. Cambridge: Cambridge University Press. 232-266.

Furman, Jason, and Joseph E. Stiglitz. 1998. "Economic Crises: Evidence and Insights from East Asia." Forthcoming in *Brookings Papers on Economic Activity* 2, (June).

Galbis, Vicente. 1993. “High Real Interest Rates Under Financial Liberalization: Is There a Problem?.” International Monetary Fund Working Paper WP/93/7, January.

Gavin, Michael, and Ricardo Hausman. 1996. “The Roots of Banking Crises: The Macroeconomic Context.” In *Banking Crises in Latin America*. Washington, DC: Inter-American Development Bank, 27-63.

Gerlach, Stefan, and Frank Smets. 1994. “Contagious Speculative Attacks.” CEPR Discussion Paper No. 1055, (November), London: Center for Economic Policy Research.

Goldstein, Morris. 1996. “Presumptive Indicators/Early Warning Signals of Vulnerability to Financial Crises in Emerging Market Economies.” Unpublished paper.

Goldstein, Morris. 1997. “The Case for an International Banking Standard.*” Policy Analyses in International Economics* 47, (April), Washington, DC: Institute for International Economics.

Goldstein, Morris. 1998a. “Early Warning Indicators and The Asian Financial Crisis” Unpublished paper.

Goldstein, Morris, 1998b. The Asian Financial Crisis: Causes, Cures, and Systemic Implications.”*Policy Analyses in International Economics* 55, (June), Washington, DC: Institute for International Economics.

Goldstein, Morris. 1998. “Commentary: The Causes and Propagation of Financial Stability: Lessons for Policy makers. In Federal reserve Bank of Kansas City *Maintaining Financial Stability in a Global Economy.* Kansas City: Federal Reserve Bank of Kansas City.

Goldstein, Morris. 1998. “Banking Crises: International Experience. In Gerard Caprio, George Kaufman, and Danny Leipziger *Preventing Banking Crises*. Chicago: Federal Reserve Bank of Chicago; Washington, DC: The World Bank. Forthcoming.

Goldstein, Morris, and Philip Turner. 1996. “Banking Crises in Emerging Economies: Origins and Policy Options.” Bank for International Settlements Economic Paper No. 46, (October). Basle: Bank for International Settlements.

Goldfajn, Ilan, and Rodrigo O.Valdés. 1995 "Balance of Payments Crises and Capital Flows: The Role of Liquidity." Unpublished paper.

Goldfajn, Ilan, and Rodrigo O.Valdés. 1998. "Are Currency Crises Predictable?," *European Economic Review*, forthcoming.

Honohan, Patrick. 1997. "Banking System Failures in Developing and Transition Countries: Diagnosis and Prediction." Bank for International Settlements Working Paper No. 39, (January).

International Monetary Fund. 1997a. *International Capital Markets,* (September). Washington: International Monetary Fund.

International Monetary Fund. 1998a. *World Economic Outlook,* (May). Washington: International Monetary Fund.

International Monetary Fund. 1998b. *International Capital Markets*, (September). Washington: International Monetary Fund.

International Monetary Fund. 1998c. *World Economic Outlook,* (October). Washington: International Monetary Fund.

Kamin, Steven B.. 1988. “Devaluation, External Balance, and Macroeconomic Performance: A Look at the Numbers,” *Studies in International Finance*, No. 62, (August). Princeton: Princeton University, Department of Economics, International Finance Section.

Kamin, Steven B., and John H. Rogers. 1997. “Output and the Real Exchange Rate in Developing Countries: An Application to Mexico,” Unpublished paper.

Kaminsky, Graciela L. 1998. “Currency and Banking Crises: A Composite Leading Indicator.” International Finance Discussion Paper Series No. 629 (December). Washington: Board of Governors of the Federal Reserve.

Kaminsky, Graciela L., and Carmen M. Reinhart. 1996. “The Twin Crises: The Causes of Banking and Balance-of-Payments Problems,” International Finance Discussion Paper No. 544, (March). Washington: Board of Governors of the Federal Reserve. Forthcoming in *American Economic Review.*

Kaminsky, Graciela, and Carmen M. Reinhart. 1998a. “Financial Crises in Asia and Latin America: Then and Now.” *American Economic Review* 88, No.2 (May). 444-48.

Kaminsky, Graciela, and Carmen M. Reinhart. 1998b. “On Crises, Contagion, and Confusion.” Unpublished paper.

Kiguel, Miguel A., and Nita Ghei. 1992. “Devaluation in Low-Inflation Economies,” Policy Research Working Paper 1224. Washington: The World Bank.

Krueger, Anne O. 1978. *Liberalization Attempts and Consequences*, Cambridge, MA: Ballinger.

Krugman, Paul. 1979. “A Model of Balance of Payments Crises.” *Journal of Money, Credit, and Banking* 11 (August), 311–25.

Krugman, Paul. 1998. “What Happened to Asia?.” Unpublished paper.

Larraín, Guillermo, Helmut Reisen, and Julia von Maltzan. 1997. “Emerging Market Risk and Sovereign Credit Ratings," OECD Development Centre Technical Papers No. 124, (April). Paris: The Organisation for Economic Co-operation and Development.

Lee, Suk Hun. 1993. "Are the Credit Ratings Assigned by Bankers Based on the Willingness of Borrowers to Repay?," *Journal of Development Economics* 40, (April), 349-59.

Leiderman, Leonardo, and Alfredo Thorne. 1996. In *Private Capital Flows to Emerging Markets After the Mexican Crisis*, ed. by Guillermo A. Calvo, Morris Goldstein, and Eduard Hochreiter Washington, DC: Institute for International Economics, 1–43.

Lindgren, Carl-Johan, Gillian Garcia, and Matthew Saal. 1996. *Bank Soundness and Macroeconomic Policy*. Washington, DC: International Monetary Fund.

Lizondo, Saul, and Peter J. Montiel. 1989. "Contractionary Devaluation in Developing Countries: An Analytical Overview." *IMF Staff Papers* 36 (March), 182-227.

Meese, Richard A., and Kenneth Rogoff. 1983. "Empirical Exchange rate Models of the Seventies: Do They Fit Out of Sample?" *Journal of International Economics* 14 (February), 3-24.

Mishkin, Frederic S. 1996. "Understanding Financial Crises: A Developing Country Perspective," in *Annual World Bank Conference on Development Economics*, Washington, DC: World Bank, 29-62.

Moore, Geoffrey H. 1959. "The 1957-58 Business Contractions: New Model or Old? *American Economic Review* 49 (May), 292-308.

Morley, Samuel A.1992. "On the Effect of Devaluation During Stabilization Programs in LDCs," *Review of Economics and Statistics* 74 No.1 (February), 21-7.

Obstfeld, Maurice, and Kenneth Rogoff. 1995. "The Mirage of Fixed Exchange Rates," *Journal of Economic Perspectives* 9, (Fall), 73-96.

Radelet, Steven, and Jeffrey Sachs. 1998. “The East Asian Financial Crisis: Diagnosis, Remedies, Prospects,”*Brookings Papers on Economic Activity*, 1.

Rojas-Suarez, Liliana. 1998. “Early Warning Indicators of Banking Crises: What Works for Emerging Markets? With Applications to Latin America,” Unpublished paper.

Rojas-Suarez, Liliana, and Steven R. Weisbrod. 1995. *Financial Fragilities in Latin America: The 1980s and 1990s.* International Monetary Fund Occasional Paper 132, (October). Washington,DC: International Monetary Fund.

Rose, Andrew K., and Lars E.O. Svensson. 1994. “European Exchange Rate Credibility Before the Fall.” *European Economic Review* 38 (May), 1185-1216.

Sachs, Jeffrey, Aaron Tornell and Andres Velasco. 1996. “Financial Crises in Emerging Markets: The Lessons From 1995.” *Brookings Papers on Economic Activity*, No. 1, 147–215.

Stock, James H., and Mark W. Watson. 1989. “New Indices of Coincident and Leading Economic Indicators.” *NBER Macroeconomics Annual*, 351-93.

Sundararajan, V. and Baliño, Tomas. 1991. *Banking Crises: Cases and Issues*. Washington, DC: International Monetary Fund.

Valdés, Rodrigo O. 1997. “Emerging Markets Contagion: Evidence and Theory.” Unpublished paper.

Velasco, Andres. 1987. “Financial and Balance of Payments Crises: A Simple Model of the Southern Cone Experience.” *Journal of Development Economics* 27 (October), 263–83.

Wolf, Holger C. 1997. “Regional Contagion Effects in Emerging Markets.” Princeton University Working Papers in International Finance, G-97-03, (October).

Zarnowitz, Victor. 1992. *Business Cycles: Theory, History, Indicators, and Forecasting*. Chicago: University of Chicago Press.