This is to certify that the

dissertation entitled

WHAT CAUSED THE ASIAN CURRENCY CRISIS?

presented by

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has been accepted towards fulfillment
of the requirements for

Ph.d. degree in Economics

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Date March 1. 2000

WHAT CAUSED THE ASIAN CURRENCY CRISIS?

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A DISSERTATION

Submitted to
Michigan State University
in partial fulfillment of the requirements
for the degree of

DOCTOR OF PHILOSOPHY

Department of Economics

2000

ABSTRACT

WHAT CAUSED THE ASIAN CURRENCY CRISIS?

By

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The main objective of this dissertation is to investigate causes and policy implications of the Asian crisis. In chapter II, an overview of the Asian economy during the 1990s is presented, with a focus on two main explanations of the crisis: "weak fundamental (WF)" and "financial panic (FP)". This chapter exemplifies that neither of the two views provides dominating evidence over the other, demanding more formal studies on this issue.

According to the literature review on currency crises in chapter III, most empirical studies use annual data in their estimations, making it difficult to capture a lot of actions a few months before and after the collapse. For example, in the case of the Asian crisis, annual data hides the rapid movement of the economy in the second half of 1997. Chapter IV tries to lessen this problem, employing *quarterly* data. The estimation results indicate that crises tend to occur when current account deficit grows, real exchange rates are overvalued, and reserves decrease. Currency crises also tend to be associated with a sharp slowdown of the economy and pure contagion.

Contrary to common expectation, the analysis in chapter IV indicates that a lending boom has had little impact on a currency crisis. Chapter V is based on the hypothesis that the effect of a lending boom on a currency crisis might be different in countries with different current account balances and international reserves. Being

consistent with the hypothesis, this chapter shows that countries with a rapid lending boom accompanied by a severe current account deficit and low reserves are susceptible to a speculative attack.

Chapter VI applies the empirical models developed in the previous chapters to the Asian economy in 1997. The empirical analyses show that the magnitude of the crisis can be fully explained only when both WF and FP are present. Briefly reviewing recent debates on the role of the IMF program and the Malaysia's capital control, this chapter offers policies to prevent or manage future crises.

To my parents and grandmother

ACKNOWLEDGMENTS

Without the assistance and encouragement of many people, this work would not have appeared in its present form.

I am especially indebted to my dissertation advisor, Mordechai E. Kreinin. I am deeply appreciative of the guidance and encouragement which I received from him over the period of this study. I would also like to thank other members of the thesis committee, Jeffrey M. Wooldridge and John D. Wilson for their time and insightful comments.

Many of my fellow graduate students have contributed to the completion of this study through their encouragement and friendship. My special thanks go to Douglas Harris, Soomyung Jang, Junhan Lee, and Jeongseok Song.

Finally, I give the largest part of my thanks to my family. My wife, Jaeyeon, provided me with constant support and love. My parents and parents-in-law have always supported and encouraged me to do my best. Thanks to all of them for their love and encouragement.

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CHAPTER I

INTRODUCTION

Two main explanations of the Asian currency crisis have emerged in the recent debate. According to one view, the crisis reflected an unsustainable deterioration in macroeconomic fundamentals and poor economic policies in the afflicted countries. Structural factors triggered the currency and financial crisis in 1997 even if, once the crisis started, market overreaction caused depreciation of exchange rates to be more severe than warranted by the initial weak macroeconomic performance. This view is denoted by "weak fundamental" (WF) hereafter.

According to an alternative view, the sudden shifts in market expectations and confidence were the key sources of the initial financial turmoil, its propagation overtime, and regional contagion in the second half of 1997. While the macroeconomic performance of some countries was somewhat weak, the extent and depth of the crisis should not be attributed to sharp deterioration in fundamentals but rather to the panic of domestic and international investors. This view is denoted by "financial panic" (FP) hereafter.

The two viewpoints on causes of the Asian crisis have different policy implications. Those who think that speculative movements are due to WF tend to support fiscal and monetary policies which make the commitment to the exchange rate objective credible. On the other hand, those who advocate the FP view think international capital markets are intrinsically unstable and vulnerable to erratic speculative movements. They tend to support measures of capital controls that might help the governments to defend their currencies.

The main objective of this dissertation is to further study the issue of causes and policy implications of the Asian crisis. The subsequent chapters are organized as follows.

In chapter II, an overview of the Asian economy during the 1990s is presented, with a focus on the movements of the macroeconomic variables which have been considered as empirical evidence for FP or WF. This chapter exemplifies that neither of the two views provides dominating evidence over the other.

Chapter III offers a review of the theoretical and empirical literature on currency crises. The theoretical literature is grouped into two categories, *first generation* model and *second generation* model. Beginning with Krugman's (1979) seminal study, the first generation models show how speculative attacks occur when the fundamentals are weak, i.e., a fixed exchange rate policy combined with overly expansive fiscal and monetary policies results in a persistent loss of international reserves that ultimately forces the authorities to depreciate the nominal exchange rate. There are two variants of the second generation model of a currency crisis. According to one view, the crisis is driven by WF (such as a fall in output or an increase in the unemployment rate) that makes it more likely that the government will eventually let the currency fall. In contrast, the other variant suggests that crises are not affected by the position of the fundamentals. Instead, they may simply occur as a consequence of pure speculation against the currency.

Regarding the empirical literature, single country studies such as Blanco and Garber (1986), have presented strong evidence suggesting that domestic macroeconomic indicators play a key role in determining a currency crisis. These results, however, are somewhat limited since they are obtained from a small number of countries during very

specific situations. Multi-country studies such as the classic study by Frankel and Rose (1996) recognize the limitations of country specific analysis, and attempt to exploit the higher variability associated with cross-country information. However, evidence from these studies is far from conclusive. The regression results either have very weak predictive power or come from a sample that focuses on very specific events such as the Mexican crisis in 1994.

Most multi-country studies use annual data in their estimations, making it difficult to capture a lot of actions in some of the explanatory variables a few months before and after the collapse. For example, in the case of the Asian crisis, annual data hides the rapid movement in the second half of 1997. I try to lessen this problem in chapter IV, following the basic ideas of multi-country studies and employing *quarterly* data. This chapter shows that crises tend to occur when current account deficit grows, real exchange rates are overvalued, and reserves decrease. Currency crises also tend to be associated with a sharp slowdown of the economy and pure contagion.

Chapter V focuses on the impact of a lending boom on a currency crisis. In this chapter, I argue and demonstrate that a lending boom increases the probability of a crisis when it is associated with low reserves and severe external imbalances. The underlying idea is as follows. An individual money manager will attack a currency only if it is anticipated that the country will respond with a sizeable depreciation. Investors use a common set of fundamentals and stable filtering rule to predict which countries are most likely to respond with sizable depreciation, and then concentrate their attacks on those currencies. As shown in this chapter, these are countries that experience a rapid lending boom accompanied by a severe current account deficit and low reserves.

The purpose of chapter VI is to revisit causes and policy issues of the Asian crisis. The empirical models developed in chapter IV and V are used as main tools to study these objectives. The estimation shows that the magnitude of the crisis can be fully explained only when both WF and FP are present. In addition, briefly reviewing recent debates on the role of the IMF program and the Malaysia's capital control, this chapter offers policies to prevent or manage future crises.

CHAPTER II

THE ONSET OF THE ASIAN CURRENCY CRISIS

Was the Asian currency crisis in 1997 caused by "weak fundamental" (WF) or "financial panic" (FP)? Advocates of the WF hypothesis such as Corsetti, Pesenti and Roubini(1998) emphasize that growing current account imbalances, real appreciation, bad loans, overinvestment and foreign debt accumulation were all contributors to the crisis.

In contrast, the FP view stresses sudden and substantially arbitrary shifts in market expectations and confidence as the key source of the crisis. For example, Radelet and Sachs (1998) admit that there were significant underlying problems in the Asian economies, but assert that these problems were not severe enough to warrant a financial crisis of such large magnitude.

The main focus of this chapter is placed on whether we can find empirical evidence for either WF or FP on the Asian currency crisis in 1997. For this purpose, an overview of the Asian economy during the 1990s is presented, with a focus on the movements of the macroeconomic variables which have been presented as evidence of the Asian currency crisis in previous studies.[1] The analysis focuses on Korea, Indonesia, Malaysia, the Philippines and Thailand, the countries whose currencies collapsed during the period.

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[1] A full list of recent studies are available at http://www.stern.nyu.edu/~nroubini/asia/AsiaHomepage.html.

1. Evidence Presented by the WF View

1.1 Real Exchange Rate Appreciation

The sharp increase of the US dollar relative to the Japanese yen and the European currencies since the second half of 1995 led to deteriorating competitiveness in most Asian countries whose currency were effectively pegged to the dollar. For example, the yen/dollar moved from 85 in June 1995 to 127 in April 1997. As a consequence, the Asian currencies that were tied in nominal terms to the dollar experienced a very rapid real appreciation.

Presented in table 1 are the data on the real exchange rate of the five Asian countries.[2] Most of the countries experienced a real appreciation by more than 10 percent, between 1995 June and 1997 June: 11 percent in Indonesia and Malaysia; 18 percent in the Philippines; and 13 percent in Thailand. The only exception was Korea, whose currency had slightly appreciated, in real terms, by 2 percent.

1.2 Current Account Imbalances

As shown in table 2, current account deficits have built up rapidly in the five countries. The two countries with the largest and most persistent current account imbalances were Thailand and Malaysia. The current account deficits in the two countries were over 6 percent of GDP on average between 1995 and mid-1997. Similarly large imbalances are observed in the Philippines where, during the same period, the ratio exceeded 4 percent. Korea's current account position shifted to a deficit during the

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[2] I use the J.P. Morgan real exchange rate database. The real exchange rate is a trade-weighted average of the exchange rates of the 45 countries.

1990s and the deficit grew up quickly to around 5 percent of GDP in 1996. Indonesia started the decade with a large imbalance (4 percent of GDP in 1990-1991). Though shrinking in 1992-1993, the deficit rose again to 3 percent of the GDP between 1995 and 1997.

Several factors contributed to those observed imbalances. First, the real appreciation contributed to export slowdowns and wider external imbalances. Competitive pressures in the region were sharpened by the effects of the 50 percent nominal devaluation of the Chinese currency in 1994. Second, the long period of stagnation of the Japanese economy in the 1990s led to a significant slowdown of the exports of the Asian countries to Japan. Finally, Mexico's participation in NAFTA and the devaluation of the Mexican peso resulted in intense competition for the Asian countries. Mexico's total exports soared from $52 billion in 1993 to $96 billion in 1996, with gains in several areas that directly compete with East Asian exports, including electronic machinery, apparel and automotive components.

1.3 Weak Banking System

Probably the biggest signs of growing risk were in the financial sector. In the 1990s the countries of East Asia carried out a financial deregulation and capital liberalization. The financial liberalization involved loosening restrictions on both interest rate ceilings and the type of lending allowed. Bank lending increased dramatically prior to the crisis, with much of it financed by inflows of international capital.

Of course, the problem was not that lending expanded, but rather that it expanded so rapidly that excessive risk-taking occurred. In fact, many of the loans made by banks

were invested in risky and low profitable projects or used for real estate, weakening the banking system.

Lending Boom

As shown in table 3, domestic bank lending to the private sector expanded rapidly in the five countries prior to the crisis. The most extreme case was the Philippines, where banking claims on the private sector, as a percent of GDP, increased by more than 80 percent between 1994 and 1996. It was also large in Malaysia (25 percent) and Thailand (25 percent). Though more modest in Indonesia and Korea, the magnitude of credit growth between December 1993 and December 1996 was much higher than in early 1990s.

Accumulation of Bad Loans

One of the main problems faced by the Asian countries was that many of the loans made by banks were invested in risky and low profitable projects or used for real estate, property and the purchase of equity funds. A possible indicator of investment in risky and low profitable projects is the proportion of non-performing loans (NPLs) in total loans (table 4). Since the 1997 crisis may have crippled otherwise healthy loans, it is appropriate to refer to data at the onset of the crisis. In 1996, the NPLs were estimated at 8-14 percent for the five afflicted countries. For the purpose of comparison, the estimated NPLs were 3-4 percent in Hong Kong, Singapore and Taiwan.

Loans Financed by Foreign Liabilities

Large increases in the foreign liabilities of the banks indicate that much of the bank lending was mostly financed by borrowing from abroad (table 5). In Korea, the foreign liabilities of the banking system more than doubled from 4.5 percent of GDP in December 1993 to 9.4 percent of GDP in December in 1996. In the Philippines, equivalent liabilities soared from 6 percent of GDP at the end of 1993 to 17 percent of GDP three years later. In Thailand the foreign liabilities jumped more sharply from a single digit in 1992 to 27 percent of GDP in 1996. In Indonesia, though the liabilities remained at more modest level, much of the offshore borrowing was undertaken directly by private firms. The only exception was Malaysia where the foreign liabilities fell off sharply in 1994 and remained at that level as of December 1996.

1.4 Refutation by FP Analysts

According to FP analysts, warning signs such as current account deficits, bad loans and overinvestment gave some reasons for concern, but the signals were not considered seriously by economic agents, as shown in the credit ratings and IMF reports. While Asian currencies had appreciated in real terms in the 1990s, the real appreciation was considerably less than in most of Latin America. Current account deficits were very high in Thailand and Malaysia in 1996, but considerably lower in Indonesia and Korea.

FP supporters accept the financial vulnerability in the five countries, but maintain that it was not large enough to warrant the magnitude of the Asian crisis.

2. Evidence presented by the FP View

2.1 Some Aspects of Solid Real Economy

It is commonly believed that some aspects of the real economy in at least some crisis economies were solid. Government budgets, which were at the center of economic crises in Latin America in the 1980s, registered regular surpluses in each country during the 1990s, as shown in table 6.

GDP growth rates were very high in the 1990s as well as before (table 7). Growth rates averaging more than 7 percent and sometimes closer to 10 percent were not unusual in the region. The partial exception is the Philippines in the early 1990s when growth was low. However, since 1994, GDP growth averaged 5 percent even in this previously slow-growing country. Most countries in the region experienced a slowdown in growth in 1996 but, since the growth rates were very high to begin with, such a slowdown was of negligible magnitude. The average growth rate of the five countries was still over 7 percent in 1996.

2.2 Crisis Not Predicted

Although some observers anticipate the possibility of a crisis,[3] such warnings were rare. All signs point to a very recent and dramatic shift in expectations. For example, inflow of capital remained strong through 1996 and, in most cases, until mid 1997. The only exception is found in the equity markets in Thailand and Korea, where foreign investors became uneasy in 1996. In Malaysia, though equity markets began a rather steep decline in March 1997, bank lending continued to be very strong at least

until mid-year. In Indonesia, both the stock market and bank lending remained strong until mid-1997.

The credit rating agencies such as Standard & Poor's and Moody provide an ongoing assessment of credit risk in the emerging markets. If the markets had expected a financial crisis and public sector bailouts, the ratings of sovereign bonds should have fallen in the run-up to the crisis. However, the rating agencies did not signal any risk until after the onset of the Asian crisis itself. Long-term debt ratings remained unchanged throughout 1996 and the first half of 1997 for each of the Asian countries except the Philippines, where debt rating was actually upgraded in early 1997. In each country, the outlook was described as "positive" or "stable" through June 1997. Only many weeks after the crisis had begun, did these ratings agencies downgrade the region's debt.

Another measure of expectations for the region may be found in IMF reports on the Asian economies. The IMF gave very little indication that there was any macroeconomic risk to the Asian region. For example, *World Economic Outlook* (IMF, December 1997) predicted 6 percent growth for Korea in 1998, 7 percent for developing Asia (or 5 percent for developing Asia excluding China and India).

2.3 Refutation by WF Analysts

WF economists undermine the FP view as follows. First, they assert that the credit ratings have had no informational value in predicting currency crises for the last 20 years. As the credit ratings failed to predict the crises in early 1980s in which

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[3] See, for example, Park (1996)

fundamentals were clearly at work, one cannot infer that their failure in case of the Asian crisis is by itself evidence that the crisis was due to FP.

Second, IMF reports are not generally informative in predicting a crisis. Given the ability of IMF reports to sharply affect markets, such reports are always written in terms that express concern in very cautious terms.

Another piece of evidence is that countries with more sound fundamentals were spared the most serious collapses. In fact, Taiwan, Singapore, Hong Kong and China were relatively less affected by the regional turmoil.

3. Summary

FP economists admit that there were significant underlying problems in the Asian economies, but assert that these problems were not severe enough to warrant a financial crisis of such a large magnitude. In contrast, WF analysts stress the crucial role of weak fundamentals in causing the crisis. Given the weakness of the macroeconomic stances in the afflicted countries, the crisis was an unavoidable outcome rather than just a potential event which needs a financial panic, so as to be real.

In sum, the empirical evidence on the causes of the Asian crisis is far from conclusive, demanding more formal studies on this issue.

Table 1. Real Exchange Rate (change rate during the period, %)

	Jun. 1995-Jun. 1997
Korea	1.9
Indonesia	10.5
Malaysia	10.7
Philippines	17.7
Thailand	12.5

Source: J.P. Morgan, http://www.jpmorgan.com.
Note: A positive number means appreciation.

Table 2. Current Account (% of GDP), Balance of Payment Definition

	1995	1996	1997 Jan.-Jun.	1995-Jun. 1997
Korea	-1.9	-4.9	-4.7	-3.8
Indonesia	-3.2	-3.4	-2.8	-3.1
Malaysia	-9.7	-4.6	-4.8	-6.3
Philippines	-2.7	-4.8	-5.0	-4.2
Thailand	-8.1	-7.9	-2.8	-6.3

Source: IMF, *International Financial Statistics*, available on CD-Rom.

Table 3. Bank Claims on Private Sector relative to GDP

(change rate during the period, %)

	Dec.1990.-Dec.1993	Dec.1993.-Dec.1996
Korea	1.9	13.5
Indonesia	4.3	13.3
Malaysia	4.8	25.3
Philippines	36.8	85.6
Thailand	23.7	25.3

Source: IMF, *International Financial Statistics*, available on CD-Rom.

Table 4. Non-Performing Loans (% of total loans in 1996)

Korea	8%	Singapore	4%
Indonesia	13%	Thailand	13%
Malaysia	10%	Hong Kong	3%
Philippines	14%	Taiwan	4%

Source: Corsetti, Pesenti and Roubini (1998c)

Table 5. Foreign Liabilities of the Banking System (% of GDP)

	1993	1994	1995	1996
Korea	4.5	5.5	6.9	9.4
Indonesia	6.2	6.4	5.8	5.5
Malaysia	19.1	8.9	7.3	8.7
Philippines	5.5	6.7	8.8	17.4
Thailand	11.1	21.5	27.8	26.6

Source: IMF, *International Financial Statistics*, available on CD-Rom.

Table 6. Government Budget Balance (% of GDP)

	1991	1992	1993	1994	1995	1996
Korea	-1.6	-0.5	0.6	0.3	0.3	-0.1
Indonesia	0.4	-0.4	0.6	0.9	2.2	1.2
Malaysia	-2.0	-0.8	0.2	2.3	0.9	0.7
Philippines	-2.1	-1.2	-1.5	1.1	0.5	0.3
Thailand	4.7	2.8	2.1	1.9	2.9	2.3

Source: IMF, *International Financial Statistics*, available on CD-Rom.

Table 7. GDP Growth Rate (%)

	1991	1992	1993	1994	1995	1996
Korea	9.1	5.1	5.8	8.6	8.9	7.1
Indonesia	7.0	6.5	6.5	7.5	8.2	8.0
Malaysia	8.6	7.8	8.3	9.3	9.4	8.6
Philippines	-0.6	0.3	2.1	4.4	4.8	5.8
Thailand	8.6	8.1	8.7	8.9	8.7	6.4

Source: IMF, *International Financial Statistics*, available on CD-Rom.

CHAPTER III

LITERRATURE REVIEW

Recent currency crises in Europe, Mexico and Asia have drawn worldwide attention to speculative attacks on government-controlled exchange rates. To improve understanding of these events, research has proceeded on both theoretical and empirical fronts. The purpose of this chapter is to review this research and relate it to my own empirical works.

1. Theoretical Literature

The theoretical literature about currency crises contains a number of models which rationalize "weak fundamental" (WF) or "financial panic" (FP). *First generation* models fall into the WF category, stressing that crises are caused by excessively expansionary fiscal and monetary policies. *Second generation* models differ in the role they assign to the economic fundamentals. In some models the WF plays a key role in determining when a crisis may occur. Once the economy reaches the region of WF, anything can happen. The exchange rate collapses if attacked, or survives otherwise. Other second generation models show that crises are not affected by the position of the fundamentals. Instead, they may simply occur as a consequence of pure speculation against the currency, falling into the FP category.

1.1 First Generation Models

Initial models, now called *first generation* research, were developed in response to currency crises in developing countries such as Mexico (1973-82) and Argentina (1978-81). First generation models show how speculative attacks occur when the fundamentals are weak, i.e., a fixed exchange rate policy combined with overly expansive fiscal and monetary policies results in a persistent loss of international reserves that ultimately forces the authorities to depreciate the nominal exchange rate.

1.1.1 Basic Framework

In a seminal paper, Krugman (1979) shows that, under a fixed exchange rate regime, domestic credit creation in excess of money demand growth leads to a gradual loss of reserves and, ultimately, to a speculative attack against the currency that forces the abandonment of the fixed exchange rate. Because of the nonlinearities involved in his model, however, Krugman does not provide explicitly a solution for the time of collapse in a fixed exchange rate regime. Later work by Flood and Garber (1984) gives an example of how such a solution can be derived in a linear model.

In this section, the Flood and Garber's model will be introduced as a basic framework to analyze the first generation approaches to a balance of payments crisis. The model, rooted in the *monetary approach*, is built around five equations: [4]

$$m_t - p_t = a_0 - a_1 i_t, \quad a_1 > 0 \qquad (1)$$

$$m_t = \eta r_t + (1-\eta)\, d_t, \quad 0 < \eta < 1 \qquad (2)$$

$$\dot{d}_t = \mu, \quad \mu > 0 \qquad (3)$$

$$p_t = p^* + s_t \qquad (4)$$

$$i_t = i^* + \dot{s}_t . \qquad (5)$$

All variables, except interest rates, are measured in logarithms. m_t, p_t and i_t are the domestic money stock, price level and interest rate, respectively. r_t and d_t denote the domestic government book value of foreign money holdings and domestic credit, respectively. s_t is the spot exchange rate, i.e. the domestic money price of foreign money. An asterisk (*) indicates "foreign variable", assumed to be constant. A dot over a variable denotes a time derivative.

Equation (1) represents the demand for real money balances. Equation (2) is a log-linear approximation to the identity linking the stock of money to reserves and domestic credit.[5,6] Equation (3) assumes that domestic credit grows at the rate μ. Equation (4) imposes purchasing power parity. Equation (5) reflects the assumptions that uncovered interest parity holds and agents have perfect foresight.

Substituting (2) ~ (5) into (1) yields the following money market equilibrium condition:

$$m_t = \eta r_t + (1-\eta) d_t = s_t - a_1 \dot{s}_t + C \ , \qquad (6)$$

where $C \equiv (a_0 - a_1 i^* + p^*)$, which is assumed to be positive. Equation (6) states that the demand for money can be satisfied either from reserves or domestic credit.

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[4] For details of the monetary approach, see chapter 15 in Kreinin (1995).
[5] See appendix 1 for details of the log-linear approximation.
[6] In applications of the model, or when using the model to discuss historical episodes, the money market is expanded to include such features as a money multiplier, scale variables such as income, consumption or wealth and a money market disturbance.

If the exchange rate is fixed at $\bar{s}$, then $\dot{s}_t = 0$ and $i = i^*$.[7] When domestic credit grows, reserves at any time t adjust to maintain money market equilibrium, following the rule in the equation below:

$$r_t = [\bar{s} - (1-\eta)d_t + C]/\eta \ . \qquad (7)$$

The rate of change of reserves is obtained from (3) and (7):

$$\dot{r}_t = -\theta \dot{d}_t = -\mu \ , \quad \theta \equiv \frac{1-\eta}{\eta} . \qquad (8)$$

Equation (8) shows that if domestic credit grows while money demand remains unchanged, reserves are run down at a rate proportional to the rate of credit expansion. Clearly the country will run out of reserves eventually and the fixed rate regime will not survive forever.

To find the time of the attack, Flood and Garber introduce the idea of the *shadow exchange rate*, which is defined as the floating exchange rate that would prevail if speculators purchased the remaining government reserves committed to the fixed rate and the government refrains from foreign exchange market intervention thereafter. The shadow exchange rate $\tilde{s}$, therefore, is the exchange rate that balances the money market following an attack in which foreign exchange reserves are exhausted.

Substituting the trial solution $\tilde{s}_t = \lambda_0 + \lambda_1 m_t$ into equation (6), they find that $\lambda_0 = a_1(1-\eta)\mu - C$ and $\lambda_1 = 1$. Thus,

$$\tilde{s}_t = a_1(1-\eta)\mu - C + m_t . \qquad (9)$$

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[7] $\dot{s}_t$ implies that the money demand remains unchanged. Recall that $m_t = s_t - a_1 \dot{s} + C$ in equation (6).

Equation (9) implies that the shadow exchange rate depreciates steadily and proportionally to the rate of growth of domestic credit.

Figure 1 plots $\tilde{s}$ in equation (9) and the pre-attack fixed exchange rate, $\bar{s}$. Let d^A denote the domestic credit level at point A where $\tilde{s}$ is equal to $\bar{s}$, i.e., the two lines intersect when $d = d^A$

Suppose that d is smaller than d^A. If speculators attack at level d, then the currency will appreciate and the speculators will experience a capital loss on the reserves they purchase from the government. There will be no attack, therefore, when $d < d^A$. Suppose instead that $d > d^A$, so $\tilde{s} > \bar{s}$. Now there is a capital gain to speculators for every unit of reserves purchased from the government. Speculators can foresee that capital gain and will compete against each other for the profit. The way they compete in this framework is to get a jump on each other and attack earlier. Such competition continues until the attack is driven back in time to the point where $d = d^A$. It follows that a foreseen attack must take place when $\tilde{s} = \bar{s}$. Exchange rate jumps are ruled out by speculative competition.

The condition that $\tilde{s} = \bar{s}$ is used to determine both the timing of the attack and the extent of government reserve holdings at the time of the attack. For simplicity, they assume that $r_t = 0$ when the fixed exchange rate regime is abandoned. Substituting $\bar{s}$ for $\tilde{s}$ and $m_t = (1-\eta)d_t = (1-\eta)(d_0 + \mu t)$ into equation (9) produces the timing of the attack T:

$$T = \frac{\bar{s} - (1-\eta)d_0 + C}{(1-\eta)\mu} - a_1 = \frac{\eta r_0}{(1-\eta)\mu} - a_1. \quad (10)$$

Equation (10) shows that the higher the initial stock of reserves or the lower the rate of credit expansion, the longer it takes before the fixed exchange rate regime collapses.

This result is consistent with the fact that Flood and Garber's model is based on the monetary approach. According to the approach, a rise in domestic money supply, with demand for money remaining unchanged would ultimately be offset by an equal and opposite change in the international reserves through the balance of payments. When the reserves are run out, the fixed exchange rate is abandoned.

1.1.2 Extensions to the Basic Framework

The basic theory of balance of payment crises presented above has been refined and extended in several directions. I focus on two models which are closely related to the empirical works in the subsequent chapters: One introduces uncertainty into the above framework and the other examines the real effects of a currency crisis in a model with endogenous output, sticky forward-looking wage contracts and external trade.[8]

Uncertainty and the Timing of a Collapse

Thus far I have presented a model of perfectly foreseen speculative attacks. It has been assumed that there is a threshold level, known by all agents, below which foreign reserves are not allowed to be depleted. The attainment of this level implies a permanent shift from a fixed exchange rate regime to a floating regime. In practice, however, agents are only imperfectly informed of central bank policies. They may not know the threshold level of reserves that triggers the regime shift. If uncertainty about current and future government policy is prevalent, the assumption of perfect foresight may be inappropriate.

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[8] For details of other major extensions, refer to the survey of first generation models by Agenor, Bhandari and Flood (1992).

Due to the assumption of perfect foresight, the basic model cannot explain rising nominal interest rates prior to a crisis. In the model the interest rate stays constant until the moment the attack occurs - at which point it jumps to a new level consistent with the post collapse regime. Uncertainty over the depreciation rate, as modeled below, may help to account for a rising interest rate in the transition period.

Flood and Garber (1984) introduce uncertainty about domestic credit growth in a discrete time stochastic model. In their framework, domestic credit is assumed to depend on a random component. Among five equations in the basic model, equations (3) and (5) are modified as follows:

$$d_t = d_{t-1} + \mu + \varepsilon_t \qquad (3)'$$

$$i_t = i^* + E_t s_{t+1} - s_t. \quad (5)'$$

Variables common to equations (1)-(5) are defined as before, except that t is now interpreted as an integer. In equation $(3)'$, ε_t represents a random disturbance in the domestic credit growth. Equation $(5)'$ introduces the notation $E_t(\cdot)$, the mathematical expectation operator conditional on the information set available at time t.

Let $\bar{s}$ and $\tilde{s}_t$ denote the fixed exchange rate and the shadow exchange rate as before. The system will be attacked if and only if $\tilde{s}_{t+1} > \bar{s}$. Therefore, the probability at time t of an attack at time $t+1$ ($_t\pi_{t+1}$) is given by

$$_t\pi_{t+1} = prob(\tilde{s}_{t+1} > \bar{s}). \qquad (11)$$

The unconditional expected future exchange rate is a probability-weighted average of $\bar{s}$ and $\tilde{s}_{t+1}$.

$$E_t s_{t+1} = [1 - {}_t\pi_{t+1}]\bar{s} + {}_t\pi_{t+1} E_t(\tilde{s}_{t+1} | \tilde{s}_{t+1} > \bar{s}). \quad (12)$$

Rearranging (12) yields:

$$E_t s_{t+1} - \bar{s} = {}_t\pi_{t+1}[E_t(\tilde{s}_{t+1}|\tilde{s}_{t+1} > \bar{s}) - \bar{s}]. \qquad (13)$$

This equation provides economic intuition of rising interest rates prior to a crisis.[9] According to the uncovered interest parity condition, the left side in equation (13) equals interest rate differential between domestic and foreign interest rate. Since the foreign interest rate is assumed to be constant, increases in $[E_t s_{t+1} - \bar{s}]$ would correspond to the higher domestic interest rate.

$[E_t s_{t+1} - \bar{s}]$ increases prior to the collapse because both ${}_t\pi_{t+1}$ and $[E_t(\tilde{s}_{t+1}|\tilde{s}_{t+1} > \bar{s}) - \bar{s}]$ rise with the approach of the crisis. The probability of an attack next period ${}_t\pi_{t+1}$ rises because the increasing value of the state variable (domestic credit) makes it increasingly likely that an attack will take place at *t+1*. The quantity $[E_t(\tilde{s}_{t+1}|\tilde{s}_{t+1} > \bar{s}) - \bar{s}]$ gives the value agents expect the exchange rate to be next period, given that there will be a speculative attack at *t+1*. In turn, that value depends on the value agents expect for the state variable next period, given that an attack will occur at *t+1*. As the value of the state variable rises from period to period, its conditional expectation also rises.

The introduction of uncertainty has a couple more implications, beyond being consistent with a rising interest rate differential prior to the crisis. First, the transition to a floating regime is stochastic, rather than certain. The collapse time becomes a random variable and cannot as before be determined explicitly, since the timing of a potential future speculative attack is unknown. Second, there is always a nonzero probability of a

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[9] For an explicit solution, refer to Flood and Garber (1984a).

speculative attack in the next period, which, in turn, produces a forward premium in foreign exchange markets.

Output, the Real Exchange Rate, and the Current Account

The early literature on currency crises focused on the financial aspects of crises and ignored the real events that were occurring simultaneously. Available evidence suggests, however, that currency crises have been often preceded by large current account deficit or economic depression.

Willman (1988) shows that crises are preceded by weak fundamentals such as economic recession and a current account deficit, in the context of a model with endogenous output and foreign trade. According to Willman's model, domestic output is demand-determined and negatively related to the real exchange rate. The trade balance also depends negatively on the real exchange rate and domestic output. A crucial feature of the model is the existence of forward looking wage contracts.

Expansionary monetary policies result in anticipated future depreciation of the exchange rate. Since wage contracts are forward looking, the expected depreciation is discounted back to the present and affect current wages. As a result, prices start adjusting before the collapse occurs. The steady rise in domestic prices is associated with appreciation in the real exchange rate and a negative impact on real output.

The continuous loss of competitiveness caused by the real appreciation, unless it is outweighed by effects from a fall in output, implies that the trade balance deteriorates in the period before the collapse of the fixed exchange rate regime.

1.2 Second Generation Models

Newer models, *second generation* research, are designed to capture features of the speculative attacks in Europe and in Mexico in the 1990s. The second generation models study what happens when government policy reacts to changes in private behavior or when the government faces an explicit trade-off between the fixed exchange rate policy and other objectives such as economic growth and low unemployment.

In this section, two examples of the second generation research are introduced. One shows that even when monetary policies are consistent with the fixed exchange rate, attack-conditional policy changes can pull the economy into an attack. The other shows that a shift in market expectations can alter the government's trades-offs and bring about self-fulfilling crises.

1.2.1 Attack-Conditional Policy Changes

Suppose a conditional shift occurs in the growth rate of domestic credit. If there is no attack on the fixed exchange rate, domestic credit grows at the rate μ_0 ; if there is an attack, domestic credit grows at the faster rate μ_1.[10]

Figure 2 duplicates figure 1, but now there are two shadow exchange rate lines, one corresponding to a rate of credit expansion μ_0 and the other related to the higher rate of credit expansion μ_1. The shadow rate line for $\mu=\mu_0$ intersects the $\bar{s}$ line at point A and the shadow rate line for $\mu=\mu_1$, at point B. d^A and d^B denote domestic credit level at point A and B, respectively.

Suppose now that domestic credit lies in the range to the left of d^B. If there is no attack, the shadow rate is on the s_{μ_0} line. If speculators attack, the shadow rate jumps to the s_{μ_1} line, which is still below the fixed exchange rate. Since any attack leads to capital losses for speculators, there is no incentive to attack the fixed exchange rate if domestic credit is less than d^B.

If domestic credit is in the range between d^A and d^B, then multiple equilibria may be possible. The economy could reside on the lower shadow rate line indefinitely if agents believe there is no chance that the market will be attacked. At the other extreme, the economy could jump to the higher shadow rate line if agents are convinced there will be a run on the currency. Convinced of a run, no individual speculator will find it profitable to hold domestic currency since this would result in a sure capital loss when the run occurs. Consequently, all agents will participate in an attack, leading to a collapse of the fixed rate and more expansionary credit policy.

If domestic credit exceeds $d^{A'}$, then $\tilde{s} > \bar{s}$ regardless of the policy changes. The currency will be attacked, as in the basic model in section 1.1.1.

1.2.2 Escape Clause

The second example comes from Obstfeld (1996). The model's basic framework is drawn from Barro and Gordon (1983), but assumes an open economy and identifies the price of foreign currency with the domestic price level. In this model, devaluations are triggered by the government's desire to offset negative output shocks, but a sudden shift

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[10] This example is provided by Flood and Marion (1996) as a simplified version of the model in Obstfeld (1986).

in market expectations on the change in exchange rate can trigger a devaluation that would not have occurred under different private expectations.

The government minimizes the loss function

$$L = (y-y^*)^2 + \beta\varepsilon^2 + C(\varepsilon), \quad (14)$$

where y is output, y^* the government's output target, and $\varepsilon \equiv s\text{-}s_{-1}$ the change in the exchange rate (the price of foreign currency).[11] Output is determined by the expectations-augmented Phillips curve

$$y = \bar{y} + \alpha(\varepsilon - \varepsilon^e) - u, \quad (15)$$

where $\bar{y}$ is the 'natural' output level, ε^e is domestic private agent's expectation of ε based on lagged information, and u is an i.i.d. mean-zero shock. The assumption $y^* > \bar{y}$ causes a dynamic inconsistency problem which provides a reason why a rational government might try to tie its hands by submitting to exchange-rate realignment costs. The government chooses the exchange rate ε after observing u (unlike private agents), but any upward change in the rate (devaluation) leads to $C(\varepsilon)=\bar{c}$ in (14), whereas downward (revaluation) changes cost the government $C(\varepsilon)=\underline{c}$.[12]

At first, suppose there is no realignment cost. With ε^e predetermined, the government wants to minimize the loss function in equation (14) and chooses

$$\varepsilon = \frac{\alpha(y^* - \bar{y} + u) + \alpha^2\varepsilon^e}{\alpha^2 + \beta}, \quad (16)$$

achieving an output level of

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[11] Obstfeld (1996) uses ε^2 in the loss function. In practice, the major results do not change when ε is used in the loss function.

$$y = \bar{y} + \frac{\alpha^2(y^* - \bar{y}) - \beta u - \alpha\beta\varepsilon}{\alpha^2 + \beta}$$

and a policy loss of

$$L^{FLEX} = \frac{\beta}{\alpha^2 + \beta}(y^* - \bar{y} + u + \alpha\varepsilon^e)^2.$$

With no option to change the exchange rate, the loss instead is

$$L^{FIX} = (y^* - \bar{y} + u + \alpha\varepsilon^e)^2.$$

Now reintroduce the fixed costs $C(\varepsilon)$. In their presence, equation (16) is operative only when u is so high that $L^{FLEX} + \bar{c} < L^{FIX}$ or so low that $L^{FLEX} + \underline{c} < L^{FIX}$. Devaluation thus occurs for $u > \bar{u}$, and revaluation for $u < \underline{u}$, where

$$\bar{u} = \frac{1}{\alpha}\sqrt{\bar{c}(\alpha^2 + \beta)} - y^* + \bar{y} - \alpha\varepsilon^e, \qquad (17)$$

$$\underline{u} = -\frac{1}{\alpha}\sqrt{\underline{c}(\alpha^2 + \beta)} - y^* + \bar{y} - \alpha\varepsilon^e.^{13} \quad (18)$$

Let u be uniformly distributed on $[-\mu, \mu]$. The rational expectation of next period's ε, given the expectation ε^e, is

$$E\varepsilon = E(\varepsilon|u < \underline{u})\Pr(u < \underline{u}) + E(\varepsilon|u > \bar{u})\Pr(u > \bar{u}).$$

Direct computation using equation (16) yields

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[12] The fixed cost of a parity change could be a political cost to reneging on a promise to fix the exchange rate (e.g., an ERM commitment).

[13] $\bar{u}$ satisfies $L^{FLEX} + \bar{c} = L^{FIX}$; and $\underline{u}$, $L^{FLEX} + \underline{c} = L^{FIX}$.

$$E\varepsilon = \begin{cases} \dfrac{\alpha}{\alpha^2+\beta}\left[\left(1-\dfrac{\bar{u}-\underline{u}}{2\mu}\right)\left(y^*-\bar{y}+\alpha\varepsilon^e\right)-\dfrac{\bar{u}^2-\underline{u}^2}{4\mu}\right] & (for\ \underline{u} > -\mu) \\ \dfrac{\alpha}{\alpha^2+\beta}\left[\left(\dfrac{1}{2}-\dfrac{\underline{u}}{2\mu}\right)\left(y^*-\bar{y}+\alpha\varepsilon^e\right)-\dfrac{\mu^2-\bar{u}^2}{4\mu}\right] & (for\ \underline{u} \le -\mu) \\ \dfrac{\alpha}{\alpha^2+\beta}(y^*-\bar{y}+\alpha\varepsilon^e) & (for\ \bar{u} \le -\mu). \end{cases} \qquad (19)$$

The slope of (19) is

$$\frac{dE\varepsilon}{d\varepsilon^e} = \begin{cases} \dfrac{\alpha^2}{\alpha^2+\beta} & (for\ \underline{u} > -\mu) \\ \dfrac{\alpha}{\alpha^2+\beta}\left[\dfrac{\alpha}{2}+\dfrac{\alpha}{2\mu}\left(y^*-\bar{y}+\alpha\varepsilon^e\right)\right] & (for\ \underline{u} \le -\mu) \\ \dfrac{\alpha^2}{\alpha^2+\beta} & (for\ \bar{u} \le -\mu). \end{cases}$$

In full equilibrium $E\varepsilon=\varepsilon^e$. To find fixed points of (19), figure 3 graphs $E\varepsilon$ together with a 45° line. The figure shows how there can be three equilibrium expected depreciation rates, ε_1, ε_2 and ε_3, corresponding to three different devaluation probabilities and realignment magnitudes conditional on devaluation. Implying the smallest devaluation probabilities and realignment magnitudes conditional on devaluation, ε_1 is preferred to ε_2 or ε_3. In contrast, ε_3 is considered "bad" equilibrium for it is associated with the largest devaluation with a probability of 1.

In this model, the government is powerless to enforce its preferred equilibrium should market expectations coalesce around the bad equilibrium. Further, a sudden shift in market expectations could result in realigning the exchange rate.

The strength of fundamentals, reflected in the loss function (2), affects the multiplicity of equilibria. One can show, for example, that a fall in the natural output

level $\bar{y}$ shifts the $E\varepsilon$ curve in equation (19) upward. Thus, as $\bar{y}$ falls from y^*, the corresponding expectations schedule shifts from a single low-inflation intersection with the 45° line, to three, and back to a unique equilibrium in which devaluation is a probability 1 event. Intuitively, $\bar{y}$'s falling from y^* implies that actual output is lower than the government's output target. As the deviation from the output target grows, the government is more likely to devalue its currency. When the deviation is small, the devaluation probabilities and realignment magnitudes conditional on devaluation are the smallest; when the deviation is an intermediate range, anything can happen. The exchange rate collapses if attacked, or survives otherwise; and when the deviation is large, there is a unique equilibrium associated with the largest devaluation with a probability of 1.

1.2.3 Alternative Mechanisms and Early Evidence

The two examples above give the flavor of the second generation research, but covers only a part of many mechanisms that have been discussed. Any economic objective that is conceivably part of the government's social welfare function and whose attainment involves a trade-off with the fixity of the exchange rate is a potential fundamentals candidate which predicts crises. Alternative mechanisms introduced in this section mainly hinge on the higher nominal interest rates associated with market expectation of depreciation.

Public debt

This mechanism was especially evident in Italy's 1992 predicament. Highly indebted governments with mostly short-term or floating-rate nominal debts will find their fiscal burden increased sharply if market expectations of depreciation drive up domestic interest rates. A government chooses depreciation of the domestic currency and/or an increase in tax rate to repay its sharply increased debt. The government that wants to minimize the social loss function under the fiscal constraint will find that a certain degree of currency depreciation is optimal (Obstfeld, 1994).

Banks

Many financial intermediaries come under pressures when market interest rates rise unexpectedly. Non-performing loans rise quickly, and depositors withdraw their funds out of concern over the safety of the banking system. The government's desire to sidestep a costly bailout at public expense results in a currency devaluation. (Tornell, 1999)

Real interest rates

The analysis in section 1.2.2 allowed for an effect of reduced competitiveness on output[14], but not for real interest rate effects. With sticky domestic prices and hikes in nominal interest rate, real interest rate rises and adversely affects economic output. A slowdown of the economy may generate self-fulfilling devaluation pressures.

Pure Speculation

Crises may simply occur as a consequence of pure speculation against the currency. For example, models of herding behavior emphasize that information costs may lead foreign investors to take decisions based on limited information and therefore to be more sensitive to rumors (Calvo and Mendoza, 1997). Contagion effects suggest that a crisis in one country may raise the odds of a crisis elsewhere by signaling that a devaluation is more likely as a result of the initial crisis. This signal may lead to a self-fulfilling speculative attack (Masson, 1998).

1.3 Summary

The theoretical literature about currency crises contains a number of models which rationalize WF or FP. Starting from the seminal contribution of Krugman (1979), *first generation* models show how speculative attacks occur when the fundamentals are weak, i.e., the models stress that crises are caused by excessively expansionary fiscal and monetary policies, which result in a persistent loss of international reserves that ultimately force the authorities to depreciate the nominal exchange rate. According to the first generation models, possible economic variables which precede crises include a fiscal deficit, domestic credit expansion, rising interest rate, low international reserves, inflation, real exchange rate appreciation and current account deficits.

Second generation models differ in the role they assign to the economic fundamentals. In some models the fundamentals play a key role in determining when a crisis may occur. For example, Obstfeld (1996) shows that once the economy reaches the

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[14] An i.i.d. mean-zero shock, u, in equation (15) can be interpreted as changes in competitiveness.

region of weak fundamentals, anything can happen. The exchange rate collapses if attacked, or survives otherwise. In addition, they show that a country with relatively strong fundamentals will never experience a currency crisis. This result suggests that even though it may not be possible to predict the timing of a crisis, it is possible to infer which countries are susceptible to falling into a currency crisis. These models suggest that crises could result from economic variables such as low economic growth, the stock and maturity structure of public debts, and banking problems.

In contrast, other second-generation models show that crises are not affected by the position of the fundamentals. Instead, they may simply occur as a consequence of pure speculation against the currency. For example, contagion effects suggest that a crisis in one country may raise the odds of a crisis elsewhere by signaling that a devaluation is more likely as a result of the initial crisis.

2. Empirical Literature

2.1 Empirical Analyses Before 1990s

Prior to the events of the 1990s, currency crises were thought to have a significant predictable component, with the first generation models identifying fundamentals useful for prediction. A fiscal deficit financed by domestic credit creation is considered to be the root cause of a speculative attack. As the monetary authority monetizes the budget deficit, it causes a gradual decline in international reserves. Eventually, investors attack the fixed exchange rate, depleting the government's reserve holdings used for a defense. Home good prices begin rising before the attack. These price increases lead to a real

exchange rate appreciation and a widening current account deficit prior to an attack. Empirical work on pre-1990s currency crises confirms this pattern in the data.

Blanco and Garber (1986), in their study of recurrent devaluations of the Mexican peso, offer the first empirical application of the speculative attack model. The Mexican authorities did not follow the theoretical scenario outlined in section 1.1. Instead, in the midst of a speculative attack, they devalued the peso against the U.S. dollar. Although such a policy switch does not exactly match the switch to a floating exchange rate usually posited in the theoretical literature, a devaluation that terminates a speculative attack must move the exchange rate to a position where it equals or exceeds the shadow floating rate. Indeed, a successful devaluation must take the shadow floating rate as a lower bound, since any fixed rate below the lower bound would be instantly attacked.

A money market equation provides the central component of their model:

$$m_t - p_t = \beta + \Omega y_t - \alpha i_t + \omega_t \qquad (1)$$

where m_t, p_t and y_t are the logarithms of the money stock, the domestic price level and the aggregate output level, respectively; i_t is the domestic interest rate; and ω_t is a stochastic disturbance to the money demand. Equation (1) represents the demand for real money balances. They further assume that the price level and the interest rate are determined by

$$i_t = i_t^* + Es_{t+1} - s_t \qquad (2)$$

$$p_t = p_t^* + s_t + u_t \qquad (3)$$

where an asterisk signifies an exogenous foreign variable, and s_t and u_t are the logarithms of the nominal and the real exchange rate, respectively. The operator E represents expectations conditional on information through time t. Equation (2) reflects the

assumption of the uncovered interest parity. Equation (3) comes from the definition of real exchange rate.

Using the money market clearing condition, the flexible exchange rate can be determined. Substituting (2) and (3) into (1) yields

$$h_t = -\alpha E\tilde{s}_{t+1} + (1+\alpha)\tilde{s}_t \quad (4)$$

where $h_t \equiv \log[D_t + \overline{R} \cdot \exp(\tilde{s})] - \beta - \Omega y_t + \alpha i_t^* - p_t^* - u_t - \omega_t$, D_t is the domestic credit component of the monetary base at time t and $\tilde{s}_t$ represents the permanently floating exchange rate. $\overline{R}$ represents a lower bound of net reserves where the central bank, having fixed the exchange rate, stops intervening in the foreign exchange market. Equation (4) says that the floating exchange rates $\tilde{s}_t$ and $E\tilde{s}_{t+1}$ are determined by the economic fundamentals h_t.

h_t is assumed to be a first order autoregressive process exogenous to the exchange rate. Specifically, the process h_t is

$$h_t = \theta_1 + \theta_2 h_{t-1} + v_t, \quad (5)$$

where v_t is a white noise process with a normal density function $g(v)$, with zero mean and standard deviation σ.

The flexible exchange rate is obtained by solving the difference equations in (4) and (5). The solution is

$$\tilde{s}_t = \mu\alpha\theta_1 + \mu h_t, \quad (6)$$

where $\mu = 1/[(1+\alpha) - \alpha\theta_2]$.

They assume that the new fixed rate is a simple linear function

$$\hat{s}_t = \tilde{s}_t + \delta v_t \quad (7)$$

where δ is the nonnegative parameter, and $\hat{s}_t$ is the new fixed exchange rate that will be established if the level of reserves attains the value $\overline{R}$ at time t.

$\hat{s}_t$'s exceeding the current fixed rate is equivalent to a devaluation at time t. Therefore, the probability of devaluation at time $t+1$ based on information available at t is

$$pr(\mu\alpha\theta_1 + \mu h_{t+1} + \delta v_{t+1} > \bar{s}),$$

where $\bar{s}$ is the time t value of the fixed rate. Alternatively, the devaluation probability is

$$1\text{-}F(k_t) \equiv pr(v_{t+1} > k_t)$$

where $k_t \equiv [1/(\mu+\delta)][\bar{s} - \mu\alpha\theta_1 - \mu(\theta_1 + \theta_2 h_t)]$, and $F(k_t)$ is the cumulative distribution function associated with $g(v)$.

Knowing this density function, agents can form expectations of future exchange rates from the average of the current fixed exchange rate and the expected rate conditional on a devaluation, both weighted by the respective probabilities of occurrence:

$$Es_{t+1} = F(k_t)\bar{s} + [1 - F(k_t)]E(\hat{s}_{t+1} | v_{t+1} > k_t). \qquad (8)$$

Using (7), the conditional expectation can be expressed as

$$E(\hat{s}_{t+1} | v_{t+1} > k_t) = \mu\theta_1(1+\alpha) + \mu\theta_2 h_t + (\mu+\delta)E(v_{t+1} | v_{t+1} > k_t) \quad (9)$$

where $E(v_{t+1} \Big| v_{t+1} > k_t) = \int_{k_t}^{\infty} \frac{v g(v)}{1 - F(k_t)} dv$. Since g(v) is a normal density function, the unconditional forecast of the exchange rate for $t+1$ is

$$Es_{t+1} = F(k_t)\bar{s} + [1 - F(k_t)][\mu\theta_1(1+\alpha) + \mu\theta_2 h_t] + \frac{\sigma(\mu+\delta)\exp[-.5(k_t/\sigma)^2]}{\sqrt{2\pi}}. \quad (10)$$

The one-step-ahead devaluation probability (8) and the conditional and unconditional exchange rate forecasts (9) and (10) are the main products of this model. It is expected

that [1- $F(k_t)$] should reach a peak immediately before a devaluation and Es_{t+1} should be closely correlated with the appropriate forward rates. Finally, the conditional forecast should approximate the exchange rate when a devaluation occurs.

Interpreting forward exchange rates as unconditional expected rates, they can estimate the unknown parameters in (10). They assume that the future rates for the Mexican peso f_t are generated by

$$f_t = Es_{t+1} + \varepsilon_t \qquad (11)$$

where ε_t is a disturbance.

Estimation proceeds as follows. In the first stage, they estimate the money demand parameters[15] in equation (1). In the second stage, they use an initial guess of $\overline{R}$ along with the money demand parameter, to construct an initial h_t series. The initial h_t series is used to estimate the parameters[16] of the AR(1) process of h_t in equation (5). Es_{t+1} is computed from the substitution of the AR(1) process estimates and the money demand parameters into equation (10). Substituting Es_{t+1} into the nonlinear equation (11), they re-estimate $\overline{R}$ and δ by minimizing the sum of squared residual of parameters and the initial values of $\overline{R}$ and δ. Since the second stage was initiated by a guessed $\overline{R}^{(1)}$ and produces an estimate $\overline{R}^{(2)}$, the estimate from the second stage is taken as the initial guess for a third stage. The iterative process is continued until the guess, $\overline{R}^{(n)}$, and the revised estimate, $\overline{R}^{(n+1)}$, converges.

The estimation method above is applied to the Mexican crisis over the 1973-1982 period. Their estimated probabilities of devaluation in the next quarter, which range

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[15] β, Ω and α.

from highs of more than 20 percent in late 1976 and late 1981, to lows of less than 5 percent in early 1974 and late 1977, reach local peaks in the period of devaluation and reach local minima in the periods following devaluation as predicted by the theory. Furthermore, the expected exchange rates conditional on devaluation are close to the values that actually materialized in the major episodes.

Subsequent studies along this line have focused on Argentina (Cumby and Van Wijnbergen, 1989), Mexico in the 1980s (Goldberg, 1994), Mexico between 1982 and 1994 (Otker and Pazarbasioglu, 1997a) and the experiences of several European countries in the context of the European Monetary System (Otker and Pazarbasioglu, 1997b). These studies, however, focus on a particular country in a specific time period, so they leave open to the question about the generality of the results.

Later studies, using a nonstructural approach to analyze crisis episodes in a set of countries before the 1990s, confirm the role of traditional fundamentals in predicting crises. For example, Edwards (1989) examines the evolution of a number of key variables during the three years preceding each of 39 devaluation episodes in developing countries between 1962 and 1983. Comparing the outcomes with those from a control group that maintained a fixed exchange rate for at least ten years, he finds that as the year of devaluation comes nearer, macroeconomic policies became increasingly expansive in the devaluing countries, the real exchange rate appreciated, the current account balance declined, and there was an important rundown of international reserves.

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[16] θ_1, θ_2 *and* σ.

2.2 Empirical Analyses After 1990s

The speculative attacks of the 1990s, particularly those in Europe, challenged the view that currency crises were due largely to the government's inability to achieve fiscal and monetary discipline. A number of researchers inspired by the crises in the 1990s and theoretical achievements by the second generation models have turned to empirical models that use a wide variety of information variable to distinguish between periods leading up to currency crises and tranquil periods.

These studies differ from one another in the definition of crisis, estimation methodology, data coverage and explanatory variables included. Three studies are provided below as examples to compare similarities and differences among the studies.

2.2.1 Three Examples

Example 1

Frankel and Rose (1996) use a panel of annual data for 105 developing countries, from 1971 through 1992, to analyze the determinants of currency crises. They define a currency crisis as a nominal depreciation of at least 25 percent in the bilateral exchange rate against the US dollar with respect to the previous years. To deal with the exchange rate change of 25 percent or more year after year in the countries with a chronic inflation, it is required that the change in the exchange rate, not only exceed 25 percent, but exceed the previous year's change in the exchange rate by a margin of at least 10 percentage points. To avoid counting the same crisis more than once, they also exclude the later observations, when two or more crises occur in successive years.

They examine variables relevant to the theoretical literature. Inspired by the first generation models, they choose the rate of growth of domestic credit, the government budget as a fraction of GDP, the ratio of reserves to imports, the degree of overvaluation of the real exchange rate, differentials between domestic and foreign interest rates, and the current account as a percentage of GDP. Based on the second generation models, they also estimate the effects of the growth rate of real output, the ratio of short-term debt to total external debt and the ratio of external debt to GDP.

Most estimation results from their probit regression are consistent with the theoretical literature.[17] Frankel and Rose find that high short-term debt ratio (as a share of total external debt), low international reserves (as a share of imports), high domestic credit growth and overvaluation of the real exchange rate increase the probability of a currency crises.

The significance of their results, however, is limited by the lack of robustness to various sensitivity tests and poor performance in predicting actual crises.[18]

Example 2

Sachs, Tornell and Velasco (1996) analyze the spillover effects of the Mexican crisis in 1995 on a group of 20 emerging market economies. They measure the extent of financial crisis in 1995 with a crisis index (denoted IND) that measures pressures on the foreign exchange market. IND is a weighted average of the devaluation rate with respect

[17] For details of the probit regression method, see section 3.2 in chapter IV.
[18] Only five of sixty nine actual crises during the sample period are predicted by their model.

to the U.S. dollar and the percentage change in foreign exchange reserves between the end of November 1994 and the end of the first six months of 1995.

The weights given to the loss in reserves and the devaluation are designed to equalize volatilities of the components of the index. For each variable they calculate the precision (inverse of variance) of the monthly series over the period 1985-1995. Then for each country they compute the weight of each variable as its precision over the sum of precisions.

The rationale for this index is as follows. If capital inflows reverse, the government can let the exchange rate depreciate. Alternatively, it can defend the currency by running down reserves or by increasing interest rates. Since there are no reliable and comparable cross-country interest rate data, they construct the index using levels of reserves and exchange rates.

Using an ordinary least square regression, they find that low international reserves relative to broad money, real exchange rate appreciation, and a weak banking system explain about 70 percent of the variation of their IND. Cooper (1996), however, has warned against overemphasizing these results, since they are drawn from a single crisis episode.

Example 3

Kaminsky and Reinhart (1999) examine the stylized facts of the period leading up to and immediately following the currency crisis. The definition of a crisis is a mix of those in Frankel and Rose (1996) and Sachs, Tornell and Velasco (1996). They construct an index of currency crisis as a weighted average of exchange rate changes and reserve

changes. Values of this index that are three standard deviations or more of the mean are cataloged as crises.

Through graphic analysis[19], they find evidence suggesting that several economic variables behave quite differently in tranquil periods as compared to crises period: The real exchange rate is overvalued; exports and the terms of trade are deteriorated; and economic growth is slowed down. The periods just before crisis are also characterized by a highly expansionary monetary policy, low reserves and increases in interest rate differentials. Based on the results, they propose an early warning system to prevent future currency crises.

A graphical approach has disadvantages. The graphs are informal. More importantly, they are intrinsically univariate. They encourage readers to examine individual variables by themselves, whereas the norm in econometrics is to look at the marginal contribution of each variable conditional on the others.

2.2.2 Similarities and Differences among Empirical Studies After 1990s

As shown in the review of three examples, empirical studies vary with respect to how a crisis is defined. Some of them examine large and infrequent devaluation.[20] Others adopt a broader definition of crises.[21] They include, in addition to devaluations, episodes of unsuccessful speculative attacks; i.e., attacks that were averted without a devaluation, but at the cost of large increase in domestic interest rates and/or a sizable loss of international reserves.

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[19] For details, see section 3.1 in chapter IV.
[20] Frankel and Rose (1996) and Esquivel and Larrain (1998a).

Regarding the methodology used, the various papers can be grouped into two broad categories. A first group of papers examines the stylized facts of the period leading up to and immediately following the currency crisis.[22] A second group of papers estimates the probability of devaluation one or several periods ahead in the probit methods typically undertaken.[23]

2.3 Summary

The empirical evidence on the determinants of currency crises is far from conclusive, and most of the interesting and robust results come from country specific studies. Evidence from multi-country studies is mixed and not very robust. Other results, like those of Sachs, Tornell and Velasco (1996), come from a sample that is far from random and that focuses on a very specific event (the aftermath of the Mexican crisis in 1994).

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[21] Sachs, Tornell and Velasco (1996) and Kaminsky and Reinhart (1999).
[22] Eichengreen, Rose and Wyplosz (1996b) and Kaminsky and Reinhart (1999).
[23] Frankel and Rose (1996), Esquivel and Larrain (1998a), and Sachs, Tornell and Velasco (1996).

Appendix 1. Log-linear Approximation of the Money Market Identity

According to the identity, $M=R+D$ where M, R and D denote the stock money, reserves and domestic credit. The log-linear approximation in equation (2) comes from the following algebra.

$$\ln M = \ln(R+D)$$

$$= \frac{R+D}{R+D}\ln(R+D)$$

$$= \frac{R}{R+D}\ln(R+D) + \frac{D}{R+D}\ln(R+D)$$

$$= \frac{R}{R+D}\left[\ln R + \ln(1+\frac{D}{R})\right] + \frac{D}{R+D}\left[\ln D + \ln(1+\frac{R}{D})\right]$$

$$= \frac{R}{R+D}\ln(1+\frac{D}{R}) + \frac{D}{R+D}\ln(1+\frac{R}{D}) + \frac{R}{R+D}\ln R + \frac{D}{R+D}\ln D$$

Ignoring the first two terms yields the log-linear approximation.

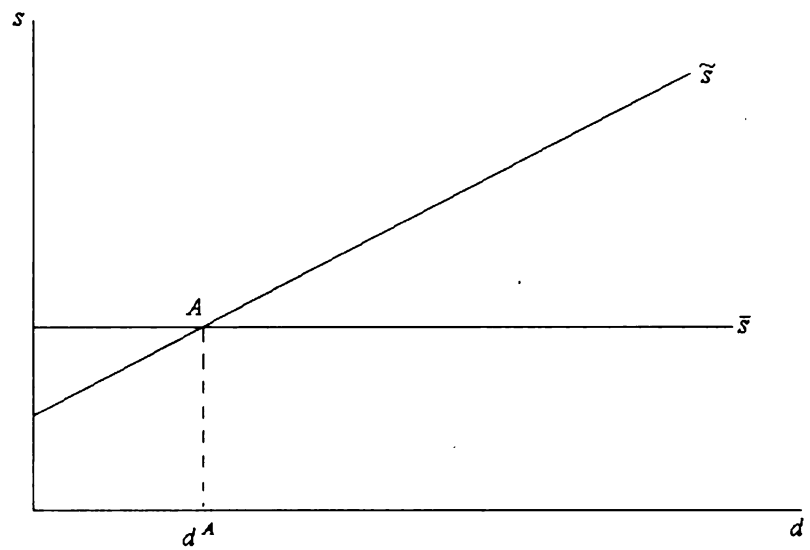

Figure 1. Attack Time in a Certainty Model

When domestic credit d is less than d^A, there is no attack; when $d > d^A$, speculators attack the currency.

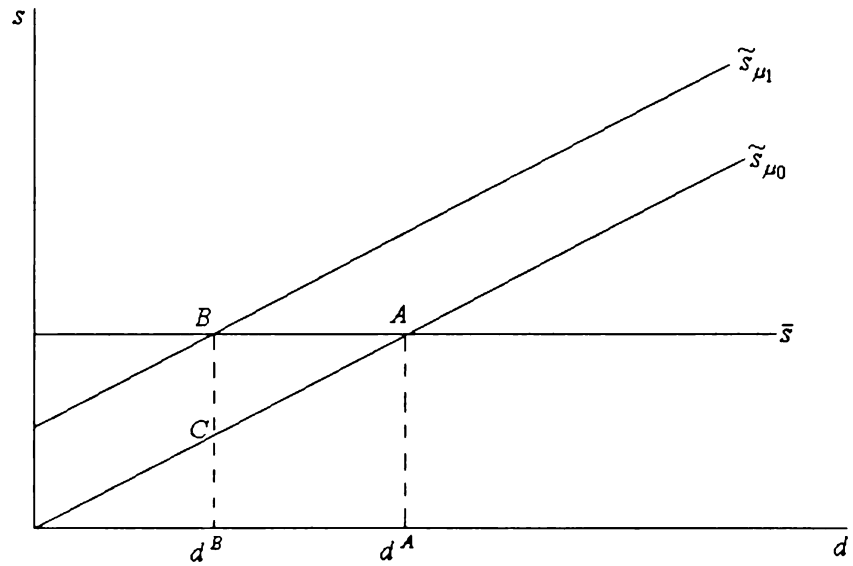

Figure 2. Attack Times with Attack-Conditional Policy Shift

When $d < d^B$, there is no attack; when $d^B < d < d^A$, multiple equilibria are possible; when $d > d^A$ speculators attack the currency.

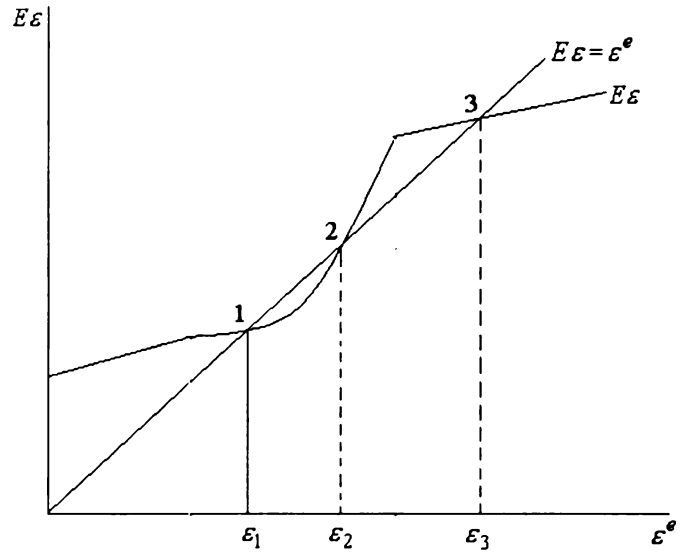

Figure 3. Three Equilibrium Expected Depreciation Rates

There can be three equilibrium expected depreciation rates ε_1, ε_2 and ε_3, corresponding to three different devaluation probabilities and realignment magnitudes conditional on devaluation.

CHAPTER IV

DETERMINANTS OF CURRENCY CRISES

This chapter offers a formal empirical analysis of the determinants of currency crises, using a panel dataset with *quarterly* information for 25 countries during the period 1980-1997. Explanatory variables are defined in close correspondence with the factors emphasized in the theoretical literature.

The analysis in this chapter differs from previous empirical studies in the use of quarterly data.[24] Estimating with annual data cannot capture all of the activities in some of the explanatory variables, a few months before and after the collapse. Identifying all of the activities is critical for an analysis of the Asian crisis since annual data hide the rapid movement in the second half of 1997.

This chapter is organized as follows: Section 1 presents the definition of a crisis used in this study; section 2 discusses data and the explanatory variables; and section 3 presents main empirical results and an application to the Asian crisis in 1997.

1. Definition of Crises

I consider that a currency crisis exists when there is an abrupt change in the nominal exchange rate. For a nominal devaluation to qualify as a currency crisis, I use two criteria. First, as defined below, the devaluation rate has to be "large" relative to what is considered standard from the viewpoint of each country (Condition A and B below). Second, the nominal devaluation has to be "real", in the sense that it should

affect the purchasing power of the domestic currency. Thus, nominal depreciations that simply follow a high inflation episode are excluded from currency crises even if they are fairly large.

These two considerations imply that a currency crisis exists only if a nominal devaluation is accompanied by a large and abrupt change in the real exchange rate. In practical terms, a currency crisis is considered to occur during the quarter when one of the following conditions is met:

Condition A

The accumulated three-month change in the real exchange rate (RER) is 15 percent or more ($\Delta^3 \varepsilon_{it} > 15\%$).

or

Condition B

The one-month change in the RER is higher than 2.54 times the country-specific standard deviation of the RER monthly change rate, provided that it also exceeds 5 percent ($\Delta^1 \varepsilon_{it} > 2.54 \sigma_i^{\Delta\varepsilon}$ and $\Delta^1 \varepsilon_{it} > 5\%$).[25]

ε_{it} is the RER in country i in period t.

$\Delta^1 \varepsilon_{it}$ is the one-quarter growth rate of the RER in country i in period t.

$\sigma_i^{\Delta\varepsilon}$ is the standard deviation of $\Delta^1 \varepsilon$ in country i.

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[24] See appendix 1 for the summary of previous studies.

[25] Assuming that changes in the RER are normally distributed, Condition B attempts to capture changes in the RER that lie in the upper 0.5 percent of the distribution.

Condition A is intended to make sure that any large real depreciation is counted as a currency crisis. The threshold value of 15 percent is arbitrary, but the sensitivity analysis provided later shows that the estimation results are robust to various threshold values. Condition B, on the other hand, attempts to capture changes in the RER that are sufficiently large relative to the historical country-specific monthly change of RER. In addition to condition A and B, I further assume that crises have to be three years apart to avoid double counting.[26]

2. Data and Explanatory Variables

2.1 Data

I have collected quarterly data for a panel of 25 countries from 1980 through 1997. All of the variables are taken from the CD-ROM version of the International Monetary Fund's *International Financial Statistics* (IFS).[27]

The sample size is dictated first by the availability of data on the real exchange rate. I use the J.P. Morgan real exchange rate database that is available for 45 countries on a monthly basis since January 1970.[28] From this group I exclude 20 countries based on several criteria. First, I exclude countries that I expect a priori to behave very differently from the rest of the group: high-income oil countries[29] and countries whose currency plays a key role in the international monetary system[30]. Second, I exclude

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[26] Previous studies also try to avoid double counting. For example, Esquivel and Larrain (1998a) assume a five-month window around each crisis, and Frankel and Rose (1996) use a three-year window

[27] Quarterly data for GDP, government budget and current account are missing in some countries. For those countries, quarterly data are created using annual data. For details, see appendix 2.

[28] The real exchange rate database is trade-weighted, adjusted for relative consumer prices.

[29] Kuwait and Saudi Arabia.

[30] The United States, Germany and Japan.

countries for which quarterly data for some variables are not available.[31] After the exclusions, there were 25 countries remaining in the sample.[32]

2.2 Number of Crises

The number of crises in the 25 countries of our sample is obtained through the imposition of conditions A and B on the real exchange rate dataset. In addition to A and B, I further assume that crises have to be at least three-years apart. I am able to identify 38 crisis episodes, a list of which is provided in appendix 3.[33]

Figures 4 and 5 provide a quick overview of the number of currency crises in the sample. Figure 4 shows the number of crises per year during the period 1980-1997. The first peak corresponds to 1982, the year the debt crisis exploded in Latin America. A second peak is observed in 1992, when financial instability affected the European Monetary System (EMS). The most recent peak in 1997 reflects the Asian currency crises.

Figure 5 shows the number of currency crises per country. As expected, given the economic turbulence that afflicted Latin America during the sample period, crises are most frequently observed in the region.

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[31] Australia, New Zealand, Canada, Austria, Belgium, Denmark, Turkey, Ecuador, India, Pakistan, Hong Kong ,Taiwan, Morocco, Nigeria, and South Africa.

[32] The United Kingdom, France, Italy, Netherlands, Norway, Sweden, Switzerland, Finland, Greece, Ireland, Portugal, Spain, Argentina, Brazil, Chile, Columbia, Mexico, Peru, Venezuela, Indonesia, Korea, Malaysia, Singapore, the Philippines, and Thailand.

[33] Conditions A and B yield 112 different crises, 74 of which are deleted because of the three-year "windowing".

2.3 Explanatory Variables

Below I define and explain the explanatory variables used in this chapter. They can be divided into two groups: those that are more closely associated with first generation models of crises, and those that capture some of the insights developed by second generation models.

2.3.1 Variables based on First Generation Models

Real Exchange Rate (RER) Misalignment[34]

Some previous empirical studies of crises have simply used a RER index as an explanatory variable. While a simple RER index may be adequate in single-country studies, it is hardly acceptable in a multi-country analysis where the cross-section information should also be exploited. Using a RER index implies that RERs of all countries in the sample are equally aligned during the base year, which is an improbable assumption.

Overcoming this problem, RER misalignment in my analysis is defined as the percentage of deviation of the RER from its average over the previous 3 years. This definition makes the RER easily comparable both across time and across countries. An increase in the RER misalignment is expected to increase the risk of a currency crisis.

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[34] As noted earlier, the RER is a trade-weighted exchange rate. The RER misalignment variable is defined so that RER appreciation, with respect to the previous 3-year average, enters with a positive sign. An increase in the misalignment variable then represents a larger appreciation and a higher risk of a crisis.

Current Account Balance

Along with an appreciation of the RER, a deterioration of the current account balance is also expected to precede a currency crisis. If the RER variable were an exact measure of changes in a country's competitive position, and the current account balance correspondingly reacted to changes in the RER, then the current account variable would likely not add any extra information to that contained in the RER variable. However, if either of these two assumptions does not hold, we should expect the current account balance to add some extra information to the RER in explaining currency crises. The current account (IFS line 78ald) is converted into domestic currency by market exchange rates (line rf) and measured as percentages of nominal GDP (line 99b or 99bc). Note that positive values imply current account deficits.

M_2/Reserves

Since government usually loses substantial reserves in the months previous to a currency crisis, I expect to find a positive association between this variable and the probability of crisis. In order to make foreign exchange reserves comparable across countries, a scale variable is needed. As in Sachs, Tornell and Velasco (1996), I have chosen the ratio of M_2 to reserves. The ratio captures the extent to which the liabilities of the banking system are backed by international reserves. In the event of a currency crisis, individuals may rush to convert their domestic currency deposits into foreign currency, so that this ratio captures the ability of the central bank to meet those demands. To reduce dispersion, I use 4-quarter change rate of this ratio.

2.3.2 Variables based on Second Generation Models

Real GDP Growth and Government Debt

The line 99bp or 99bpr is used for the measure of real GDP. This variable attempts to capture the escape-clause interpretation that has been developed in various second-generation models of currency crises.[35] A slowdown in GDP growth rate is assumed to increase the policymaker's incentives to switch to a more expansionary policy, which can be achieved through a nominal devaluation of the currency. I expect a negative coefficient associated with this variable.

A large amount of government debt (line 80) as a ratio to nominal GDP is also expected to increase the possibility of a crisis.

Lending Boom Financed by Foreign Liabilities

A broad cross-country set of comparable bank balance sheets does not exist. Hence, the weakness of the banking sector cannot be assessed directly by comparing ratios of non-performing loans to total assets. I use, instead, an indirect measure of financial system vulnerability: the magnitude of the increase in bank lending measured as a ratio of claims on the private sector by deposit money bank (line 32d) to GDP. A bank lending boom is likely to end up with a large proportion of weak borrowers in their portfolios as the banks' ability to screen marginal projects declines and high risk areas, such as credit cards and consumer and real estate loans, tend to grow more than proportionately.

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[35] For example, Obstfeld (1994, 1996).

The measure of foreign liabilities used is the banks' foreign liabilities (line 26c) as a ratio to GDP which captures the extent to which the banking system is exposed to international capital flows. I expect a positive relationship between the variables above and the probability of a crisis..

Contagion Effects

Contagion effects are the most recent contribution of second generation models. There are several channels through which they may be transmitted across countries. Most explanations, however, imply that contagion effects tend to occur at the regional level.

I make use of this finding in the definition of a contagion variable. First, I define three regions (Europe, Latin America and Asia) and assign countries to each one of them. Next, I define a dichotomous variable that takes the value of 1 for the countries belonging to a region where at least one other country has had an exchange rate crisis in the current or previous quarter. Otherwise, the value is 0.[36]

As long as my set of explanatory variables captures the fundamentals reasonably well, the estimated impact of the contagion variable can be interpreted as a pure contagion effect. This effect reflects a situation where a crisis in one country may trigger a crisis elsewhere for reasons unexplained by macroeconomic fundamentals.

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[36] One caveat of the definition is that the contagion dummy does not capture contagion from the Asian crisis to Russia and Latin America in 1998.

3. Empirical Results

3.1 Graphic Analysis

The definition of a crisis in section 1 yields 38 crises that are spread over 22 countries.[37] Figure 6 is a set of seven graphs each of which portrays the movement in a variable of interest beginning four quarters before the crisis and continuing through the crisis (marked by 0 on the X-axis) until four quarters afterwards.

The graphs are set up as follows. First, I choose one variable, for example, current account, and focus on the observations four quarters before and after the crisis episodes. Since there are 38 crisis episodes, we have 38 observations for each of 9 periods (four quarters within a crisis). Second, the average for each of 9 periods is calculated and plotted in the graph for the current account. Third, the average for tranquil periods is marked by a horizontal line, being compared with the pre- and post-crisis behavior. The observations that are not within four quarters of a crisis constitute a sample of tranquil observations. The above steps are repeated for each of the other six variables.

The movements of current account and real exchange rate are not much different from what is expected. The ratio of current account to GDP in figure 6 is positive and above the straight line before the crisis period, meaning current account is in deficit and the deficits are larger than those in tranquil periods.[38] The RER in the associated graph indicates overvaluations in the periods preceding crises.

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[37] No crisis is observed in France, the Netherlands and Switzerland. See appendix 3 for the detail.
[38] A point in the horizontal line would indicate that the variable has exactly the same value with the average in tranquil periods.

With regards to the financial variables, both claims on the private sector and foreign liabilities of deposit money banks show results consistent with the theoretical literature. They are above normal and being built up before a crisis.

Domestic macroeconomic variables are generally weak as expected. The GDP growth rates are shrinking sharply before crises, reflecting a slowdown of the economy during crisis periods. The ratio of M_2 to international reserves increases steadily, reaching a peak a quarter before the crisis. An unexpected result is observed in the movement of the government budget. Although the government budget tends to be in deficit, the deficits are less than those in tranquil periods.

Even though most variables show the expected movements, the graphic analysis does not provide the marginal contribution of each variable conditional on the others. To overcome this problem, the next section estimates probit models, where all the variables are employed simultaneously.

3.2 Regression Analysis

3.2.1 Methodology

The currency crisis variable (Y_{it}) is dichotomous, set to 1 if a currency crisis occurs during the period t and 0 otherwise.

It is assumed that there is an unobservable or latent variable (Y_{it}^{*}) which is described by

$$Y_{it}^{*} = \beta' X_{it-1} + u_{it}$$

where X_{it-1} is a vector of explanatory variables from country *i* in period *t-1*, β is a vector of coefficients to be estimated, and u_{it} is an error term. I now assume that the observed currency crisis variable behaves according to

$$Y_{it}=1 \text{ if } Y_{it}^{*} > 0$$

and

$$Y_{it}=0 \text{ otherwise.}$$

The applied econometric estimation method is a probit model that has the following form:

$$\text{Prob}(\text{Crisis}_{it})=\text{Prob}(Y_{it}=1)=\Phi(\beta' X_{it-1})$$

where X_{it-1} and β are as before, and Φ represents the standard normal distribution. Since the dependent variable is dichotomous and takes the value of 1 when there is a crisis and 0 otherwise, the fitted values may then be interpreted as the one-step-ahead probabilities of a currency crisis.

3.2.2 Estimation Results

Since probit coefficients are not easily interpretable, I report the effects of one-unit changes in regressors on the probability of crisis, evaluated at the mean of the data. I tabulate the associated z-statistics, which test the null of no effect. Diagnostics are reported at the foot of table 8, including pseudo-R^2 and a test for the joint significance of all the coefficients.[39] In addition, appendix 4 provides the percentage of crisis and no-crisis observations predicted correctly by the bench mark estiamtion.

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[39] There are various pseudo-R^2 measures for a binary response model. I report the measure suggested by McFadden (1974)

The probit regression, the results of which are reported in table 8, use one-quarter-lagged explanatory variables. There are two reasons why I use lagged variables. First, I would like to interpret my results as one-step-ahead probabilities of the occurrence of a crisis. Second, I expect a huge effect from the dependent variable, the currency crisis dummy, to the contemporaneous explanatory variables. For example, negative economic growth is not uncommon during crisis periods, but it is most likely a result of restrictive macroeconomic policies to overcome crises. Thus, estimating contemporaneous values of the explanatory variables would not provide the effects of the explanatory variables on the dependent variable.

Benchmark Estimation

In the benchmark estimation I use quarterly data for 25 countries from 1980 through 1997, and estimate the following equation. The main results are presented in the second column of table 8.

$$\Pr(Crisis) = \Phi(\alpha_0 + \alpha_1 CA + \alpha_2 RER + \alpha_3 M_2 / RES + \alpha_4 GDP + \alpha_5 GOVT + \alpha_6 LB + \alpha_7 FOR + \alpha_8 CONTAG) \qquad (11)$$

where CA = the ratio of current account deficit to GDP, RER = the real exchange rate misalignment, M_2/RES = four-quarter change rate in the ratio of M_2 to international reserves, GDP = GDP growth rate, GOVT = the ratio of government budget balance to GDP, LB = the ratio of bank lending to GDP, FOR = the ratio of banks' foreign liabilities to GDP, and CONTAG = the contagion dummy. Pr(crisis) denotes the probability of a crisis.

All external variables have statistically and economically significant coefficients. First, the coefficient of the current account variable shows that one percentage point increase in the ratio of current account to GDP increases the probability of a crisis by

0.09 percentage point. The results are of special interest since many of previous empirical studies such as Frankel and Rose (1996) and Kaminsky, Lizondo and Reinhart (1997) found this variable to be non-significant as a determinant of a currency crisis. Second, the RER misalignment and the M_2/reserves also have statistically and economically significant coefficients. Even though their impact on the probability of a crisis appears small (0.06 and 0.03 percentage point, respectively), we should consider that the regression controls for one of the most direct effects of the external variable, the current account balance, which may explain the relatively small size of the coefficients.

The domestic macroeconomic effects show mixed results. The coefficient for real output growth shows that one percentage point decrease in GDP growth raises the probability of a crisis by 0.15 percentage point, providing some support to the escape-clause models developed by Obstfeld (1994, 1996). The government budget balance, however, has no significant impact. This may be explained by diverse natures of crisis episodes. For example, the government debt caused the crisis in Latin America in early 1980s, while it is not considered as a main factor of the Asian crisis in 1997.

Interestingly, the estimation provides little evidence that the lending boom financed by foreign capital raises the probability of crises. Contrary to the graphic analysis, neither the bank lending nor the banks' foreign liabilities variable has a significant coefficient. This puzzling result will be further studied in chapter V, which shows that a lending boom increases the probability of crises when it is associated with low reserves and external imbalances.

Finally, the contagion dummy is statistically significant. The positive coefficient suggests that a crisis in one country raises the possibility of a crisis in other countries in the same region.[40]

Robustness Tests

The third to the fifth column in table 8 present robustness tests of the benchmark estimation to different sub-samples and an alternative definition of the crisis dummy. The third column uses quarterly data for the developing countries in the sample. The fourth column presents the regression results based on data for 1990-1997. Finally, the last column uses a different definition of a crisis. The condition A is modified by a 10 percent threshold.

None of the estimation results is sensitive to the changes in the definition and the sample coverage. All five variables that were significant in the benchmark regression (current account, RER misalignment, M_2/RES, GDP growth and contagion) remain significant in the various robustness tests. The only exception is the insignificant coefficient of the current account variable in the developing countries. Meanwhile, as in the benchmark estimation, the effect of the three variables (government budget, banks lending, and foreign liabilities) are not significantly different from zero.

[40] As noted earlier, the "naïve" measure of contagion in the estimation cannot capture the contagion from Asia to Russia and Latin America in 1998. A modification of the contagion variable will be an interesting topic for future research.

4. Summary

In this chapter, I developed a formal empirical analysis of the determinants of currency crises. Both the graphic analysis and the probit regression show that crises tend to occur when current account deficit grows, real exchange rates are overvalued and M_2/reserves increases. They also tend to be associated with a sharp slowdown in GDP growth and pure contagion. Contrary to theoretical expectation, government debt, bank lending to the private sector, and foreign liabilities of banks turned out to be insignificant in the probit regression.

Table 8. Probit Results

variables	All	Developing Countries	Post 1990	10% threshold
CA	0.09*	-0.05	0.10**	0.09*
	(1.87)	(-0.52)	(2.01)	(1.78)
RER	0.06**	0.10**	0.05**	0.06**
	(2.68)	(2.82)	(2.46)	(2.25)
M_2/RES	0.03**	0.04**	0.02**	0.03**
	(4.35)	(3.68)	(3.11)	(4.35)
GDP	-0.15**	-0.21**	-0.11**	-0.17**
	(-2.86)	(-2.75)	(-2.16)	(-2.97)
GOVT	-0.02	-0.07	0.02	-0.01
	(-0.44)	(-1.05)	(0.41)	(-0.12)
FOR	-0.01	-0.01	-0.00	-0.00
	(-1.37)	(-0.77)	(-0.08)	(-0.49)
LB	0.00	0.01*	0.00	0.00
	(1.32)	(1.75)	(0.38)	(0.30)
CONTAG	0.02**	0.02*	0.04**	0.03**
	(3.10)	(1.93)	(3.34)	(4.14)
observations	1173	564	528	1117
Pseudo-R^2	0.24	0.28	0.36	0.26
$\chi^2(8)$ (Ho:slopes=0)	69.27	47.88	44.24	77.69
P-value	0.00	0.00	0.00	0.00

Significance at the 10 percent level is denoted by *; at the 5percent level, by **.
The numbers in parentheses are z-statistics.

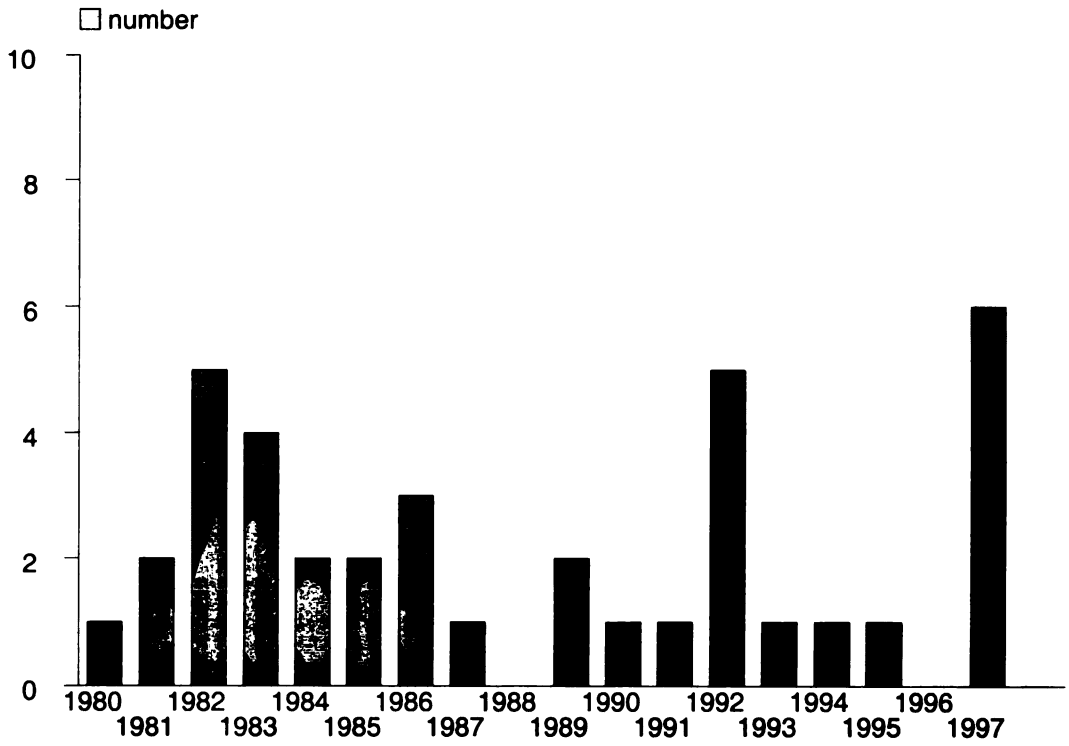

Figure 4. Currency Crises per Year

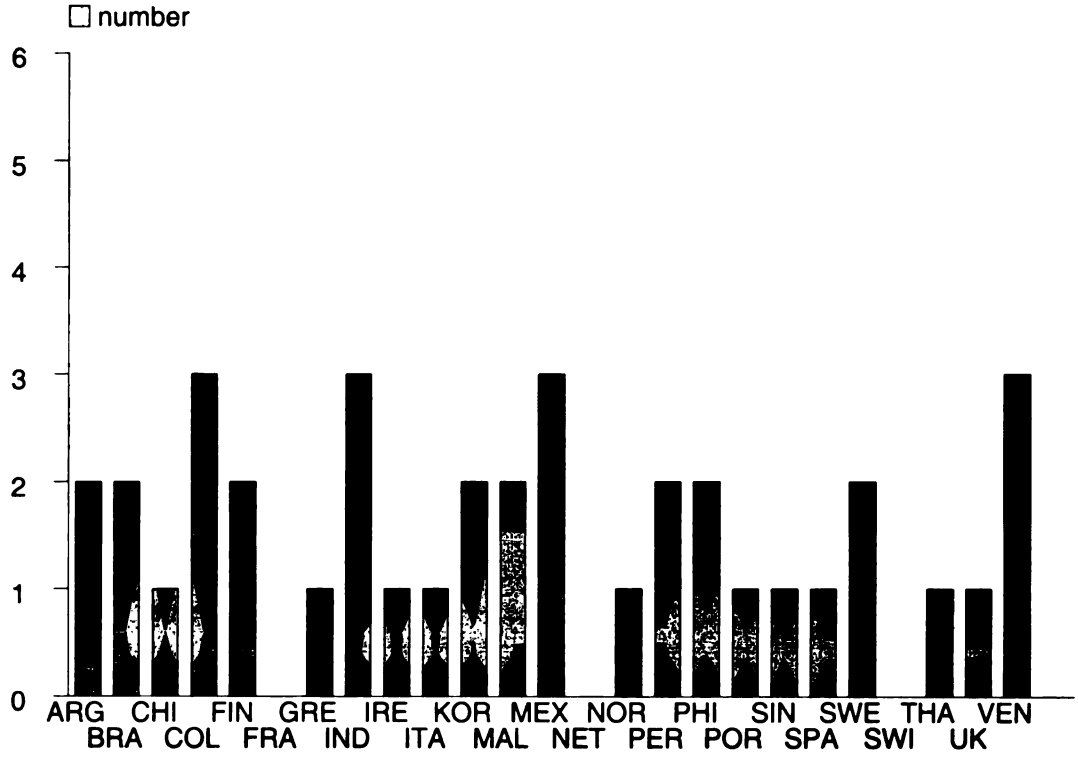

Figure 5. Currency Crises per Country

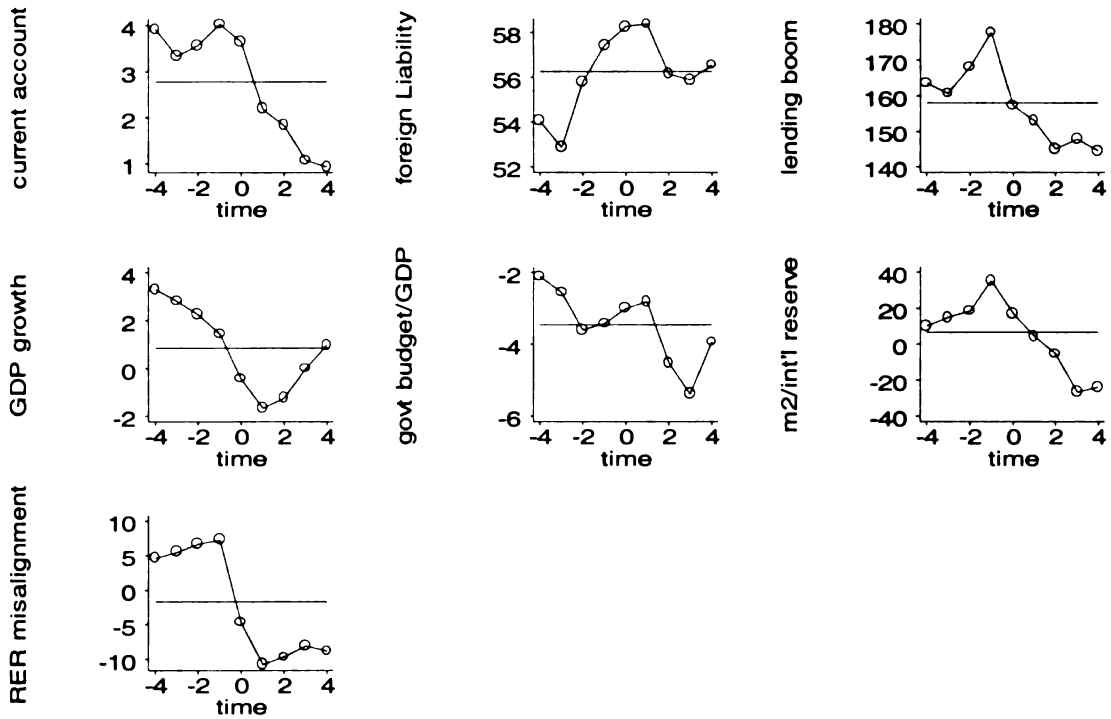

Figure 6. Movements Four Quarters Before and After Crises

Appendix 1. Previous Studies of Currency Crises Based on Panel Data

Author and Year Published	Countries	Time Period	Data Frequency	Comments
Eichengreen, Rose and Wyplosz(1996a)	20 industrial countries	1959-1993	quarterly	Main focus is on the channel of contagion effects. The effects of the macroeconomic variables are not significant.
Frankel and Rose(1996)	105 developing countries	1971-1992	annual	
Sachs, Tornell and Velasco(1996)	20 developing countries	1985-1995	annual	The emphasis is on explaining why some countries were more affected by the Mexican crisis than others.
Radelet and Sachs (1998b)	24 developing countries	1994-1997	annual	This study provides a formal test on the "financial panic" and the "weak fundamental" view on crises.
Esquivel and Larrain (1998a)	30 countries	1975-1996	annual	

Appendix 2. Creation of Quarterly Data

Quarterly data for GDP, current account and government budget are completely or partly missing in some countries. For those countries, I create the data using the following steps. First, I estimate the relationship between quarterly data and annual data in the countries where both data are available. Second, I substitute annual data for the countries where quarterly data are missing, into the right hand side of the estimated equation. Third, the predicted values of the equation are used as quarterly data.

Estimation Results:

Real GDP	Nominal GDP	Gov't Budget	Current Account
$Y_{t,Q1}$=-.019*Y_{t-1} +.220*Y_t (R^2=.99)	$Y_{t,Q1}$=.202*Y_{t-1} +.057*Y_t (R^2=.99)	$Y_{t,Q1}$=.220*Y_{t-1} +.033*Y_t (R^2=.95)	$Y_{t,Q1}$=.112*Y_{t-1} +.173*Y_t (R^2=83)
$Y_{t,Q2}$=-.155*Y_{t-1} +.377* Y_t (R^2=.99)	$Y_{t,Q2}$=.064*Y_{t-1} +.184* Y_t (R^2=.99)	$Y_{t,Q2}$=-.042*Y_{t-1} +.211* Y_t (R^2=.90)	$Y_{t,Q2}$=.009*Y_{t-1} +.241*Y_t (R^2=.90)
$Y_{t,Q3}$=.606*Y_t +-.281*Y_{t+1}(R^2=.99)	$Y_{t,Q3}$=.189*Y_t +.062*Y_{t+1} (R^2=.99)	$Y_{t,Q3}$=.360*Y_t +-.047*Y_{t+1}(R^2=.98)	$Y_{t,Q3}$=.256*Y_t +-.004*Y_{t+1}(R^2=.87)
$Y_{t,Q3}$=.103* Y_t +.154*Y_{t+1} (R^2=.99)	$Y_{t,Q3}$=.207* Y_t +.049*Y_{t+1}(R^2=.99)	$Y_{t,Q3}$=.214* Y_t +.084*Y_{t+1}(R^2=.91)	$Y_{t,Q3}$=.177* Y_t +.065*Y_{t+1}(R^2=.83)

$Y_{t,Q*}$ and Y_t represent quarterly and annual data in year *t*, respectively.

Countries where quarterly data are created

Real GDP	Nominal GDP	Gov't Budget	Current Account
Ireland, Brazil, Chile, Columbia, Venezuela, Indonesia, Malaysia, Thailand	Greece, Ireland, Argentina, Brazil, Chile, Columbia, Venezuela, Indonesia, Malaysia, Singapore, Thailand	Norway, Sweden, Portugal, Argentina, Chile, Indonesia	Switzerland, Chile, Columbia, Peru, Venezuela, Malaysia, the Philippines, Singapore

Appendix 3. List of Currency Crises during the Sample Period

Country	Crisis Period
United Kingdom	1992.IV
Italy	1992.III
Norway	1986.III
Sweden	1981.III, 1992.IV
Finland	1982.IV, 1992.III
Greece	1983.I
Ireland	1993.I
Portugal	1982.II
Spain	1982.IV
Argentina	1981.II, 1989.II,
Brazil	1983.I, 1990.II
Chile	1982.III
Columbia	1985.II, 1991.III, 1997.III
Mexico	1982.I, 1985.III, 1995.I
Peru	1987.IV,1992.II
Venezuela	1984.I, 1989.I, 1994.II
Indonesia	1983.II, 1986.III, 1997.III
Korea	1980.I, 1997.IV
Malaysia	1986.I, 1997.III
The Philippines	1983.IV, 1997.III
Singapore	1984.II
Thailand	1997.III

Appendix 4. Prediction Performance

	Tranquil period	crisis	total
Predicted tranquil period	A	B	A+B
Predicted crisis	C	D	C+D
Total	A+C	B+D	A+B+C+D

Threshold Values (P^*)	Percentage of crises predicted correctly D/(B+D)	Percentage of tranquil periods predicted correctly A/(A+C)
0.03	80.6	81.4
0.1	41.9	94.8
0.2	22.6	98.1
0.3	16.1	99.9
0.4	9.7	99.9
0.5	9.7	99.9

1. A standard prediction rule is used: a crisis is predicted if the predicted probability is higher than a certain threshold value.
2. The average of the predicted probabilities is 0.026.

CHAPTER V

THE IMPACT OF A LENDING BOOM ON CURRENCY CRISES

Contrary to common expectation, the analysis in chapter IV indicates that a lending boom has had little impact on a currency crisis. In this chapter I argue and demonstrate that a lending boom increases the probability of a crisis when it is associated with low reserves and a severe current account deficit.

The underlying idea is as follows. An individual money manager will attack a currency only if it is anticipated that the country will respond with a sizeable depreciation. Investors use a common set of fundamentals and stable filtering rule to predict which countries are most likely to respond with sizable depreciation and then concentrate their attacks on those currencies. As shown later, these are countries with low international reserves, a severe current account deficit, and a rapid lending boom.

This chapter is organized as follows. Section 1 presents a simple model that links a rapid lending boom to a currency crisis. Section 2 offers a review of the empirical literature. Finally, section 3 discusses data, and estimates the impact of a lending boom on a currency crisis.

1. Conceptual Framework

1.1 Three Policy Alternatives

There are three policy alternatives to respond to an attack: run down reserves; implement tight monetary policy; and depreciate currencies. The first option may be the

least costly politically, but it is available only to governments with plenty of reserves to cover their external deficits.

Governments with low reserves relative to external imbalances are faced with a difficult choice between monetary contraction and currency depreciation. Tight monetary policy is beneficial because the consequent increase in interest rate attracts foreign currencies, and improves the current account by reducing absorption. Yet those effects may come at the cost of a recession and bank failures in particular in a country with a rapid lending boom. A bank lending boom is likely to end up with a large proportion of bad loans as the bank's ability to screen marginal projects declines and high risk areas, such as credit cards and consumer and real estate loans, tend to grow more than proportionately. When the banking system has a large share of bad loans, a higher interest rate may lead to a rapid increase of non-performing loans. Depositors withdraw their funds out of concern over the safety of the banks, which may lead to a full-scale banking crisis. The resulting credit crunch can stagger an economy. In these circumstances, i.e., low reserves, a large current account defict, and a rapid lending boom, the government is forced to close the external imbalance through depreciation.

In sum, an individual money manager will attack a currency only if it is anticipated that the country will respond with a sizeable depreciation. These are countries with low international reserves, a large current account deficit, and a rapid lending boom.

1.2 A Simple Model[41]

Consider a small open economy where there are many identical foreign and domestic investors who initially hold an aggregate stock M of deposits denominated in domestic currency that pay an interest rate i. The model is static, and focuses on the interaction between investor's expectation of devaluation and the government's management of the external account in the very short run.

The sequence of events would be as follows. First, each investor chooses the stock of domestic deposits she wishes to hold and the amount she wishes to convert into foreign currency. Then the government responds to the capital outflow by running down reserves, by implementing tight monetary policy, or by depreciating its currency. Finally, investors cash their deposits plus the interest accrued.

1.2.1 Investors' Problem

A risk neutral investor will hold domestic deposits as long as $\frac{1+i}{1+\varepsilon_j^e} \geq 1+i^*$, where i^* denotes the world interest rate and ε_j^e, the devaluation rate expected by investor j. That is, investor j will be willing to hold domestic deposits only if the devaluation rate she expects is not greater than the interest rate differential.

Under the assumption that each investor, who initially holds a stock m of deposits, can either continue to hold the deposits or withdraw everything, investor j's strategy is as follows:

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[41] The model in this section is based on Tornell (1999).

$$\Delta m_j^d = \begin{cases} 0 & if \quad \varepsilon_j^e \le \bar{\varepsilon} \\ -m & if \quad \varepsilon_j^e \succ \bar{\varepsilon} \end{cases} \qquad (1)$$

where $\bar{\varepsilon} = \dfrac{i - i^*}{1+i}$.

In a symmetric equilibrium all investors derive the same conclusions from the information available, i.e., all of them either withdraw their entire deposits or continue to hold all deposits. Thus, the change in aggregate deposits ΔM^d is equal to either $-M$ or 0, where M denotes the aggregate initial stock of deposits. Since it is assumed that deposits withdrawn are converted into foreign currency, the corresponding change in reserves is $\frac{-M}{1+\varepsilon}$ or 0.[42]

1.2.2 Government's Problem

The government has an initial stock R of international reserves. Taking ΔM^d as given, the government chooses the change in reserves ΔR, the depreciation rate ε, and the unemployment rate u, in order to minimize the loss function (2), subject to equations (3), (4) and (5).[43]

$$\min_{\Delta R, \varepsilon, u} [\varepsilon + \alpha u] \qquad (2)$$

$$CA + \frac{\Delta M^d}{1+\varepsilon} = \Delta R, \quad \Delta R \ge -R \qquad (3)$$

$$CA = \theta\varepsilon + u(bl) - H(rer) \qquad (4)$$

---

[42] For simplicity, the initial exchange rate is assumed to be 1.

[43] As described in section 1.1, monetary contraction may cause economic recession. The unemployment rate in equation (2) captures the recessionary effect of tight monetary policy.

$$0 < u < \bar{u}(bl), \quad \bar{u}'(bl) < 0 \qquad (5)$$

where ΔR = the change in reserves, ε = the depreciation rate, u = the unemployment rate, CA = the current account, rer = the real exchange rate, bl = the share of bad loans in banks

Equation (2) says that the government minimizes the sum of the depreciation (i.e., inflation) rate and the unemployment rate, but does not care about the changes in international reserves.[44] The parameter α captures how sensitive the government is to recessions. Equation (3) is the identity linking the balances of current account CA and capital account $\frac{\Delta M^d}{1+\varepsilon}$ to the changes in reserves. As shown in equation (4), the current account depends positively on nominal depreciation and unemployment, but it is negatively related to the real exchange rate.

The upper bound on unemployment $\bar{u}(bl)$ in equation (5) captures the idea that it is virtually impossible to increase unemployment beyond a certain point without causing generalized bankruptcies of non-financial firms and the consequent full-scale banking crisis. The negative sign of the first derivative of $\bar{u}(bl)$ implies that the higher the share of bad loans, the more vulnerable the banks are to an economic recession.

There are three possible solutions of the government's problem, depending on the size of reserves.

(i) If international reserves are sufficient to cover the maximum possible capital outflow plus the current account deficit,[45] the government's best response is to close the external deficit by running down reserves regardless of the investor's withdrawal policy.

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[44] There is no immediate political cost associated with depletion of reserves.

[45] $R \geq M + H(rer)$. Substituting $\varepsilon=u=0$ into equation (3) yields this condition.

Since the entire external deficit $\Delta M^d + H(rer)$ is covered by reserves, the government can avoid currency depreciation or an economic recession.

$$\begin{aligned} \Delta R^* &= \Delta M^d + H(rer) \\ \varepsilon^* &= 0 \\ u^* &= 0 \end{aligned} \qquad (7)$$

(ii) If reserves can cover the current account deficit, but are not sufficient enough to cover both the current account and the potential withdrawal of deposits,[46] then government's policy depends on investors' expectation of devaluation.

- If $\varepsilon^e \leq \bar{\varepsilon}$, then investors will not attack the currency. Since there is no capital outflow, the government can cover the entire external deficit by running down reserves. $\Delta R^*, \varepsilon^*$ and u^* are the same as in (7).

- If $\varepsilon^e \geq \bar{\varepsilon}$, investors will attack the currency. The government prefers to close the external deficit by running down its reserves. Thus, when reserves are not sufficient to close the external gap, the government waits until *R=0* before pursuing the alternatives. The deficit uncovered by reserves must be closed by either depreciation or recession. Let Γ be the unemployment rate that would be chosen by the government if there were no upper limit of the unemployment rate. When Γ is less than the maximum feasible unemployment rate ($\Gamma \leq \bar{u}$), the choices of unemployment and devaluation are given by (9). However, when $\Gamma > \bar{u}$, Γ is not feasible any more. As shown in (10), the government sets unemployment at $\bar{u}$, and close the external deficits through further depreciation than it would be if $\Gamma \leq \bar{u}$.

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[46] $H(rer) \leq R < M + H(rer)$

$$\Delta R^* = -R \tag{8}$$

$$\begin{cases} \varepsilon^* = \sqrt{\frac{\alpha M}{1-\alpha\theta}} - 1 \\ u^* = \Gamma \end{cases} \quad \text{if } \Gamma \le \bar{u} \tag{9}$$

$$\begin{cases} \varepsilon^* = \frac{-(E+\theta)+\sqrt{(E+\theta)^2+4\theta M}}{2\theta} \\ u^* = \bar{u} \end{cases} \quad \text{if } \Gamma > \bar{u} \tag{10}$$

where $E \equiv \bar{u} + R - H$ and $\Gamma \equiv \frac{1-2\alpha\theta}{\sqrt{\alpha(1-\alpha\theta)}}\sqrt{M} - R + H$.

(iii) When reserves are too low to cover the current account deficit,[47] reserves are not sufficient to close the external gap regardless of the value of ΔM^d. The government will set $\Delta R^* = -R$ and close the external gap by setting the depreciation and the unemployment rate equal to (9) or (10).

1.2.3 Symmetric Rational Expectations Equilibria

The symmetric rational expectation equilibria are obtained by combining the investors' withdrawal policy (1) and the government's strategies (7)-(10). There are three cases:

Case 1. $\varepsilon^*(-M) \le \bar{\varepsilon}$. There is a unique symmetric equilibrium.

$$\Delta\hat{M}^d = 0 \text{ and } \hat{\varepsilon} = \varepsilon^*(0).$$

Case 2. $\bar{\varepsilon} \in [\varepsilon^*(0), \varepsilon^*(-M)]$. There are two symmetric equilibria.

$$\Delta\hat{M}^d = 0 \text{ and } \hat{\varepsilon} = \varepsilon^*(0)$$

$$\Delta\hat{M}^d = -M \text{ and } \hat{\varepsilon} = \varepsilon^*(-M).$$

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[47] *R<H(rer)*

Case 3. $\bar{\varepsilon} < \varepsilon^*(0)$. There is a unique symmetric equilibrium.

$$\Delta\hat{M}^d = -M \text{ and } \hat{\varepsilon} = \varepsilon^*(-M).$$

In case 1 an attack never occurs. This is the situation where reserves are high *or* fundamentals are strong (i.e., there are neither many bad loans nor a severe current account deficit). When reserves are high, the government will respond to any ΔM^d by running down reserves and setting $\varepsilon = 0$; Knowing this, investors set ΔM^d=0 regardless of the fundamentals. When the fundamentals are strong, the devaluation needed to close the external gap is smaller than $\bar{\varepsilon}$; Investors have no reason to withdraw their deposits.

Cases 2 and 3 occur when reserves are low *and* the fundamentals are weak. In case 2 there are multiple equilibria. In the crisis equilibrium, investors believe that the devaluation will be greater than $\bar{\varepsilon}$ and consequently withdraw their deposits. As a result the devaluation is indeed greater than $\bar{\varepsilon}$. In the no-attack equilibrium, investors believe the opposite, and do not withdraw their deposits. Thus, depreciation is not greater than $\bar{\varepsilon}$. In case 3 the fundamentals are so weak that the government will have to depreciate more than $\bar{\varepsilon}$ regardless of investors' expectations.

In sum, an individual money manager will attack a currency only if it is anticipated that the country will respond with a sizeable depreciation. These are countries with low international reserves, a severe current account deficit, and a rapid lending boom.

2. Literature Review

Sachs, Tornell and Velasco (1996) studied, for the first time, the role of a lending boom in a currency crisis, in connection with economic fundamentals. They examine closely the financial events following the Mexican peso devaluation and explore the question of why, during 1995, some emerging markets were hit by financial crises while others were not.

They measure the extent of financial crisis in 1995 on a group of 20 emerging market economies with a crisis index (denoted by IND). IND for each country is a weighted average of the devaluation rate with respect to the U.S. dollar and the percentage change in foreign exchange reserves between the end of November 1994 and the end of the first six months of 1995.[48] They find that low international reserves relative to broad Money, real exchange rate appreciation, and a lending boom explain about 70 percent of the variation of IND.

Subsequent studies along this line have focused on the Asian crisis (Corsetti, Pesenti and Roubini, 1998a) and both the Tequila and the Asian crisis (Tornell, 1999). These studies have generally confirmed the same pattern as in Sachs, Tornell and Velasco (1996), finding that crises tend to be preceded by a lending boom, low reserves and real exchange rate overvaluation. These studies, although suggestive, are somewhat limited since they focus on one or two crisis episodes.

This chapter departs from the previous studies of this subject in three important ways. First, by focusing on a sufficiently large period and number of countries, my

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[48] See section 2.2 in chapter III for details of the crisis index such as weights to each component .

empirical approach avoids the risks of generalizing from a single crisis episode.[49] Second, my study shows not only a lending boom but also variables such as GDP growth, real exchange rate misalignment and contagion have significant effects on a crisis, while the earlier studies generally failed to find the significance of the latter variables. Third, as in chapter IV, estimating with *quarterly* data can capture the rapid movements in some of the explanatory variables a few months before and after crises.

3. Empirical Analysis

3.1 An Econometric Model

The estimation model in (11) includes interaction terms among the ratio of bank lending to GDP, the ratio of current account to GDP, and the ratio of M_2 to international reserves. The idea is that the effect of a lending boom on a currency crisis might be different in countries with different current account balances and international reserves. Contrary to the empirical model in chapter IV, the linear probability model (LPM) is estimated.[50]

$$\begin{aligned} Crisis = {} & \alpha_0 + \alpha_1 LB + \alpha_2 LB \cdot CA + \alpha_3 LB \cdot M_2 / RES + \alpha_4 LB \cdot CA \cdot M_2 / RES \\ & + \alpha_5 GDP + \alpha_6 RER + \alpha_7 CA + \alpha_8 M_2 / RES + \alpha_9 GOVT + \alpha_{10} FOR \\ & + \alpha_{11} CONTAG + u \end{aligned} \qquad (11)$$

where Crisis = the crisis dummy, LB = the ratio of bank lending to GDP, CA = the ratio of current account to GDP, M_2/RES= four-quarter change rate in the ratio of M_2 to international reserves, GDP= GDP growth rate, RER = the real exchange rate misalignment, GOVT = the ratio of government budget balance to GDP, FOR = the ratio of banks' foreign liabilities to GDP, CONTAG = the contagion dummy.

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[49] See, for example, Cooper's (1996) comments on Sachs, Tornell and Velasco (1996).

The sample consists of quarterly data for 25 countries from 1980 through 1997.[51] The "crisis dummy", the definition of which is the same as in chapter IV, is used as a dependent variable in the ordinary least square (OLS) estimation with the usual standard errors.[52]

Following is a detailed explanation of the explanatory variables. Interpretation of the interaction terms will be provided in the next section. A lending boom is measured as the ratio of banks' claims on the private sector (IFS line 24) to nominal GDP (line 99b). To adjust for inflation, banks' claims are divided by consumer price index (line 64). I expect that the greater the increase of loans provided by the banking system during a short span of time, the greater would be the share of bad loans in the bank balance sheet.

I proxy the central bank's contingent liabilities by the ratio of M_2 to international reserves. The ratio captures the extent to which the liabilities of the banking system are backed by international reserves. In the event of a currency crisis, individuals may rush to convert their domestic currency deposits into foreign currency, so that this ratio captures the ability of the central bank to meet those demands.

The current account (line 78ald) is converted into domestic currency by the market exchange rate (line rf) and measured as percentages of nominal GDP. Note that a positive value of this variable implies current account deficits. The definition of GDP

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[50] Employing a probit regression does not change the main empirical results. Since the interaction effect have a more complex form in the probit model, I simply report the LPM estimation results in this chapter.

[51] The United Kingdom, France, Italy, Netherlands, Norway, Sweden, Swiss, Finland, Greece, Ireland, Portugal, Spain, Argentina, Brazil, Chile, Columbia, Mexico, Peru, Venezuela, Indonesia, Korea, Malaysia, Philippines, Singapore and Thailand

[52] The estimation results do not change much in the OLS estimation with the heteroskedasticity-robust standard error.

growth rate, the RER misalignment, and the contagion dummy is identical with that in chapter IV.

3.2 Interaction Terms in the Model[53]

As noted earlier, what makes this chapter's analysis unique is the inclusion of interaction terms among LB, CA, and M_2/RES. The purpose of this section is to explain how to interpret the interaction terms in the model. The main estimation results will be provided in the next section. Based on quarterly data for 25 countries from 1980 through 1997, the estimation results of equation (11) are reported in (12).

$$\begin{aligned}\hat{Crisis} = {} & \underset{(2.398)}{0.029} + \underset{(0.697)}{0.003}\,LB + \underset{(1.662)}{0.119}\,LB \cdot CA - \underset{(0.486)}{0.007}\,LB \cdot M_2 / RES \\ & + \underset{(3.918)}{0.702}\,LB \cdot CA \cdot M_2 / RES - \underset{(3.114)}{0.360}\,GDP + \underset{(3.785)}{0.225}\,RER - \underset{(0.962)}{0.194}\,CA \\ & + \underset{(3.171)}{0.080}\,M_2 / RES + \underset{(0.144)}{0.012}\,GOVT - \underset{(1.651)}{0.009}\,FOR + \underset{(3.034)}{0.035}\,CONTAG\end{aligned} \qquad (12)$$

Numbers in parentheses are t-values. n=1173, R^2=0.085, $\bar{R}^2$=0.077

If we simply look at the coefficient of LB, since the t-value is 0.04, we would conclude incorrectly that a lending boom has little effect on a crisis. But this coefficient supposedly measures the effect when CA= M_2/RES=0, which is not our interest. In fact, the partial effect of LB on Crisis is:

$$\frac{\Delta Crisis}{\Delta LB} = 0.003 + 0.119CA - 0.007M2 / RES + 0.702CA \cdot M2 / RES \qquad (13)$$

Equation (13) can be evaluated at interesting values of CA and M_2/RES, such as the mean value, or the lower and upper quartiles in the sample. For example, the mean values of

CA and M_2/RES are 0.012 and -0.004, so substituting them into (13) yields the effect of LB on Crisis, as 0.005. This means that, in countries with average CA and M_2/RES, one percentage point increase in LB increases the probability of a crisis by 0.005 percentage point.

To determine whether the estimate 0.005 is statistically different from zero, we need to test the hypothesis in (14), which is obtained by the following two steps. First, differentiating (11) with respect to LB yields the partial effect of LB on Crisis, $\alpha_1 + \alpha_2 CA + \alpha_3 M_2 / RES + \alpha_4 CA \cdot M_2 / RES$. Second, plugging in the mean values of CA and M_2/RES yields:

$$\begin{aligned} H_0 &: \alpha_1 + 0.012\alpha_2 - 0.004\alpha_3 - 0.00005\alpha_4 = 0 \\ H_1 &: \alpha_1 + 0.012\alpha_2 - 0.004\alpha_3 - 0.00005\alpha_4 \neq 0 \end{aligned} \qquad (14)$$

The associated t statistic is:

$$t = \frac{\hat{\alpha}_1 + 0.012\hat{\alpha}_2 - 0.004\hat{\alpha}_3 - 0.00005\hat{\alpha}_4}{se(\hat{\alpha}_1 + 0.012\hat{\alpha}_2 - 0.004\hat{\alpha}_3 - 0.00005\hat{\alpha}_4)} \qquad (15)$$

In the case of the mean values of CA and M_2/RES, the numerator in (15) is 0.005 as calculated before. Unfortunately, the regression results in (12) do not contain enough information to obtain the denominator in (15), the standard error of $\hat{\alpha}_1 + 0.012\hat{\alpha}_2 - 0.004\hat{\alpha}_3 - 0.00005\hat{\alpha}_4$.

The t statistic in (15) can be obtained by estimating a different model that directly delivers the standard error of interest. Let $\alpha_1 + 0.012\alpha_2 - 0.004\alpha_3 - 0.00005\alpha_4 = \theta_1$. Then, the t statistic in (15) in terms of $\hat{\theta}_1$ is just $t=\hat{\theta}_1/se(\hat{\theta}_1)$, and α_1 can be expressed as

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[53] The interpretation of interactions terms in this section is based on chapters 4 and 6 in Wooldridge (1999).

$\alpha_1 = \theta_1 - 0.012\alpha_2 + 0.004\alpha_3 + 0.00005\alpha_4$. Substituting $\theta_1 - 0.012\alpha_2 + 0.004\alpha_3 + 0.00005\alpha_4$ for α_1 in (11) and rearranging yields the following equation:

$$\begin{aligned} Crisis = {} & \alpha_0 + \theta_1 LB + \alpha_2 LB \cdot (CA - 0.012) + \alpha_3 LB \cdot (M_2 / RES + 0.004) \\ & + \alpha_4 LB \cdot (CA \cdot M_2 / RES + 0.00005) + \alpha_5 GDP + \alpha_6 RER + \alpha_7 CA \\ & + \alpha_8 M_2 / RES + \alpha_9 GOVT + \alpha_{10} FOR + \alpha_{11} CONTAG + u \end{aligned} \qquad (16)$$

The parameter α_1 has disappeared from the model, while θ_1 appears explicitly. Thus, estimating (16) yields $\hat{\theta}_1$ and t statistic for $\hat{\theta}_1$, the coefficient and the t statistic for LB in (17).

$$\begin{aligned} \hat{Crisis} = {} & \underset{(2.398)}{0.029} + \underset{(0.967)}{0.005}\, LB + \underset{(1.662)}{0.119}\, LB \cdot (CA - 0.012) - \underset{(0.486)}{0.007}\, LB \cdot (M_2 / RES + 0.004) \\ & + \underset{(3.918)}{0.702}\, LB \cdot (CA \cdot M_2 / RES + 0.00005) - \underset{(3.114)}{0.360}\, GDP + \underset{(3.785)}{0.225}\, RER - \underset{(0.962)}{0.194}\, CA \\ & + \underset{(3.171)}{0.080}\, M_2 / RES + \underset{(0.144)}{0.012}\, GOVT - \underset{(1.651)}{0.009}\, FOR + \underset{(3.034)}{0.035}\, CONTAG \end{aligned} \qquad (17)$$

$$\text{n=1175, } R^2 = 0.085, \ \overline{R}^2 = 0.077$$

The t statistic for $\hat{\theta}_1$, which should correspond to (15), is 0.967. Against the alternative in (15), the p-value is about 0.334, so there is no evidence that the estimate 0.005 is statistically different from zero.

Note that the slope estimates and the associated t statistics for the explanatory variables except LB are the same as in (12). Comparing (11) and (16), we know that this fact must be true.

3.3 Estimation Results

The transformed equation (16) is the special case when CA and M_2/RES are at their mean value. The generalized version of (16), which allows us to estimate the LB effect at various values of CA and M_2/RES, is expressed as follows.

$$\begin{aligned} Crisis = {} & \alpha_0 + \theta_1 LB + \alpha_2 LB \cdot (CA - CA_i) + \alpha_3 LB \cdot (M_2 / RES - M_2 / RES_i) \\ & + \alpha_4 LB \cdot (CA \cdot M_2 / RES - CA_i \cdot M_2 / RES_i) + \alpha_5 GDP + \alpha_6 RER \\ & + \alpha_7 CA + \alpha_8 M_2 / RES + \alpha_9 GOVT + \alpha_{10} FOR + \alpha_{11} CONTAG + u \end{aligned} \qquad (18)$$

where CA_i and M_2/RES_i denote interesting values of CA_i and M_2/RES_i, respectively.

The estimation results of (18) in the various samples are reported in this section. The regression uses one-quarter-lagged explanatory variables so that we can interpret the estimation results as one-step-ahead probabilities of a crisis. Appendix 1 provides the percentage of crisis and no-crisis observations predicted correctly by the benchmark estimation.

Benchmark Estimation

In the benchmark estimation I use quarterly data for 25 countries from 1980 through 1997, and estimate equation (18) at selected values of CA and M_2/RES such as the mean, the 75 percentile, and the 90 percentile of the sample. I expect that the lending boom will have the larger effect as CA and M_2/RES increase.

Table 9 presents the results of the benchmark estimation. They are consistent with the theoretical expectation presented in section 1. The second column provides the estimates at the mean value of CA and M_2/RES in the sample. The coefficient corresponding to LB is not significant, showing no effect on a crisis in countries with

manageable CA balances and reserves. Meanwhile, the last two columns provide the estimates at the 75 and 90 percentiles of CA and M_2/RES in the sample, respectively. The coefficients of LB at the 75 and 90 percentiles are positive and significantly different from zero, implying that one percentage point increase in LB increases the probability of a crisis by 0.01 and 0.03 percentage point, respectively. In sum, the estimation confirms the pattern that the lending boom has the larger effect as CA and M_2/RES increase.

Being consistent with the theoretical expectations, the regression shows that crises tend to be preceded by economic recession, real exchange rate overvaluation, and contagion. As in chapter IV, the government budget balance has no significant impact on crises. Although the banks' foreign liabilities variable is significant at the ten percent level, it is not found statistically significant in the various robustness tests as shown below.

Robustness Test

Tables 10 and 11 present robustness tests of the benchmark estimation. Table 10 uses quarterly data for 1990-1997, while table 11 presents the regression results in the developing countries.

The estimation results associated with the lending boom are robust to the sample coverage. The LB effects at the 75 and 90 percentiles of CA and M_2/RES in the sample are positive and significant in both the "post-1990" and "developing countries" sub-samples, showing that the LB effect becomes larger as CA and M_2/RES increases. Meanwhile, the LB effect at the mean of CA and M_2/RES is not different from zero at the ten percent significance level in both sub-samples.

The coefficients of GDP growth, the RER misalignment and the contagion dummy are robust to the sample coverage, remaining statistically and economically significant. Neither the government budget balance nor the banks' foreign liabilities variable has a significant impact on crises.

4. Summary

In this chapter, I developed a formal empirical analysis of the effect of a lending boom on a currency crisis. The regressions show that crises tend to occur when a lending boom is associated with severe current account deficits and low reserves. They also tend to occur when GDP growth rate is low, real exchange rate is overvalued, and there is a contagion effect.

Table 9. Regression Results (Benchmark Estimation)

variable	Mean	75 percentile	90 percentile
LB	0.01 (0.97)	0.01** (2.00)	0.03** (2.98)
LB*(CA-CA_i)	0.12* (1.66)	0.12* (1.66)	0.12* (1.66)
LB*(M_2/RES-M_2/RES_i)	-0.01 (-0.49)	-0.01 (-0.49)	-0.01 (-0.49)
LB*(CA* M_2/RES-CA_i* M_2/RES_i)	0.70** (3.92)	0.70** (3.92)	0.70** (3.92)
GDP	-0.36** (-3.11)	-0.36** (-3.11)	-0.36** (-3.11)
RER	0.23** (3.79)	0.23** (3.79)	0.23** (3.79)
CA	-0.19 (-0.96)	-0.19 (-0.96)	-0.19 (-0.96)
M2RES	0.08** (3.17)	0.08** (3.17)	0.08** (3.17)
GOVT	0.01 (0.14)	0.01 (0.14)	0.01 (0.14)
FOR	-0.01* (-1.65)	-0.01* (-1.65)	-0.01* (-1.65)
CONTAG	0.03** (3.03)	0.03** (3.03)	0.03** (3.03)
observations	1173	1173	1173
R^2	0.09	0.09	0.09
Adjusted-R^2	0.08	0.08	0.08

Significance at the 10 percent level is denoted by *; at the 5 percent level, by **.
Numbers in parentheses are t-values.

Table 10. Regression Results (post 1990)

variable	Mean	75 percentile	90 percentile
LB	0.01 (1.08)	0.02** (2.21)	0.04** (2.81)
LB*(CA-CA_i)	0.23* (2.35)	0.23* (2.35)	0.23* (2.35)
LB*(M_2/RES-M_2/RES_i)	0.01 (0.67)	0.01 (0.67)	0.01 (0.67)
LB*(CA*M_2/RES-CA_i* M_2/RES_i)	0.65** (2.30)	0.65** (2.30)	0.65** (2.30)
GDP	-0.55** (-2.88)	-0.55** (-2.88)	-0.55** (-2.88)
RER	0.43** (3.92)	0.43** (3.92)	0.43** (3.92)
CA	-0.51 (-1.52)	-0.51 (-1.52)	-0.51 (-1.52)
M2RES	0.07* (1.68)	0.07* (1.68)	0.07* (1.68)
GOVT	0.12 (0.83)	0.12 (0.83)	0.12 (0.83)
FOR	-0.01 (-1.13)	-0.01 (-1.13)	-0.01 (-1.13)
CONTAG	0.08** (3.89)	0.08** (3.89)	0.08** (3.89)
observations	528	528	528
R^2	0.13	0.13	0.13
Adjusted-R^2	0.11	0.11	0.11

Significance at the 10 percent level is denoted by *; at the 5 percent level, by **.
Numbers in parentheses are t-values.

Table 11. Regression Results (developing countries)

variable	Mean	75 percentile	90 percentile
LB	0.02 (1.57)	0.03** (2.58)	0.05** (3.02)
LB*(CA-CA$_i$)	0.15 (0.93)	0.15 (0.93)	0.15 (0.93)
LB*(M_2/RES-M_2/RES$_i$)	0.02 (0.44)	0.02 (0.44)	0.02 (0.44)
LB*(CA*M_2/RES-CA$_i$* M_2/RES$_i$)	0.56 (1.54)	0.56 (1.54)	0.56 (1.54)
GDP	-0.61** (-3.53)	-0.61** (-3.53)	-0.61** (-3.53)
RER	0.30** (3.83)	0.30** (3.83)	0.30** (3.83)
CA	-0.57 (-1.50)	-0.57 (-1.50)	-0.57 (-1.50)
FOR	0.08** (2.31)	0.08** (2.31)	0.08** (2.31)
GOVT	-0.19 (-1.19)	-0.19 (-1.19)	-0.19 (-1.19)
M2RES	-0.01 (-0.60)	-0.01 (-0.60)	-0.01 (-0.60)
CONTAG	0.03* (1.77)	0.03* (1.77)	0.03* (1.77)
observations	564	564	564
R^2	0.12	0.12	0.12
Adjusted-R^2	0.98	0.98	0.98

Significance at the 10 percent level is denoted by *; at the 5 percent level, by **.
Numbers in parentheses are t-values.

Appendix 1. Prediction Performance

	Tranquil period	crisis	total
Predicted tranquil period	A	B	A+B
Predicted crisis	C	D	C+D
Total	A+C	B+D	A+B+C+D

Threshold Values (P^*)	Percentage of crises predicted correctly D/(B+D)	Percentage of tranquil periods predicted correctly A/(A+C)
0.03	87.1	61.8
0.1	41.9	95.0
0.2	12.9	99.8
0.3	3.2	100.0
0.4	3.2	100.0
0.5	3.2	100.0

1. A standard prediction rule is used: a crisis is predicted if the predicted probability is higher than a certain threshold value.
2. The average of the predicted probabilities is 0.026.
3. The LPM model does not do well for prediction, relative to the probit model in chapter IV.

CHAPTER VI

REVISITING THE ASIAN CRISIS: CAUSES AND POLICY IMPLICATIONS

Chapter II contains two competing views on causes of the Asian crisis: "weak fundamental" (WF) and "financial panic" (FP). The two viewpoints on causes of the Asian crisis have different policy implications. Those who think that speculative movements are due to WF tend to support fiscal and monetary policies which make the commitment to the exchange rate objective credible. On the other hand, those who advocate the FP view believe that the international capital markets are intrinsically unstable and vulnerable to erratic speculative movements. They tend to support measures of capital controls that might help the governments defend their currencies.

The purpose of this chapter is to revisit the causes and policy implications of the Asian crisis. The empirical models of a currency crisis developed in chapters IV and V are used as the main tools to study these objectives. This chapter is organized as follows. Section 1 discusses causes of the Asian crisis. Providing an overview of the recent debates on the role of the IMF program and capital controls, section 2 focuses on policy issues of the Asian crisis. Finally, section 3 suggests policies to prevent or manage future crises.

1. WF or FP?

Since, as discussed in chapter II, the individual movements in the economic variables show mixed evidences, I have developed the estimation models in chapter IV and V, with which I test simultaneously the effects of various economic determinants on a crisis. In this section, I apply the estimation methods of the previous chapters to the Asian crisis.

1.1 Model I

The first model, whose results are reported in table 12, is basically the same as the probit estimation in chapter IV except for one aspect. The explanatory variables are confined to those which were found statistically significant in the previous probit estimation.

- Estimated Equation: $\Pr(Crisis) = \Phi(\alpha_0 + \alpha_1 CA + \alpha_2 RER + \alpha_3 GDP + \alpha_4 M_2 / RES + \alpha_5 CONTAG)$

where CA denotes the ratio of current account deficit to nominal GDP; RER, the real exchange rate (RER) misalignment; GDP, real GDP growth rate; M_2/RES, the ratio of M_2 to foreign reserves; and CONTAG, the contagion dummy. Φ denotes the standard normal distribution; and Pr, the probability of a crisis.[54]

Among the variables, the current account, GDP growth rate, the RER misalignment and the M_2/reserves represent the weak fundamentals, while the contagion variable is inserted to capture financial panic.

The second column in table 12 presents the probit estimation results. The third to the eighth column report the values of the explanatory variables in the second quarter of 1997, while the figures in parentheses are the values of the explanatory variables weighted by the estimated coefficients in the first column. The higher number in parentheses indicates the larger contribution to the crisis.

The probability of a crisis, reported at the bottom of the third to the eighth column, is obtained by plugging in the values of the second quarter in 1997 for the explanatory

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[54] For details of the estimation, see section 3.2 in chapter IV.

variables.[55,56] Since the estimation uses one-quarter-lagged explanatory variables, the probability of a crisis can be interpreted as a predicted possibility of a currency collapse in the next quarter (the third quarter of 1997 here).

Though the probability of a crisis in the afflicted countries is not high except for Thailand, the probability is higher than that for Singapore, Mexico or the other countries in the sample. The values of the fundamental variables show that Thailand, where the crisis broke out first, had the most vulnerable economy.

Interestingly, the contagion dummy has the largest effect on the crisis in Indonesia and Korea. As long as the explanatory variables measure the fundamentals reasonably well, the contagion variable captures a situation where a crisis in one country may trigger a crisis elsewhere for reasons unexplained by the fundamentals. Thus the largest effect of the contagion dummy implies that the magnitude of the crisis can be fully explained only when both WF and FP are present.

1.2 Model II

The second model applied to the Asian crisis is the linear probability model in chapter V, which focuses on the impact of a lending boom on a currency crisis.[57] As in model I, the explanatory variables are confined to those which were found statistically significant in the previous estimation.

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[55] For Korea, the values in the third quarter of 1997 are plugged, since the crisis occurred in the fourth quarter. This is also true to the second model in the next section.
[56] The probability of a crisis in Malaysia and the Philippines are not reported due to missing data.
[57] See section 3 in chapter V for details of the estimation methods and the explanatory variables.

- Estimated Equation:

$$Crisis = \alpha_0 + \alpha_1 LB + \alpha_2 LB \cdot CA + \alpha_3 LB \cdot M_2 / RES + \alpha_4 LB \cdot CA \cdot M_2 / RES$$

$$+ \alpha_5 GDP + \alpha_6 RER + \alpha_7 CA + \alpha_8 M_2 / RES + \alpha_9 CONTAG + u \qquad (11)$$

where Crisis = the crisis dummy, LB = the ratio of bank lending to GDP, CA = the ratio of current account deficit to GDP, M_2/RES = four-quarter change rate in the ratio of M_2 to international reserves, GDP= GDP growth rate, RER = the real exchange rate misalignment, CONTAG = the contagion dummy.

Using the same technique as in the first model, the probability of a crisis in the Asian countries is provided at the bottom of each column in table 13. As before, the probability means a predicted possibility of a crisis in the third quarter of 1997, based on information in the previous quarter. The results of model II are consistent with those of model I: The probability of a crisis in the three afflicted Asian countries is higher than that for other countries; judging from the numbers in parentheses, Thailand had the most vulnerable economy; and the contagion dummy has the largest effect on the crisis in Indonesia and Korea.

2. Policy Issues on the Asian Crisis

For a crisis as the Asian one, explained by both WF and FP, the policy responses should focus on both reforming fundamental structures and restoring market confidence. One dilemma is that the policy implications from the two views do not always coincide. For example, while WF supports reforms such as closure of weak banks, it could aggravate investors' panic (at least, in the short run) from the standpoint of FP. Meanwhile, a main suggestion of the FP advocates, restraining short-term capital movements, has been criticized as a futile attempt to block the operation of a market principle by the WF economists.

According to them, a speculative attack plays a useful disciplinary role by sending a signal to the government that it should adjust its fiscal and monetary policies.

Facing the crisis, the governments of Indonesia, Korea and Thailand signed emergency lending agreements with the IMF, which gave priority to reforming the weak fundamentals. In contrast, the Malaysian government decided to restrict capital outflows. In this section, I provide an overview of the recent debates on the IMF program and Malaysia's capital controls.

2.1 Initial Responses of the Asian Governments

Amid deepening economic difficulties in 1997, the Asian governments drafted and implemented various policies designed to overcome them. But these policies were frequently ineffective due to inappropriate timing and sometimes the markets were given confusing signals by inconsistent policies. Several examples are provided below.

In Thailand, despite massive capital outflows, the government made a futile attempt to defend its currency, leading to loss of most reserves. As a result, the country became extremely vulnerable to investor panic, because investors recognized that Thailand's available foreign currency reserves had fallen far below the outstanding short-term debts owed to international banks.

Once the crisis began to spread, other countries also made mistakes that accelerated the capital withdrawals. Malaysian Prime Minister's harsh comments about foreign investors and his threats to ban foreign currency trading are prime examples. Korea seemed to be boldly facing some of its problems by allowing some "chaebols" to go bankrupt, but it

spent down its reserves in a desperate attempt to defend the Korean won in October and November of 1997.

Indonesia initially was widely praised for its handling of the crisis, as it first widened the trading band of the rupiah and then floated the currency in August. It resisted the temptation to spend reserves, eased rules governing foreign ownership of stocks, and announced that it would postpone over one hundred investment projects. It retracted that decision for several large projects, but later postponed them again. These on-again and off-again pronouncements encouraged further withdrawals of foreign funds.

2.2 The Role of the IMF Program

2.2.1 Main Elements

The IMF signed three emergency lending agreements: with Thailand in August 1997, Indonesia in November 1997, and Korea in December 1997. These three programs established an unprecedented sum of international financial support: $17 billion for Thailand, $35 billion for Indonesia, and $57 billion for Korea.

The three loan agreements were similar in basic design. Each involved the following elements: a macroeconomic framework based on a balanced budget or a surplus, high nominal interest rates, and restrictive domestic credit targeted on exchange rate stability; a program of drastic financial sector restructuring such as immediate closure or suspension of several financial institutions, and significant intensification of financial sector supervision; and other structural reforms aimed at increasing the transparency and competitiveness of the economic system.

2.2.2 An Overview of the Debates on the IMF Prgram

Since the launch of the IMF agreements, exchange rates in Indonesia, Korea and Thailand had depreciated far below the targets set in the program, despite a very sharp increase in interest rates. Actual outcomes in each country had been far worse than projected. The IMF was repeatedly forced to reduce its growth forecasts for 1998.[58]

The continued turmoil in the financial market and deep recessions in the afflicted countries have created a widespread debate on the IMF's role in the Asian crisis. An overview of the recent debate is presented below.

Tight Monetary Policies and High Interest Rates

The IMF placed great emphasis on the need for tight monetary policies and high interest rates. According to its view, loose monetary policies in the early stages of a crisis exacerbate the depreciation, increasing the financial burden of domestic banks and firms with large foreign currency exposures.

According to critics of the IMF program, the effects of tight monetary policies are described in terms of a vicious circle. As discussed in chapter V, high interest rates result in deterioration of bank balance sheets, leading to a contraction in the supply of credit. The credit crunch can stagger the economy. In the light of theses considerations, the appropriate policy response to the crisis should have been loose monetary policies and low interest rates.

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[58] For details, see table 14.

Strict Fiscal Policies

The rationale of strict fiscal policies is the need to strengthen the fiscal position and to bring about reduction in imports, so as to improve the countries' current account. It has been argued that loose fiscal policies at the onset of the crisis would have raised doubts about the policymaker's commitment to reduce the current account imbalances, jeopardizing the credibility of their plans.

Several commentators maintained that the fiscal policy requirements included in the IMF plans were unnecessarily strict. At the onset of the crisis, the Asian countries under attack were running low budget deficits or fiscal surpluses. Excessively tight fiscal discipline made the crisis-induced recession worse.

Bank Closures and Recapitalization

Based on the view that financial sector weaknesses were at the root of the Asian crisis, the IMF required the three countries to recapitalize weak but viable financial institutions and to close those that are insolvent.

The key issues challenged by critics of the bank reforms are how to introduce such reforms and over what time frame, in the midst of a financial panic. The critics of the IMF plans point out that closing banks and tightening supervisory standards would not restore market confidence in the middle of a panic, because concerns over the safety of the banking system will increase demands for the repayment of short-term debts. They also argue that pushing banks to recapitalize within a short time can force them to sharply curtail lending. This, in turn, can lead to a severe credit crunch, increased distress for private firms and a further rise in non-performing loans.

2.3 Malaysia's Capital Controls in 1998

2.3.1 Main Elements

The devaluation of the Thai baht in July 1997 sparked significant capital outflows from Southeast Asia, leading to a fall in local equity prices and plunging exchange rates. To counter these outflows of capital, (unlike other countries in the region) Malaysia imposed capital controls on September 1, 1998. The controls banned transfers between domestic and foreign accounts and between foreign accounts, eliminated credit facilities to offshore parties, prevented repatriation of investment until September 1, 1999 and fixed the exchange rate at M3.8 per dollar. Foreign exchange transactions were permitted only at authorized institutions and required documentation to show that they were for current account purposes.

The Malaysian government and business community claimed to be pleased with the effect of the controls in increasing demand and returning stability to the economy. Even economists who oppose capital controls believe that they may have been of some use in buying time to implement fundamental reforms (Barro, 1998; Edwards, 1999).

2.3.2 Debates on Capital Controls

Economic recovery in Asia was hampered by high interest rates, but, under perfect capital mobility, a reduction in these rates would further depreciate the exchange rate. For countries with a high stock of liabilities denominated in foreign currency, a depreciation would be recessionary, via the increasing burden of foreign debt. In response to this dilemma, advocates of capital controls argue that, by restricting capital mobility, the

Malaysian government gained some monetary independence, being able to lower interest rates without provoking a plunge in the value of the currency.

Several objections have been raised against Malaysia's capital controls: The capital controls have replaced reform, rather than buying time for reform; although low interest rates may be helpful in the short run, it may exacerbate the underlying problems; the government must be concerned about the long-term impact that the controls will discourage investors' willingness to invest in the country; and finally, capital controls are not implemented and managed by governments that are potential sources of distortions and moral hazard. This implies the possibility of a political misuse of such controls, the risk of creating incentives to rent-seeking, and the temptation to use controls to avoid and or delay necessary reforms.

2.4 Asian Economy in 1998-1999

Following financial volatility and deep recession in 1998, the crisis-hit economies in Asia improved in 1999. Reflecting recovery in investor confidence domestically and abroad, interest rates stabilized at near or below pre-crisis levels during 1999 as shown in figure 7.

In foreign exchange markets, three countries have introduced a floating exchange rate regime since the crisis erupted: Indonesia in August 1997; Korea in December 1997; and Thailand in July 1997. The Philippines already had a floating exchange rate before the crisis, and has kept that regime until now. In contrast, Malaysia fixed its exchange rate at M3.8 per dollar in September 1998. Owing to improved economic outlook and market confidence, exchange rates have stabilized in all of the afflicted countries since late 1998 (figure 8).

With financial stabilization and competitive exchange rates allowing monetary and fiscal policies to be relaxed, most crisis countries are expected to experience positive GDP growth in 1999: 7 percent in Korea; 2 percent in Malaysia and the Philippines; and 4 percent in Thailand (table 15). The only exception is Indonesia where real GDP growth is still projected to be negative (-1 percent) in 1999. However, it is much better than the -14 percent growth in 1998.

While it is clear that a significant recovery in economic activity is now underway in most Asian countries, risks of setbacks cannot be excluded given the exposure to international capital flows and the still widespread need for financial reforms. Of particular concern is that recent favorable macroeconomic developments could weaken support for the reform agenda, which are needed to sustain financial stabilization in the long run.

3. Preventing or Managing Future Crises

3.1 Comments on the Policy Debates: "Incompatible Trinity"

No government can maintain simultaneously fixed exchange rates, free capital mobility, and an independent monetary policy. This is known as the "incompatible trinity".[59] Facing a crisis, the government must give up one of the three options. What creates a dilemma for policymakers is that each alternative has advantages and disadvantages as follows.

If the exchange rate is flexible and the external balance is in deficit, the domestic currency tends to depreciate. The *depreciation* of the domestic currency raises prices of imported goods and assets to domestic residents and lowers the prices of domestic goods

and assets on world markets, reducing the relative demand for foreign goods and assets until the external imbalance is eliminated. This option, however, foregoes the benefits of exchange rate stability for international trade. For countries with large liabilities denominated in foreign currency, a depreciation would increase the burden of foreign debt. In addition, excessive currency depreciation not only causes domestic inflation but also damages domestic banks and firms with large foreign currency exposures.

If a government is committed to maintaining a particular fixed exchange rate, on the other hand, its central bank can prevent the depreciation of its currency with *contractionary monetary policy*. The policy lowers the domestic money supply and raises domestic interest rates, which in turn reduces the prices of domestic goods, services, and assets relative to their foreign counterparts. The consequent reduction in demand and higher prices for foreign goods, services, and assets would eliminate a balance of payments deficit. However, this defense of the exchange rate requires that monetary policy be devoted solely to maintaining the exchange rate. It cannot be used independently to achieve domestic inflation or employment goals.

It is worth mentioning *currency boards* and *dollarization*, as extreme forms of fixed exchange rate. Making strong commitment to a permanently fixed exchange rate, both regimes give up independent monetary policies. Under a currency board regime, the amount of money in circulation is governed strictly by the country's dollar reserves. This arrangement offers the prospect of a stable exchange rate, which can promote both trade and investment. Its strict discipline also brings benefits that will be especially attractive to countries with a record of the central bank's printing money to fund large deficits. On

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[59] McKinnon and Oates (1966)

the other hand, giving up independent monetary or exchange rate policy to cushion the economy against external shocks could result in greater volatility in output and employment where domestic prices and wages cannot adjust rapidly in response to such shocks.

Dollarization occurs when residents of a country extensively use a foreign currency alongside or instead of the domestic currency. By using a foreign currency, a dollarized country assures itself of a rate of inflation close to that of the issuing country. Because of confidence that inflation will continue to be low, interest rates are also low and relatively steady. However, as in a currency board regime, the benefits will come with the cost of losing flexible monetary policy. In addition, the government will have to accept the cost of obtaining enough foreign currency reserves to replace domestic currency.

Capital flows play a crucial role in balance of payments crises. By directly reducing demand for foreign assets and the potential for speculation against the fixed exchange rate, *controls on capital outflows* allow a country to maintain fixed exchange rates and an independent monetary policy while alleviating external deficits. In addition, the monetary authorities can meet their internal goals (employment and inflation). However, as discussed in section 2.3, capital control may accompany some disadvantages. For example, the government must be concerned about less investment from abroad, the risk of creating incentives to rent-seeking, allocation inefficiency, and the temptation to use controls to avoid or delay necessary reforms.

A less radical measure to restrict capital mobility is to place *taxes on short-term capital inflows*, as Chile did from May 1992 to May 1998. The objective of the Chilean

tax is to discourage locals from relying too heavily on short-term borrowing, and thereby mitigate the problem of maturity mismatch, i.e., heavy short-term borrowing and long-term lending. Indeed, Chile has been successful in avoiding speculative pressures. However, many developing countries may find that foreign investors demand a much higher premium. In this case, the borrower will have to choose between accepting short-term loans with a higher premium or not being able to borrow from abroad at all.

The incompatible trinity offers an interesting way to understand the policy debates on the Asian crisis. Individual debates on monetary policies (contractionary versus expansionary) or capital controls (restrictions versus free movement) can be misguided. Since policymakers wishing to avoid excessive fluctuations of the exchange rate should choose one of independent monetary policies or free capital flows, the key issue should be which of tight monetary policies or capital controls had advantages over the other in the Asian crisis. [60]

3.2 Several Lessons from the Asian Crisis

The Incompatible Trinity

As Kreinin (1999, p.xxi) has stated, "at the root of the crisis is an age-old problem: Free capital mobility, fixed or targeted exchange rates, and independent monetary policy cannot co-exist. When they collide, a crisis occurs. The Asian crisis erupted following the removal of restriction on the inflow and outflow of capital in the

[60] I presume that tight monetary policies gain more advantages in a WF-induced crisis, while capital controls, in a FP-induced crisis.

five countries" that maintained a fixed (or targeted) exchange rate and pursued independent monetary policies.

In the long run many countries may have to choose which feature they wish to drop. Thus Argentina and Hong Kong gave up independent monetary policy by operating currency boards. Eleven European countries are about to give up independent monetary policy, and establish a common currency and a common central bank. Moreover, dollarization has been significantly considered in some countries in Latin America. As of late January 2000, Ecuador is seriously considering it. Other countries may choose capital controls, as Chile and Malaysia did. Finally, some countries may opt for floating exchange rates, as most crisis-afflicted countries in Asia did in 1997.[61]

Bank Reforms

The clash between the three objectives in the Asian case ran deeper than in earlier episodes in other countries. It is commonly believed that the crisis had its origin in the financial sector. Thus, promoting safety and soundness of the financial system is crucial to preventing future financial instability. Elements of this structure include deposit insurance, capital requirements for banks, independent auditing, risk limitations (for example, on foreign currency exposure), close supervision and a lender of last resort.

Capiro and Honohan (1999) provides an interesting approach to restore banking stability. They argue that the paradigm of supervised capital adequacy provides less protection than it may appear. Even in developed economies, often neither the level of bank

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[61] All of the afflicted countries in Asia except Malaysia have adopted floating exchange rate since the crisis occurred.

capital nor the risks involved can be reliably measured. In developing countries, the situation is worse for reasons such as the severe information asymmetries between banks and regulators and the level of interference by politically powerful bank insiders.

As a complement to supervised capital requirements, they suggest an approach to improve the incentives for key participants in financial markets. For example, to increase the quality of private creditor monitoring, and to increase incentives for the private production of information about banks, Capiro and Honohan propose "to require banks to issue a special class of debt which would be subordinate to all other claims. That is, in the case of bankruptcy, holders of subordinated debt would lose their money first....It would establish a new set of concerned and watchful eyes on banks. The debtholders will demand better information and disclosure....The market price of this debt would also provide a useful signal of market participants' assessment of the health of the bank." (1999, p.56)

Capital Controls

Much discussion has focused on whether international capital movements should be viewed as a major contributing factor to global financial instability. One mechanism through which the problem of financial instability becomes manifest is a vicious cycle of capital inflows which leads to a lending boom and excessive risk-taking on the part of banks, followed by capital outflows. The dangers arising from capital flows thus beg the question of whether these flows should be regulated or limited in some way.

Though, as described earlier, the arguments in favor of capital controls, especially during a crisis, are controversial, the views on the optimal speed and sequencing of capital account liberalization have reached a widespread and explicit consensus. This consensus

view emphasizes that policymakers should be careful about liberalizing capital account. Moreover, once liberalized, controls are difficult to reintroduce. As long as financial systems are weak, poorly regulated and subject to political distortions, a rush to capital account liberalization may be unwise and produce destabilizing effects.

The Role of the IMF

First, the priority of future IMF programs should be the stopping of financial panic in the short run. Though the IMF program in the Asian crisis may have been right about the need for structural reforms, theses should not have been initiated in the midst of a financial crisis. Note that in each country, although the signing of the IMF agreement was greeted by brief enthusiasm, it was followed by continued depreciation of the exchange rate and deep recessions. It is also noteworthy that the first sign of an end to the currency free-falls came only after the international community initiated a different approach to the problem based on debt restructuring and accelerated disbursements of international funding.

Second, beyond providing emergency lending to countries threatened by financial instability, the IMF needs to step into the role of lender of last resort. Mishikin states that "central banks in emerging market countries have only a very limited ability to extricate their countries from a financial crisis. If they attempt to use expansionary monetary policy to make credit more available, or employ a lender of last resort policy, the risk is that they will set off currency depreciation, and possibly higher interest rates because of increases in expectations of future inflation, both of which will make matters worse. Liquidity provided from foreign sources does not lead to these undesirable consequences, and it helps to stabilize the value of the domestic currency which strengthens domestic balance sheets."

(1999, p.18) However, an international lender of last resort brings risks of its own, especially the risk that if it is perceived as standing ready to bail out irresponsible financial institutions, it may lead to excessive risk-taking that makes financial crises more likely. An international lender of last resort must find ways to limit this moral hazard problem, or it can actually make the situation worse.

4. Summary

This chapter revisited the causes and policy implications of the Asian crisis. The analyses in section 1 show that the crisis first hit Thailand, the weakest economy in the region; there followed sudden shifts in market expectations, spreading into the countries where economic fundamentals were weak; and the magnitude of the crisis can be fully explained only when both WF and FP are present.

Section 2 offers an overview of debates on the IMF program and Malaysia's capital control. The debate involves controversies on tight monetary and fiscal policies, bank closures and recapitalization, and capital controls.

Section 3 argues that the individual debate on "contractionary versus expansionary monetary policies" or "capital controls versus free capital movement" could be misguided. The incompatible trinity suggests that future studies focus on the question of which of tight monetary policies or capital controls have advantages over the other. In addition, this section provides policy measures to prevent future crises.

Table 12. Probability of a Currency Crisis (I)

variable	Probit	IND	KOR	THA	SIN	MEX	All
CA	4.782 (0.010)	0.018 (0.086)	0.017 (0.081)	0.069 (0.330)	-0.156 (-0.746)	0.011 (0.053)	0.009 (0.043)
RER	2.230 (0.009)	0.056 (0.125)	0.007 (0.016)	0.072 (0.161)	0.054 (0.120)	0.095 (0.212)	0.029 (0.065)
GDP	-5.669 (0.005)	0.026 (-0.147)	0.061 (-0.346)	-0.062 (0.351)	0.085 (-0.482)	0.088 (-0.499)	0.058 (-0.317)
M_2/RES	1.064 (0.000)	-0.077 (-0.082)	0.134 (0.143)	0.301 (0.320)	-0.029 (-0.031)	-0.155 (-0.165)	-0.044 (-0.047)
CONTAG	0.646 (0.000)	1 (0.646)	1 (0.646)	0 (0.000)	1 (0.646)	0 (0.000)	-
Probability of a Crisis(%)	-	4.12	3.48	12.27	0.02	0.25	0.62

1. The second column provides the estimated coefficients along with their p-values in parentheses.
2. Numbers in parentheses in the third to the eighth column are the second quarter values except for Korea. The third quarter values are used for Korea. Figures in parentheses are the values of the explanatory variables multiplied by the estimated coefficients in the second column.
4. The last column is for the averages of non-crisis country observations.
5. The key statistics for the probit estimation in the second column are as follows: number of observations, 1235; pseudo-R^2, 0.225; and $\chi^2(8)$, 68.36.

Table 13. Probability of a Currency Crisis (II)

variable	Estima-tes	IND	KOR	THA	SIN	MEX	All
GDP	-0.305 (0.005)	0.026 (-0.008)	0.061 (-0.019)	-0.062 (0.019)	0.085 (-0.026)	0.088 (-0.029)	0.058 (-0.018)
RER	0.202 (0.000)	0.056 (0.011)	0.007 (0.001)	0.072 (0.010)	0.054 (0.011)	0.095 (0.019)	0.029 (0.005)
CA		0.018	0.017	0.069	-0.156	0.011	0.009
M2/RES		-0.077	0.134	0.301	-0.029	-0.155	-0.044
LB		2.227	2.703	4.110	3.902	0.485	2.494
$\left(\frac{\Delta crisis}{\Delta LB} * LB\right)$		(0.004)	(0.010)	(0.085)	(-0.037)	(0.001)	(0.003)
Contagion	0.042 (0.000)	1 (0.042)	1 (0.042)	0 (0.000)	1 (0.042)	0 (0.000)	-
Probability of a Crisis(%)	-	6.44	6.25	15.26	-2.50	0.45	1.10

1. The second column provides the estimated coefficients along with their p-values in parentheses.
2. Numbers in parentheses in the third to the eighth column are the second quarter values except for Korea. The third quarter values are used for Korea. Figures in parentheses are the values of the explanatory variables multiplied by the estimated coefficients in the second column.
4. The last column is for the averages of non-crisis country observations.
5. $\Delta crisis / \Delta LB = 0.001 + 0.088CA - 0.005M_2 / RES + 0.711CA \cdot M_2 / RES$. Substituting the values of LB, CA, and M_2/RES for each country into ($\Delta crisis / \Delta LB$)*LB yields the partial effect of LB. For details, see section 3.3 in chapter V.
6. For simplicity, coefficients for CA, M_2/RES, LB, LB*CA, LB*M_2/RES, and LB*CA*M_2/RES are not reported in the table.
7. The key statistics for the linear probability estimation in the second column are as follows: number of observations, 1235; R^2, 0.08; and adjusted R^2, 0.07 .

Table 14. IMF GDP Growth Rate Forecasts for Indonesia, Korea, and Thailand

Country and forecast source	Date	1997	1998
Indonesia			
IMF, first program	Oct. 31, 1997	5.0	3.0
IMF, second program	Jan. 15, 1998		0.0
IMF, third program	Apr. 10, 1998		-5.0
IMF, *World Economic Outlook*	Apr. 1998		-5.0
Korea			
IMF, first program	Dec. 4, 1997	6.0	2.5
IMF, third program	Feb. 7, 1998		1.0
IMF, *World Economic Outlook*	Apr. 1998		-0.8
Thailand			
IMF, first program	Aug. 20, 1997	2.5	3.5
IMF, second program	Nov. 25, 1997	0.6	0.0~1.0
IMF, third program	Feb. 24, 1998		-3.0~-3.5
IMF, *World Economic Outlook*	Apr. 1998		-3.1

Source: Radelet and Sachs (1998a)

Table 15. Real GDP Growth Rate (percent)

	1997	1998	1999[e]	2000[e]
Indonesia	4.7	-13.7	-0.8	2.6
Korea	5.0	-5.8	6.5	5.5
Malaysia	7.7	-6.7	2.4	6.5
Philippines	5.2	-0.5	2.2	3.5
Thailand	-1.3	-9.4	4.0	4.0

Source: IMF, *World Economic Outlook*, October 1999.

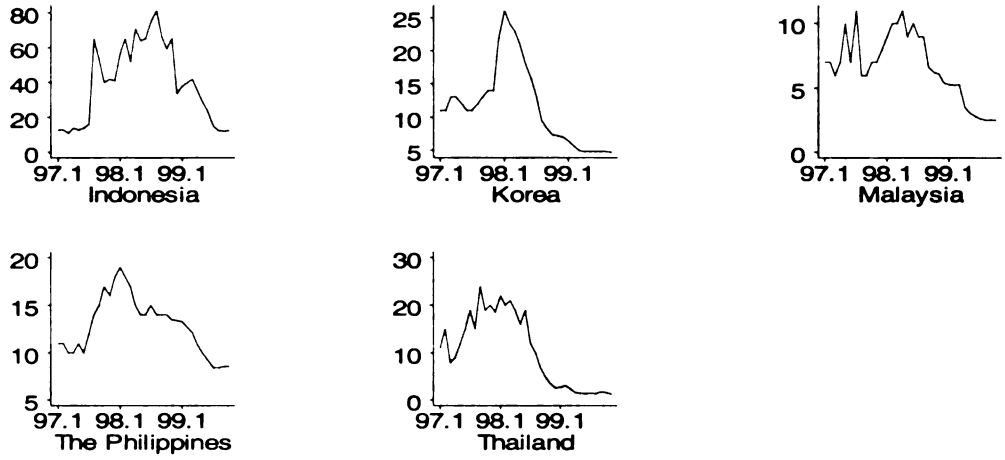

Figure 7. Short-Term Interest Rates

Source: IMF, *International Financial Statistics*, available on CD-Rom. Money market rate (IFS line 60b) , if unavailable, Treasury bill rate (line 60c).

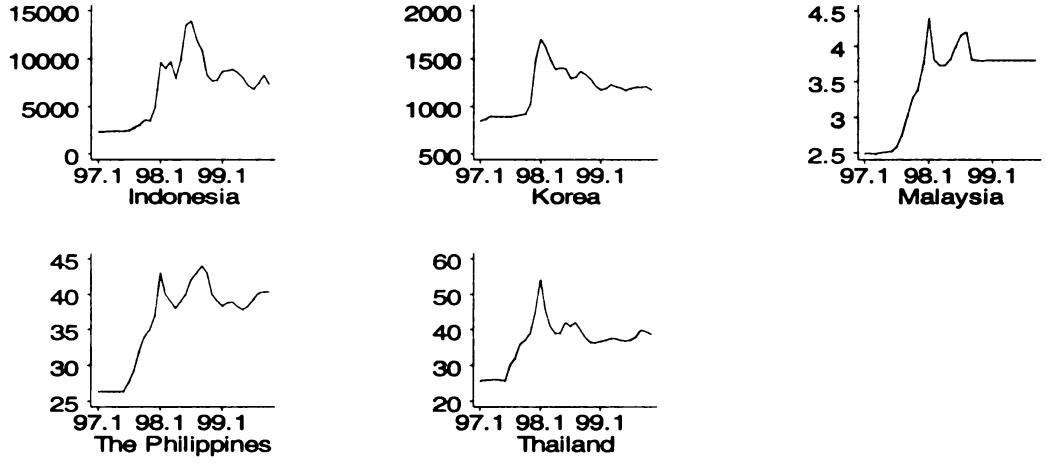

Figure 8. Exchange Rates (currency per U.S. dollar)

Source: IMF, *International Financial Statistics*, available on CD-Rom.

CHAPTER VII

CONCLUSION

Two main explanations of the Asian currency crisis have emerged in the recent debate. According to the "weak fundamental" (WF) view, the crisis reflected an unsustainable deterioration in macroeconomic fundamentals and poor economic policies in the afflicted countries. Those who think that speculative movements are due to WF tend to support fiscal and monetary policies which make the commitment to the exchange rate objective credible. In contrast, according to "financial panic" (FP) view, the sudden shifts in market expectations and confidence were the key sources of the initial financial turmoil, its propagation overtime and regional contagion in the second half of 1997. Those who advocate the FP view think international capital markets are intrinsically unstable and vulnerable to erratic speculative movements. They tend to support measures of capital controls that might help the governments to defend their currencies. However, the overview of the Asian economy during the 1990s presented in chapter II exemplifies that neither of the two views provides dominating evidence over the other, demanding more formal studies on this issue.

The theoretical literature about currency crises contains a number of models which rationalize WF or FP. Starting from the seminal contribution of Krugman (1979), *first generation* models show how speculative attacks occur when the fundamentals are weak, i.e., monetary policy is inconsistent with pegged exchange rate. According to the models, possible economic variables which precede crises include a fiscal deficit, domestic credit expansion, rising interest rate, low international reserves, inflation, real exchange rate

appreciation, and current account deficits. *Second generation* models differ in the role they assign to the economic fundamentals. In some models the fundamentals play a key role in determining when a crisis may occur. For example, Obstfeld (1996) and Tornell (1999) show that once the economy reaches the region of weak fundamentals, anything can happen. The exchange rate collapses if attacked, or survives otherwise. These models suggest that crises could result from economic variables such as low economic growth, the stock and maturity structure of public debts, and banking problems. Meanwhile, other second-generation models show that crises are not affected by the position of the fundamentals. Instead, they may simply occur as a consequence of pure speculation against the currency. For example, contagion effects suggest that a crisis in one country may raise the odds of a crisis elsewhere by signaling that a devaluation is more likely as a result of the initial crisis.

Although the theoretical models provide the logic of WF or FP, they say little or nothing about causes on the Asian crisis. The question of which model fits the Asian crisis better can only be answered by empirical studies. The empirical literature is grouped into two categories: *single-country* studies and *multi-country* studies. Single-country studies such as Blanco and Garber (1986), have presented strong evidence suggesting that domestic macroeconomic indicators play a key role in determining a currency crisis. These results, however, are somewhat limited since they are obtained from a small number of countries during very specific situations. Multi-country studies such as the classic study by Frankel and Rose (1996) recognize the limitations of country specific analysis, and attempt to exploit the higher variability associated with cross-country information. However, the regression results either have very weak predictive power or come from a sample that focuses on very specific events such as the Mexican

crisis in 1994. In addition, most multi-country studies use annual data in their estimations, making it difficult to capture a lot of actions in some of the explanatory variables a few months before and after the collapse.

This dissertation tries to lessen this problem, following the basic ideas of multi-country studies and employing *quarterly* data. The probit estimation in chapter IV shows that crises tend to occur when current account deficit grows, real exchange rates are overvalued, and reserves decrease. Currency crises also tend to be associated with a sharp slowdown of the economy and pure contagion. Contrary to common expectation, the analysis indicates that a lending boom has had little impact on currency crises.

In chapter V, I argue and demonstrate that the effect of a lending boom on a currency crisis might be different in countries with different current account balances and international reserves. The simple model shows that countries with a rapid lending boom accompanied by a severe current account deficit and low international reserves are susceptible to a speculative attack. The estimation model in this chapter differs from the one in chapter IV in the inclusion of interaction terms among the ratio of bank lending to GDP, the ratio of current account to GDP, and the ratio of M_2 to international reserves. Being consistent with the theoretical expectation, the estimation results show that the lending boom has statistically and economically significant effect only when it is associated with a severe current account deficit and low reserves.

Chapter VI applies the estimation models in the previous chapters to the Asian crisis. The estimation results show that: though the probability of a crisis in the Asian crisis-afflicted countries is not high except for Thailand, the probability is higher than that for Singapore, Mexico or the other countries in the sample; and Thailand, where the

crisis broke out first, had the most vulnerable economy. Interestingly, the contagion dummy, which is designed to capture a situation where a crisis in one country may trigger a crisis elsewhere for reasons unexplained by the fundamentals, has the largest effect on the crisis in Indonesia and Korea. Thus, the largest effect of the contagion dummy implies that the magnitude of the crisis can be fully explained only when both WF and FP are present.

For a crisis as the Asian one, explained by both WF and FP, the policy responses should focus on both reforming fundamental structures and restoring market confidence. One dilemma is that, the policy implications from the two views do not always coincide. Facing the crisis, the governments of Indonesia, Korea and Thailand signed emergency lending agreements with the IMF, which gave priority to reforming the weak fundamentals. In contrast, the Malaysian government decided to restrict capital outflows.

The continued turmoil in the financial market and deep recession after the launch of the IMF program have created a widespread debate on the IMF's role in the Asian crisis. While the debate on strict monetary and fiscal polices is still ongoing, the views on bank closures and recapitalization have reached a widespread consensus. It has been pointed out that closing banks and tightening supervisory standards would not restore market confidence in the middle of a panic, because concerns over the safety of the banking system will increase demands for the repayment of short-term debts. Moreover, pushing banks to recapitalize within a short time can lead to a severe credit crunch, increased distress for private firms, and a further rise in non-performing loans.

Though the arguments in favor of capital controls are still controversial, the views on the optimal speed and sequencing of capital account liberalization have also reached a

widespread and explicit consensus. This consensus view emphasizes that, as long as financial systems are weak, poorly regulated and subject to political distortions, a rush to capital account liberalization may be unwise and produce destabilizing effects.

Finally, the "incompatible trinity" says that no government can maintain simultaneously free capital mobility, fixed or targeted exchange rates, and independent monetary policy. The Asian crisis erupted following capital liberalization in the five countries that maintained a fixed (or targeted) exchange rate and pursued independent monetary policies. In the long run many countries may have to give up one of the three options. We should also remember that a sound financial system is needed to make a success of a number of different exchange rate regimes. Otherwise, it is probably impossible to make a success of any.

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