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Lending Booms and Currency Crises
Empirical Link

Aaron Tornell

2.1 Introduction

Imagine a money manager with a crystal ball that predicts the future. This crystal ball tells the manager that a currency crisis will erupt in six months and that it will spread across emerging markets. However, it does not tell the manager anything else. Can he or she use this information to help predict whether a specific country, say Mexico or Indonesia, will fare badly? If this is possible, he or she can then make the right portfolio decision regarding that country.

The answer will depend on the manager's view regarding the manner in which currency crises spread across emerging markets. One view he or she might hold is that that crises spread randomly. In this case the prediction supplied by the crystal ball will help, but not a great deal. A second view the manager might have is that there is a neighborhood effect. That is to say, fads develop and crises spread mainly to countries in the same area. After all, the 1994 Mexican crisis hit Latin American countries hardest, while the 1997 Thai crisis hit mainly Southeast Asian currencies. In this case the crystal ball would not be very valuable, unless the manager knows which neighborhood will be the unlucky one. A third view is that the spread of these crises is determined to a large degree by fundamentals. In this case the manager will be able to exploit the crystal ball's information (a) if there is a set of fundamentals, and a filtering rule that might allow him or her to predict which countries would be hardest hit by the crisis and which would be spared; (b) if it is possible to observe these fundamentals before the onset of the crisis; and (c) if these emerging markets have

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sufficiently free and developed financial markets that permit him to take the right portfolio positions.

In this paper I argue that in light of the Tequila and Asian crises, the third view (c) is the correct one. I find that these crises neither spread across emerging markets randomly, nor were simply driven by fads. Rather, I find that the cross-country variation in the severity of crisis can be largely explained by three fundamentals: the strength of a country's banking system, its real exchange rate appreciation, and the liquidity of its central bank.

I also find that the rule linking fundamentals to the crises' severity is the same in both the Tequila and Asian crises. Hence, if one had estimated such a rule using data from the Tequila crisis, then one could have reasonably attempted to predict how the Asian crisis would spread using data available in late 1996 or early 1997. Thus, the simple knowledge of an upcoming currency crisis is far from useless, and the crystal ball's prophecy is a helpful one.

The idea underlying my analysis is that the eruption of a currency crisis in an emerging market serves as a coordinating device that informs money managers that others will attack certain currencies. The currencies that are attacked are not selected randomly, however. Rather, money managers concentrate their attacks on countries that are most likely to respond with a high depreciation. This view is consistent with balance-of-payments crises models with multiple equilibria, like those of Cole and Kehoe (1996), Obstfeld (1994), and Sachs, Tornell, and Velasco (1996a).

There is a growing empirical literature on the determinants of currency crises. This paper is closely related with a previous paper I wrote with Jeff Sachs and Andres Velasco, in which we tried to explain the spread of the Tequila crisis. Other related papers are those of Frankel and Rose (1996), Kaminsky, Lizondo, and Reinhart (1996), Corsetti, Pesenti, and Roubini (1999), and Radelet and Sachs (1998), to mention just a few.

2.2 Conceptual Framework

In order to determine which countries are more likely to loose reserves or to depreciate during a crisis, I will consider the thought processes of risk-neutral money managers and government officials across emerging markets. Since the short positions involved in a currency attack entail significant interest rate costs, an individual money manager will attack a country only if (a) the manager expects that other money managers will also attack that country; and (b) he or she expects that the country in question will respond with a sizable depreciation.

In order for the first condition to be satisfied it is necessary that money managers coordinate with each other in selecting which currencies should be attacked and the timing of the attack itself. In this respect, the eruption of a crisis in some emerging market acts as a coordinating device that signals money managers that others might attack certain currencies in the near future. Accordingly, the question then becomes, which currencies will be attacked? Money managers will concentrate their attacks on currencies that are expected to react with greater depreciation in response to capital outflow.

The expected response of a country depends on the preferences of the government and on the constraints it faces. A country might respond to an attack by simply loosing reserves, by increasing its interest rate, or by depreciating.

The first alternative may be the least politically costly. At the same time, it is available only to governments with plenty of reserves to cover their liquid liabilities; thus this option is not open to the majority of countries, as their short-run liabilities far exceed their reserves. In these cases, governments are faced with a difficult choice between two unpleasant alternatives. Increasing the interest rate makes speculation against the currency more expensive, and it can help close the external gap by reducing absorption; yet, the effects come at the cost of a recession. In emerging markets, the health of the banking system is a very important determinant of the effect that increasing interest rates have on the economy. When the banking system has a big share of bad loans, a given interest rate increase is more likely to induce a greater recession or even a meltdown of the payments system. Thus, money managers know that the weaker the banking system, the less likely the government to respond to an attack with an interest rate hike.

If a government chooses the third alternative, depreciation, what is the extent of the depreciation the government must engineer in order to close a given external gap? The greater the real appreciation has been during the previous few years, the more likely it is that firms in the tradable sector have shifted to the nontradable sector, and the greater the nominal depreciation necessary to close the external gap.

Summing up, when a currency crisis erupts in an emerging market, money managers will expect others to attack those countries that are more likely to respond to an attack with a big depreciation. Thus, the crisis is not likely to spread to countries with high reserves. Among the low reserves countries, the crisis is more likely to reach those where interest rate increases are likely to generate big recessions (e.g., countries with weak banking systems), and will also affect countries that have experienced a high real appreciation.

2.3 Empirics

There are several ways to measure the three fundamentals discussed in the previous section and the severity of a crisis. In this paper, I have chosen to proxy the three fundamentals with variables that are available in data sources, such as the *International Financial Statistics* (*IFS*), where one might be confident that the same definitions have been applied to all countries. Note that the variables must be available on a timely basis if this exercise is to have some connection with the decision rules used by money managers. In the end, one would like the derived rule to apply to future currency crises in emerging markets. Therefore, the formulas used to construct the indexes will be as simple as possible. By interacting several variables in a nonlinear way, one could produce indexes that eliminate "nasty" observations and insure a fairly good explanation of a specific crisis. The drawback to this approach is that the rule so derived might not explain other crises.

I measure the severity of the crisis in the standard way it is done in the literature.[1] Thus, my crisis index is a weighted average of the loss in reserves and the depreciation against the U.S. dollar. Each of the two components is weighted by its precision over the sum of both precisions, calculated from a monthly series of ten years.

Ideally, one should measure the weakness of the banking system with the "true" share of bad loans. Unfortunately, this information is available neither on a timely basis nor in data sources that insure cross-country comparability. For instance, suppose that country *A* has a smaller true bad-to-total loans ratio than country *B*, but that *A* has adopted U.S. generally accepted accounting procedure (GAAP) rules, while country *B* has not. In this case, it is very likely that *B* might report a smaller bad-loans ratio because it classifies only the debt service that is delinquent as a bad loan. In contrast, country *A* will consider the entire stock of the delinquent debt as a bad loan. A second problem that arises is misreporting, or the so-called "evergreen accounts problem." Banks (and often regulators) have many incentives to disguise the fact that there are nonperforming loans. Hence, banks will simply continue to lend to the nonperforming accounts an amount equivalent to the payments the accounts were supposed to make. This cultivation of evergreen accounts can go on for a long period of time without market participants' noticing the problem. This brings us to the third problem, namely that information on nonperforming loans is not available on a timely basis. For instance, money managers looking at the Mexican bad loans ratio in 1994 saw very decent numbers; the recognition of a sizable share of bad loans did not come until after the crisis had erupted.

For these reasons, I proxy the weakness of the banking system with a lending boom index. This variable is available on a timely basis and is

1. This way of measuring crises is used in Frankel and Rose (1996), Kaminsky, Lizondo, and Reinhart (1996), and Sachs, Tornell, and Velasco (1996b).

comparable across countries. I measure the lending boom as the real percent increase in loans provided by the banking system to the private sector and state-owned enterprises over the previous four years. One should expect that the greater the increase of loans provided by the banking system during a short span of time, the greater the share of bad loans in the subsequent period. There are several reasons this is true. First, banks have limited capacity to evaluate projects. Second, regulatory agencies have limited monitoring capacity and resources. Last, there exists only a limited supply of "good" projects with high expected returns relative to their variance.

I then replace the real exchange rate with a weighted average of the bilateral real exchange rates of a given country with respect to the U.S. dollar, the Mark, and the yen. The weights add up to 1 and are proportional to the shares of bilateral trade in the given country with the United States, the European Union, and Japan, respectively. My real depreciation index is the percentage change in this index over the four years prior to the onset of the crisis, i.e., December 1994 relative to December 1990, and December 1996 relative to December 1992.[2] The problems associated with measuring real depreciation in this way are well understood, so I will not discuss them here.

I proxy the government's liquidity by the ratio of M2 to reserves in the month preceding the onset of the crisis (November 1994 or May 1997). If the central bank is not willing to let the exchange rate depreciate, it must be prepared to cover all the liabilities of the banking system with reserves. Thus it is M2, and not simply the monetary base, that must be the relevant proxy of the central bank's contingent liabilities. During a crisis, banks are likely to experience runs. If the central bank does not act as a lender of last resort, generalized bankruptcies are likely to follow. Since, in most circumstances, authorities will not find it optimal to allow the economy to experience generalized bankruptcies, the central bank will have to be prepared to exchange the amount withdrawn by depositors for foreign exchange.

My sample consists of all the developing countries (for which data are available) that have had free convertibility, and financial markets in which foreigners could freely invest during the 1990s. I consider all countries considered as emerging markets by the International Finance Corporation, with the exception of (a) Greece and Portugal, as they belong to the European Union and are not developing countries; (b) China, because there is no free convertibility; and (c) Nigeria, because there is no data availability. Thus, my sample consists of Hong Kong and twenty-two other countries:

2. An alternative index is the J. P. Morgan real exchange rate index. I decided to construct my own proxy, since I am unsure how that index is constructed.

Argentina, Brazil, Chile, Colombia, Hungary, India, Indonesia, Korea, Jordan, Malaysia, Mexico, Pakistan, Peru, the Philippines, Poland, South Africa, Sri Lanka, Taiwan, Thailand, Turkey, Venezuela, and Zimbabwe.

I discuss the two generalized emerging-market currency crises that have occurred in the 1990s. Previous crises, like the debt crisis of the early 1980s, were of a different nature and are not considered. In those cases, financial markets in emerging markets were not yet liberalized, and the majority of capital inflows took the form of loans to governments by big foreign banks or official agencies. The currency crises of the 1990s have happened under different conditions, and thus one should expect different mechanisms at work.

2.3.1 The Benchmark Regression

As mentioned earlier, I am not trying to determine the timing of a crisis, but rather the manner in which a crisis will spread across emerging markets, given the eruption of a crisis somewhere. As discussed in the previous section, the onset of a crisis in one country serves as a coordinating device for investors. At this point, each money manager knows that others will do the same and will reshuffle his or her portfolio accordingly. If a country has strong fundamentals or high reserves, it is not likely to depreciate significantly in response to an attack. Hence, investors will not find it profitable to attack such a country—they will have to incur the interest costs associated with the attack while the expected capital gains are small. Because of this, one should not expect that variations in the explanatory variables should significantly affect the crisis indexes in this subset of countries. Thus, investors will concentrate their attacks on countries with weak fundamentals and low reserves. Furthermore, within this subset of countries they will allocate more resources to attack countries that are more likely to respond with greater depreciations. Such countries have had a greater lending boom or a greater real appreciation, or both. Countries from the first group have weaker banking systems that induce authorities to resist raising interest rates because of the greater risk of a deep recession or generalized bankruptcies. Countries belonging to the second group will have to engineer a greater nominal depreciation in order to close a given current account deficit.

I implement these ideas empirically by classifying observations into four groups: high- and low-reserves cases, and strong and weak fundamentals cases. In my benchmark regression, I classify most country-years as being the ones with low reserves and weak fundamentals. Then, I consider more and less stringent definitions of the vulnerable region, and see how results change.

In the benchmark case, a country-year has high reserves ($D^{hr} = 1$) if its M2/reserves ratio is below 1.8. A country-year has strong fundamentals ($D^{sf} = 1$) if its lending boom (LB) is below 0 percent and its real exchange rate appreciation is lower than 5 percent. The group with high reserves includes seven country-years while the group with strong fundamentals includes five country-years.

In the benchmark I stack the observations for the 1994 and 1997 crises, and estimate the following regression using ordinary least squares:[3]

$$(1)\quad \text{Crisis}_{it} = \alpha_0 + \alpha_i * \text{LB}_{it} + \alpha_2 * \text{RER}_{it} + \alpha_3 * \text{D}^{hr} * \text{LB}_{it} + \alpha_4 * \text{D}^{hr} * \text{RER}_{it} + \alpha_5 * \text{D}^{sf} * \text{LB}_{it} + \alpha_6 * \text{D}^{sf} * \text{RER}_{it} + \varepsilon_{it},$$

where i indexes the country and t indexes time. Lending boom is represented by LB, and real exchange rate depreciation by RER.

The effects of the lending boom and real depreciation in the case of weak fundamentals and low reserves are captured by α_1 and α_2, respectively. Theory predicts that when there is fragility, the crisis will be greater if the lending boom is large (i.e., $\alpha_1 > 0$) and the real depreciation is low (i.e., $\alpha_2 < 0$). The effects of the lending boom and real depreciation for the case of high reserves are captured by $\alpha_1 + \alpha_3$ and $\alpha_2 + \alpha_4$, respectively. Meanwhile, in the case of strong fundamentals, these effects are captured by $\alpha_1 + \alpha_5$ and $\alpha_2 + \alpha_6$, respectively. According to the theory, if there is no fragility ($D^{hr} = 1$ or $D^{sf} = 1$), neither a greater lending boom nor a greater appreciation will affect the investors' decision to attack. Thus one expects to find that $\alpha_1 + \alpha_3 = \alpha_2 + \alpha_4 = 0$, and $\alpha_1 + \alpha_5 = \alpha_2 + \alpha_6 = 0$.

For the benchmark, I consider the crisis index that corresponds to the five months after the onset of the crisis. In the Mexican crisis, I look at November 1994–April 1995; for the Asian case, I consider May 1997–October 1997. The estimated regression is shown in table 2.1, which shows how the estimates change as the crisis index varies.

The estimates in table 2.1 accord with the theory espoused earlier. First, for countries with weak fundamentals and low reserves, the coefficients corresponding to the lending boom (α_1) and the real depreciation (α_2) are significantly different from zero at the 5 percent level. The point estimates indicate that (a) a unit increase in the LB index for a country with low reserves and weak fundamentals leads to a 0.24 unit increase in the crisis index of that country relative to the average of our emerging markets sample; and (b) a unit increase in the real appreciation index leads to a 0.12 increase in the crisis index relative to the average. Second, as expected, neither the LB index nor the RER enter significantly in countries with high reserves. In these cases, the corresponding point estimates are $\alpha_1 + \alpha_3 = -0.01$ and $\alpha_2 + \alpha_4 = 0.03$. Furthermore, Wald tests indicate that the hypotheses $\alpha_1 + \alpha_3 = 0$ and $\alpha_2 + \alpha_4 = 0$ cannot be rejected (the associated p-values are 0.74 and 0.91, respectively). Similarly, in countries with strong fundamentals, neither LB nor RER affect the severity of the

3. Below I test whether there are fixed or random effects.

Table 2.1 Benchmark Regression

Estimated Coefficient and Summary Statistic	Independent Variable	Simple OLS
α_1	LB	0.24
		(0.09)
α_2	RER	−0.12
		(0.05)
α_3	LB*D^{hr}	−0.25
		(0.08)
α_4	RER*D^{hr}	0.15
		(0.27)
α_5	LB*D^{sf}	−0.04
		(0.33)
α_6	RER*D^{sf}	0.17
		(0.16)
α_7	constant	−1.27
		(3.63)
Summary statistics		
R^2		0.45
Adjusted R^2		0.37

Note: The dependent variable is the Crisis Index; Newey-West heteroscedasticity–adjusted standard errors in parentheses.

crisis. The *p*-values associated with Wald tests of the hypotheses that $\alpha_1 + \alpha_5 = 0$ and $\alpha_2 + \alpha_6 = 0$ are 0.51 and 0.74, respectively.

In summary, the regression results support the idea that currency crises do not spread randomly. One can predict—with fair confidence—that a crisis will spread to countries that are vulnerable. A country is vulnerable to an attack if it has had an appreciated real exchange rate for the past few years or if it has experienced a lending boom, increasing the likelihood that its banking system is laden with bad loans. Both effects point in the direction of a higher expected depreciation, unless the country in question has sufficient international reserves relative to its short-term liabilities. In this case, the best response of the government might be to defend the peg.

A few examples illustrate how the combination of these three fundamentals can help one rationalize some puzzling cases. If one looks at Peru, for instance, one sees that over the four years prior to the Tequila crisis Peru had experienced a similar appreciation and a greater lending boom than Mexico. However, Peru's crisis index was only −2.7, while Mexico's was 79.3. This can be explained by the fact that Mexico was illiquid (recall the Tesobonos story), while Peru was not. In fact, in November 1994, the ratio of M2 to reserves was 1.25 for Peru and 9.25 in Mexico.

The results presented here for the two crises are very similar to those obtained by Sachs, Tornell, and Velasco (1996b; henceforth STV) for the Tequila crisis. In order to compare results, one should take note of the following slight differences between the papers. The first difference is that STV multiply the estimated coefficients by ten. Also, STV use a weak fundamentals dummy instead of the strong fundamentals dummy used here. My coefficients α_1 and α_2 correspond to the STV coefficients $\beta_3 + \beta_5 + \beta_7$ and $\beta_2 + \beta_4 + \beta_6$, respectively. Last, due to data availability, the STV sample contains fewer countries than the sample examined here.

2.3.2 Structural Change

At this point in the analysis, a natural question arises as to whether the same model that explains the spread of the crisis in 1995 also explains the cross-country variation in the 1997 crisis, or whether there was, in fact, a structural change. The first column of table 2.2 shows the estimates of the benchmark regression that includes the Tequila and Asian crisis. The second and third columns show the estimates of regression equation (1) for the 1994 and 1997 crises, respectively. The point estimates for the coefficient corresponding to the lending boom (α_1) are very similar (0.24, 0.25, and 0.22, respectively). Those corresponding to the real exchange rate depreciation (α_2) are −0.12, −0.16, and −0.07, respectively.

To test the hypothesis that the coefficients in equation (1) are the same in both periods, I perform a Chow test. The test statistic is

$$F[7,32] = \frac{\dfrac{[6657 - 3461 - 2985]}{7}}{\dfrac{[3461 + 2985]}{32}} = 0.1496.$$

Since the critical value at the 1 percent level is 3.3, one cannot reject the hypothesis that the sets of coefficients are the same in the two periods.

Next, I check whether the two coefficients that interest me most (α_1 and α_2) are the same in both periods. To do this, I first add the term $\alpha_8 * LB * D^{97}$ to equation (1), where D^{97} takes the value of 1 for observations that correspond to the 1997 crisis. It follows that in countries with weak fundamentals and low reserves, the effect of the lending boom on the crisis index is α_1 for the 1994 crisis and $\alpha_1 + \alpha_8$ for the 1997 crisis. Therefore, the null hypothesis is $\alpha_8 = 0$. As can be seen in column 4 in table 2.2, the estimate of α_8 is not different from zero at the 10 percent significance level. Next, I perform the same test for the real exchange rate depreciation. Column 5 in table 2.2 shows the estimation results for equation (1), adding the extra term $\alpha_9 * RER * D^{97}$. Again, the estimate for α_9 is not significantly different from zero at the 10 percent level.

2.3.3 Predicting the Asian Crisis

Suppose that the crystal ball predicted that a crisis would erupt in mid-1997, and suppose the money manager had estimated the model of equation (1) using data from the 1994 crisis. How well will he or she predict

Table 2.2 **Structural Change**

Estimated Coefficient and Summary Statistic	Independent Variable	Benchmark (1)	Only 1994 Sample (2)	Only 1997 Sample (3)	(4)	(5)
α_1	LB	0.24	0.25	0.22	0.24	0.24
		(0.09)	(0.17)	(0.07)	(0.11)	(0.09)
α_2	RER	−0.12	−0.16	−0.07	−0.12	−0.12
		(0.05)	(0.08)	(0.08)	(0.05)	(0.08)
α_3	$LB * D^{hr}$	−0.25	−0.29	−0.23	−0.25	−0.25
		(0.08)	(0.19)	(0.06)	(0.08)	(0.08)
α_4	$RER * D^{hr}$	0.15	−0.39	0.35	0.09	0.15
		(0.27)	(0.96)	(0.24)	(0.25)	(0.28)
α_5	$LB * D^{sf}$	−0.04	−0.63	0.09	−0.05	−0.04
		(0.33)	(0.81)	(0.33)	(0.33)	(0.34)
α_6	$RER * D^{sf}$	0.17	0.07	−0.01	0.17	0.17
		(0.16)	(0.11)	(0.15)	(0.16)	(0.16)
α_7	constant	−1.27	−4.12	2.13	−1.51	−1.28
		(3.63)	(6.34)	(2.83)	(3.39)	(3.67)
α_8	$LB * D^{97}$				0.02	
					(0.07)	
α_9	$RER * D^{97}$					0.02
						(0.12)
R^2		0.45	0.48	0.44	0.45	0.45
Adjusted R^2		0.37	0.29	0.23	0.35	0.35

Note: The dependent variable is the Crisis Index; Newey-West heteroscedasticity–adjusted standard errors in parentheses.

the spread of the crisis across emerging markets? Note that the question is not “When will the next crisis erupt?” Rather, the objective here is simply to make an out-of-sample prediction conditional on the occurrence of a crisis.

Toward this end, I will construct an out-of-sample predicted crisis index by substituting in equation (1) the following: (a) the estimated coefficients of a regression that uses only data from the 1994 crisis; and (b) the explanatory variables that correspond to the 1997 crisis, i.e., the lending boom and the real depreciation over the period 1992–96 and the M2/reserves of May 1997. The resulting predicted crisis indexes are depicted as the dashed line in figure 2.1. The solid line represents the actual crisis indexes, while the dotted lines represent the fitted values of the regression using only the data from 1997. As can be seen in figure 2.1, the predicted crisis indexes using 1994 data are quite similar to the fitted crisis indexes using 1997 data.

To measure how well the out-of-sample prediction fits the actual crisis indexes of 1997, I regressed the actual crisis indexes of 1997 on the predicted crisis indexes

$$97\text{Crisis} = \underset{0.3}{0.88} \times [\text{out-of-sample predicted 97crisis}] + u_i$$

$$R^2 = 0.24.$$

The correlation between the two series is 0.88, and it is significantly different from zero at the 1 percent level. Thus one can see that, by using the 1994 model, a manager would not have fared badly in predicting which countries would have been hard hit in 1997.

2.3.4 The Crisis Index

In order to analyze whether the results are robust to changes in the period over which the crisis index is measured, I estimate the regression equation using six crises indexes. For all indexes, the starting point is the month preceding the onset of the crisis (i.e., November 1994 for the Tequila crisis and May 1997 for the Asian crisis). Then, we vary the terminal month over a period of six months starting in January 1995 or July 1997. As table 2.3 shows, in columns (4)–(6) the point estimates and significance levels are similar to those of the benchmark regression (column [3]). Moreover, the estimate of α_1 (which corresponds to the lending boom) is significantly different from zero at the 5 percent level in all columns, and the point estimates in columns (4)–(6) are very similar to the benchmark estimate of 0.26.

2.3.5 Alternative Definitions of the Dummies

In the benchmark regression, a country year is classified as having high reserves if, at the onset of the crisis, its ratio of M2 to reserves is lower

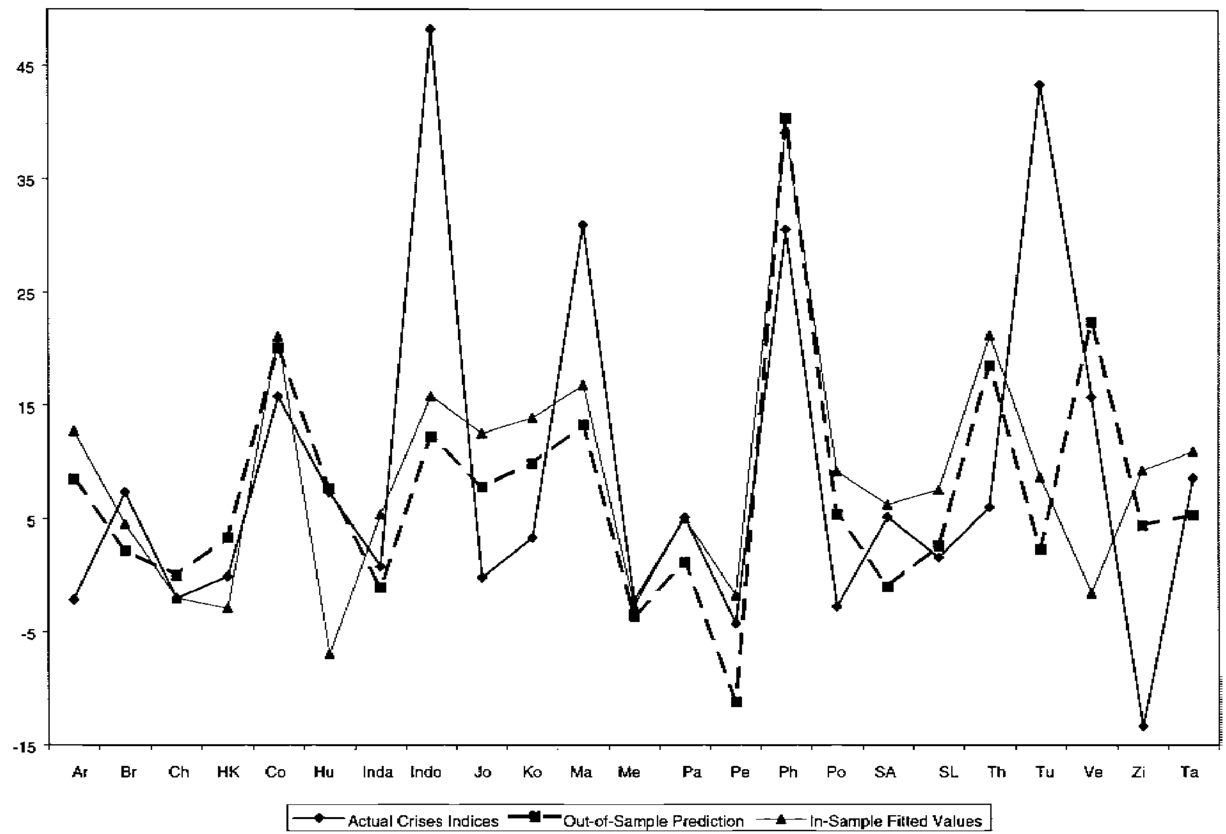

Fig. 2.1 1997 crisis

Table 2.3 **Alternative Crisis Indexes**

Estimated Coefficient and Summary Statistic	Independent Variable	Interval Used to Calculate Crisis Index[a]					
		Nov.–Jan. May–July	Nov.–Feb. May–Aug.	Nov.–Mar. May–Sept.	Nov.–Apr. May–Oct.	Nov.–May May–Nov.	Nov.–Jun. May–Dec.
α_1	LB	0.13	0.16	0.26	0.24	0.23	0.28
		(0.09)	(0.08)	(0.11)	(0.09)	(0.08)	(0.09)
α_2	RER	−0.04	−0.02	−0.11	−0.12	−0.09	−0.02
		(0.03)	(0.04)	(0.05)	(0.05)	(0.08)	(0.12)
α_3	$LB * D^{hr}$	−0.14	−0.16	−0.25	−0.25	−0.24	−0.31
		(0.08)	(0.08)	(0.11)	(0.08)	(0.07)	(0.08)
α_4	$RER * D^{hr}$	−0.12	−0.06	0.02	0.15	0.32	0.33
		(0.18)	(0.22)	(0.28)	(0.27)	(0.30)	(0.41)
α_5	$LB * D^{sf}$	−0.17	−0.01	−0.12	−0.04	0.09	0.16
		(0.20)	(0.34)	(0.36)	(0.33)	(0.36)	(0.42)
α_6	$RER * D^{sf}$	0.14	0.12	0.24	0.17	0.20	−0.02
		(0.12)	(0.15)	(0.18)	(0.16)	(0.15)	(0.21)
α_7	constant	−2.40	−1.94	−3.24	−1.27	1.11	4.53
		(2.93)	(2.90)	(4.04)	(3.63)	(3.52)	(4.86)
R^2		0.34	0.40	0.48	0.45	0.43	0.28
Adjusted R^2		0.23	0.30	0.40	0.37	0.35	0.17
Addendum: Wald tests							
Null hypothesis							
$\alpha_1 + \alpha_3 = 0$		0.72	0.94	0.47	0.74	0.42	0.08
$\alpha_2 + \alpha_4 = 0$		0.43	0.71	0.74	0.91	0.45	0.50
$\alpha_1 + \alpha_5 = 0$		0.80	0.65	0.68	0.51	0.36	0.29
$\alpha_2 + \alpha_6 = 0$		0.33	0.50	0.43	0.74	0.46	0.81

Note: The dependent variable is the Crisis Index; Newey-West heteroscedasticity–adjusted standard errors in parentheses.

[a] First row of months for year 1994; second row of months for year 1997.

than 1.8. According to this criterion, seven cases had high reserves. Under the benchmark, a country has strong fundamentals if its lending boom variable is negative and its real appreciation is less than 5 percent (this yields four country years). The second and third columns of table 2.4 show the estimates for different thresholds concerning the high reserves dummy, while keeping the strong fundamentals dummy unchanged. In the second column, the threshold is 1.5 three country years), and, in the third column, 2.0 (ten country years). Column (4) corresponds to the case in which fundamentals are strong if the lending boom is less than 20 percent and the real appreciation is less than 5 percent (nine country years), while in column (5) these thresholds are both zero (two cases).

For countries with low reserves and weak fundamentals, the point estimates corresponding to the lending boom (α_1) and the real depreciation (α_2) are very similar to the benchmark estimates in all cases. Furthermore, they are all significant at the 5 percent and 10 percent levels, respectively. The estimates for the remaining parameters are stable. Lastly, the *p*-values associated with the Wald tests are greater than 0.10, except in three cases. Since the thresholds we have considered vary over wide ranges, we might conclude that the benchmark results are robust to the way in which I define strong fundamentals and high reserves.

2.3.6 Outliers

To see if the benchmark results are driven by a single outlier, I estimate equation (1) by eliminating, one at the time, the country-years whose residuals are greater than two standard deviations away from the mean. As can be seen in table 2.5, in all cases, the point estimates of α_1 are positive and those of α_2 are negative. Furthermore, both are significantly different from zero at the 5 percent and 10 percent levels, respectively.

2.3.7 Additional Determinants of Currency Crises

High government consumption, excessive capital inflows, and unsustainable current account deficits have been identified as important determinants of currency crises in some well-known episodes. Here, I analyze whether these variables help explain the cross-country variation in the crisis indexes after controlling for the lending boom, the real appreciation, and the reserves adequacy ratio. I measure each concept as the average ratio to GDP over the four years prior to the onset of the crisis (either 1990–94 or 1992–96). In each case I interact the extra variable with the high-reserves dummy and the strong-fundamentals dummy. The estimated coefficients are presented in table 2.6.

My regression estimates indicate that in countries with low reserves and weak fundamentals, government consumption has a positive effect on the crisis index if the lending boom and real depreciation variables are

Table 2.4 Alternative Definitions of the Dummies

Estimated Coefficient and Summary Statistic	Independent Variable	Benchmark: RA < 1.8, RER > −5%, LB < 0%	RA < 1.5, RER > −5%, LB < 0%	RA < 2.0, RER > −5%, LB < 0%	RA < 1.8, RER > −5%, LB < 20%	RA < 1.8, RER > 0%, LB < 0%
α_1	LB	0.24	0.24	0.26	0.24	0.24
		(0.09)	(0.09)	(0.09)	(0.09)	(0.09)
α_2	RER	−0.12	−0.11	−0.14	−0.13	−0.12
		(0.05)	(0.05)	(0.07)	(0.07)	(0.05)
α_3	$LB * D^{hr}$	−0.25	−0.23	−0.28	−0.25	−0.25
		(0.08)	(0.08)	(0.08)	(0.08)	(0.08)
α_4	$RER * D^{hr}$	0.15	0.20	−0.27	0.16	0.14
		(0.27)	(0.19)	(0.21)	(0.27)	(0.29)
α_5	$LB * D^{sf}$	−0.04	−0.05	0.10	−0.06	−0.34
		(0.33)	(0.33)	(0.25)	(0.18)	(0.34)
α_6	$RER * D^{sf}$	0.17	0.16	0.26	0.14	0.06
		(0.16)	(0.15)	(0.15)	(0.16)	(0.06)
α_7	constant	−1.27	−1.64	−1.63	−1.42	−1.32
		(3.63)	(3.57)	(3.50)	(3.54)	(3.39)
R^2		0.45	0.41	0.47	0.45	0.45
Adjusted R^2		0.37	0.32	0.39	0.37	0.37
Addendum: Wald tests						
Null hypothesis						
$\alpha_1 + \alpha_3 = 0$		0.74	0.93	0.01	0.79	0.72
$\alpha_2 + \alpha_4 = 0$		0.91	0.65	0.05	0.92	0.94
$\alpha_1 + \alpha_5 = 0$		0.51	0.55	0.13	0.30	0.73
$\alpha_2 + \alpha_6 = 0$		0.74	0.71	0.37	0.91	0.00

Note: The dependent variable is the Crisis Index; RA stands for reserves adequacy ratio (M2/reserves); RER stands for real exchange rate depreciation; LB stands for lending boom; Newey-West heteroscedasticity–adjusted standard errors in parentheses.

Table 2.5 **Regression Excluding Some Country-Years**

Estimated Coefficient and Summary Statistic	Independent Variable	All Countries Except: Brazil 1994	Hungary 1994	Malaysia 1994	Mexico 1994	Thailand 1994	Hungary 1997	Indonesia 1997	Malaysia 1997	Thailand 1997
α_1	LB	0.25	0.28	0.25	0.15	0.27	0.25	0.23	0.24	0.23
		(0.09)	(0.09)	(0.09)	(0.05)	(0.09)	(0.09)	(0.09)	(0.09)	(0.10)
α_2	RER	−0.10	−0.08	−0.12	−0.10	−0.11	−0.11	−0.12	−0.12	−0.12
		(0.06)	(0.05)	(0.05)	(0.05)	(0.06)	(0.06)	(0.05)	(0.05)	(0.05)
α_3	$LB * D^{hr}$	−0.25	−0.28	−0.25	−0.16	−0.27	−0.27	−0.24	−0.24	−0.23
		(0.08)	(0.08)	(0.08)	(0.05)	(0.08)	(0.09)	(0.09)	(0.08)	(0.09)
α_4	$RER * D^{hr}$	0.09	−0.01	0.17	0.28	0.13	−0.01	0.11	0.14	0.15
		(0.27)	(0.26)	(0.26)	(0.23)	(0.27)	(0.26)	(0.27)	(0.27)	(0.27)
α_5	$LB * D^{sf}$	−0.06	−0.12	−0.03	0.10	−0.05	0.28	−0.05	−0.04	−0.03
		(0.34)	(0.35)	(0.33)	(0.26)	(0.34)	(0.11)	(0.34)	(0.33)	(0.33)
α_6	$RER * D^{sf}$	0.16	0.18	0.16	0.06	0.17	0.31	0.18	0.17	0.17
		(0.16)	(0.16)	(0.15)	(0.09)	(0.16)	(0.14)	(0.15)	(0.15)	(0.16)
α_7	constant	−1.91	−3.41	−0.96	1.60	−1.52	−1.76	−1.84	−1.49	−1.29
		(3.71)	(3.75)	(3.36)	(1.97)	(3.60)	(3.64)	(3.66)	(3.65)	(3.70)
R^2		0.46	0.50	0.47	0.30	0.51	0.48	0.48	0.45	0.44
Adjusted R^2		0.38	0.42	0.38	0.19	0.43	0.40	0.39	0.36	0.35
Addendum: Wald tests										
Null hypothesis										
$\alpha_1 + \alpha_3 = 0$		0.81	0.99	0.71	0.39	0.78	0.12	0.78	0.75	0.73
$\alpha_2 + \alpha_4 = 0$		0.98	0.74	0.85	0.38	0.94	0.64	0.99	0.95	0.92
$\alpha_1 + \alpha_5 = 0$		0.55	0.62	0.48	0.36	0.51	0.00	0.56	0.53	0.52
$\alpha_2 + \alpha_6 = 0$		0.66	0.50	0.76	0.76	0.69	0.11	0.68	0.72	0.75

Note: The dependent variable is the Crisis Index; Newey-West heteroscedasticity–adjusted standard errors in parentheses.

Table 2.6 **Additional Determinants of Crises**

Estimated Coefficient and Summary Statistic	Independent Variable	Variables Added as the Average Ratio to GDP: Government Consumption (1)	Government Consumption (2)	Capital Inflows (3)	Capital Inflows (4)	Current Account (5)	Current Account (6)
α_1	LB		0.24		0.22		0.22
			(0.10)		(0.09)		(0.09)
α_2	RER		−0.14		−0.12		−0.11
			(0.07)		(0.06)		(0.06)
α_3	LB * D^{hr}		−0.26		−0.22		−0.21
			(0.09)		(0.08)		(0.08)
α_4	RER * D^{hr}		−0.28		0.15		0.07
			(0.28)		(0.45)		(0.40)
α_5	LB * D^{sf}		−0.07		−0.003		−0.11
			(0.32)		(0.36)		(0.35)
α_6	RER * D^{sf}		0.18		0.16		0.26
			(0.19)		(0.16)		(0.18)
α_7	constant	6.54	−0.97	5.75	−0.96	4.98	−3.18
		(2.48)	(4.06)	(2.37)	(4.08)	(2.20)	(4.05)
α_8	added variable x	0.14	0.03	0.35	0.11	−0.50	−0.25
		(0.08)	(0.06)	(0.19)	(0.15)	(0.25)	(0.22)
α_9	$x * D^{hr}$	−108.97	−68.88	−114.07	−38.66	8.62	−3.15
		(49.62)	(71.53)	(53.53)	(64.35)	(3.56)	(8.75)
α_{10}	$x * D^{sf}$	−0.22	−0.04	−0.63	−0.13	0.66	0.31
		(0.08)	(0.06)	(0.18)	(0.15)	(0.23)	(0.22)
R^2		0.15	0.47	0.17	0.46	0.20	0.52
Adjusted R^2		0.08	0.33	0.10	0.31	0.14	0.41

Note: The dependent variable is the Crisis Index; Newey-West heteroscedasticity–adjusted standard errors in parentheses.

excluded. As column 1 in table 2.6 shows, the estimated coefficient on government consumption is significantly different from zero at the 10 percent level. However, if the lending boom and real depreciation variables are included, government consumption ceases to be significant (column 2). One can interpret this finding as saying that if excessive government consumption leads to a greater crisis, it does so, not directly, but rather through its effects on the lending boom and the real exchange rate. It is interesting to note that the point estimates and significance levels of the remaining parameters in column 2 are very similar to the ones in benchmark equation (1).

Now I turn the discussion to capital inflows. A popular view is that excessive capital inflows must lead eventually to a currency crisis. The reason for that is because in a short span of time, excessive inflows cannot be efficiently channeled to productive projects. Thus, they end up invested in "white-elephant" or "crony" projects. As a result, the economy is not able to generate, over the medium run, the necessary returns to repay investors. It is at this point that the economy becomes vulnerable to a crisis. Column 3 of table 2.6 presents the estimates of a regression equation that includes only the capital inflows variable. For countries with low reserves and weak fundamentals, capital inflows enter positively and significantly at the 10 percent level. However, if one includes the lending boom and the real depreciation indexes, capital inflows have no effect on the severity of the crisis (column 4). As before, this finding suggests that capital inflows do not have an extra effect on the extent of a crisis beyond the effect they exert on the lending boom and real appreciation.

Last, I consider the ratio of the average current account deficit to gross domestic product (GDP). It is frequently argued that countries cannot run large current account deficits for long periods of time; this view is related to the Feldstein-Horioka finding. Here, I consider the average current account over the four years preceding each crisis. Since four years is hardly the long run, one should not expect to see a positive relation between the current account variable and the crises indexes. Surprisingly, the point estimates of the current account variable are negative. As before, the estimates are significant only when I exclude the lending boom and real depreciation indexes from the regression (see columns 5 and 6).

2.4 Conclusions

These findings suggest that in the recent Tequila and Asian episodes, currency crises did not spread in a purely random way. Rather, a set of fundamentals helps explain the cross-country variation of the severity of those crises. I find that crises did not spread to countries with strong fundamentals or high international reserves; furthermore, within the set of vulnerable countries (those with weak fundamentals and low reserves), I find that the crisis index was increasing in the extent of the lending boom and the severity of the real appreciation experienced by the country.

I also find it untrue that Latin American countries were hardest hit by the crisis in 1995 simply because they were located in Latin America, and that in 1997 Asian countries were the hardest hit simply because they were located in Asia. I find that the same model that explains the spread of the crisis in 1995 also explains the cross-country variation in the 1997 crisis. This finding helps explain why in 1995 the hardest hit countries were Latin American, while in 1997 the Southeast Asian countries were the hardest hit. Prior to the Tequila crisis, Latin American countries, on average, had experienced bigger lending booms and more severe real appreciations than Southeast Asian countries; interestingly, the opposite is true for the period preceding the Asian crisis.

There is an ongoing debate regarding the causes of currency crises. Some researchers argue that crises are caused mainly by fundamentals, while other researchers claim that crises are simply the result of speculative behavior in a world with multiple equilibria. Our findings indicate that both views are in some sense correct. The fundamentalist view is correct in the sense that if fundamentals are strong, it is very unlikely that a country will be attacked. The sunspots view is correct in the sense that if fundamentals are weak, the country enters into a region of multiple equilibria and becomes vulnerable to an attack. Note, however, that the fact that a country is vulnerable does not imply that it must suffer a crisis in the near future. It implies only that if investors' expectations turn pessimistic, a crisis will ensue because the government will be forced to close the external gap through a large depreciation, justifying investors' expectations. To the extent that investors' expectations are unpredictable, the crisis in a particular country is unpredictable.

Appendix

Real Exchange Rate Depreciation

I use the percentage change in the weighted average of the bilateral real exchange rates (using consumer price indexes [CPIs]) with respect to the yen, the U.S. dollar, and the Deutsche mark as a proxy for real exchange depreciation. The weights sum to 1 and are proportional to the bilateral trade shares with Japan, the United States, and the European Union. The extent of depreciation is measured as the percentage increase in the real exchange rate index from 1990 to 1994 for the earlier crisis period and from 1992 to 1996 for the later crisis period. I compute trade shares from the International Monetary Fund's *Direction of Trade Statistics Yearbook,* *1997,* for the years 1992 and 1995, and use average nominal exchange rates (line rf from the *IFS* CD-ROM) and CPIs (line 64). Using 1992 weights, J. P. Morgan data are used for Hong Kong and Taiwan.

Lending Boom

I use the percentage change in total domestic credit (line 32 from the *IFS* CD-ROM) minus government claims (line 32an) adjusted for inflation using the December CPIs (line 64). The lending boom is the percentage change from 1990 to 1994 for the earlier crisis and from 1992 to 1996 for the later crisis.

Reserve Adequacy

I use the ratio of M2 to total reserves minus gold (line 1Ld) as a proxy for reserve adequacy; the ratio is calculated as of November 1994 and for June 1997. M2 is calculated using the sum of money (line 34) and quasi-money (line 35). Reserves are converted to national currency using the monthly exchange rate (line rf). Several countries did not have data updated through June 1997, so the most recent measure was used. For Malaysia, Poland, Taiwan, and Hungary the relevant measures are as of November 1996, November 1996, December 1996, and March 1997, respectively. The ratios for these countries are fairly stable over time.

Crisis Index

The crisis index is the depreciation of the exchange rate plus the negative of the percentage change in reserves between November 1994 and a given month in 1995 or May 1997 and various later months. Each of the two components is weighted by its precision over the sum of precision calculated from a monthly series of ten years. For several countries, reserve data were not available monthly for the entire ten-year period and were calculated from the data available in the *IFS.* Precision for Hong Kong is calculated from mixed frequency data (quarterly for several years and then monthly). Precision for Hungary begins September 1989. Taiwan is measured from 1994 through 1997. For Poland, precision calculation begins in 1990 when the currency stabilized after the transition to a free market economy. *IFS* was missing reserve information for many countries for recent data; reserves were filled in using a variety of sources, including *The Economist,* Bloomberg, and the central banks of various countries. In addition, Datastream was used to extend exchange rates. All of these data sources were checked with the previous figures from the *IFS.*

Current Account

I converted (line 78a1) to national currency using annual exchange rates (line rf). This enters into the regression as an average over 1990–94, as a share of GDP over 1992–96, and the percentage change (in U.S. dollars).

Capital Inflows

The sum of capital account (line 78bc), financial account (line 78bj) and net errors and omissions (line 78ca) was converted to national currency using annual exchange rates (line rf). This enters into the regression as average over 1990–94, as share of GDP over 1992–96, and as percent change (in U.S. dollars). Data are missing for Hong Kong and Taiwan.

Government Consumption

This information is taken from line 91f. It enters into the regression as average over 1990–94, as share of GDP over 1992–96, as percent change as share of GDP, and as percent change adjusted for inflation using annual CPIs. Data are missing for Argentina.

Taiwan

Montly reserves and exchange rates were taken from *Bulletin of Statistics* of the Republic of China and supplemented by Datastream and Asian Development Bank (for more recent data).

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