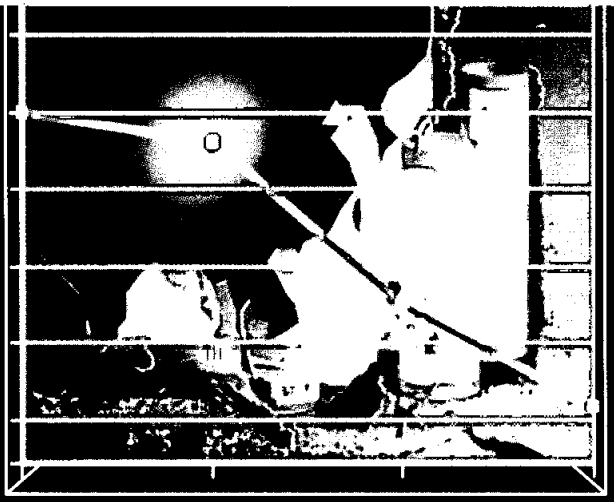
EARLY WARNING SYSTEM FOR CURRENCY CRISES: AN EMPIRICAL STUDY OF SEACEN COUNTRIES



Yih-Jiuan Wu
Tzung-Ta Yen
Pei-Wen Chen

The South East Asian Central Banks (SEACEN)
Research and Training Centre
Kuala Lumpur, Malaysia

EARLY WARNING SYSTEM FOR CURRENCY CRISES: AN EMPIRICAL STUDY OF SEACEN COUNTRIES

by
Yih-Jiuan Wu
Tzung-Ta Yen
Pei-Wen Chen

Economic Research Department
The Central Bank of China, Taipei

The South East Asian Central Banks (SEACEN)
Research and Training Centre
Kuala Lumpur, Malaysia

Published by The South East Asian Central Banks (SEACEN)
Research and Training Centre
Lorong Universiti A
59100 Kuala Lumpur
Malaysia

Tel. No.: (603) 7958-5600
Fax No.: (603) 7957-4616
Telex: MA 30201
Cable: SEACEN KUALA LUMPUR

EARLY WARNING SYSTEM FOR CURRENCY CRISES: AN EMPIRICAL STUDY OF SEACEN COUNTRIES
YIH-JIUAN WU, TZUNG-TA YEN & PEI-WEN CHEN

ISBN: 983-9478-13-3

Printed in Malaysia by Graphic Stationers Sdn. Bhd.

FOREWORD

The Asian financial and currency crisis that broke out in mid-1997 took almost everyone by surprise. Neither the policy makers, the international financial institutions or market participants anticipated the crisis to be so severe and widespread in the economies that were deemed as fundamentally strong at that time. This has sparked off interest among policy makers to develop an early warning system (EWS) that could correctly flash a warning light in time, so that measures could be taken to ward off, or at least lessen the severity of the looming crisis. It is recognised that along with efforts to strengthen the financial sector, there is a need to have reliable EWS for financial and currency crises.

The SEACEN study on *Early Warning System for Currency Crises: An Empirical Study of SEACEN Countries* aims to help member countries fulfill the above-mentioned need. To make the study more focused, the study investigates the macroeconomic indicators that will help predict the currency crisis in a sample of seven SEACEN economies (Indonesia, Korea, Malaysia, Philippines, Singapore, Taiwan and Thailand). Using quarterly data from 1970-95, some early warning models were estimated. These models were then tested on an out-of-sample basis from 1996 to the first quarter of 1999 to test their ability to predict the timing of the crisis.

The SEACEN Centre wishes to thank The Central Bank of China, Taipei, for making available a research team from the Economic Research Department, comprising Dr. Yih-Jiuan Wu, Dr. Tzung-Ta Yen, and Ms. Pei-Wen Chen to undertake the study. The authors gratefully acknowledged the assistance from Bank Indonesia, The Bank of Korea, Bank Negara Malaysia, Bangko Sentral ng Pilipinas, the Monetary Authority of Singapore and the Bank of Thailand, for providing data and information. In addition, the Centre wishes to express its appreciation to the member banks and monetary authorities for their useful comments and suggestions.

The views expressed in the study, however, are those of the authors and do not necessarily reflect those of the member central banks/monetary authorities or the SEACEN Centre.

Dr. Subarjo Joyosumarto
Executive Director
The SEACEN Centre

Kuala Lumpur
October 2000

EARLY WARNING SYSTEM FOR CURRENCY CRISES: AN EMPIRICAL STUDY OF SEACEN COUNTRIES1

ABSTRACT

In the wake of 1997 Asian currency crisis, the issue of the predictability of currency crises has become the major challenge facing the international market. If there were a model that is developed before 1997 to serve as early warning system on a regular basis, we would like to examine its forecasting ability for the 1997-1998 crises. This research investigates the macroeconomic factors in predicting the currency crises in a sample of seven SEACEN countries using the logit econometric models. Some models are estimated using quarterly data from 1970 to 1995 to serve as early warning system. On an out-of-sample basis from 1996:1Q through 1999:1Q, we assess how well these models track the 1997-1998 crises and the aftermath periods they claim to predict. In general, the empirical results indicate that some economic variables may help predict the timing of currency crises. These variables include the real US interest rate, the ratio of import to foreign reserves, the ratio of M2 to foreign reserves, the real effective exchange rate, or the money multiplier. In particular, the model that includes the variables such as the real US interest rate and the ratio of import to foreign reserves can forecast better than other models for most of these seven countries.

* We would like to thank the following central banks for providing valuable information for this research. These central banks include Bank Indonesia, The Bank of Korea, Bank Negara Malaysia, Bangko Sentral ng Pilipinas, Monetary Authority of Singapore, Bank of Thailand, and The Central Bank of China, Taipei. Our thanks also go to other SEACEN member banks that offer valuable comments on this research.

TABLE OF CONTENTS

LIST OF TABLES AND FIGURES

Page

Table

Figure

LIST OF APPENDICES

I. INTRODUCTION

Since the eruption of the Asian currency crisis in July 1997, how to prevent a potential currency crisis has become the major challenge facing the international market. Many proposals have emerged in the aftermath of the crisis (see Blinder, 1999), one of which is to develop an Early Warning System (EWS) to signal the potential currency crisis to minimize possible losses.

Various studies have investigated the factors that are associated with different currency crises. Most of the previous multi-country analyses have concentrated on in-sample prediction and only covered the pre-1997 sample period. In seminal work, Kaminsky and Reinhart (1996) have examined the behaviors of many economic and financial variables before and after the previous currency crises. They attempt to identify the variables that act as early warning indicators for crises. Many subsequent studies have focused on forecasting currency crises using different methodologies. Some recent studies have been done in predicting the 1997 crisis, but the results have been mixed (see Berg and Pattillo, 1998, and Glick and Moreno, 1999).

The objective of this research is to look into the feasibility of developing an EWS using pre-1997 data to forecast the 1997-1998 crises. We examine seven SEACEN countries to further investigate their economic features that may help predict currency crises. The seven SEACEN countries studied are Indonesia, Korea, Malaysia, the Philippines, Singapore, Thailand and the Republic of China, Taipei. Our fundamental question is whether the factors that account for pre-1997 currency crises could be used to predict the 1997 crises. The factors that cause the 1997 currency crises may not be the same as the previous ones in these Asian countries. Nonetheless, we would like to find a set of common economic indicators that could be useful in predicting the timing of the previous and recent crises. Several variables that are widely discussed in previous empirical studies are evaluated.

Specifically, we analyze the determinants of the probability of a currency crisis in a logit specification using quarterly panel data during the period 1970:1Q-1999:1Q. Unlike most former studies that emphasize only on predicting the onset of the 1997 currency crisis, we further investigate the role of the models as EWS on a regular basis. That is, some logit models are estimated using quarterly data from 1970 to 1995 to serve as EWS. On an out-of-sample basis from 1996:1Q through

1999:1Q, we assess how well these models track the 1997-1998 crises and the aftermath periods they claim to predict. One-quarter-ahead out-of-sample forecasts are compared across countries.

To evaluate the forecasting ability, the forecasts of different models are compared by the following criteria: the timing of signals, the type I error and type II error, and the χ^2 tests of independence of the true value and the forecast value.

Overall, we would like to know whether there is a model that can forecast all SEACEN countries as well. In addition, we want to evaluate which country's crisis is comparatively easy to predict, and which one is less foreseeable.

Generally, the empirical results indicate that some economic variables could help predict the timing of currency crises. These variables include the real US interest rate, the ratio of import to foreign reserves, the ratio of M2 to foreign reserves, the real effective exchange rate, or the money multiplier. In particular, the model that includes the variables such as the real US interest rate and the ratio of import to foreign reserves can forecast better than other models for most of these seven countries. Furthermore, our study shows that the exact timing of the Indonesian crisis in 1997 was somewhat less predictable.

This research is organized as follows. Section II reviews the literature on the currency crises and the early warning system. Section III describes the financial crises and the seven SEACEN countries, which includes the causes and the process of the 1997 crises, the policy responses to the crises, and the initiative to develop the EWS in the respective SEACEN countries. In addition, the relative importance of the qualitative and quantitative factors for the 1997 currency crisis is also compared across the seven SEACEN countries. Section IV presents the empirical forecasting results of the currency crises for the seven SEACEN countries. Section V concludes this research.

II. Literature Review

2.1 Overview

The 1990s have witnessed several financial crises in the world. The financial crises in Europe, Mexico and Asia have drawn worldwide

attention to understand the incidence of financial crises. It is interesting to note that the forecasts of economists, the risk assessments by credit rating companies, and the IMF and World Bank failed to provide an early signal of the impending currency crises. Recent financial crises have further raised questions about whether financial crises are predictable with early warning signals in advance to allow the relevant authorities to take some actions before the crisis actually happened or whether the crises are basically unpredictable.[1]

In recent years, economists have built different predicting models for currency crises. The development of the early warning system (EWS) for currency crises is important from both theoretical and practical viewpoints. On the one hand, they might help the authorities understand theoretically the nature of crises and single out a good early warning model. On the other hand, they might help the authorities predict future currency crises, or help the authorities identify the extent of fragility or vulnerability that the economies could suffer from an attack during turbulent times. In this section, we review the literature of several early warning models of currency crises, and make some comparisons among those models.[2]

2.2 Theoretical Models of Currency Crises

In order to enhance the understanding of currency crises, we review some of the theoretical models on currency crises.

2.2.1 First-generation models

The first generation models focused on understanding the currency crises and showed that a fixed exchange-rate policy combined with excessively expansionary pre-crisis fundamentals could push a country into currency crisis. Developed in the 1980s, these models have represented the mainstream view about crises for more than a decade.

1. In literature, there are different definitions of the economic or financial crisis. See IMF (1998) report and Sachs (1995).

2. The early warning system has been developed for the financial industries since 1970s. In order to monitor the changes in the operating conditions of insured institutions and help problem institutions make timely improvements, the FDIC in 1970s established an off-site monitoring program referred to as the "Insured Financial Institutions' Early-Warning System" to strengthen the function of financial examination and risk management. As a result, this system has now functioned effectively for many years.

Krugman (1979) developed the first theoretical model of balance-of-payments crises. Krugman argued that crises occurred when a continuous deterioration in the economic fundamentals became inconsistent with an attempt to fix the exchange rate. In Krugman's model, the source of the currency problem is excessive domestic credit creation used to finance fiscal deficits or to provide assistance to a weak banking system. The model assumes that the government does not have access to the capital markets, and therefore has to monetize its expenditures. Therefore, the increase in the quantity of money tends to lower domestic interest rates as well as induce capital outflows and a gradual loss of foreign exchange reserves. Consequently, the currency under a fixed exchange rate regime becomes vulnerable to a speculative attack. In this model, a critical level of reserves determines the timing of the currency attack.

The Krugman model and its extensions show that crises arise because of an inconsistency between domestic policies and a fixed exchange rate regime.[3] In this manner, a currency crisis is both unavoidable and predictable in an economy with a persistent deterioration in its economic fundamentals. These models show that the movements of several variables, such as the real exchange rate, the current account balance, real wages and domestic interest rates, could be used as the leading indicators of currency crises. In other words, prior to the events of the 1990s, the fundamentals had explanatory power in predicting the currency crises in the typical first-generation models. That is, according to the first-generation models, it is possible to develop an early-warning system to predict when a currency will be vulnerable to a speculative attack.

2.2.2 Second-generation models

Unlike the early works, the second-generation models are built to capture the features of speculative attacks. Several economists have focused on the possibility of currency crises even in the absence of a

3. Based on the Krugman's work, Flood and Garber (1984) extended a simplified linear model that introduced a stochastic component. Connolly and Taylor (1984) analyzed a crawling-peg regime and focused on the behavior of the relative prices of traded goods preceding the collapse of the exchange rate regime. In their analyses, the real exchange rate appreciated and the current account deteriorated prior to the collapse.

continuous deterioration in economic fundamentals. This approach regards currency crises as shifts between different monetary policy equilibriums in response to self-fulfilling speculative attacks. In other words, this approach focuses on the contingent nature of government policies, which may give rise to multiple equilibria and generate self-fulfilling crises. For example, Obstfeld (1994, 1996) shows that a key aspect of these models is the existence of a circular process that leads to more than one equilibrium in the exchange-rate regime. Basically, multiple equilibria arose from nonlinearities in the government behavior.[4] Countries with relatively sound fundamentals could suffer from currency attacks simply because of a sudden adverse shift in market sentiment or confidence, which is essentially unrelated to their economic fundamentals. In this way, second-generation models tend to focus on the effects of the actions of economic agents in determining the movements from one good equilibrium to a bad one. Models built along these lines included Calvo (1995), Cole and Kehoe (1996), Sachs, Tornell and Velasco (1996), and Drazen (1998).

Most economists of the second-generation models assume that a government has the explicit incentive either to defend or to abandon the exchange rate system. Economic agents may anticipate such policy and react by attacking the domestic currency, which accelerates the currency crises. Since the change in policy does not necessarily occur, a crisis in these models tends to have a highly unpredictable component. Based on this approach, currency crises may simply occur as a result of pure speculative attack against a currency.

Compared with the first-generation model, which has a linearity behavior setting, the second-generation models include one or more nonlinearities behavior in their models. However, what is common to both approaches is that they emphasize on macroeconomic and financial fundamentals as determinants of currency crises. According to second generation models, currency crises can be triggered by self-fulfilling expectations just as likely as they can be induced by the deteriorating

4. Kaminsky, Lizondo and Reinhart's (1998) point out that the crucial assumption in the second generation models is that the government policies are not predetermined but instead respond to changes in the economy, and that economic agents take this relationship into account in forming their expectations. At the same time, the expectations and actions of economic agents affect some variables to which economic policies respond. This circularity creates the sources of multiple equilibria.

fundamentals. Thus, it is not possible to construct a reliable early-warning system to forecast future crises.

2.3 Empirical Methodology and Results of Crisis Prediction

2.3.1 The Definition of the Currency Crisis

In recent literature, there are different definitions of a currency crisis. Eichengreen, Rose, and Wyplosz (1995) first use the Girton and Roper (1977) idea of "speculative pressure index", which is measured as a weighted average of the changes in exchange rate, interest rates and reserve changes. The rationale for this index is that if speculative attacks happen or capital inflows reverse, the government can defend the currency by either depreciating the exchange rate or running down the reserves. However, in many empirical studies, the interest rate variable was not included in the index simply because data for market-determined interest rates in emerging markets economies may not span the entire sample period. This standard measure[5] has been used to define the currency crisis by other researchers, such as Sachs *et al.* (1996), Kaminsky, Lizondo and Reinhart (1998), Kaminsky and Reihart (1999), Corsetti, Pesenti and Roubini (1998) as well as Tornell (1999).

Unlike the previous definition of currency crises, Esquivel and Larrain (1998) assume that a currency crisis only exists when there is an abrupt change in the nominal exchange rate. Therefore, unlike previous studies, they exclude unsuccessful speculative attacks from the definition of the currency crisis. The main reason to rule out unsuccessful speculative attacks is the difficulty and subjectivity in defining when a speculative attack has occurred. They criticize the standard measure of currency crises based on two reasons. First, there is no clear guidance on the weights that should be attached to each variable, and the previous studies that use this index tend to exclude a sensitivity analysis of the weighting scheme. Second, they are interested in actual

5. There are other definitions of the currency crisis. For example, Frankel and Rose (1996) define a currency crash as a depreciation of the nominal exchange rate of not only exceeding 25 percent, but exceeding the previous year's depreciation by a margin of at least 10 percent. Recently, Glick and Hutchison (1999) defined currency crises as a weighted average of monthly real exchange rate changes and monthly (percent) reserve losses.

currency crises, and thus prefer to focus on "successful" speculative attacks[6]. Moreover, as pointed out by Flood and Marion (1998), this measure is plagued by a series of time aggregation problems that cast doubt on the effects it is capturing. They also point out that the index is defined in such a way that it tends to pick the situations that are largely unpredictable from a "bad fundamentals" perspective.

2.3.2 Empirical Methodology

Based on the review of the theoretical literature on currency crises, it is possible to design an early-warning system either to predict a currency crisis in first-generation models, or to serve as indicators of a country's vulnerability to future crisis in second-generation models. Since our research focuses on the predictability of currency crises by using the early warning system, we discuss the following three approaches based on their promise as early warning systems for predicting currency crises.

- ***The Signal Approach***

Kaminsky, Lizondo and Reinhart (1998) examine 76 currency crises from a sample of 20 countries during 1970-1995 and propose an early warning system to help assess the possibility of an impeding crisis. They monitor 15 economic variables[7]. Those economic variables that deviate from a certain threshold value are taken as warning signals of a currency crisis within a specified period of time (defined *a priori* as 24 months). A signal that is followed by a crisis within 24 months is regarded as a good signal. On the contrary, a signal that is not followed by a crisis within 24 months is called a false signal.

6. Esquivel and Larrain (1998) use two criteria to qualify a nominal devaluation as a currency crisis. First, the devaluation rate must be large relative to what is considered standard in a country. Second, the nominal devaluation has to affect the purchasing power of the domestic currency.

7. Those indicators are international reserves, imports, exports, terms of trade, deviations of the real exchange rate from trend, differential between foreign and domestic real interest rates on deposits, excess real M1 balances, money multiplier of M2, ratio of domestic credit to GDP, real interest rate on deposits, ratio of lending to deposit interest rates, ratio of broad money to gross international reserves, index of output, and index of equity prices.

In their model, for each country, the thresholds are defined relative to the percentiles of the distribution of the indicator. An "optimal" set of thresholds is calculated for each variable by minimizing the ratio of false signals to good signals for the sample countries[8]. Indicators with noise-to-signal ratios less than one are useful in predicting crises. The indicators that have predictive power are international reserves, real exchange rate, domestic credit, credit to the public sector, and domestic inflation.

The signal approach was also adopted by the IMF (1998) to analyze the behavior of a number of macroeconomic variables around the time of currency crises during the period 1975–97, for the group of 50 advanced and emerging market countries. The appreciation of the real exchange rate, the growth of real domestic credit, and the ratio of M2 to international reserves were used to form an index of macroeconomic vulnerability to a currency crisis, which was calculated for six Asian and four Latin American countries. The index shows that, beginning in early 1997, vulnerability increased in almost all of the East Asian economies that are most affected by the recent turmoil. Kaminsky (1998) further calculates a single composite indicator of a crisis index as a weighted-sum of the indicators, where the weights are based on the noise-to-signal ratios of each indicator. Then, she calculates a probability of crisis of each value of the aggregate index by observing how often within the sample a given value of the aggregate index is followed by a crisis within 24 months.

The advantages for the signal approach are as follows. First, the signal approach gives the signals of several variables in predicting an impending crisis and provides information about the sources and breadth of problems that underline a currency crisis. The differences in the average behavior of a number of macroeconomic variables between periods leading up to a currency crisis and tranquil periods are suggestive. Second, this approach takes into account a broad variety of economic variables which seem to usually be preceded by a broad range of economic problems.[9]

8. The percentile for each indicator is uniform across countries, but the corresponding country-specific thresholds associated with that percentile will differ across countries.

9. Kaminsky (1998) points out that this approach is easy to implement and does not impose restrictive models on the data. However, when multiple indicators are available, we had better put those indicators together to better help predict the possibility of a crisis.

However, there are several drawbacks in this approach. Firstly, the fixed effects specification. In the model specification, a common percentile threshold rather than a common threshold is designated for each country. Secondly, many indicators are in the form of 'rates of growth', therefore, if there are fixed effects in levels, these indicators which are in the form of 'rates of growth' will not be useful in predicting the crisis. This fixed effect means that the indicator will overpredict crises in countries with good histories and underpredict crises in countries with bad histories.[10] Thirdly, the usefulness of the index depends on the availability of timely information. If the relevant information is not available on a timely basis, the behavior of the indicator examined is not useful to serve as leading indicator. Finally, deficiencies in the institutional and regulatory or social safety and political sector of the country are often important factors in explaining the currency crises. Without consistent data on such institutional factors, it is difficult to include those variables into the early warning system.

- ***The Probit or Logit Model***

A second approach, which uses "limited-dependent variable" econometric models, estimates the probability of a currency crisis and identifies the variables that are statistically significant in predicting the crises. This approach, which relies on a multi-country analysis and focuses on the predictability of currency crises is used in our empirical study. The advantage of the probit approach is that several indicators of economic variables could be evaluated simultaneously. Frankel and Rose (1996) adopt the methodology used by Eichengreen, Rose, and Wyplosz (1995). They use a panel of annual data for over 100 developing countries from 1971 through 1992 to estimate the probability of a currency crashes. They define a currency crash as a large depreciation together with a substantial increase in the rate of depreciation. They regard a sample of "tranquil" observations as a control sample, and compare the behavior around crash episodes with the behavior during periods of tranquility[11].

10. Furman and Stiglitz (1998) pointed out the above two drawbacks. For example, if a country has consistently run a current account deficit of a certain percent of GDP, it does not necessarily mean that this certain level of deficit is not worrisome.

11. Four categories of variables are studied in their empirical works: the foreign variables, domestic macroeconomic indicators, external variables (such as the overvaluation, the current account and the level of international indebtedness), and the composition of debt stock.

Unlike the signal approach, Frankel and Rose (1996) only focus on the type of currency crisis that does not include speculative attacks.[12] However, the use of annual data may limit the applicability of the approach as an early warning system. They find that the probability of a crisis tend to occur when the share of foreign direct investment as a fraction of total debt is low, when reserves-to-imports ratio or GDP growth is low, and when domestic credit growth or foreign interest rates is high. Interestingly, neither current account deficit nor government budget deficit appears to play an important role in a currency crisis. Goldfjan and Valdés (1997) use the survey data for 26 countries and apply a logit model to predict the one-month ahead probability of a currency crisis as a function of the expected devaluation and the real exchange rate misalignment. They conclude that the "exchange rate crisis are largely unpredictable events".

Recently, Furman and Stiglitz (1998) fit the Frank and Rose (1996) model to the data from crises during 1980-1996 and construct fitted values for the probability of a crisis in 1997. They find that, in the case of 1997 Asia crisis, the predicted probability of a crisis in four of the East Asian countries are all below 7.0 per cent. In general, this model shows some promise for forecasting the crisis based on this in-sample assessment, however, the overall explanatory power is relatively low. Nevertheless, the use of annual data, not higher frequency data, may limit the applicability of this approach as an early warning system for the authorities. Furthermore, the use of a panel data relies on the assumption that all currency crises can be explained in the same way. Even with a large panel of crises, it is not possible to consider all the nonlinearities and interaction effects among a large number of explanatory variables.[13] Glick and Moreno (1999) analyzed the role of money, credit, trade and competitiveness variables in signaling currency crises of six countries in East Asia and seven countries in Latin America over the period 1972-1997. They used multivariate probit regressions focusing on the joint contribution of money and competitiveness variables

12. Frankel and Rose (1996) argue that the reserve movements are noisy measures of the exchange market intervention for most countries. In addition, few of those countries have market-determined short-term interest rates for long periods.

13. Both Furman and Stiglitz (1998) and Berg and Pattillo (1998) briefly point out some drawbacks of this approach.

to predict currency crises. They found that the reductions in real domestic credit and in foreign reserves as well as the appreciation in the real exchange rate could increase the likelihood of a currency crisis.

Without attempting to seek completeness, Appendix Table A1 briefly summarizes what has been done in predicting the currency crises by using the probit or logit models[14].

- ***The Cross-Country Regressions***

A third approach is the cross-country regressions. Sach, *et al.* (1996) analyzed the impact of Mexico's currency crisis of December 1994 that did not spread randomly across 20 emerging markets in 1995. They defined a crisis index as a pressure on the foreign exchange market. The index is the function of the lending boom, the change in the real exchange rate, low reserves, and weak fundamentals. They estimated a regression equation with cross-country data. In particular, they examined the determinants of the magnitude of the currency crisis in a cross-section of countries in 1995.

According to their empirical work, they find that the effect of the real exchange rate is significantly negative for the countries with low foreign reserves and weak fundamentals, and the effect of the lending boom is significantly positive for these same countries. In addition, the high value of R-square of the regression indicates that their model explains the pattern of contagion fairly well. In general, Sach, et al. (1996) concluded that overvalued real exchange rates, lending booms, and low foreign reserves were the necessary conditions for currency crises. However, in the absence of these weak fundamentals, contagion effect was short-lived. The advantages of this approach are: to predict the incidence of a currency crisis across countries; to impose the economic structure on the particular currency crisis; and to point out that the determinants of crisis episodes may have changed over time.

14. Some studies do not use the probit or logit model. However, they are presented because they either investigate the Asian countries (e.g. Moreno, 1995) or are widely discussed in relevant literature (e.g. Sachs et al., 1995, Kaminsky and Reinhart, 1996, and Kaminsky et al., 1998).

Overall, the previous empirical works indicate that there might be a number of symptoms of weak fundamentals around the time of currency crises[15]. Recently, a number of researchers have claimed success in predicting currency crises. However, due to different methodologies, sample countries, sample period, and the definition of currency crises, it is difficult to compare results across the various studies and reach consistent conclusions.

Furman and Stiglitz (1998) replicate the empirical estimations of the currency-crisis prediction models. They find that overall the signals approach could have done better in predicting the Asian currency crisis than the other two approaches discussed above. Furthermore, Berg and Patillo (1999) compare both the in-sample and the out-of-sample forecasts of different approaches. They find that the probit model tends to slightly outperform the signal approach-based probabilities in terms of scores and goodness-of-fit for the in-sample period. For their out-of-sample forecasts, they find that the probit model generally forecasts better than other approaches. In summary, the empirical evidence on the determinants of currency crises is still far from conclusive.

2.4 Difficulty in the Crisis Prediction

Theoretically, it is possible to design an early-warning system either for predicting a currency crisis or for serving as indicators of a country's vulnerability to future crises. However, the forecasting results of recent empirical studies on early-warning systems are not conclusive. Therefore, the establishment of early-warning systems for currency crises is still in their early stage[16]. We would like to address several difficulties

15. The IMF (1998) analyzed the behavior of 12 key macroeconomic variables around the time of currency crises in 50 countries over the 1975-97 period. They find a number of stylized facts emerge in currency crises. For example, the real exchange rate is substantially higher than its mean level, export performance significantly deteriorates, foreign-exchange reserves tend to decline, terms of trade deteriorates, inflation tends to be significantly high, ratio of M2-to-reserves tends to rise, broad money growth tends to rise sharply, and nominal private credit growth tends to rise sharply.

16. Rosenberg (1998) argues that there are several important features for an ideal early-warning system. Firstly, it should have a strong record both in predicting actual crises and in avoiding the frequent issuance of false signals. Secondly, it should include macroeconomic indicators with data available on a timely basis. Thirdly, the EWS should start flashing well in advance of an actual currency crisis.

in applying an early-warning system practically to predict currency crises as follows.

First, even if there were a well-designed early-warning system, the system itself could lose its ability to signal currency crises either because market expectation could trigger the crises earlier, or the authorities could take actions to prevent the crises from occurring. Hence, based on the efficient market hypothesis, the prediction on currency crisis could be intrinsically unattainable. If the authorities know how to predict currency crises, they will take appropriate actions to eliminate the crisis, which the EWS was trying to predict.[17]

Second, except for the quantitative macroeconomic and financial indicators, other qualitative factors also need to be included in the EWS. For instance, the structure of a country's economy, institutional developments, changes in the country's political regime, and the confidence of domestic and foreign players in various market are also important in predicting currency crises.

Third, as pointed out by Rosenberg (1998), the lack of data on currency crisis events intrinsically thwart empirical efforts to further modify current empirical models that examine such events for the purpose of building an EWS. Therefore, researchers are forced to assume that the parameters of their models characterizing the behavior of certain variables when a crisis builds up and unfolds are similar across time and countries. However, given the diversity of the countries' institutional arrangements, the dramatic changes that have taken place in their financial systems, and the increased integration of global markets, such an assumption may not be correct. Furthermore, the paucity of data for currency-crisis events makes it difficult to test such an assumption for the early-warning system.

Finally, since the market sentiment or expectation is regarded as an important factor to trigger crises, an early-warning system should be monitored by variables with a high-frequency-data basis. However, the lack of high-frequency data on some important variables such as for-

17. Furman and Stiglitz (1998) argued that the efficient market hypothesis implies that the expected returns are unpredictable, but the volatility or possibility may be predictable.

eign debt, foreign reserves, and nonperforming loans makes the currency-crisis prediction more difficult and almost impossible. Furthermore, data for the behavior of market sentiment and the economic variables are often not available on a timely basis to make them useful elements of the EWS.

2.5 Indicators of Vulnerability

In general, the previous empirical studies indicate that currency crises mostly occur in vulnerable economies. Lately, several researchers have tried to investigate whether there is an EWS that has systematically been associated with vulnerability to crises.[18] Generally, when countries have weak fundamentals, the risk of currency crises increases sharply. Therefore, the indicator of vulnerability of the economy can be used to identify the situations in which an economy faces the risk of a currency crisis being triggered by shocks or changes in economic conditions. In this regard, the development of indicators or early-warning systems of vulnerability could be important and quite useful for the authorities.

Recently, the IMF (1998) argued that an early warning system should indicate vulnerability to crises well in advance. Therefore, if the authorities use an EWS as indicators of vulnerability, they need to collect more country-specific information in order to evaluate a country's true vulnerability to an impending crisis. There is a zone of vulnerability in which the fundamentals are so weak that a shift in expectation could cause a crisis. Therefore, the policy makers could try to avoid the "crisis zone" or "vulnerability zone" by taking some preventive policies in advance.

18. The IMF (1998) argued that, if currency crises were arising from contagion effects, the early warning system could be useless because the crises arose from intrinsically unpredictable market reactions. The IMF also investigated the indicators of vulnerability and showed that, beginning in early 1997, vulnerability increased in almost all of the East Asian economies most affected by the recent turmoil. For example, Thailand, Malaysia, and to a lesser extent Indonesia and Korea were all vulnerable.

III. Financial Crises and SEACEN Countries

3.1 Overview[19]

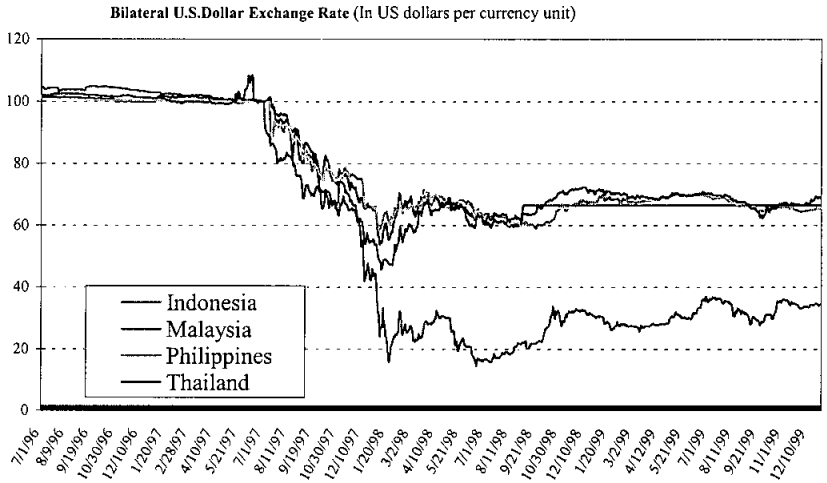
The Asian financial crisis that erupted in Thailand in mid-1997 suddenly halted the region's unprecedented three decades of rapid economic growth. The contagion effect that followed the crisis in Thailand has spread swiftly to other economies in Asia. Indonesia and Korea were severely affected by the contagion effect. Malaysia, the Philippines, and to a lesser extent, Singapore and R.O.C, Taipei were not spared the contagion even with their strong financial fundamentals. The extent of the Asian crisis has been deeper and more prolonged than many had expected. As a result, a number of Asian economies have suffered from the severe declines in the value of their currencies, stock prices, and other asset prices (see Figure 3.1), the contraction of the economic activities, and the disruption of the financial systems. In addition to its harsh effects in Asia, the crisis has subsequently put pressure on other financial markets in the emerging economies outside the region as well as advanced economies, contributing to contagion effects and instability in the international markets.

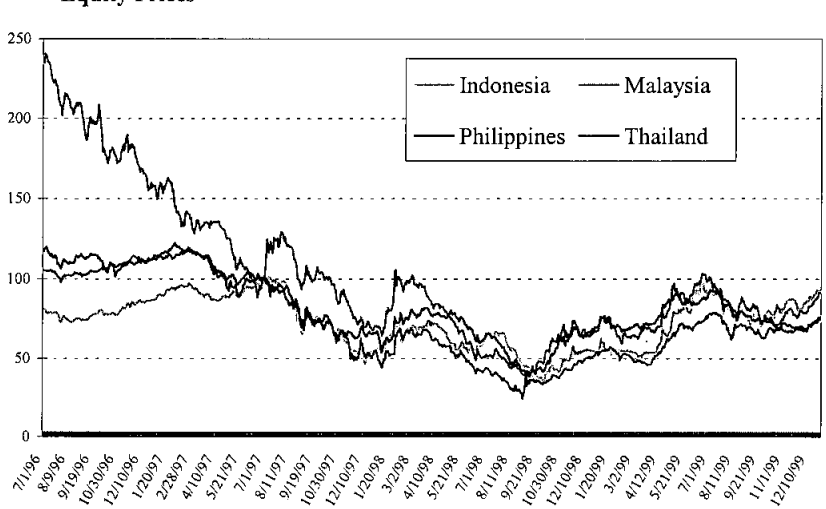
3.1.1 The Origins of the Asian Crisis

It is not easy to identify the precise causes of the Asian financial crisis as they were complex and differed across countries. According to the IMF, the Asian crisis did not originate primarily from macroeconomic imbalances as only in Thailand that there was a clear evidence of significant real exchange rate misalignments. Rather, it was the result of weaknesses in the financial systems and to a lesser degree, poor corporate governance and inadequate transparency, which made economies increasingly vulnerable to shifts in market sentiment and the worsening of economic conditions. In addition, the Asian crisis occurred in the course of rapid moves toward financial liberalization and globalization.

19. Most of the views expressed in this section are from the following sources: Alba et al. (1998), IMF (1999a), IMF (1999b), SEACEN (1998), SEACEN (1999), and Appendix Table 2 and Appendix Table 3.

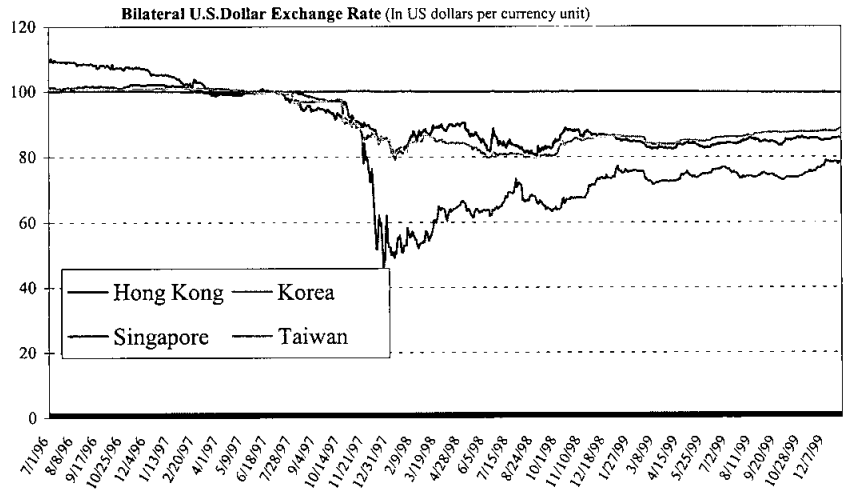
Figure 3.1 Selected Asian Countries : Bilateral U.S.Dollar Exchange Rates and Equity Prices (July 1 1997=100)

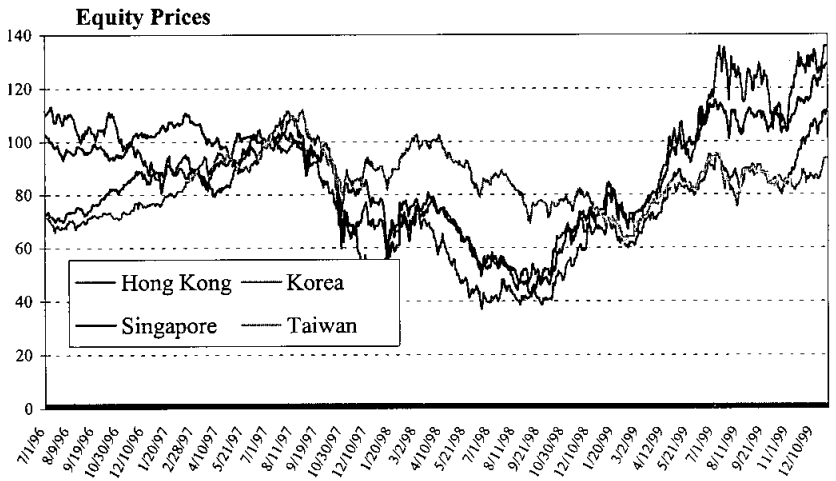




Source : PRIMARK DATASTREAM

Figure 3.1 Selected Asian Countries : Bilateral U.S.Dollar Exchange Rates and Equity Prices (Cont'd)
(July 1 1997=100)





Source : PRIMARK DATASTREAM

Weaknesses in the financial sector, stemming from incentive and moral hazard problems (e.g., implicit government guarantees and policy loans), as well as institutional and regulatory weaknesses, led to the misallocation of credit, deteriorated loan quality and inflated asset prices. Highly interacting with these weaknesses was the financial liberalization and globalization. The inadequate measures during the period of large unrestricted capital inflows as well as the insufficient government policies to match the rapid financial liberalization also raised the vulnerabilities of the financial system to external shocks. The large short-term inflows, which were channeled through the financial system, led to excessive-lending to unproductive sectors. Moreover, the pegged exchange rate regime resulted in the accumulation of largely unhedged private foreign currency borrowing, making the currencies vulnerable to speculative attacks.

Prior to the crisis, the Asian economies were perceived as 'fundamentally sound' and the crisis was not anticipated. However, the crisis-hit countries, for instance, Indonesia, Korea as well as Thailand, did show some early warning signs of weakness in their economies. These included: (i) sluggish productivity and export growth; (ii) escalating and persistent current account deficits; (iii) increasing fragility in the financial sector associated with excessive expansion of domestic credit, a consequently asset boom and growing exposure to risky sectors; and (iv) rising external debts.

Appendix Table A2 compares the reasons that caused the previous crises with those of the recent 1997 crisis for seven SEACEN countries[20].

3.1.2 The Main Policy Responses

During the initial period of the Asian financial crisis, several central banks in the region heavily intervened in the foreign exchange market and adopted tight monetary policies to defend their currencies. However, as the value of their currencies continued to plunge and the international reserves sharply depleted, some countries had to abandon

20. The dates of the previous and recent currency crises for each country are identified according to the definition of Kaminsky and Reinhart (1999), which will be discussed in more details in Section IV.

their exchange rate regimes. Countries that joined the IMF programs adopted a floating exchange rate system while Malaysia opted for a fixed exchange rate and selective capital controls to regain its monetary policy independence.

In terms of monetary and fiscal policies, the initial responses of all the crisis-affected countries was similar, with high interest rates and tight budget. However, as the ensuing recession was found to be deeper than expected, and as their currencies were stabilized, both the IMF-programmed and non-programmed countries adopted accommodative monetary and fiscal policies. All of them also pursued rigorous reforms in the financial and the real sectors.

3.1.3 The Early Warning System

Prevention is better than cure. The purpose of the Early Warning System (EWS) is to signal a potential crisis in advance so that the authorities can take some timely action to prevent the crisis from occurring. Before the 1997 crisis, several Asian countries such as Korea, Singapore, and R.O.C., Taipei have already implemented some kinds of the EWS for financial institutions. However, the Asian countries generally began to seriously look into the feasibility of the EWS for currency crises only after the recent 1997 crisis. Appendix Table A3 summarizes the EWS for the financial institutions or the currency crisis in seven SEACEN countries.

In this section, we briefly describe the causes of the 1997 crises, the process of the crises, the policy responses to the crises, and the development of the EWS in the individual SEACEN country (please see Appendix Table A2 and Table A3 for more details). In addition, we compare the relative importance of the qualitative and quantitative factors for the 1997 currency crisis across the seven SEACEN countries.

3.2 Indonesia[21]

Indonesia's economy has been severely affected by the recent Asian crisis in spite of the fact that its economy at the onset of the crisis

21. Most of the views expressed in this section are from the following sources: Pincus and Ramli (1998), Report for the Financial Year (Bank Indonesia, various isues), and Appendix Table 2 and Appendix Table 3.

was fundamentally sound with stable inflation, reasonable export growth, moderate current account deficits, and a surplus in fiscal balance (see Table 3.1). However, as the regional turbulence aggravated, confidence in the Indonesian economy eroded as a consequence of its escalating foreign debt and deteriorating financial sector. A sudden shift in market expectation and confidence triggered the reversal of short-term capital flow and therefore ignited the financial turmoil.

Started in Thailand in July 1997, contagious speculative attacks led to massive and unexpected reversal of short-term capital flow and plunged the rupiah exchange rate. Unlike the previous crises that were generally triggered by the external oil shock, the 1997 currency crisis in Indonesia was exacerbated by the large foreign debts, which were mostly unhedged and with short-term maturity. Subsequently, the substantial depreciation in rupiah exchange rate caused many domestic firms to default on their loans.

In addition, along with external debt problem, domestic banks had to deal with mounting non-performing loans, which mostly owing to moral hazard practices resulting from 'crony capitalism', and the violation of prudent banking practices.

In general, although the crisis in Indonesia was brought about by external factors, its roots could be traced to weak domestic economic and financial structures, which included over-reliance of the private sector on short-term foreign debt, poorly regulated domestic financial system, and moral hazard.

The extent and depth of the crises were aggravated by the existing social and political instability, as well as the loss of foreign investor confidence in Indonesia. Therefore, what started off as a rupiah crisis became a banking and financial crisis with wide-scope unfavorable impact on the domestic economy.

In July 1997, soon after the floating of the Thai baht, pressure on the Indonesian rupiah deepened despite intervention by Bank Indonesia. In response, Bank Indonesia discarded the managed floating exchange rate system, and floated the rupiah on August 14, 1997. When the rupiah again came under pressure and the weak banking sector started to suffer from distress, Indonesia had no option but to turn to the IMF for a three-year standby loan in October 1997. A bailout

Table 3.1: Key Economic and Financial Indicators in Indonesia

	1990	1991	1992	1993	1994	1995	1996	1997	1998
1. GDP (growth rate,%)	7.2	7.0	6.5	6.5	7.5	8.2	7.8	4.7	-13.2
Investment (% of GDP)	28.4	28.1	27.2	26.3	23.5	24.6	25.8	32.9	20.9
Saving (% of GDP)	24.9	24.3	24.8	24.8	21.8	21.3	22.4	40.0	24.9
2. Unemployment (%)	2.5	2.6	2.7	2.8	4.4	7.2	4.9	4.7	5.5
3. Inflation (growth rate, %)	7.9	9.3	7.6	9.6	8.6	9.4	8.0	6.7	57.7
4. External Account (billion of $)									
Export (growth rate, %)	15.9	13.5	16.6	8.4	8.8	13.4	9.7	7.3	-8.6
Import (growth rate, %)	33.5	18.5	5.5	3.8	12.9	27.0	5.7	-2.9	-34.4
Current account (% of GDP)	-2.6	-3.3	-2.0	-1.3	-1.6	-3.2	-3.4	-2.3	4.0
International reserves (total reserves minus gold)	7.5	9.3	10.4	11.3	12.1	13.7	18.3	16.6	22.7
Short-term external debt (% of reserves)	-	136.6	107.0	108.7	129.0	171.1	170.2	177.4	122.0
Short-term external debt (% of imports)	-	41.7	40.5	43.0	41.6	47.9	60.8	52.0	49.5
5. Government Fiscal Balances (% of GDP)	0.4	0.4	-0.4	0.6	0.9	2.2	1.4	-1.1%*	-2.2%*
6. Monetary Statistic									
M2 (growth rate, %)	44.2	17.0	20.2	22.0	20.2	27.6	29.6	23.2	62.3
Loan & advances of commercial banks (growth rate, %)	53.6	16.3	8.9	21.6	25.6	24.2	24.8	29.1	28.9
Lending rate-working capital (end of period)	21.0	25.1	22.1	20.5	17.8	19.3	19.0	25.4	34.8
Deposit rate-1 year time deposit (end of period)	18.5	22.8	19.0	16.3	13.0	16.3	16.7	15.9	28.3
7. Exchange rate (averages) (Rupiah:US$)	1,843	1,950	2,030	2,087	2,161	2,249	2,342	2,909	10,014
8. Stock price index (end of year)	418	247	274	589	470	514	637	402	398

Sources: Statistics Indonesia website (http://www.bps.gov.id); International Financial Statistics Yearbook 1999, IMF; SEACEN Financial Statistics, SEACEN, July 1999; Key Indicators of Developing Asian and Pacific Countries 1998, Volume XXIX, ADB; Report of the Working Group on Financial Crisis in Emerging Markets, Institute of International Finance, Inc., Jan. 1999; Primark Datastream.

Note: * indicates the figures of 1997 (FY 97/98) and 1998 (FY 98/99), respectively.

package of $43 billion including bilateral and multilateral assistance was unveiled on October 31, 1997. The policy package included tight monetary policy, strengthening of the underlying fiscal position to smoothen the progress of current account adjustment, a plan to restructure the financial sector (including closure of insolvent institutions), and structural reforms to improve efficiency and transparency in the corporate sector.

The EWS for financial institutions has been implemented by Bank Indonesia to assist bank supervisors in identifying potential problems faced by banks. Bank Indonesia continues to improve the system to efficiently monitor the banking sector. The EWS for the currency crisis is being developed.

3.3 Korea[22]

On the whole, Korea's macroeconomic fundamentals were still generally favorable in the early part of 1997, although some signs of vulnerability had been evident since 1996. Current account deficits widened significantly while export growth in industrial production dropped sharply compared with the previous year (see Table 3.2 for details).

From early 1997, the large current account deficits combined with the declining foreign capital inflows brought about a drastic decrease in the country's foreign exchange reserves. From the beginning of the third quarter, foreign investors' confidence eroded significantly due mainly to concerns over the fragility of financial institutions and chaebol (family-owned conglomerates) following a string of chaebol insolvencies, an increase in financial institutions' bad loans, and the adverse contagion effect of the Asian currency crisis. This led to a large net outflow of foreign portfolio capital. Therefore, without sufficient foreign currency liquidity to meet the maturing liabilities following a sharp decline in its foreign exchange reserves from early November, Korea could not remain immune in the regional crisis.

22. Most of the views expressed in this section are from the following sources: Annual Report (the Bank of Korea, various issues), Chang et al. (1998), Ministry of Financial and Economy of Korea (1998), and Appendix Table 2 and Appendix Table 3.

Table 3.2: Key Economic and Financial Indicators in Korea

	1990	1991	1992	1993	1994	1995	1996	1997	1998
1. GDP (growth rate, %)	9.5	9.2	5.4	5.5	8.3	8.9	6.8	5.0	-5.8
Investment (% of GDP)	37.6	39.8	37.3	35.4	36.5	37.3	38.1	34.4	20.9
Saving (% of GDP)	37.5	37.3	36.4	36.2	35.5	35.5	33.8	33.4	33.2
2. Manufacturing industrial production (growth rate, %)	8.9	9.6	6.0	4.1	11.1	12.0	8.6	5.2	-7.5
3. Unemployment (%)	2.4	2.3	2.4	2.8	2.4	2.0	2.0	2.6	6.8
4. Inflation(growth rate, %)	8.5	9.3	6.3	4.8	6.2	4.5	4.9	4.5	7.5
5. External Account (billion of $)									
Export (growth rate, %)	4.2	10.5	6.6	7.3	16.8	30.3	3.7	5.0	-2.8
Import (growth rate, %)	13.6	16.7	0.3	2.5	22.1	32.0	11.3	-3.8	-35.5
Current account (% of GDP)	-0.8	-2.8	-1.2	0.3	-1.0	-1.7	-4.4	-1.5	12.6
International reserves (gold & foreign exchange holdings)	14.8	13.7	17.2	20.3	25.7	32.7	33.2	20.4	52.0
Short-term external debt (% of reserves)	-	245.7	210.8	194.6	206.0	217.6	284.1	314.5	59.0
Short-term external debt debt (% of imports)	-	36.4	38.2	40.3	44.1	44.5	53.7	37.3	24.6
6. General Government Financial Balances (% of GDP)	3.8	2.0	1.5	2.7	3.3	4.4	4.2	2.4	0.7
7. Monetary Statistic									
M3 (average, growth rate, %)	29.9	25.7	22.2	21.6	22.0	19.9	19.0	16.3	13.9
Loans of DMB (growth rate, %)	18.4	20.8	15.0	12.0	18.0	12.2	16.2	13.1	-0.1
Interest rate on loans of NCBs (end of year)	10.0-12.5	10.0-12.5	10.0-12.5	8.5-12.0	8.5-12.5	9.0-12.5	11.10	15.32	11.11
Interest rate on the time deposit at NCBs (end of year)	10.0	10.0	10.0	8.5	8.5-10.0	7.5-10.0	9.80	12.59	9.06
8. Exchange rate (averages) (Won : US $)	707.8	733.4	780.7	802.7	803.5	771.3	804.5	951.3	1401.4
9. Stock price index (end of year)	696	611	678	866	1,027	882	651	376	562

Sources: Bank of Korea website (http://www.bok.or.kr); Monthly Bulletin, Bank of Korea, various issues; Monthly Financial Statistics Bulletin, Financial Supervisory Service, various issues; OECD Economic Outlook, Dec. 1999, OECD; Report of the Working Group on Financial Crisis in Emerging Markets, Institute of International Finance, Inc., Jan. 1999.

During the initial period of the regional crisis, the value of Korean won against the US dollar remained generally stable until October 1997. However, too much short-term external debt and only moderate international reserves resulted in a major loss in confidence by foreign investors and a massive depreciation of the won. By the end of November 1997, the won had depreciated by more than 20 percent against the U.S. dollar while the usable official foreign exchange reserves fell from $22.3 billion at the end of October 1997 to $7.3 billion.

What triggered the Korean crisis was the large short-term debt used to finance the current account deficits, and the subsequent repayment demands. In addition, the escalating depreciation expectation of the Korean won due to the persistent wide current account deficits also played an important role in exacerbating the foreign exchange situation.

Unlike the earlier crises that were caused by oil price shock, the 1997 crisis was caused by the banking sector problems and insufficient foreign reserves. The excessive portion of short-term debt relative to the amount of foreign reserves triggered the Korea crisis. Furthermore, the major cause can be traced to the structural weaknesses of the Korea economy. The rapid and inadequately-designed financial liberalization, especially the capital account liberalization, led the private sector to rely too much on short-term external debt. In addition, the Korean economy has long been plagued by moral hazard problems. Under the umbrella of government protection, financial institutions indulged in questionable lending practices, and consequently were severely weakened by mounting non-performing loans.

Faced with the inability to roll over short-term debt and depleting international reserves, the Korean government had to seek assistance from the IMF on November 21. On December 4, 1997, the IMF agreed to provide about $21 billion three-year stand-by loan for Korea as part of an emergency package totaling $57 billion from the international community. The IMF program aimed to orderly reduce the current account deficits, increase foreign exchange reserves, and keep inflation in check through a tightening of monetary and fiscal policies. In addition, the program incorporated a variety of structural reforms in the financial and corporate sectors to deal with the core causes of the crisis, as well as the liberalization measures in the capital markets and foreign exchange transactions.

The successful debt extension negotiation in March 1998, and the US$ 4 billion sovereign bond offering in April 1998, helped to significantly stabilize the won and enabled the government to shift its focus to financial and economic reforms. To jump start the economy, the Korean government also launched an economic stimulus package focusing on deficit spending for 1998 and a flexible monetary policy.

Korea has the EWS for financial institutions to help identify potential problems faced by the financial institutions. The EWS for currency crisis was started in April 1999 under the responsibility of the Korea Center for International Finance. It is felt that the system's main limitations are associated with "data availability" and "data frequency" (see Table A3 for more details).

3.4 Malaysia[23]

Prior to July 1997, Malaysia's macroeconomic fundamentals had been generally strong with the exception of a large current account deficit. The real GDP growth rates were extraordinarily high at above 9 percent in most part of the 1990s. Inflation was modest, ranging between 2.7 percent and 4.7 percent during 1990-97, while fiscal balances were healthy. The current account deficits, financed partly by short-term capital inflows including portfolio and foreign borrowings, was originally perceived as sustainable with continued robust growth rates. However, there were some concerns over asset price inflation, high credit growth, as well as excessive-investment in infrastructure and property. The asset price inflation had been exacerbated by financial liberalization and high investment that surpassed the high savings rate (see Table 3.3 for details).

Unlike the earlier crises that resulted from the weakness in the real sector and the external demand, the recent 1997 crisis was sparked off by regional foreign exchange market instability, which impinged on the ringgit and adversely affected the real sector. In fact, the magnitude of the ringgit depreciation was unprecedented. From end-June 1997 to end-August 1998, the ringgit had depreciated by 40 percent. The impact of the ringgit's depreciation on the nation's international reserves was

23. Most of the views expressed in this section are from the following sources: Annual Report (Bank Negara Malaysia, various issues), Hussin (1999a), Hussin (1999b), Jomo (1998), and Appendix Table 2 and Appendix Table 3.

Table 3.3: Key Economic and Financial Indicators in Malaysia

	1990	1991	1992	1993	1994	1995	1996	1997	1998
1. GDP (growth rate, %)	9.0	9.5	8.9	9.9	9.2	9.8	10.0	7.5	-7.5
Investment (% of GNP)	33.8	39.8	37.3	41.2	43.3	45.8	43.5	45.3	28.2
Saving (% of GNP)	31.6	30.7	33.4	36.3	35.3	35.6	38.9	39.4	41.9
2. Unemployment (%)	5.1	4.3	3.7	3.0	2.9	3.1	2.5	2.4	3.2
3. Inflation (growth rate, %)	3.1	4.4	4.7	3.6	3.7	3.4	3.5	2.7	5.3
4. External Account (billion of $)									
Export (growth rate, %)	17.4	16.8	18.5	15.7	24.7	26.0	5.8	0.5	-6.9
Import (growth rate, %)	30.1	25.3	8.9	14.4	30.5	30.5	0.9	0.8	-26.2
Current account (% of GNP)	-2.2	-9.1	-3.9	-4.8	-7.9	-10.2	-4.6	-5.9	13.7
International reserves (total reserves minus gold)	9.8	10.9	17.2	27.2	25.4	23.8	27.0	20.8	25.6
Total external debt	17.0	18.7	21.4	25.6	28.7	33.4	38.6	43.8	42.6
(% of GNP)	40.3	39.7	39.2	42.2	39.6	40.1	40.4	64.0	60.2
Short-term external debt (% of total debt)	9.6	14.1	23.5	25.0	19.3	19.1	25.7	25.3	20.0
Short-term external debt (% of reserves)	-	47.5	48.9	50.8	35.0	34.7	41.6	69.2	63.6
Short-term external debt (% of imports)	-	11.8	17.3	23.9	12.1	8.8	11.5	14.5	16.2
5. Government Overall Balances (% of GDP)	-3.0	-2.0	-0.8	0.2	2.3	0.9	0.7	2.4	-1.8
6. Monetary Statistic									
M2 (growth rate, %)	22.4	14.5	19.1	22.1	14.7	24.0	19.8	22.7	1.5
Domestic credit (end of period) (% change)	20.5	19.8	10.3	10.4	16.7	30.1	25.4	27.0	3.2
Base lending rate (period averages)	7.49	8.68	9.29	8.22	6.83	8.03	9.18	9.67	10.29
1-year fixed deposit rate (end of period)	7.21	8.19	7.84	6.29	6.15	6.89	7.26	9.33	5.74
7. Exchange rate (Ringgit:US $)									
Nominal (averages)	2.70	2.75	2.55	2.57	2.62	2.50	2.52	2.81	3.92
Real (averages)	97.3	94.8	101.3	102.3	99.5	100.0	104.3	101.9	80.9
8. Stock price index (end of year)	506	556	644	1,275	971	995	1,238	594	586

Sources: Central Bank and the Financial System in Malaysia – A Decade of Change, Bank Negara Malaysia, Jan. 2000; International Financial Statistics Yearbook 1999, IMF; SEACEN Financial Statistics, SEACEN, July 1999; Report of the Working Group on Financial Crisis in Emerging Markets, Institute of International Finance, Inc., Jan. 1999; Primark Datastream.

also more acute in 1997 compared with the previous crises. During the same period, international reserves declined by US$7.8 billion to US$20.2 billion as at end-August. The decline in reserves was mostly caused by the outflow of short-term capital.

The combined forces of currency speculation and short-term capital outflows were compounded by the rapid increase in the internationalization of the ringgit from April 1998. Opportunities to speculate on the ringgit increased with the build-up of offshore ringgit and led to a further depreciation of the ringgit. Thus, the negative market perception of the Malaysian economy which had led to a reversal of short-term capital flows, aggravated by the speculative activity and the availability of offshore ringgit to fund this speculative activity, were the main factors leading to the July 1997-September 1998 currency crisis.

During the early period of the crisis, the Malaysian government implemented tight monetary and fiscal policies, as well as financial reforms to restore stability and confidence in the financial markets. In order to reduce the pressure on the currency, government cut expenditure and raised interest rates. However, the ringgit continued to depreciate while the high interest rate policy caused severe difficulty in the banking and corporate sectors. By August 1998, the speculative pressures on currency and the stock markets had reached intolerable levels. The Malaysian government decided to implement an unorthodox policy to regain independence in the conduct of monetary policy. On September 1, 1998, Malaysia imposed selective capital and exchange controls. These controls were mainly aimed at holding back speculative attacks, hindering capital flight, and rescuing distressed companies and banks.

The exchange control measures gradually restored financial stability. Hence, the central bank could ease monetary policy to boost the economy and speed up reform measures in the banking system. Overall, the desired impact of the selective exchange control policy is increasingly evident in the increasing balance of payments surplus and foreign reserves.

There was no EWS for financial institutions before the 1997 crisis. However, in conjunction with technical assistance from the World Bank, an EWS is now being developed to enable better monitoring of the

banking system. Currently, there is no EWS for currency crisis. It is felt that due to the intertwining of banking and currency crises, a banking crisis can help predict future currency crisis.

Some limitations on the EWS are noted. While it is possible to construct an EWS for a banking crisis or to detect problems of the economy, it may be more difficult to build an EWS for a currency crisis. As seen in the Asian crisis, the exchange rate adjustments were far in excess of the change in fundamentals. In addition, a currency crisis could be caused by variables that are less predictable and do not exhibit trends.

3.5 The Philippines[24]

Unlike the previous crises, the external sector before the eruption of the 1997 crisis was relatively strong. For example, a year before the 1997 crisis, the country registered a balance of payment surplus of US$4,107 million, foreign reserves peaked at US$11,833 million in March 1997 before dropping to US$8,648 million at end-1997, and the ratio of the short-term debt to total external debt in 1997 was 18.6 percent. The banking sector was also strengthened after a comprehensive re-structuring.

The contagion effect following the baht crisis in mid-1997 led to speculative attacks on the peso. Consequently, the central bank, Bangko Sentral ng Pilipinas (BSP), had to intensify its dollar sales and raise its key interest rates to defend the peso. When it was realized that these measures did not work well, the central bank allowed the peso to move within a wider band against the dollar on July 11, 1997. It also required approval of sale of non-deliverable forward contracts. The IMF offered the Philippines almost $1.1 billion in financial support on July 14, 1997. However, the continued uncertainty in Indonesia, Korea and Thailand led the peso to depreciate sharply towards the end of 1997. To cushion the economy against further unexpected turmoil, a precautionary standby credit with the IMF was secured on March 11, 1998.

24. Most of the views expressed in this section are from the following sources: Annual Report (Bangko Sentral ng Pilipinas, various issues), Bangko Sentral ng Pilipinas (1999), and Appendix Table 2 and Appendix Table 3.

The Philippines economy registered a negative growth rate of minus 0.5 percent in 1998, falling from a positive rate of 5.2 percent posted in 1997. However, the decline was smaller compared with those in most other countries (see Table 3.4 for details). Its ability to withstand the crisis relatively better was partly due to the healthy state of the financial sector, which has just undergone a comprehensive reform. In addition, the Philippine economy did not have an overheating problem, having just moved up in the business cycle after a long bout of recession. Its foreign debt was also manageable.

Table 3.4: Key Economic and Financial Indicators in the Philippines

	1990	1991	1992	1993	1994	1995	1996	1997	1998
1. GDP (growth rate, %)	3.0	-0.6	0.3	2.1	4.4	4.7	5.8	5.2	-0.5
Investment (% of GDP)	24.2	20.2	21.3	24.0	24.1	22.5	24.0	24.8	20.2
Saving (% of GDP)	19.7	19.0	18.1	16.6	19.3	18.9	19.1	20.7	-
2. Unemployment (%)	8.1	9.0	9.8	9.3	9.5	9.5	8.6	8.7	10.1
3. Inflation (growth rate, %)	13.2	18.5	8.6	7.0	8.3	8.0	9.1	5.9	9.8
4. External Account (billion of $)									
Export (growth rate, %)	3.8	9.5	11.1	15.8	18.5	29.4	17.7	22.8	16.9
Import (growth rate, %)	20.0	-1.5	20.5	21.2	21.2	23.7	20.8	14.0	-18.8
Current account (% of GDP)	-6.1	-2.3	-1.9	-5.5	-4.6	-2.7	-4.8	-5.3	2.0
International reserves (total reserves minus gold)	0.9	3.2	4.4	4.7	6.0	6.4	10.0	7.3	9.2
External debt (end-of-period)	-	-	32.09	35.54	38.72	39.37	41.88	45.43	47.82
(% of GNP)	-	-	59.5	63.8	58.9	51.7	48.5	53.1	70.0
Short-term external debt (% of reserves)	-	222.5	149.3	127.9	119.0	113.7	125.7	152.2	91.9
Short-term external debt (% of imports)	-	44.7	34.7	26.5	25.6	20.1	28.6	20.7	21.9
5. Government Fiscal Balances (% of GDP)	-3.5	-2.1	-1.2	-1.5	1.0	0.6	0.3	0.1	-1.9
6. Monetary Statistic									
M3 (growth rate, %)	18.4	15.5	11.0	24.6	26.5	25.3	15.8	20.9	7.4
Domestic credits (growth rate, %)	23.6	13.3	-0.7	45.5	88.2	35.1	40.1	27.0	12.0
Secured loan rate (period averages)	24.3	23.5	19.5	14.7	15.1	14.7	14.8	16.3	16.8
Over 1-year time deposit rate (period averages)	12.0	15.4	13.0	10.9	11.5	9.7	9.8	10.7	11.8
7. Exchange rate (Peso:US$)									
Nominal (averages)	24.31	27.48	25.51	27.12	26.42	25.71	26.22	29.47	40.89
Real (averages)	83.1	82.9	92.1	91.7	97.4	100.0	108.0	107.1	87.3
8. Stock price index (end of year)	651	1,152	1,256	3,242	2,786	2,594	3,170	1,869	1,969

Sources: Bangko Sentral ng Pilipinas website (http://www.bsp.gov.ph); International Financial Statistics Yearbook 1999, IMF; SEACEN Financial Statistics, SEACEN, July 1999; Report of the Working Group on Financial Crisis in Emerging Markets, Institute of International Finance, Inc., Jan. 1999; Primark Datastream.

3.6 Singapore[25]

As seen in Table 3.5, Singapore's economic and financial fundamentals were strong throughout the period 1990-97. It is free from foreign debt and has few structural problems. However, Singapore was also affected by the regional crisis partly due to its close economic linkages to Indonesia, Malaysia, and Thailand. In addition, the sharp depreciation of the ringgit, rupiah, baht and peso, resulted in a loss of competitiveness of Singapore's exports. The slowdown in exports and growth adversely affected consumption as well as the retail and property sectors. Nevertheless, the Singapore economy was less-hit by the crisis, given to its positive growth rate of 0.3 percent in 1998 among most other countries suffering negative growth.

Table 3.5: Key Economic and Financial Indicators in Singapore

	1990	1991	1992	1993	1994	1995	1996	1997	1998
1. GDP (growth rate, %)	9.0	7.1	6.6	12.7	11.4	8.1	7.6	8.9	0.3
Investment (% of GNP)	35.6	34.2	35.3	38.0	32.8	33.8	35.8	37.1	32.1
Saving (% of GNP)	43.9	45.4	46.4	45.3	48.8	50.4	51.2	52.3	52.1
2. Unemployment (%)	1.7	1.9	2.7	2.7	2.6	2.7	3.0	2.4	3.2
3. Inflation (growth rate, %)	3.4	3.4	2.3	2.3	3.1	1.7	1.4	2.0	-0.3
4. External Account (billion of $)									
Export (growth rate, %)	18.1	11.9	7.6	16.6	30.8	22.1	5.7	-0.0	-12.1
Import (growth rate, %)	22.6	8.9	8.9	18.1	20.5	21.3	5.5	0.8	-20.9
Current account (% of GDP)	8.3	11.2	11.9	7.2	16.1	17.0	15.6	15.8	20.9
International reserves (total reserves minus gold)	27.7	34.1	39.9	48.4	58.2	68.7	76.8	71.3	74.9
5. Government Fiscal Balances (% of GDP)	9.6	10.1	11.8	13.8	12.1	13.1	14.4	9.6	16.4
6. Monetary Statistic									
M2 (growth rate, %)	20.0	12.5	8.9	8.5	14.4	8.5	9.8	10.3	30.2
Bank loans & advances (growth rate, %)	13.6	10.9	8.0	13.5	16.0	19.8	16.5	12.8	5.9
Prime lending rate (end of year)	7.73	7.10	5.55	5.34	6.49	6.26	6.26	6.96	5.90
Bank 12-month fixed deposit rate (end of year)	5.48	4.17	2.97	2.79	4.23	4.01	3.99	4.41	2.51
7. Exchange rate (S$:US $)									
Nominal (averages)	1.81	1.73	1.63	1.62	1.53	1.42	1.41	1.48	1.67
Real (averages)	89.2	92.2	94.0	94.9	98.4	100.0	103.5	105.7	101.8
8. Stock price index (end of year)	947	1,215	1,240	2,087	1,854	1,917	1,992	1,508	1,393

Sources: Monetary Authority of Singapore website (http://www.mas.gov.sg); Statistics Singapore website (http://www.singstat.gov.sg); Economic Survey of Singapore, Ministry and Trade and Industry, Republic of Singapore, various issues; International Financial Statistics Yearbook 1999, IMF; Primark Datastream.

25. Most of the views expressed in this section are from the following sources: Annual Report (Monetary Authority of Singapore, various issues), Lee (1998), Lee (1999a), Lee (1999b), and Appendix Table 2 and Appendix Table 3.

At the early stage of the Asian financial crisis of 1997-98, the Singapore dollar depreciated sharply against the currencies of major industrialized countries. For example, the Singapore dollar fell by 10 percent against the US dollar. On the other hand, the Singapore dollar strengthened compared to most of the crisis-hit Asian currencies. In the same period, it appreciated by 15 percent compared to the Malaysian ringgit, 19 percent compared to the Thai baht, 23 percent compared to the Korean won, and more than 68 percent compared to the Indonesian rupiah. Due to the increased volatility of the currency markets during the crisis, the Monetary Authority of Singapore (MAS) managed the value of the Singapore dollar more flexibly and temporarily widened the band within which the Singapore dollar was allowed to fluctuate. In general, the MAS manages the Singapore dollar against a trade-weighted basket of currencies. On a trade-weighted basis, the Singapore dollar appreciated slightly, especially after July 1997, but returned to close to its pre-crisis level in 1999.

Like the previous crisis in the 1970s, the origins of the currency crisis of 1997-98 were primarily external as the effect of the instability in international markets spilled over to Singapore. Given its openness and heavy reliance on trade, it is inevitable that external shocks will occasionally augment the volatility in domestic markets. It is therefore crucial for Singapore to continue to strengthen its financial and monetary infrastructure. The key strategies in this respect included allowing more foreign competition in the domestic banking sector, boosting the fund management industry, building up the bond market, and implementing risk-focused supervision and inspection.

Regarding the EWS for financial institutions, the Monetary Authority of Singapore has been maintaining high prudential and supervisory standards in overseeing its financial sector even before the 1997 crisis. Furthermore, the emphasis has been shifted from 'one-size-fits-all" regulation towards greater emphasis on supervision. Even though there is no formal EWS for the currency crisis, the Monetary Authority of Singapore continually monitors developments in the real sector and the financial system at various levels. It is felt that a quantitative EWS on currency crisis has some limitations. These include the inability to include some important qualitative factors in the model, and the difficulty in capturing the changing relationship between the crises and explanatory variables.

3.7 Thailand[26]

Prior to 1996, the Thai economy recorded high growth rate, moderate inflation, and a stable exchange rate. However, by 1996, the fundamental weakness in the economy became more apparent with over-reliance on short-term foreign capital, progressively high current account deficits, deteriorated external debt, and excessive investment and consumption. Table 3.6 shows the development of key economic and financial variables during the period 1990-98.

Table 3.6: Key Economic and Financial Indicators in Thailand

	1990	1991	1992	1993	1994	1995	1996	1997	1998
1. GDP (growth rate, %)	11.2	8.6	8.1	8.4	9.0	8.9	5.9	-1.8	-10.4
Investment (% of GDP)	41.4	42.8	40.0	39.9	40.3	41.6	41.7	35.0	-
Saving (% of GDP)	32.8	35.2	34.4	34.9	34.7	33.6	33.7	32.9	-
2. Unemployment (%)	3.4	2.1	2.8	2.6	2.6	1.7	1.5	1.9	4.0
3. Inflation (growth rate,%)	6.0	5.7	4.1	3.3	5.0	5.8	5.9	5.6	8.1
4. External Account (billion of $)									
Export (growth rate, %)	15.1	23.8	13.8	13.4	22.5	24.8	-1.9	3.8	-6.8
Import (growth rate, %)	29.8	15.7	6.0	12.4	18.1	31.9	0.6	-13.4	-33.8
Current account (% of GDP)	-8.3	-7.5	-5.5	-4.9	-5.4	-7.8	-7.9	-2.0	12.3
International reserves	14.3	18.4	21.2	25.4	30.3	37.0	38.7	27.0	29.5
Total external debt	29.3	37.9	43.6	52.1	64.9	82.6	90.5	93.4	86.2
Total debt service ratio (%)	10.8	10.6	11.3	11.3	11.7	11.4	12.2	15.6	20.8
Short-term external debt (% of reserves)	-	92.5	97.4	105.2	99.7	115.2	102.5	114.5	76.9
Short-term external debt (% of imports)	-	35.6	39.8	45.4	43.1	47.1	42.6	37.5	38.8
5. Government Cash Balances (Fiscal year, % of GDP)	4.7	4.9	3.0	2.2	1.8	2.7	2.3	-0.7	-2.5
6. Monetary Statistic									
M2 (growth rate, %)	26.7	19.8	15.6	18.4	12.9	17.0	12.6	16.4	9.5
Domestic credit (growth rate, %)	26.9	15.5	18.0	22.7	28.9	23.1	14.0	34.5	-1.2
Prime rate (end of year)	16.25	14.00	11.50	10.50	11.75	13.75	13.00-13.25	15.25	11.50-12.00
1-year fixed deposit rate (end of year)	13.00-15.50	10.50	8.50	7.00	8.25-10.25	10.25-11.00	8.50-9.25	10.00-13.00	6.00
7. Exchange rate (averages) (Baht:US$)	25.59	25.52	25.40	25.32	25.15	24.92	25.34	31.37	41.37
8. Stock price index (end of year)	613	711	893	1683	1361	1281	832	373	356

Sources: Bank of Thailand website (http://www.bot.or.th); International Financial Statistics Yearbook 1999, IMF; SEACEN Financial Statistics, SEACEN, July 1999; Report of the Working Group on Financial Crisis in Emerging Markets, Institute of International Finance, Inc., Jan. 1999; Primark Datastream.

26. Most of the views expressed in this section are from the following sources: Annual Economic Report (Bank of Thailand, various issues), Bank of Thailand (1998), Meecharoen (1999), and Appendix Table 2 and Appendix Table 3.

In late 1996, due to signs of weakening economic fundamentals, mounting difficulties in the financial sector and pervasive rumor of currency devaluation, the pressures on the Thai baht increased. Foreign investors began to lose confidence, and the economic and financial systems were seriously affected by volatile capital movements. Speculative attacks on the baht set off in February 1997 as the fixed exchange rate regime was deemed unsustainable, the Bank of Thailand intervened heavily in the foreign exchange market and imposed controls on some capital account transactions. However, following the escalating speculative attacks and the depletion of reserves, the baht was finally floated on July 2, 1997.

Even after changing to the managed float exchange rate regime, the baht continued to depreciate. Consequently, Thailand sought financial and technical assistance from the IMF for a stand-by credit. A bailout package of $17.2 billion was granted on August 20, 1997. Under the IMF economic adjustment program, Thailand was committed to follow the objectives of exchange rate stabilization and economic adjustment in the medium term, through tight monetary and fiscal policies as well as financial sector restructuring (including closure of insolvent financial institutions).

The crisis in Thailand was generally attributed to the misallocation of resources, financial liberalization without adequate infrastructure, and weakness in the macroeconomic policies. Amidst strong capital inflows to the developing countries since 1990, the comparatively stable Thai baht and high domestic interest rate encouraged both the financial and corporate sectors to rely heavily on foreign borrowing. The rapid inflows led to over investment in the manufacturing sector as well as the unproductive sectors such as real estate, generating an asset price bubble and misallocation of economic resources, an accumulation of large current account deficit, a buildup of foreign debt (especially short-term), and poor loan quality of the financial institutions. Moreover, the moral hazard related to implicit guarantee by the authority and inadequate supervision resulted in a highly vulnerable financial system. The rigid exchange rate system and the insufficient political will to tighten fiscal policy further intensified the overheating of the economy.

The earlier and recent 1997 crises were all directly related to the deterioration in the balance of payments, which reduced the central bank's net international reserves to unsustainable level. However, the

crisis in 1997 was preceded by the bubble economy and asset price inflation, which were not present in earlier crises. Therefore, the severe asset price deflation and weakening financial institutions made it much more difficult for the economy to adjust in the wake of the 1997 crisis.

Furthermore, the regional contagion effect (absent in earlier crises) also accentuated the adjustment problem after 1997.

During the pre-crisis years, Thailand had no EWS for financial institutions. However, there are some key indicators that are closely watched by foreign analysts and investors after the 1997 crisis. These indicators include the non-performing loan figures, the standard of asset classification, and the provisional requirement. In addition, the EWS for the currency crisis has been gradually developed since the eruption of the 1997 crisis. The central bank is in charge of developing the EWS that are related to currency matters. Other indicators are also being developed by other relevant government departments.

3.8 R.O.C., Taipei[27]

As shown in Table the 3.7, prior to the 1997 crisis, the R.O.C., Taipei economy was strong as the current account was in surplus, foreign reserves were abundant, and foreign debt was negligible. However, due to the regional contagion effect, in July 1997, the NT dollar also came under heavy pressure to depreciate as the Asian crisis intensified.

To prevent speculative attacks, the Central Bank of China (CBC) adopted a mix of exchange rate and monetary policies to stabilize the exchange market as well as domestic financial markets. During the early period of the Asian crisis, the CBC actively intervened in the foreign exchange market to slow down the depreciation of local currency. However, as the regional crisis escalated, the effects of the currency turmoil spread to other financial markets in R.O.C., Taipei. In October 1997, the CBC decided to let market forces determine the NT dollar exchange rate. Thereafter, the local currency soon fell against the US dollar.

From early March to the end of June 1998, the NT dollar once again depreciated sharply against the US dollar. The factors that caused

27. Most of the views expressed in this section are from the following sources: Annual Report (the Central Bank of China, various issues), Shea (1999), Shea, and Shih (1999), and Appendix Table 2 and Appendix Table 3.

the depreciation were the economic difficulties faced by the neighboring Asian countries such as Indonesia and Japan, as well as the declining exports and the shrinking trade surplus. Therefore, non-delivery forward (NDF) transactions increased, which pressed down the NT dollar. In May 1998, the CBC imposed a strict limit on the trading of non-deliverable forward contracts to reduce foreign exchange speculation. The NT$/US$ exchange rate subsequently reached a low of 34.896 on June 10 and then steadily stabilized. After effectively stabilizing the

Table 3.7 Key Economic and Financial Indicators in R.O.C., Taipei

	1990	1991	1992	1993	1994	1995	1996	1997	1998
1. Real GDP (growth rate, %)	5.4	7.6	7.5	7.0	7.1	6.4	6.1	6.7	4.6
Investment (% of GNP)	22.5	22.7	25.0	25.7	25.0	25.0	22.9	24.0	24.8
Saving (% of GNP)	29.3	29.4	29.0	28.8	27.7	27.1	26.8	26.5	26.1
2. Unemployment (%)	1.7	1.5	1.5	1.5	1.6	1.8	2.6	2.7	2.7
3. Inflation (growth rate, %)	4.1	3.6	4.5	2.9	4.1	3.7	3.1	0.9	1.7
4. External Account (billion of $)									
Export (growth rate, %)	1.4	13.3	7.0	4.4	9.4	20.0	3.8	5.3	-9.4
Import (growth rate, %)	4.7	14.9	14.5	7.0	10.8	21.3	-1.1	11.8	-8.5
Current account (% of GNP)	6.7	6.8	3.9	3.1	2.6	2.0	3.9	2.4	1.3
Foreign exchange reserves	72.4	82.4	82.3	83.6	92.5	90.3	88.0	83.5	90.3
5. Central Government Fiscal Overall Balances (% of GNP)	0.5	-3.6	-6.5	-4.8	-2.3	-2.9	-1.7	-2.4	1.2
6. Monetary Statistic									
M2 (growth rate, %)	12.9	16.3	19.9	16.4	16.3	11.6	9.2	8.3	8.8
Loans & investments of major financial institutions (growth rate, %)	14.8	22.2	28.6	19.5	15.2	10.5	7.9	9.1	7.6
Prime lending rate (end of year)	10.1	8.7	8.3	8.0	7.9	7.7	7.4	7.5	7.7
1-year deposit rate (end of year)	9.5	8.3	7.9	7.6	7.3	6.7	6.0	6.0	5.4
7. Exchange rate (averages) (NT$:US$)	26.89	26.82	25.16	26.39	26.46	26.48	28.46	28.70	33.46
8. Stock price index (end of year)	6,775	4,929	4,272	4,215	6,253	5,544	6,004	8,411	7,714

Sources: Financial Statistics Monthly, Taiwan District, R.O.C., the Central Bank of China, various issues; Quarterly National Economics Trends, Taiwan area R.O.C.. Directorate-General of Budget, Accounting and Statistics Executive Yuan, R.O.C., Nov. 1999.

exchange rate, the CBC has been able to implement an easy monetary policy to provide the funds needed for both private investment and public infrastructure.

To restore confidence in the stock market, the Taiwan government took several administrative measures in October 1997 and May 1998. In addition, the government also implemented a set of support measures during the fourth quarter of 1998 to stop a further plunge in the stock market.

Like its neighboring Asian countries, Taiwan has also experienced economic sluggishness, currency depreciation, rising interest rates, declining stock prices, and a weakening in the banking system. However, based on its economic growth rate, price stability, and unemployment rate, the R.O.C., Taipei's performance is the best among these seven SEACEN countries, posting a robust growth rate of 4.6 percent in 1998. The scope of the downturn in the financial sector has also been relatively smaller than that of the neighboring Asian countries.

The EWS for financial institutions has been developed by the CBC before the 1997 currency crisis. In addition, the feasibility of developing the explicit EWS for currency crisis within the central bank has been continually investigated since the eruption of 1997 crisis. The CBC is in charge of developing the EWS. In addition to developing the formal EWS on currency crises, the CBC closely watches the abrupt changes in the economic and financial sectors. Like most other countries, the CBC carefully tracks some external indicators relevant to the current and capital accounts. Moreover, the CBC would pay attention to the unusually large amounts of short-term capital flows. In practice, there are still some limitations on developing an EWS due to the intrinsic problems arising from the data and statistical models.

3.9 Comparison of Important Factors for the 1997 Crisis across Countries

In this section, we attempt to investigate which factor is perceived by the individual central bank as the most important common factor affecting the 1997 currency crisis for all seven countries. In addition, we want to examine whether there is any important factor that is specific to an individual country's crisis. Table 3.8 and Table 3.9 summarize the

relative importance of the qualitative and quantitative factors for seven SEACEN countries, respectively[28].

3.9.1 Qualitative Factors (see Table 3.8)

Among all qualitative factors, the "contagion effect" is perceived as relatively important for almost all countries. The 'exchange rate misalignments" factor is very important for Indonesia and Korea, and is absolutely important for Thailand. The "rapid capital account liberalization" is relatively important for Korea and Thailand. The "speculative attack by hedge funds" factor is very important for the Philippines and Thailand, and is extremely important for Malaysia. The "crisis spilled over because of trade and capital market linkages" factor is relatively important for Singapore and the R.O.C, Taipei. Apparently, these two countries which have relatively strong economic fundamentals were affected by the regional crisis mostly through the spillover or contagion effect.

The "unsustainable levels of foreign debt" factor is relatively important for Indonesia, Korea, and Thailand. The "overly expansionary monetary and fiscal policies spurred lending booms" factor is relatively important for Thailand. The "banking problems" factors are very important for Indonesia and Korea. The "cross-ownership between lending and borrowing institutions" factor is very important for Indonesia. The "high leverage concentrations of capital on property and commercial buildings, or on important industrial sectors" is especially important for Malaysia. The "corporations relied too much on bank debt" factor is very important for Indonesia, Korea, Malaysia and Thailand. The "moral hazard problems" factor is relatively important for Indonesia.

28. The views expressed in Table 3.8 and Table 3.9 are based on the questionnaire filled out by the Central Banks in these countries, which include Bank Indonesia (November 10, 1999), Bank of Korea (Jan. 11, 2000), Bank Negara Malaysia (Nov. 10, 1999), Bangko Sentral ng Pilipinas (December 6, 1999), Monetary Authority of Singapore (Jan. 3, 2000), Bank of Thailand (Nov. 9, 1999), and the Central Bank of China (Nov. 10, 1999).

Table 3.8: Relative Importance of Qualitative Factors for the 1997 Currency Crisis

	Indonesia	South Korea	Malaysia	Philip-pines	Singapore	Thailand	R.O.C., Taipei
• Exchange rate misalignments	* (1)	*(1)	-1	0	-2	** (2)	0
• Rapid capital account liberalization	0	*(1)	0	-1	-2	*(1)	0
• Speculative attack by hedge funds	0	0	** (2)	*(1)	-2	*(1)	0
• The crisis spilled over because of trade and capital market linkages or because of interdependencies in creditors' portfolios	0	0	NA	0	*0	-1	*(1)
• Contagion effects: herding behaviors driven by asymmetric information or the attitude of the fund managers	*(1)	-1	** (2)	** (2)	*0	*(1)	*(1)
• Global financial conditions in industrialized countries	-1	-1	-2	0	-2	-1	0
• Financial institutions were exposed to unsustainable levels of foreign debt (with excessive short-term international borrowing)	*(1)	*(1)	-2	-1	-2	*(1)	-1
• Overly expansionary monetary and fiscal policies spurred lending booms, which drove up equity and real estate prices to unsustainable levels	0	0	-1	0	-2	*(1)	-1
• Financial institutions were over leveraged ; undercapitalized banks were kept afloat	*(1)	*(1)	-2	-1	-2	-1	0
• Linked lending, politically motivated lending, and fraud worsened the quality of asset portfolios	*(1)	*(1)	-1	-1	-2	-1	0
• Cross-ownership between lending and borrowing institutions	*(1)	-2	-2	-1	-2	0	0
• High leverage concentrations of capital on property and commercial buildings, or on important industrial sectors	-1	0	* (1)	0	-2	-1	0
• Corporations relied too much on bank debt	*(1)	*(1)	* (1)	0	-2	*(1)	-1
• Government intervention without loss shared by the private sector triggered moral hazard problems	*(1)	-1	-2	-2	-2	0	0

Note : (-2) indicates 'not important', (-1) indicates "less important", (0) indicates "important, (1) indicates "very mportant", and (2) indicates "absolutely important".
The above views are from the questionnaire filled out by the central banks in these countries.

3.9.2 Quantitative Factors (see Table 3.9)

The information of the quantitative factors for Indonesia and the Philippines are not available, therefore, we only compare the other five countries. Overall, the "current account sector" factors including "current account/GDP", "terms of trade", "net exports/imports" as well as "export growth rate", and some "financial sector" factors including "domestic credit", "foreign exchange turnover", "nonperforming ratio" as well as "capital adequacy of banks" are relatively important for most of the countries. Among all, the "nonperforming ratio" factor is considered as relatively important for all countries.

The "capital account sector" and "debt sector" variables are relatively important for Korea, Malaysia and Thailand, which are seriously affected by the crisis. Some "international sector" factors including "GDP growth rate in industrialized countries", "¥/US", and "interest rate differential with US" are also relatively important for some countries.

Table 3.9: Relative Importance of Quantitative Indicators

	Indonesia	Korea	Malaysia	Philip-pines	Singapore	Thailand	R.O.C., Taipei
• **Current Account sector** • Real effective exchange rate	NA	0	0	NA	*0	0	* (1)
• US real effective exchange rate		0	0		NA	-1	0
• Japan real effective exchange rate		0	0		NA	-1	-1
• Current account / GDP		* (1)	0		*0	* (1)	* (1)
• Terms of trade		* (1)	NA		*0	-1	* (1)
• Net exports / Imports		* (1)	0		NA	* (1)	* (1)
• Export growth rate		* (1)	0		*0	* (1)	* (1)
• Import growth rate		* (1)	0		*0	* (1)	0
• **Capital Account sector** • Foreign reserves / Imports		* (1)	0		-1	-1	* (1)
• Short-term capital inflow / GDP		0	* (1)		-1	* (1)	0
• Foreign asset		0	0		-1	-1	0
• Foreign liability		* (1)	0		-1	-1	0
• Net foreign asset		0	0		NA	* (1)	0
• **Debt sector** • Short-term foreign debt / GDP		* (1)	* (1)		-1	* (1)	-1
• Interest payment for foreign debt		0	0		-1	0	-1
• External debt / GDP		0	* (1)		-1	* (1)	-1
• Short-term foreign debt / Foreign reserves		**(2)	* (1)		-1	* (1)	-1
• **Financial sector** • M2 / Base money		-1	NA		NA	-1	0
• Nominal M2 growth rate		0	NA		NA	-1	0
• Credit to private sector / GDP		* (1)	*(1)		*0	0	* (1)
• Domestic credit / GDP		0	*(1)		*0	* (1)	* (1)
• Foreign exchange turnover		0	0		*0	* (1)	* (1)
• Stock market capitalization		0	0		NA	-1	0
• Stock price index		0	0		NA	-1	0
• Stock price index for property		0	NA		NA	-1	0
• Real interest rate		0	0		*0	0	0
• M2 / Foreign reserves		**(2)	-1		-1	-1	0
• Deposit rate / Lending rate		* (1)	NA		NA	* (1)	0
• Inflation		* (1)	0		NA	* (1)	-1
• Nonperforming loan ratio		**(2)	* (1)		*0	* (1)	* (1)
• Central bank credit to the banking sector		* (1)	0		-1	-1	0
• Capital adequacy ratio of banks		* (1)	* (1)		*0	0	* (1)
• ROE (return on equity) ratio of banks		0	0		*0	-1	0
• ROA (return on asset) ratio of banks		0	0		*0	-1	0
• Debt/equity ratio of listed corporations		0	NA		-1	-1	-1
• P/E ratio of listed corporations		-1	NA		-1	-1	-1
• ROE (return on equity) ratio of listed corporations		-1	NA		-1	-1	-1
• ROA (return on asset) ratio of listed corporations		-1	NA		-1	-1	-1
• **Real sector** • Savings rate		-1	0		*0	-1	-1
• GDP growth rate		0	0		*0	* (1)	0
• Investment / GDP		-1	0		*0	* (1)	0
• **International sector** • US GDP growth rate		-1	0		*0	* (1)	* (1)
• Japan GDP growth rate		-2	-1		*0	* (1)	0
• European Union GDP growth rate		-2	-1		*0	* (1)	0
• Yen/US$		-1	*(1)		NA	* (1)	* (1)
• Chinese Renminbi/US$		0	-1		NA	* (1)	0
• Interest rate differential with US		0	-1		*0	-1	* (1)
• Interest rate differential with Japan		-1	-1		NA	-1	-1
• **Fiscal sector** • Fiscal balance / GDP		0	NA		-1	-1	0

Note: Same as Table 3.8. The information for Indonesia and the Philippines are not available.

IV. EMPIRICAL STUDY

4.1 Definition of a Currency Crisis

In this research, we use a variance-weighted average of the rate of change of the exchange rate, and of the change of reserves to indicate the currency crisis. A currency crisis is identified and dated when a weighted average of quarterly percent changes in exchange rates and (negative) of quarterly percent changes of foreign reserves is 1.5 standard deviations[29] from the mean (see Kaminsky and Reinhart, 1999). This definition of a currency crisis includes both the successful and unsuccessful speculative attacks.

The dates of currency crises defined by using quarterly data are summarized in Table 4.1 and are called the crisis-hit periods. Some previous studies assume that crises have to be at least several months apart so as to avoid double counting (see Frankel and Rose, 1996; Goldfajn and Valdés, 1995, and Esquivel and Larraín, 1998). However, we do not exclude any crisis-hit period with the intention that we can fully explore the relationship between the crisis-hit period and the explanatory variables over the whole sample period.

4.2 Timing of Currency Crises

Table 4.1: Timing of Currency Crises: Quarterly Data

	Indonesia	South Korea	Malaysia	Philippines	Singapore	Thailand	R.O.C., Taipei
Previous crisis-hit periods	1975:1Q	1974:4Q					
			1975:3Q		1975:3Q		
	1978:4Q						
		1980:1Q			1980:1Q		
						1981:3Q	
			1982:1Q		1982:1Q		
	1983:1Q					1984:4Q	
	1983:2Q			1983:2Q			
				1984:2Q			
	1986:3Q						
							1990:2Q
							1995:3Q
Recent crisis-hit periods	1997: 3Q		1997: 3Q	1997: 3Q	1997: 3Q	1997: 3Q	
	1997: 4Q	1997: 4Q	1997: 4Q	1997: 4Q	1997: 4Q	1997: 4Q	1997: 4Q
	1998:1Q						
	1998:2Q		1998:2Q		1998:2Q	1998:2Q	1998:2Q
					1999:1Q		

29. The threshold value of the standard deviation, 1.5, is decided after experimenting with various values. The timing of currency crises will not be all the same if different threshold value is chosen.

4.3 Sample, Data and Explanatory Variables

The pooled quarterly panel data including seven SEACEN countries are estimated over the 1970:1Q-1995:4Q period and are forecasted over the 1996:1Q-1999:1Q period. The explanatory variables selected are broadly analyzed in previous studies of currency crises and are subject to data availability. Some macroeconomic and financial data series were left out because they were generally incomplete for much of the period under consideration. Owing to lack of data, for some countries the observations included in the panel may not cover the entire period. The definition and sources of main economic and financial variables studied in this research are summarized in the Appendix Table A4. Unless otherwise indicated, most variables are expressed as one-quarter percent change in models. These explanatory variables are lagged one period in estimating the models.

4.4 Empirical Model

We use the logit regression analyses to examine the effects of key economic variables on the one-step-ahead probability of the emergence of a currency crisis. The logit model is discussed in great detail in Greene (1997) and Eviews (1994-1997). One advantage of the multivariable logit model is that it could incorporate possible correlation among different variables. Therefore, we could analyze the marginal contribution of each variable conditional on the other variables.

The dependent variable, the currency-crisis dummy, takes the value of one if a crisis occurred in that period, and takes the value of zero otherwise. That is, the crisis-hit periods identified in Table 4.1 take the value of one, and zero elsewhere. The probability that a currency crisis will take place at a specific time in a particular country is hypothesized to be a function of a vector of explanatory variables X. Pr(Y = 1) indicates a dummy variable that takes the value of one when a currency crisis occurs, and a value of zero if there is no crisis. That is,

$$\Pr(Y = 1) = 1 - F(-\beta' X)$$

$$\Pr(Y = 0) = F(-\beta' X)$$

where β is a vector of n unknown coefficients and $\beta' X$ is the cumulative probability distribution function evaluated at $\beta' X$. Here, the logistic cumulative distribution function is used. Therefore, $(\text{pr}(Y = 1) = 1 - \frac{e^{-\beta' X}}{1 + e^{-\beta' X}} \quad \frac{e^{\beta' X}}{1 + e^{\beta' X}}$. This model is called the logit model. The parameters are computed by maximizing the log-likelihood function. The estimated coefficients from a binary model cannot be interpreted as the marginal effect on the dependent variable. That is, the estimated coefficients do not imply the increase in the probability of a crisis given a one-unit increase in the corresponding explanatory variables. The marginal effect of X_i on the conditional probability is as follows:

$$\frac{\partial E(Y \setminus X)}{\partial X_i} = \left\{ \frac{dF(-\beta' X)}{d(-\beta' X)} \right\} \beta_i = (f(-\beta' X))\ \beta_i$$

where f is the density function related to F. Specifically, β_i is weighted by f that depends on all of the regressors in X. However, the sign of the β_i does indicate the direction of the effect of a change in X_i. Positive values of β_i indicate that increasing X_i will boost the probability of the currency crisis.

4.5 Criteria for Evaluation of the In-sample Estimation

- Log likelihood (Average log likelihood): maximized value of the log likelihood function l.

- LR statistic test: tests the joint null hypothesis that all coefficients except the constant term are zeros. This statistic is asymptotically distributed as a X^2 variable, with degrees of freedom equal to the number of restrictions under test.

4.6 Empirical Results

4.6.1 In-sample Estimation

To examine the relative importance of each of the variables discussed in Appendix Table A4, we estimate the bivariate logit model for each variable. Empirically, these models are estimated with explanatory

variables lagged by one period. Unless otherwise indicated, the variables enter in the one-quarter percent change form. The results of bivariate logit models using quarterly data from 1970 through 1995 are summarized in Appendix Table A5. In addition, to investigate whether the significance of the variables changes over time, we also estimate bivariate logit models using data over 1983-1995 period (the recent subperiod) and those using data from 1970 through 1997. Their estimation results are summarized in Appendix Table A6 and Table A7, respectively.

From Appendix Table A5, we find the following variables statistically significant: exports, imports/reserves, money multiplier, M2/reserves, real effective exchange rate, reserves, real US interest rate, and US-domestic real interest rate differential. Comparing Appendix Table A5 with Table A6, we find three additional significant variables when only the later part of the data (1983-1995 period) is used for estimation. The additional variables include the M2/GDP, domestic real interest rate, and the Japan-domestic real interest rate differential. Comparing Appendix Table A5 with Table A7, we find some additional variables that are also significant when up-to-date data over 1996-1997 period is also included for estimation. The additional variables include the M2/GDP, foreign liability/GDP, current account/GDP, domestic credit/GDP, Japan-domestic real interest rate differential, Japanese growth rate and stock price index.

Using quarterly data from 1970:1Q to 1995:4Q, different multivariate logit models are estimated in a variety of combination of variables. Table 4.2 presents the estimates of seven multivariate logit models that have relatively better out-of-sample forecasting ability. In logit models, the sign of the coefficient does indicate the direction of the particular variable on the dependent variable. All the coefficients of the variables of models in Table 4.2 have the expected sign as indicated in Appendix Table A4.

The estimation results generally illustrate that the probability of a currency crisis increases with the higher level of real US interest rate, the higher level of real effective exchange rate, the high growth rates of import/foreign reserves, the high growth rates of M2/ foreign reserves or the high growth rates of money multiplier.

4.6.2 Classification Accuracy in Out-of-sample Forecasts

A simple 2 by 2 classification matrix of hits and misses for each country and each model can be used for evaluating the accuracy of out-of-sample forecasts. In order to compute the number of hits and misses in the classification matrix, the predicted probabilities are redefined according to a specific threshold value, p (a cutoff point of probability).

Table 4.2: Estimated Logit Models of Currency Crises Using Quarterly Data (1970-1995)

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7
Constant	-4.22* (-10.96)	-4.07* (-6.02)	-4.21* (-11.00)	-3.84 * (-13.43)	-3.57 * (-6.78)	-6.86 * (- 6.52)	-6.90 * (- 6.52)
M2/reserves (%)	0.0254 * (3.07)	0.0243 * (2.87)					
Real effective exchange rate (level)						0.0259 * (3.52)	0.026 * (3.52)
Real US interest rate	0.1467 * (1.96)	0.1580 * (2.01)	0.1558 * (2.09)				
Import/reserves (%)			0.0199 * (2.46)	0.023 * (2.56)	0.0223 * (2.56)	0.018 * (2.03)	0.018 * (2.04)
Money multiplier (%)				0.058* (2.14)	0.0585 * (2.14)	0.0655 * (2.26)	0.0662 * (2.29)
logUSGDP (differenced)		-2.55 (-0.10)			-14.55 (-0.58)		
Net export / import (%)							-0.0002 (-0.8)
logJPGDP (differenced)						-14.37 (-0.73)	-14.09 (-0.72)
Bank deposit (%)		-0.027 (-0.48)					
In-sample (1970:1Q-1995:4Q)							
Sample size T = 0 T = 1	670 652 18	641 623 18	670 652 18	641 623 18	641 623 18	641 623 18	641 623 18
LR statistic (df) p-value	12.88 (2) 0.002	13.43 (4) 0.01	10.39 (2) 0.006	9.85 (2) 0.007	10.20 (3) 0.017	21.03 (4) 0.0003	21.39 (5) 0.001
Log Likelihood Ave. Log Likelihood	-76.42 -0.114	-75.38 -0.118	-77.67 -0.116	-77.13 -0.12	-76.95 -0.12	-71.54 -0.112	-71.36 -0.111
McFadden R-squared	0.08	0.081	0.063	0.06	0.062	0.128	0.130

Notes: * indicates that the variable is significant at the 5 percent level. The z statistics are in parentheses. Unless otherwise indicated the explanatory variables are expressed as the one-quarter percent change. All explanatory variables were lagged one period.

		Forecast		
		F = 0 (Non-crisis-hit period)	F = 1 (Crisis-hit period)	sum
Actual	T = 0 (Non-crisis-hit period)	a	b	$a+b$
	T = 1 (Crisis-hit period)	c	d	$c+d$

Where, F: Forecast value (F = 1, if predicted probability >= p; F = 0, otherwise),
T: True value (T = 1, if currency crisis, T = 0, otherwise).

While the *a, b, c* and *d* represent the number of out-of-sample forecasts that are classified into each category. For the quarterly data, the sum of *a, b, c* and *d* and d is equal to thirteen, which is the total out-of-sample (1996:1Q-1999:1Q) forecasts for each country.

As mentioned above, two types of errors can occur in classifying currency crises this way. To misclassify crisis-hit periods as non-crisis periods is a type I error (failure to identify a currency crisis), which is calculated as $\frac{c}{c+d}$. The type II error is to misclassify non-crisis periods as crisis-hit periods (false identification of a currency crisis), which is calculated as $\frac{b}{a+b}$. There is a trade-off between these two types of errors. The choice of the cutoff point of the predicted probability will change the value of these two types of errors. Decreasing the type I error will increase the type II error. The cost of type I error can be expensive because it can result in a currency crisis that might have been prevented by early prompt actions. The cost of type II error is relatively less expensive because it is the unnecessary spending of inspection on a healthy economic structure (see Cole *et al.*, 1995).

4.6.3 Evaluation of Out-of-sample Forecasts

Two cases of probability cutoff points are compared on an out-of-sample basis generated by the logit models. The selected threshold value of the cutoff point of probability (p) is equal to the in-sample crisis frequency (see Demirgüç-Kunt and Detragiache, 1998, p. 97, and Greene, 1997, pp. 892-893). In this study, two threshold values equal to 0.025 and 0.03 are selected for comparison.[30] "F", the predicted value, takes the value of 1, if its predicted probability value exceeds the cutoff point 0.025 (or 0.03), and takes the value of 0, if its predicted probability value is less than the cutoff point 0.025 (or 0.03). "T", the

30. The values of in-sample crisis frequency investigated in this research are within the range of 0.025 and 0.03 (see Table 4.2). Therefore, we use the probability cut-off points of 0.025 and 0.03 to compare the out-of-sample forecasting ability of different models in Table 4.2. All the results discussed hereafter are based on the choice of the probability cut-off points of 0.025 and 0.03. It should also be noted that the use of different probability cut-off points makes a difference in ranking the models.

true value, takes the value of 1, if it is identified and dated as the currency crisis shown in earlier Table 1, and takes the value of 0, otherwise.

The one-quarter-ahead out-of-sample (1996:1Q-1999:1Q) forecasting results of seven models for seven countries with different cutoff probability points are reported in Table 4.3. Also see Appendix Table A6 for detailed forecasting signals. In addition, Table 4.4 also compares the timing of signals of seven models under two cases of probability cutoff points. For the currency crisis starting in mid-1997, some of the periods from 1997 to 1999:1Q are identified as crisis-hit periods by the definition of currency crisis used in our study. For example, the quarterly data indicates that four crisis-hit periods are identified for Indonesia: 1997:3Q, 1997:4Q, 1998:1Q and 1998:2Q (see Table 4.1). In this case, we would prefer a model that exactly gives an early signal for 1997:3Q to a model that correctly gives a signal for later crisis-hit periods but misses the 1997:3Q period.

Furthermore, among all models that do not give an "exact" one-quarter-ahead signal for the first crisis-hit period, we would prefer a model that gives an "early" signal before the first crisis-hit period to a model that either gives a lagged signal for the latter crisis-hit periods or gives no signal at all. For example, for a country that is identified to have two crisis-hit periods, a model that does not give an exact signal for 1997:3Q but indicates an early signal for 1997:1Q would be considered as better than a model that either gives a lagged signal for 1997:4Q or gives no signal at all.

In addition, all models are ranked by the values of the type I and type II errors (see Table 4.5). The type I error is emphasized more than the type II error, because the cost of the type I error is relatively more expensive[31] than that of the type II error. We would like to investigate whether there are models that can predict as well for all countries.

In general, the out-of sample forecasts of seven models are compared by the criteria of the timing of signals, the two types of errors, and the X^2 tests of independence of the true value and the predicted value. Two cases of the threshold values of the cutoff points of probability are discussed as follows.

31. However, we do not like too big a value of the type II error, either.

- ***Case 1: the Probability Cutoff Point (p) = 0.025***

Except for model 2, the aggregate X^2 tests of other models reject the null hypotheses of independence of the true values and predicted values at the 5-percent significance level. For Malaysia, the X^2 tests of model 2, model 3, model 6 and model 7 reject the null hypotheses of independence. For Thailand, the X^2 tests of the model 3 and model 4 reject the null hypotheses of independence (see Table 4.3 and Table 4.5).

Table 4.3: The Type I and II Errors of One-quarter-ahead Out-of-sample Prediction of Logit Models (1996:1Q-1999:1Q)

Case 1: The threshold value of probability cutoff point (p) = 0.025												
	I(I)	I(II)	χ^2 test	K(I)	K(II)	χ^2 test	M(I)	M(II)	χ^2 test	P(I)	P(II)	χ^2 test
1	100	44.44	2.57	0	33.33	1.73	33.33	20	2.36	50	45.45	0.014
2	100	44.44	2.57	0	33.33	1.73	0	30	4.55*	50	45.45	0.014
3	50	11.11	2.36	0	33.33	1.73	0	30	4.55*	0	36.36	2.76
4	75	11.11	0.41	100	50	0.93	33.3	30	1.31	0	54.55	1.48
5	75	11.11	0.41	100	58.33	1.26	0	40	3.34	0	63.64	1.05
6	100	11.11	0.48	100	25	0.33	0	10	8.78*	0	36.36	2.76
7	100	11.11	0.48	100	25	0.33	0	10	8.78*	0	36.36	2.76
	S(I)	S(II)	χ^2 test	T(I)	T(II)	χ^2 test	TN(I)	TN(II)	χ^2 test	All(I)	All(II)	χ^2 test
1	25	33.33	1.93	33.33	20	2.36	0	27.27	3.78	42.11	31.94	4.33*
2	25	55.56	0.44	33.33	60	0.043	0	63.64	1.05	36.84	47.2	1.53
3	50	33.33	0.33	0	30	4.55*	0	27.27	3.78	21.05	29.17	15.58*
4	25	22.22	3.26	0	20	6.24*	50	45.45	0.014	36.84	34.72	5.04*
5	25	33.33	1.93	0	40	3.34	50	45.45	0.014	31.58	43.06	3.87*
6	50	33.33	0.33	66.67	0	3.61	100	0	NA	57.89	16.67	5.67*
7	50	22.22	1.00	66.67	0	3.61	100	0	NA	57.89	15.28	6.55*
Case 2: The threshold value of probability cutoff point (p) = 0.03												
	I(I)	I(II)	χ^2 test	K(I)	K(II)	χ^2 test	M(I)	M(II)	χ^2 test	P(I)	P(II)	χ^2 test
1	100	22.22	1.05	0	16.67	3.61	66.67	10	0.97	50	27.27	0.41
2	100	22.22	1.05	0	16.67	3.61	33.33	20	2.36	50	36.36	0.13
3	75	0	2.43	0	8.33	5.96*	33.33	10	4.17*	0	27.27	3.78
4	75	11.11	0.41	100	41.67	0.68	33.33	10	4.17*	0	36.36	2.76
5	75	11.11	0.41	100	50	0.93	33.33	30	1.31	0	45.45	2.03
6	100	11.11	0.48	100	16.67	0.2	33.33	10	4.17*	50	18.18	0.97
7	100	11.11	0.48	100	16.67	0.2	33.33	10	4.17*	50	18.18	0.97
	S(I)	S(II)	χ^2 test	T(I)	T(II)	χ^2 test	TN(I)	TN(II)	χ^2 test	All(I)	All(II)	χ^2 test
1	75	0	2.44	33.33	10	4.17*	100	0	NA	68.42	9.72	3.97*
2	75	0	2.44	33.33	10	4.17*	0	0	13*	52.63	15.28	9.03*
3	75	11.11	0.41	33.33	10	4.17*	50	9.09	2.18	47.37	11.11	16.33*
4	50	11.11	2.36	33.33	0	7.88*	50	9.09	2.18	47.37	18.06	9.52*
5	50	22.22	1.00	33.33	10	4.17*	50	18.18	0.97	47.37	27.78	4.2*
6	50	22.22	1.00	100	0	NA	100	0	NA	73.68	11.11	2.84
7	50	22.22	1.00	100	0	NA	100	0	NA	73.68	11.11	2.84

Note: I: Indonesia, K: South Korea, M: Malaysia, P: the Philippines, S: Singapore, T: Thailand, TN: R.O.C., Taipei, ALL: all seven countries.

χ^2 test is for the null hypothesis that the true value "T" and predicted value "F" are independent.

* indicates significant at the 5% level, where $\chi^2_{(0.05,1)} = 3.84$.

The (I) and (II) indicate the type I error (%) and type II error (%) expressed as percentage, respectively.

Table 4.4: Timing of Signals

Case 1: The probability cutoff point (p) = 0.025								
Country	**Timing of Signal**	**Model 1**	**Model 2**	**Model 3**	**Model 4**	**Model 5**	**Model 6**	**Model 7**
Indonesia	Latest signal before 1997/3Q	96/4Q	96/4Q		96/3Q	96/3Q	96/3Q	96/3Q
	Exact signal for 1997/3Q			97/4Q (Lag)	97/4Q (Lag)	97/4Q (Lag)		
Korea	Latest signal before 1997/4Q	97/2Q	97/2Q	96/4Q	97/2Q	97/2Q	97/2Q	97/2Q
	Exact signal for 1997/4Q	Yes	Yes	Yes				
Malaysia	Latest signal before 1997/3Q	96/1Q	96/4Q	96/1Q		96/1Q		
	Exact signal for 1997/3Q	Yes	Yes	Yes	97/4Q (Lag)	Yes	Yes	Yes
The Philippines	Latest signal before 1997/3Q	97/1Q	96/1Q	96/1Q	97/2Q	97/2Q	97/2Q	97/2Q
	Exact signal for 1997/3Q	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Singapore	Latest signal before 1997/3Q	96/1Q	96/4Q	96/1Q				
	Exact signal for 1997/3Q	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Thailand	Latest signal before 1997/3Q	96/1Q	97/1Q	96/1Q	96/3Q	96/3Q		
	Exact signal for 1997/3Q	Yes	Yes	Yes	Yes	Yes	97/4Q (Lag)	97/4Q (Lag)
R.O.C., Taipei	Latest signal before 1997/4Q	96/1Q	97/3Q	97/3Q	96/3Q	96/3Q		
	Exact signal for 1997/4Q	Yes	Yes	Yes	Yes	Yes		
Case 2: The probability cutoff point (p) = 0.03								
Country	**Timing of Signal**	**Model 1**	**Model 2**	**Model 3**	**Model 4**	**Model 5**	**Model 6**	**Model 7**
Indonesia	Latest signal before 1997/3Q				96/3Q	96/3Q	96/3Q	96/3Q
	Exact signal for 1997/3Q			98/1Q (Lag)	97/4Q (Lag)	97/4Q (Lag)		
Korea	Latest signal before 1997/4Q	96/4Q	96/4Q	96/1Q	97/2Q	97/2Q	97/2Q	97/2Q
	Exact signal for 1997/4Q	Yes	Yes	Yes				
Malaysia	Latest signal before 1997/3Q	96/1Q	96/1Q	96/1Q				
	Exact signal for 1997/3Q	98/2Q (Lag)	Yes	Yes	97/4Q (Lag)	97/4Q (Lag)	97/4Q (Lag)	97/4Q (Lag)
The Philippines	Latest signal before 1997/3Q	96/1Q	96/1Q	96/1Q	97/2Q	97/2Q	97/2Q	97/2Q
	Exact signal for 1997/3Q	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Singapore	Latest signal before 1997/3Q				96/1Q	96/1Q		
	Exact signal for 1997/3Q			97/4Q (Lag)	Yes	Yes	Yes	Yes
Thailand	Latest signal before 1997/3Q							
	Exact signal for 1997/3Q	Yes	Yes	Yes	97/4Q (Lag)	97/4Q (Lag)		
R.O.C., Taipei	Latest signal before 1997/4Q					96/1Q		
	Exact signal for 1997/4Q		Yes	Yes	Yes	Yes		

Note: All signals are one-quarter-ahead forecasts.

Table 4.5: Models Ranked by Two Types of Errors and the Timing of Signals

Case 1: Probability cutoff point (p) = 0.025							
	Country						
	Indonesia	Korea	Malaysia	Philippines	Singapore	Thailand	R.O.C., Taipei
Best models (I; II)	3 (50; 11.)	1, 2, 3 (0; 33)	6, 7 (0; 10)	3, 6, 7 (0; 36)	4 (25; 22)	4 (0; 20)	1, 3 (0; 27)
Second best models (I; II)	4, 5 (75; 11)	6, 7 (100; 25)	2, 3 (0; 30)	1, 2 (50; 45)	1, 5 (25; 33)	3 (0; 30)	4, 5 (50; 45)
Exact first signal		1, 2, 3	1, 2, 3, 5, 6, 7 (except 4)	All models	All models	1, 2, 3, 4, 5 (No for 6,7)	1, 2, 3, 4, 5
χ^2 test (*)			2, 3, 6, 7			3, 4	
Case 2: Probability cutoff point (p) = 0.03							
	Country						
	Indonesia	Korea	Malaysia	Philippines	Singapore	Thailand	R.O.C., Taipei
Best models (I; II)	4, 5 (75; 11)	3 (0; 8)	3 (33; 10)	3 (0; 27)	4 (50, 11)	1, 2, 3 (33; 10)	2 (0; 0)
Second best models (I; II)	6, 7 (100; 11)	1, 2 (0, 17)	2 (33; 20)	6, 7 (50; 18)	5, 6, 7 (50; 22)	4 (33; 0)	3, 4 (50; 9)
Exact first signal		1, 2, 3	2, 3	All models	4, 5, 6, 7	1, 2, 3 (No for 4, 5, 6, 7)	2, 3, 4, 5
χ^2 test (*)		3	3, 4, 6, 7			1, 2, 3, 4, 5	2

Note: (I, II) indicates the type I error (%) and type II error (%) expressed as percentage, respectively.

* indicates that the models are significant at the 5% level.

The timing of signals of seven models is discussed as follows (see Table 4.1). Indonesia does not receive any exact signal for the first crisis-hit period from all models; however, it receives earlier signals in 1996 from six models. Model 6 and model 7 do not give R.O.C., Taipei any signal in 1997 and only give Thailand lagged signals in 1997:4Q. Except for Indonesia and Korea, model 5 gives other five countries the exact signals for their first crisis-hit periods in 1997. Except for Indonesia, Korea and Malaysia, model 4 gives other four countries the exact signals for their first crisis-hit periods. Except for Indonesia, model 1, model 2 and model 3 give other six countries the exact signals for their first crisis-hit periods.

Among models that can give similar exact signals, we would prefer the one that issues fewer false signals. That is, given the same type I error, we prefer a model that has the smallest type II error. Based on the aggregate values of the two types of errors for all countries, model 3 is generally better than model l, model 2, model 4 and model 5 (see Table 4.3). Model 1 and model 2 can forecast the same exact signals for the first crisis-hit periods for six countries. Even though model 1 misses some of the second crisis-hit periods (i.e. it has a higher value of total type I error), it has smaller value of total type II error (i.e. fewer false signals) than model 2. From Table 4.5, it can be seen that model 3 can forecast better than other models for four countries.

- ***Case 2: the Probability Cutoff Point (p) = 0.03***

Except for model 6 and model 7, the aggregate X^2 tests of the other five models reject the null hypotheses of independence of the true values and predicted values at the 5-percent significance level. For Korea, the X^2 test of model 3 rejects the null hypotheses of independence. For Malaysia, the X^2 tests of model 3, model 4, model 6 and model 7 reject the null hypotheses of independence. For Thailand, the X^2 tests of model 1, model 2, model 3, model 4 and model 5 reject the null hypotheses of independence. For R.O.C., Taipei, the X^2 test of model 2 rejects the null hypotheses of independence (see Table 4.3 and Table 4.5).

The timing of signals of the seven models is discussed as follows (see Table 4.4). Indonesia does not receive any exact signals for the first crisis-hit periods from all models; however, it receives earlier signals in 1996 from four models. Model 6 and model 7 do not give Thailand and R.O.C., Taipei any signal in 1997 and only give Malaysia

lagged signals in 1997:4Q. Model 4 and model 5 give Malaysia and Thailand lagged signals in 1997:4Q. Model 1 gives Korea, the Philippines and Thailand the exact warning signals for their first crisis-hit periods in 1997. Except for Indonesia and Singapore, model 2 and model 3 give other five countries the exact warning signals for their first crisis-hit periods in 1997. Note that only model 1, model 2 and model 3 give the exact signals for the onset of the Asian crises, i.e., Thai crisis.

Model 2 and model 3 can give similar exact signals for the first crisis-hit periods in five countries. Note that model 2 can forecast the timing of R.O.C., Taipei's crisis-hit periods without identifying any false signal. From Table 4.5, it can be observed that model 3, model 2 and model 4 can forecast better for more countries than other models. However, model 4 cannot give the timing signal for the inception of the Thai crisis. Model 2 has higher aggregate type I and type II errors than model 3. Generally, model 3 can generally forecast better than other models for four countries.

- ***Summary of Case 1 and Case 2***

The following Table 4.6 briefly summarizes the overall performance of each model. Because the Thai currency crisis leads the currency crises in Asian region, we would pay less attention to the models that cannot issue exact warning signals for the Thai crisis. Therefore, model 6 and model 7 in both cases (and model 4, model 5 in case 2) rank among those with the failures.

Table 4.6: Overall Performance of Each Model

Case 1:The probability cutoff point (p) = 0.025							
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7
Ranked as best model (no. of countries)	2	1	4	2	0	2	2
Ranked as second best model (no. of countries)	2	2	2	2	3	1	1
Case 2: The probability cutoff point (p) = 0.03							
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7
Ranked as best model (no. of countries)	1	2	4	2	1	0	0
Ranked as second best model (no. of countries)	1	2	1	2	1	3	3
Statistically significant variables	M2/reserves; and Real US interest rate	M2/reserves; and Real US interest rate	Import/ reserves; and Real US interest rate	Import/ reserve; and money multiplier	Import/ reserve; and money multiplier	Real effective exchange rate; Import/ reserve; and money multiplier	Real effective exchange rate; Import/ reserve; and money multiplier

Overall, model 1, model 2 and model 3 can predict better than other models based on the timing of signals and the values of the two types of errors after comparing two cases of probability cutoff points. Furthermore, from Table 4.5 and Table 4.6, model 3 that includes the variables such as the real US interest rate and import/foreign reserves can forecast better than other models for most of these seven countries. Frankel and Rose (1996) also find these two variables[32] helpful in predicting the likelihood of a currency crisis. For some countries, the rise in US interest rates might indicate an adverse shift in international conditions that could cause a sudden reversal of capital inflows.

Overall, Indonesia does not receive any exact timing signal in 1997 from all models. In line with what Berg and Pattillo (1998) found in their paper, our study also shows that the Indonesian crisis was to some extent less predictable.

- ***Graphs of Out-of-sample Forecasts of Probabilities***

The graphs of true probability (left axis) versus the forecast probability (right axis) for seven models are illustrated in Figure 4.1. Appendix Table A9 presents the values of probability forecasts. There are 91 out-of-sample forecasts in total. The forecasts of each model represent the values of the seven countries in sequence (see Table 4.7).

Table 4.7: Sequence of Probability Forecasts

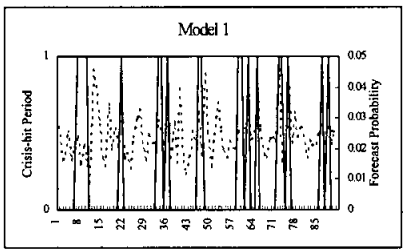
Observations	Country	Observations	Country	Observations	Country
1-13	Indonesia	40-52	Philippines	79-91	R.O.C., Taipei
14-26	Korea	53-65	Singapore		
27-39	Malaysia	66-78	Thailand		

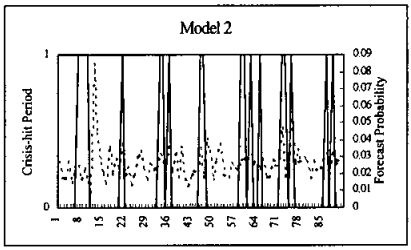
32. Frankel and Rose (1996) focus on short-term northern interest rate, which is the weighted average of short-term interest rates for the United States, Germany, Japan, France, the United Kingdom and Switzerland.

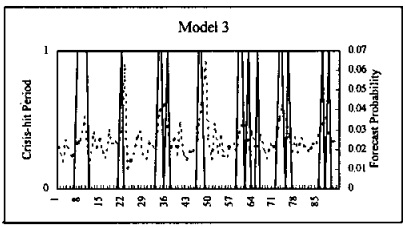
- ***Graphs of Important Variables***

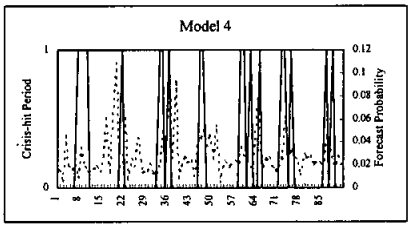
The important variables of the models discussed in Table 4.2 are illustrated for each country in Appendix Figure A.1. The variables include real exchange rate, import/reserves, M2/reserves, money multiplier, bank deposit, net export/import and other variables (real US interest rate, US GDP and Japan GDP).

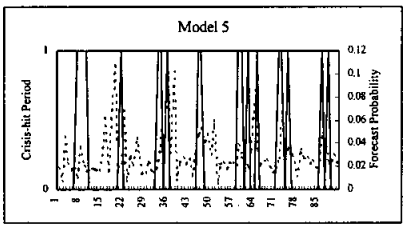
Figure 4.1: Out-of-sample Probability Forecasts for 1996:1Q-1999:1Q

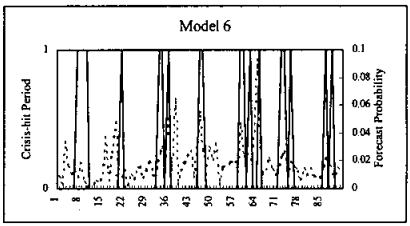


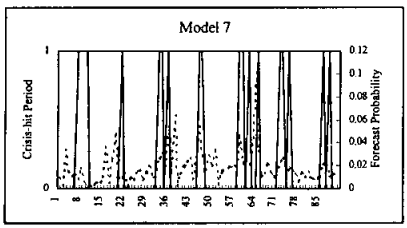












V. CONCLUSIONS AND FUTURE WORK

Prior to 1997 Asian currency crises, most countries do not pay much attention to early warning systems. Thereafter, the feasibility of developing EWS for currency crises has been extensively studied.

This paper investigates whether models estimated prior to 1997, which serve as EWS on a regular basis, can predict the 1997-1998 currency crises. We estimate logit models to predict the timing of currency crises during the period 1996:1Q-1999:1Q, using the relationship between previous crises and some macroeconomic variables. Overall, on an out-of-sample basis, some models seem to have ability in predicting the timing of currency crises in some countries.

The causes of the Asian crises are diverse and complicated. With important differences across countries, we find there is no model that can forecast well for all countries. However, there is a model that can forecast fairly well for more than half of the countries. This best model includes two significant variables: the real US interest rate and the import/foreign exchange reserve.

In order to predict the timing of the 1997-1998 currency crises, we estimate the models using data from 1970 through 1995. However, the variables found to be significant in explaining the previous and recent crises could be different (see Appendix Table A5, Table A6 and Table A7). If we want to use the models to signal the timing of future potential crises beyond 1997 on a regular basis, the models need to cover the recent 1997 data for in-sample estimation, and include other significant variables[33] examined in Appendix Table A7 or discussed in Table 3.9. Furthermore, based on the experience of 1997-98 crises, the possible contagion effect may also be included for future model estimation (see Alba *et al.,* 1998).

33. The additional variables include the M2/GDP, foreign liability/GDP, current account/GDP, domestic credit/GDP, Japanese real interest rate, Japanese growth rate, and stock price index.

Several implications for policy-makers are discussed as follows. First, even there are limitations on a quantitative EWS,[34] some objective framework is better than no framework at all. The models discussed in this paper could serve as the basis for providing a warning signal for potential crisis. The systematic application of the EWS for currency crisis could enhance the ability of policy-makers in taking effective actions to reduce the distortionary impact. By way of EWS, we could allocate scarce regulatory resources more precisely. In addition to developing the formal EWS model for currency crises, the central banks could closely watch the unusual changes in the economic and financial sectors. For instance, the central banks may carefully track some external indicators relevant to the current and capital accounts. Furthermore, the central banks should pay more attention to the abnormally large amount of short-term capital flows. The ratio of short-term debt to the foreign reserves is a good indicator for the vulnerability of a country's economy.

Second, the currency-crisis forecasting model alone is insufficient for signaling the potential full-fledged financial crisis in a country. We need a more sophisticated way in predicting the potential financial crises. It must be supplemented with a local financial crisis predicting model and prudent supervisory judgment to help predict the potential problem financial institutions. In addition, more complicated credit risk and capital allocation models can be used to ensure banks make more precise lending activities.

Third, in general, the countries with manageable foreign debts and sound economic fundamentals would have better chance to prevent financial crisis from occurring. Therefore, every country should implement prudential macroeconomic policies and strengthen its financial infrastructure to enhance its resistance to future shocks. Moreover, the

34. As mentioned in Section 2.4 and Appendix Table A3, some limitations on a quantitative EWS are reviewed as follows: (1) An econometric model using panel data of several countries assumes that its parameters giving a picture of the behavior of particular economic variables are alike across time and countries. However, given the diverse changes in economic structures of different countries over time, such assumption may not be realistic. According to earlier global experiences, no two crises are the same. Therefore, a useful EWS in forecasting one crisis may not be effective in predicting others. (2) The lack of timely high-frequency data on some important variables such as the short-term foreign debt and short-term capital flows.

ongoing development of bond markets should also top the list of every country's financial restructuring.

Finally, through regular international cooperation, the financial crisis could be under control in the early stages. For instance, by means of a regional joint monitoring system, which closely watches the shift in short-term capital flows, could be built up as part of the EWS.[35]

35. This view is widely discussed by many economists in the wake of 1997 Asian crisis.

REFERENCES

1. *Annual Economic Report,* Bank of Thailand, various issues.

2. *Annual Report,* Bank Negara Malaysia, various issues.

3. *Annual Report,* Monetary Authority of Singapore, various issues.

4. *Annual Report,* the Bank of Korea, various issues.

5. *Annual Report,* the Central Bank of China, Taipei, Taiwan, the Republic of China, various issues.

6. Alba, Pedro, Amar Bhattachar, Stijn Claessens, Swati Ghosh, and Leonardo Hernandez (1998), "Volatility and Contagion in a Financially-Integrated World: Lessons from East Asia's Recent Experience," paper presented at the PAFTAD 24 Conference, *Asia Pacific Financial Liberalization and Reform,* May 20-22, 1998, Chiangmai, Thailand, hosted by School of Development Economics, NIDA, in collaboration with PAFTAD International Steering Committee.

7. *Asian Development Outlook 1999, (Special Chapter) Economic Openness: Growth and Recovery in Asian,* Oxford University Press: Asian Development Bank.

8. Bangko Sentral ng Pilipinas (1999), "The Philippines: Sustaining the Recovery", January 1999.

9. Bank of Thailand (1998), "Focus on the Thai Crisis", Bank of Thailand Economic Focus, Volume 2, Number 2, April-June 1998.

10. Berg, Andrew and Catherine Pattillo (1998), "Are Currency Crises Predictable? A Test," *IMF Working Paper.*

11. Blinder, Alan S. " Eight Steps to a New Financial Order," *Foreign Affairs,* September/October 1999.

12. Calomiris, C.W., and G. Gorton (1991), (The Origins of Banking Panics: Models, Facts, and Bank Regulation,(in G. Hubbard, ed., *Financial Markets and Financial Crises,* University of Chicago Press: Chicago, pp. 109-173.

13. Calvo, Guillermo A. (1995), "Varieties of Capital-Market Crises", *Inter-American Development Bank Working Paper Series,* No. 306.

14. Calvo, Guillermo A. (1996), "Capital Flows and Macroeconomic Management: Tequila Lessons," *International Journal of Finance and Economics,* Vol. 1, pp. 207-24.

15. Calvo, Guillermo A. and Enrique G. Mendoza (1996), "Mexico's Balance-of-payments Crisis: a Chronicle of a Death Foretold," *Journal of International Economics,* Vol. 41, pp. 235-64.

16. Calvo, G., L. Leiderman, and C. Reinhart (1993), *Capital Inflows and Real Exchange Rate Appreciation in Latin America: The Role of External Factors,* IMF Staff Papers 40, No. 1, pp. 108-150.

17. Chang, Ha-Joon, Hong-Jae Park, and Chul Gyue Yoo (1998), "Interpreting the Korean Crisis: Financial Liberalisation, Industrial Policy and Corporate Governance", *Cambridge Journal of Economics,* Vol. 22, pp. 735-746.

18. Cole, Rebel A., Barbara G. Cornyn and Jeffrey W. Gunther (January 1995), "FIMS: A New Monitoring System for Banking Institutions," *Federal Reserves Bulletin,* pp. 1-15.

19. Cole, Rebel A. and Patrick Kehoe (1996), "A Self-Fulfilling Model of Mexico's 1994-95 Debt Crisis", *Journal of International Economics,* Vol. 41, No. 3/4, November, pp. 307-330.

20. Connolly, Michael B., and Dean Taylor (1984), "The Exact Timing of the Collapse of and Exchange Rate Regime and its Impact on the Relative Price of Traded Goods," *Journal of Money, Credit and Banking,* Vol. 16, May, pp. 194-207.

21. Crosetti, Giancarlo, Paolo Pesenti, and Norriel Roubini (1998), "What Caused the Asian Currency and Financial Crisis?" paper presented at the CEPR/World Bank conference "Financial Crises: Contagion and Market Volatility," London, May 9.

22. Demirgüç-Kunt, Asli, and Enrica, Detragiache (March 1998), "The Determinants of Banking Crises in Developing and Developed Countries," *IMF Staff Papers,* Vol. 45, No. 1.

23. Dornbusch, Rudiger and Alejandro Werner (1994), "Mexico: Stabilization, Reform, and No Growth, " *Brookings Papers on Economic Activity,* No. 1, pp. 253-297.

24. Drazen, Alan (1998), "Political Contagion in Currency Crises," mimeo, University of Maryland.

25. Edwards, Sebastian (1989), *Real Exchange Rates, Devaluation, and Adjustment: Exchange Rate Policies in Developing Countries,* Cambridge Press.

26. Eichengreen, Barry, Andrew Rose, and Charles Wyplosz (1996), "Contagious Currency Crises: First Tests," *Scandinavian Journal of Economics,* Vol. 98 (No. 4), pp. 463-84.

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

28. Esquivel, Gerardo and Felipe Larraín (1998), "Explaining Currency Crises, " Development *Discussion Paper* No. 666, Harvard Institute for International Development, pp. 1-41.

29. *Eviews: Command and Programming Reference* (1994-1997), Quantitative Micro Software.

30. Flood, Robert and Peter Garber (1984), "Collapsing Exchange-Rate Regimes: Some Linear Examples", *Journal of International Economics,* Vol. 17, pp. 1-13.

31. Flood, Robert and Nancy P. Marion (1998), "Perspectives on the Recent Currency Crisis Literature", *NBER Working Paper,* No. 6380.

32. Frankel, Jeffrey and Andrew Rose (1996), "Currency Crashes in Emerging Markets: An Empirical Treatment," *Journal of International Economics* Vol. 41 (December), pp. 351-66.

33. Furman, Jason and Joseph E. Stiglitz (1998), "Economic Crises: Evidence and Insights from East Asia," *Brookings Papers on Economic Activity* No. 2, pp. 1-135.

34. Galbis Vicente (1993), "High Real Interest Rates under Financial Liberalization: Is There a Problem?" *IMF Working Paper* No. WP/93/7, January (Washington: International Monetary Fund).

35. Girton, Lance and Don Roper (1997), "A Monetary Model of Exchange Market Pressure Applied to Postwar Canadian Experience," *American Economic Review* No. 76, pp. 537-48.

36. Glick, Reuven and Michael Hutchison (1999), "Banking and Currency Crises: How Common Are Twins?," 1999 Pacific Basin Conference "Financial Crises in Emerging Markets", Federal Reserve Bank of San Francisco.

37. Glick, Reuven and Ramon Moreno (March 1999), "Money and Credit, Competitiveness, and Currency Crises in Asia and Latin America," Working Paper PB99-01, Center for Pacific Basin Monetary and Economic Studies, Economic Research Department, Federal Reserve Bank of San Francisco.

38. Goldfajn, I. and R. Valdés (1995), *Balance-of-Payments Crises and Capital Flows: the Role of Liquidity,* MIT: Cambridge.

39. Greene, William H. (1997), *Econometric Analysis,* New Jersey: Prentice-Hall, Inc.

40. Huh, Chan and Kenneth Kasa (1997), " A Dynamic Model of Export Competition, Policy Coordination, and Simultaneous Currency Collapse," Federal Reserve Bank of San Francisco Center for Pacific Basin, *Working Paper* No. PB97-08.

41. Hussin, Awang Adek (1999a), "Responding to Financial Crisis: The Malaysian Experience", Paper presented at the International Conference on March 22-23: Responding to Financial Crisis: Challenges for Policy and International Cooperation.

42. Hussin, Awang Adek (1999b), "Central Banking Policies in Malaysia", Paper Presented at the 5th Annual Nanyang Asia-Pacific Central Banking Conference on July 8-10.

43. IMF (1997), *Crisis in Asia: Regional and Global Implications,* World Economic Outlook: Interim Assessment (December), International Monetary Fund.

44. IMF (1997), *World Economic Outlook,* October 1997.

45. IMF (1998), *World Economic Outlook,* May 1998.

46. IMF (1999a), "IMF's Response to the Asian Crisis", January 1999.

47. IMF (1999b), "IMF-Supported Programs in Indonesia, Korea and Thailand: A Preliminary Assessment", January 1999.

48. *International Financial Statistics,* Washington, D.C.: International Monetary Fund, various issues.

49. Jomo, K. S. (1998), "Malaysian Debacle: Whose Fault?", *Cambridge Journal of Economics,* Vol. 22, pp. 707-722.

50. Kaminsky, Graciela L. and Garmen M. Reinhart (1999), "The Twin Crises: The Causes of Banking and Balance-of-Payments Problems," *American Economic Review,* Vol. 89, No. 3.

51. Kaminsky, Graciela L. (1998), (Currency and Banking Crises: The Key Warnings of Distress,(Board of Governors of the Federal Reserve System, *International Finance Discussion Papers,* No. 629, October.

52. Kaminsky, Graciela L., Saul Lizondo and Carmen M. Reinhart (1998), "Leading Indicators of Currency Crises," *IMF Staff Papers,* Vol. 45, No. 1, March.

53. Kaminsky, Graciela L. and Carmen M. Reinhart (1996), "The Twin Crises: The Causes of Banking and Balance-of-Payments Problems," *International Finance Discussion Paper,* No. 544, Washington, Board of Governors of the Federal Reserve.

54. Klein, Michael and Nancy P. Marion (1994), "Explaining the Duration of Exchange-Rate Pegs," *NBER Working Paper,* No. 4651.

55. Krugman, Paul (1979), "A Model of Balance-of-Payments Crises," *Journal of Money, Credit, and Banking,* Vol. 11, pp. 311-325.

56. Kumar, Manmohan, Uma Moorthy, and William Perraudin (1998), "Determinants of Emerging Market Currency Crises and Contagion Effects," paper presented at CEPR/World Bank conference "Financial Crises: Contagion and Market Volatility, London, May 8-9.

57. Lee, Hsien Loong (1998), "Singapore Seminar", Speech delivered at Nomura Securities Tokyo on September 30, Hotel New Otani.

58. Lee, Hsien Loong (1999a), "Investor Opportunities in the Asia Pacific Region", Speech delivered at the Merill Lynch Asia Pacific Investor Conference 1999, London, April.

59. Lee, Hsien Loong (1999b), "Towards Sounder International Financial", Speech delivered at the Fifth Meeting of Financial and Central Bank Deputies on the Manila Framework, at Shangri-la Hotel, August.

60. Meecharoen, Kiettisak (1999), "Central Banking Policies in Thailand", Paper Presented at the 5th Annual Nanyang Asia-Pacific Central Banking Conference on July 8-10.

61. Milesi-Ferretti, Gian Maria and Assaf Razin (1998), "Determinants and Consequences of Current Reversals and Currency Crises", paper prepared for the National Bureau of Economic Research conference on Currency Crises, Cambridge, Massachusetts, Feb. 6-7.

62. Ministry of Financial and Economy of Korea (1998), "The Year in Review: Korea's Reform Progress", November 1998.

63. Monetary Authority of Singapore, *Annual Report,* 1997/1998.

64. Moreno, Ramon (1995), "Macroeconomic Behavior During Periods of Speculative Pressure or Realignment: Evidence From Pacific Basin Economies", Federal Reserve Bank of San Francisco, *Economic Review,* 1995, No. 3, pp. 3-16.

65. Obstfeld, Maurice (1994), "The Logic of Currency Crises", *NBER Working Paper,* No. 4640.

66. Obstfeld, Maurice (1996), "Models of Currency Crises with Self-Fulfilling Features", *CEPR Discussion Paper Series,* No. 1315.

67. Pill, Huw, and Mahmood Pradhan (1995), "Financial Indicators and Financial Change in Africa and Asia," IMF Working Paper 95/123 (Washington: International Monetary Fund, November).

68. Pincus, Jonathan and, Rizal Ramli (1998), "Indonesia: from showcase to basket case", *Cambridge Journal of Economics,* Volume 22, pp. 723-734.

69. *Report for the Financial Year,* Bank Indonesia, various issues.

70. Rosenberg, Michael R., "Currency Crises in Emerging Markets," Global Fixed Income Research, Merrill Lynch, July 1998.

71. Sachs, Jeffrey (1995), "Alternative Approaches to Financial Crises in Emerging Markets," draft, Harvard Institute for International Development

72. Sachs, Jeffrey and Steven Radelet (1998), "The Onset of the East Asian Financial Crisis, " paper prepared for the *Harvard Institute Development,* March 30.

73. Sachs, Jeffrey, Aaron Tornell and Andrés Velasco (1996), "Financial Crises in Emerging Markets: The Lessons from 1995," *Brookings Papers on Economic Activity:* 1, Brookings Institution, pp. 147-215.

74. SEACEN (1998), "SEACEN Trends and Outlook 1998".

75. SEACEN (1999), "SEACEN Trends and Outlook 1999".

76. Shea, Jia-Dong (1999), "Responding to Financial Crises: Challenges for Domestic Policy and International Cooperation Workshop", Paper presented at the International Conference on March 22-23: Responding to Financial Crisis: Challenges for Policy and International Cooperation.

77. Shea, Jia-Dong and Tsuen-Hua Shih (1999), "Taiwan's Financial Policies in Response to the Asian Financial Crisis", Paper presented at the 5th Annual Asia-Pacific Central Banking Conference on July 8-10 in Singapore.

78. Thomas S. Sealy (edited) (1998), *International Country Risk Guide,* Vol. XIX, No. 8, The PRS Group: A Division of International Business Communications.

79. Tornell, Aaron (1999), "Common Fundamentals in the Tequila and Asian Crises," draft, Harvard University.

80. World Bank (1999), *Global Economic Prospects and the Developing Countries: Beyond Financial Crisis* (1989/1999).

APPENDICES

Table A1: Significant Variables in Previous Empirical Studies of Currency Crises

		1	2	3	4	5	6	7
	Previous studies	**Edwards (1989)**	**Klein and Marion (1994)**	**Moreno (1995)**	**Sachs *et al.* (1995)**	**Frankel and Rose (1996)**	**Kaminsky & Reinhart (1996)**	**Kaminsky *et al.* (1998)**
	Time period	**1962-1982 (quarterly)**	**1957-1991 (monthly)**	**1980-1994 (monthly; quarterly)**	**1985-1995 (monthly; annual)**	**1971-1992 (annual)**	**1970-1995 (monthly)**	**1970-1995 (monthly)**
	Sample	**24 (Developing)**	**17 (Latin American)**	**7 (Asian)**	**20 (Emerging)**	**105 (Developing)**	**5 (Industrial), 15 (Developing)**	**5 (Industrial), 15 (Developing)**
	Estimation method	**Probit**	**Probit**	**Variable difference test**	**Mexican crisis impact**	**Probit**	**Probability conditional on a signal**	**Signal**
1	Real exchange rate	*	*		*	*		*
2	Current account							
3	Terms of trade							
4	Export growth							*
5	Trade balance							
6	Openness		*					
7	M2/foreign reserves				*			*
8	Domestic credit growth				*	*		
9	Broad money growth			*				
10	Capital flows; foreign debt (concessional debt)					*		
11	Foreign direct investment (/Debt)					*		
12	Inflation			*				
13	Banking crisis						*	
14	Foreign interest rate					*		
15	OECD growth							
16	Foreign reserve (growth)	*	*					
17	Foreign reserves/import					*		
18	Stock price change							*
19	Output growth			*				*
20	Fiscal balance (Public sector debt)	*		*		*		
21	Liberalization						*	
22	Contagion							
23	Parallel market premium	*						
24	(Seignorage) Reserve money/GDP (%)							

* indicates statistically significant in predicting the inception of currency crises. The Kaminsky *et al.* (1998) discussed most of the studies summarized in this table in great detail. Similar to Glick and Moreno's (1999) study, this table briefly reviews thirteen studies that use the probit or logit models and involve the developing countries.

Table A1. (Continued)

		8	9	10	11	12	13
	Previous studies	**Esquivel and Larraín (1998)**	**Milesi-Ferretti and Razin (1998)**	**IMF (1998)**	**Kumar *et al.* (1998)**	**Berg and Pattillo (1998)**	**Glick and Moreno (1999)**
	Time period	**1975-1996 (Annual)**	**1970-1996 (Annual)**	**1975-1997 (Monthly)**	**1985/1-1998/3 (Monthly)**	**1970/1-1995/4 1995/5-1997/12 (Monthly)**	**1972/1-1997/10 (Monthly)**
	Sample	**15 (High income); 15 (Middle Income)**	**105 (Low & middle income)**	**22 (Industrial); 31 (Developing)**	**32 (Emerging)**	**23 (Developing)**	**6 (East Asian); 7 (Latin American)**
	Estimation method	**Probit; Logit**	**Probit**	**Probit**	**Probit**	**Signal, Probit**	**Probit**
1	Real exchange rate	*	*	*		*	*
2	Current account	*				*	
3	Terms of trade	*	*	*			
4	Export growth				*	*	
5	Trade balance						
6	Openness		*				
7	M2/foreign reserves	*		*		*	
8	Domestic credit growth			*			* (Only for Latin American)
9	Broad money growth						
10	Capital flows; foreign debt (concessional debt)		*				
11	Foreign direct investment (/Debt)		*				
12	Inflation						
13	Banking crisis						
14	Foreign interest rate		*	*			
15	OECD growth		*				
16	Foreign reserve (growth)		*		*		*
17	Foreign reserves/import				*		
18	Stock price change						
19	Output growth	*					
20	Fiscal balance (Public sector debt)				*		
21	Liberalization						
22	Contagion	*			*		
23	Parallel market premium						
24	(Seignorage) Reserve money/GDP (%)	*					

Table A2: Reasons for Earlier and Recent 1997 Crises*

[*A currency crisis is identified and dated when a weighted average of quarterly percent changes in exchange rates and (negative) of quarterly percent changes of foreign reserves is 1.5 standard deviations from the mean (see Kaminsky and Reinhart, 1999). The detailed dates for each country are identified in Table 4.1, Chapter 4]

(1) INDONESIA	
Earlier crises (1978, 1983, 1986)	***1997 crisis***
• The earlier crises were mainly triggered by the external (oil shock), when oil and gas sector was still regarded as the major source of government budget to stimulate the economic growth.	• A sudden shift in market expectation and confidence triggered the reversal of short-term capital flow and therefore the initial financial turmoil. • Once started in Thailand in mid-1997, contagious speculative attack caused huge and sudden reversal of short-term capital flow and plunged Rupiah exchange rate. Unlike the previous crises, the 1997 currency crisis in Indonesia is exacerbated by the existence of huge foreign debt, which mostly unhedged. • In the real sector, the average maturity of external debts is very short. Consequently, the substantial depreciation in Rupiah exchange rate led to a collapse of a large number of domestic corporations. • Meanwhile, along with the external debt problem, domestic banks were also dealing with mounting non-performing loans, partly as a result of moral hazard practices and violation of prudent banking practices. • The extent and depth of the crises were aggravated by the existing social and political instability and worsened by the lost of foreign investor confidence in Indonesia.
The adjustment towards recovery	
• The adjustment towards recovery was supported by the presence of more favorable environment both economically and politically.	

Note: Unless otherwise stated, the above views are from the questionnaire filled out by the Dept. of Economic Research and Monetary Policy, BANK INDONESIA (November 10, 1999).

Table A2. (Continued)

(2) KOREA		
Earlier crises (1974, 1980)	***1997 crisis***	***Comment***
1974:4Q (from 26th Annual Report 1974, The Bank of Korea, pp. 35-36) • On 7 December the government raised the basic Bank of Korea concentration exchange rate by 21.3%, from 399.00 won per dollar to 484.00 won. • Since the adoption of a floating exchange rate system on 3, May 1964, this devaluation is the second upward adjustment of more than 10% in one day, the first being the 13% adjustment on 28 June 1971. The main reason for adjusting the exchange rate upward is that since the 28 June 1971 adjustment the exchange rate had risen a mere 7.5%, while domestic wholesale prices spurted by 77.7%. This disparity resulted in weakening the international competitiveness of Korean export goods. Moreover, Korea has been experiencing serious balance of payments constraints due primarily to the worldwide recession associated with the oil crisis. • In reviewing the trend of the foreign exchange rate before the drastic adjustment on 7 December, the concentration rate at the Bank of Korea had risen by 1.5 won per dollar, from 397.5 won at the end of 1973 to 399.00 won on 6 December. After the upward adjustment on 7 December, the rate remained unchanged at 484.00 won through the end of the year.	**1997** (from Annual Report 1997, The Bank of Korea, pp. 17-18) • From early 1997, the relation between receipts and payments of foreign exchange rate showed unstable movements. The large current account deficit and the slowdown of foreign capital inflows combined to bring about a decrease in the country's foreign exchange reserves and in the exchange value of the Korean Won. However, from April the Korean won strengthened temporarily against the U.S. dollar, thanks to the announcement of an early capital market opening schedule by the government and the narrowing deficit in the goods balance. • From the beginning of the third quarter, however, foreign investors' misgivings about the health of the Korean economy deepened, owing to the delay in handling Kia's financial difficulties, financial institutions' accumulation of bad loans, and the negative impact of the Southeast Asian currency crisis. Accordingly, there was a large net outflow of foreign portfolio capital, new external borrowing became almost impossible, and Korean financial institutions faced substantial difficulty in rolling over their existing short-term debts in the international financial markets. In consequence, Korea found itself in crisis, lacking sufficient foreign currency liquidity to meet its maturing liabilities following a sharp decline in its foreign exchange reserves from early November. • What brought about this large mismatch between demand and supply in the foreign exchange market was mainly the heavier debt taken on to finance the current account deficit, and the difficulty in coping with a flood of repayment demands because of the heavy reliance on short-term external borrowings. Besides these factors, the building of expectations of a massive depreciation of the Korean won due to the persistent wide current account deficit also played a large part in the further worsening of the foreign exchange situation.	While the previous crises were caused by oil price shock, the recent crisis was caused by banking sector problem and depleting foreign reserves. Over-borrowing and the excessive portion of short-term debt relative to the amount of foreign reserve were critical in causing the crisis in 1997.

Note: Unless otherwise stated, the above views are from the questionnaire filled out by the Bank of Korea.

Table A2. (Continued)

(2) KOREA (cont'd)		
Earlier crises (1974, 1980)	***1997 crisis***	*Comment*
1980:1Q (from Annual Report 1980, The Bank of Korea) • On 12 January 1980, the Bank of Korea standard concentration rate was changed from Won 484 per US$1 to Won 580 per US$1, a devaluation of the won by 16.6%. This drastic devaluation was inevitable to support reduced export competitiveness resulting from high domestic price increases. • On 27 February, a new exchange rate system was introduced whereby the won was linked to a multi-currency basket consisting of a trade-weighted and the SDR basket, but other factors were also taken into account in determining the exchange rate. Under the new system, the won-US dollar exchange rate changes daily. The exchange rate had gradually increased to 659.90 won per U.S. dollar by the end of 1980, an increase of 36.3% compared with the end of 1979 and 13.8% compared with the rate before it was floated.	• The country's foreign exchange reserves, which had stood steady at around 30 billion US$ until October, declined sharply to 24.4 billion US dollars at the end of November and to 20.4 billion U.S. dollars at the end of December. The reason they dwindled so rapidly was because the Bank of Korea was forced, as the lender of last resort, to provide support for the settlement of foreign claims on domestic financial institutions when demands for the redemption rather than the customary roll over of their maturing short-term foreign liabilities mounted from early November. • Most seriously, usable official foreign exchange reserves, which are official foreign exchange reserves less the BOK's deposits at overseas branches of domestic banks, decreased to just 7.3 billion dollars as of the end of November as against 22.2 billion dollars as of the end of October. • Consequently, the government had to turn to the IMF to request a stand-by credit on November 21. An agreement was reached with the IMF on December 4 for the provision of an amount of some 21 billion US dollars. • In addition, major international financial institutions such as the IBRD and the ADB and also a number of developed countries including the United States and Japan indicated their readiness to provide an additional 36 billion U.S. dollars, upon the conclusion of the agreement with the IMF. This meant that Korea was to receive in stages a total amount of 57 billion U.S. dollars by way of the emergency rescue package.	

Note: Unless otherwise stated, the above views are from the questionnaire filled out by the Bank of Korea (Jan 11, 2000).

Table A2. (Continued)

(3) MALAYSIA		
Earlier crises (1975, 1982)	***1997 crisis***	***Comment***
• The ringgit's weakness in 1975 was reflective of the instability in international currency markets against a backdrop of global recession following the perverse impact of the oil-price shock in 1973. • The recession in industrial countries, which had become increasing severe towards the end of 1974, resulted in a reduced demand for Malaysian exports and a steep decline in commodity prices. • The deterioration in Malaysia's terms of trade and weak external demand had an adverse impact on economic activities in 1975 and contributed to the recession. • During the year, the ringgit fell to a low of RM 2.5940 per US dollar on 30 September 1975. For the year as a whole, the ringgit had depreciated by 10.7%. • However, international reserves remained strong, where net international reserves increased by RM171.3 million to RM3.9 billion, sufficient to finance 5.8 months of retained imports.	• In contrast, the currency crisis witnessed in 1997 was distinct in that the depreciation of the ringgit was not sparked off by a real sector shock but was fuelled by the turbulence in regional financial markets following the floating of the Thai baht. • The decline in the ringgit levels observed in 1997 did not reflect the underlying fundamentals of the economy. In early 1997, the economic fundamentals for Malaysia were strong (GDP 1 Half 1997: +8.5%); inflationary pressure were contained (1 Half: +2.8%) and the external deficit had narrowed. • However, with the increasing integration of financial markets, the contagion effects of developments in the region were quickly transmitted to Malaysia. The contagion-induced negative market perception of risks in the Malaysian financial system and economic outlook resulted in substantial outflows of short-term capital. This led to a significant downward adjustment of the ringgit exchange rate. • Speculative activity during the period of uncertainty increased the extent of adjustments in the equity market as foreign investors liquidate their positions. • The combined forces of currency speculation and short-term capital outflows were compounded by the rapid increase in the internationalization of the ringgit from April 1998. Opportunities to speculate on the ringgit increased with the build-up of offshore ringgit and led to a further depreciation of the ringgit. Thus the negative market perception of the Malaysian economy which had led to a reversal of short-term capital flows, aggravated by speculative activity and the availability of offshore ringgit to fund this speculative activity, were the main factors leading to the currency crisis experienced between July 1997-September 1998.	• The currency crisis in 1997 was different from the ringgit's weakness experienced in 1975. • The recent 1997 crisis was the result of regional foreign exchange market instability, which impinged on the currency and adversely affected the real sector. • In comparison, the ringgit's weakness in 1975 was the result of real sector weakness and weak external demand. • In addition, the magnitude of the ringgit depreciation was also unprecedented where in 1975, the ringgit depreciated modestly by 10.7% whereas during the 1997-98 currency turmoil, the ringgit had depreciated by 40%. The impact of the ringgit's depreciation on the nation's international reserves was also more acute in 1997 compared with 1975.

Note: Unless otherwise stated, the above views are from the questionnaire filled out by Economics Department, Bank Negara Malaysia (Nov 10, 1999).

Table A2. (Continued)

(3) MALAYSIA (cont'd)		
Earlier crises (1975, 1982)	***1997 crisis***	***Comment***
1982:1Q (from Bank Negara Malaysia, Annual Report 1982, pp. 148-150) • The ringgit weakened steadily in terms of the United States dollar during most of 1982. It weakened initially from an Average of $2.25=US$1 in December 1981 to an average of 2.34 in April 1982. The weakness of the ringgit reflected partly the strengthening of the United States dollar abroad, supported mainly by the maintenance of high interest rates in the United States, and partly the strong commercial demand for the dollar in the Kuala Lumpur foreign exchange market. • The fall in international reserves occurred entirely in the first half of 1982, despite the substantial capital inflows, reflected mainly the deterioration in the merchandise and services accounts because of the sluggish export growth, particularly in the first half year, while imports of both goods and services continued to increase. International reserves at the end of 1982 were sufficient to finance about four months of retained imports at the 1982 level.	• During the period end-June 1997 to end-August 1998 the ringgit had depreciated by 40% and had breached an intra-day low of RM4.88 per US dollar on 7 January 1998. • During the same period, the international reserves of the nation declined by US$ 7.8 billion to US$ 20.2 billion as at end-August, a level sufficient to finance 4 months of retained imports. The decline in reserves was largely caused by the outflow of short-term capital. Nevertheless, since August 1998, the reserves had increased significantly by US$ 11.2 billion to US$ 31.4 billion as at end-September 1999 sufficient to finance 6.2 months of retained imports.	

Table A2. (Continued)

(4) THE PHILIPPINES		
	A. Cause of the crisis (Immediate cause)	
February 1970	***1983, 1984, 1986***	***1997***
• The peso came under attack due to the negative effects of the huge balance of payments (BOP) incurred in 1969 and the large volume of maturing short-term debt in 1970.	**October 1983-** • The peso weakened significantly as the Philippines declared a moratorium on debts owed to foreign banks and other financial institutions in October 1983. Following the assassination of former Senator Aquino in August 1983. • In the domestic financial markets, a scandal involving an estimated P800 million in unpaid debt to a number of financial institutions and political instability gave rise to one of country's worst financial crisis. • External factors, which aggravated domestic economic conditions, were the increase in oil prices in 1978 and the recession in developed countries from 1980 to 1982. The hike in oil prices exerted upward pressure on inflation and increases import payments. The recession, meanwhile, reduced demand for the country's exports. **June 1984-** • The full impact of the crisis, which broke out in late 1983, was felt in 1984. **Feb 1986-** • Political turmoil, which led to the change in government, fueled speculation in the foreign exchange market.	• The peso depreciated after the flotation of the baht on 2 July, 1997, following intense speculation against the baht as weaknesses in the financial system and external position of Thailand surfaced. This, in turn led to the massive withdrawal of funds from the Philippines and other emerging markets in Asia, which weakened significantly the local currency.
	A. Cause of the crisis (Underlying cause)	
February 1970	***1983, 1984, 1986***	***1997***
• As early as 1966 the government pursued expansionary monetary and fiscal policies to stimulate economic growth. These policies resulted in output gains but heavy government and import spending eventually led to the deterioration in the BOP position and to a drop in international reserves. • In addition to these domestic factors, external factors contributed to the worsening of the external position. The decline in world market prices and drop in US military expenditures reduced export receipts.	• The year preceding 1982 was characterized by the unprecedented growth in the budget deficit and increased government involvement in the financial markets and the private sector. • Intensified government spending, involvement in private sector operations and tolerance of monopolies in some agricultural industries weakened economic fundamentals and promoted inefficiencies in the economy. • The government also guaranteed foreign loans of private corporations, which were not channeled to productive uses, making repayment difficult.	• The competitive depreciation of the yuan in 1994 gave China a significant edge in its export pricing over those of the Philippines and its other Asian neighbors. • In addition, the underdeveloped capital and forward market made the economy vulnerable to external shocks due to heavy reliance on short-term debt instruments and inadequate hedging mechanisms.

Note: Unless otherwise stated, the above views are from the questionnaire filled out by the Department of Economic Research, Bangko Sentral ng Pilipinas (06 December 1999).

Table A2. (Continued)

(4) THE PHILIPPINES (cont'd)		
	B. External Position prior to and during the crisis	
February 1970	***1983, 1984, 1986***	***1997***
The external sector position registered a deficit. • The BOP recorded a deficit of $136.5 million in 1968 but recovered to register a surplus of $20.89 in 1969 with the implementation of stabilization measures in the early part of the year. • International reserves dropped from $161.4 million in 1969 to $120.66 million in 1970	External sector suffered foreign exchange liquidity crisis. • The BOP posted a deficit of $1,671 million in 1982, which widened further to $2,118 million in 1983. • International reserves fell from $1,711 million in 1982 to $864.7 million in 1883. • Short-term debt as a percent of total external debt in 1983 stood at 37.9 percent.	External sector fundamentals before the outbreak of the crisis were relatively sound. • A year before the 1997 crisis, the country registered a positive BOP of $4,107. • International reserves peaked at $11,833 million in March 1997 before dropping to $8,648 million at end-1997. • The ratio of short-term debt to total external debt in 1997 was 18.6%.
	C. Response to the Crisis	
February 1970	***1983, 1984, 1986***	***1997***
Stabilization measures were geared towards: a) reducing domestic liquidity; b) implementing foreign exchange measures, e.g., free float of the peso, control of non-trade payments. c) securing standby arrangement from the IMF; and d) restructuring of external debt.	The following measures were directed mainly at the external sector: a) depreciation of the peso; b) foreign exchange pooling system and the import prioritization scheme were implemented as emergency measures.	Measures implemented the height of the crisis is sought to: a) restore order in the foreign exchange market, e.g., allowing the peso to float within a wider band; required approval of sale of non-deliverable forward contracts; b) manage liquidity in the system; c) institute reform in the banking system; d) secured a precautionary arrangement with the IMF.

Table A2. (Continued)

(5) SINGAPORE	
Earlier crises	*1997 crisis*
December 1970 • In the early 70s, the Singapore Dollar was pegged to the Pound Sterling under the Bretton Woods system. Following heavy funds outflow from the United States in 1971, the US government suspended the convertibility of its currency into gold. This was followed by an effective devaluation of the US dollar as major industrial economies re-aligned their currencies under the Smithsonian Agreement in Dec 71. Singapore had decided to maintain the local currency peg to the Pound Sterling at that time, the revaluation of the US Dollar therefore meant that both the Pound Sterling and the Singapore Dollar rose by almost 9% in value in Dec 71. Against other currencies, such as the Deutschemark and the Japanese Yen, the Singapore Dollar was significantly weaker following the Smithsonian re-alignment in currencies took place in a fairly orderly manner and did not seriously threaten macroeconomic or financial stability in Singapore. **July 1975** • As a result of the oil price shock in late 1973, Singapore consumer prices rose by nearly 30% in the first half of 1974. At the same time, the global economy was headed for a slowdown and Singapore faced the prospect of stagflation. Monetary policy was aimed at curbing inflation, and credit ceilings were imposed, together with selective credit guidelines. These measures resulted in the significant strengthening of the Singapore Dollar compared to most major international and regional currencies. Between the end of Jan and Dec 74, the currency appreciated by 4% against the Pound Sterling, 7% against the US Dollar and 8% against the Japanese Yen. • With inflation moderating in the second half of 1974, monetary policy was gradually eased to support growth. In 1975, the Singapore Dollar reversed some of its gains in the previous year and depreciated against most currencies over the year. By the close of the year, the Singapore dollar was 8% below its Dec. 74 value compared to the US Dollar while its value in terms of the Yen was 6% lower. **1982:1Q** • The Singapore dollar eased slightly against the United States dollar as United States interest rates firmed again. (Annual report 1981/1982, The Monetary Authority of Singapore, p. 13) • The uptrend in U.S. interest rates in the first part of 1982 moved interest rate differential not in favor of Singapore dollar **investment and contributed to the decrease in short-term capital inflow. (Annual Report 1981/1982, The Monetary Authority of Singapore, p. 11)** • The Singapore dollar was relatively stable against the currencies of major trading partners during 1982 but weakened slightly against the U.S. dollar. . (Annual report 1982/1983, The Monetary Authority of Singapore, p. 10)	• In the 1970s, Singapore's monetary policy involved a variety of intermediate targets such as the monetary base, interest rates and loans growth. By the 1980s, the focus of Singapore's monetary policy had shifted to the exchange rate. Since then, the Singapore Dollar has been managed against a trade-weighted basket of currencies. • In the Asian financial crisis of 1997-98, Singapore dollar depreciated sharply against the currencies of major industrialized countries. The Singapore Dollar fell by 10% against the US Dollar, by 8% against the Deutschemark, by 9% against the Pound Sterling and by 17% against the Yen. On the other hand, the Singapore Dollar strengthened compared to the currencies of crisis-hit Asian economies. In the same period, it appreciated by 15% compared to the Malaysian Ringgit, 19% compared to the Thai Baht, 23% compared to the Korean Won and more than 68% compared to the Indonesian Rupiah. On a trade-weighted basis, the Singapore Dollar remained broadly stable during this period. Due to the increased volatility of the foreign exchange markets during the crisis, the Monetary Authority of Singapore managed the value of the Singapore Dollar more flexibly and the band within which it was allowed to fluctuate was temporarily widened. • The currency crisis of 1997/98 resembled the early in the 1970s in that the origins of the turbulence were largely external. The transmission mechanism was from instability in international markets, which caused spillover effects on Singapore. Given the openness and reliance on trade, it is inevitable that external shocks will time to time cause increased volatility in domestic markets. It is therefore crucial for Singapore to continue to strengthen its financial and monetary infrastructure, small and open economy. In 1997/98, contagion effects also compound the impact on Singapore.

Note: Unless otherwise stated, the above views are from the questionnaire filled out by the Department of Economics, Monetary Authority of Singapore (Jan. 3, 2000).

Table A2. (Continued)

(6) THAILAND		
Earlier crises	***1997 crisis***	***All***
• The earlier crises were mainly caused by prolonged current account deficit, while the crisis in 1997 was caused by both huge current deficit and large-scale capital flight (following the huge foreign debt built-up). This supports the hypothesis of exchange rate overvaluation in all cases.	• The crisis in 1997 was preceded by the bubble economy and asset price inflation, while the earlier crises were not. Therefore, it is much more difficult for the economy to adjust in the aftermath of the 1997 crisis due to sharp asset price deflation and failing financial institutions. • The global contagion effect (not present in earlier crises) also accentuated the adjustment problem after 1997.	• All currency crises were directly related to the balance of payments deterioration that reduced central bank's net international reserves to dangerous level.

Note: Unless otherwise stated, the above views are from the questionnaire filled out by Economic Research department, Bank of Thailand.

Table A2. (Continued)

(7) R.O.C., Taipei (cont'd)	
Earlier crises (1990, 1995)	***1997 crisis***
1995:3Q • In January and February, the crash of the Mexican peso and the collapse of Barings, together with the large outward remittances resulting from the profit-taking in the local stock market by foreign investors, exerted pressure on the NT dollar to depreciate in the local currency market, However, the Bank's intervention as well as the buoyant demand for NT dollars over the Chinese lunar new year period eased such pressure to some extent. As a result, the NT dollar exchange rate moved within a narrow range of between 26.261 and 26.363. From early March to the middle of April, the NT dollar was affected by the large appreciation of both the Deutsche mark and Japanese yen against the US dollar in the international currency markets, with the result that it soared against the US dollar in the local market, reaching a thirty-two month high of 25.1405 at the close trade on April 10. • In July, as an agreement was reached in the US-Japan auto talks, the US dollar shed the weakness by which it had been characterized during the first half of the year and began to rebound steadily. In addition, concerted market intervention by the Federal Reserve, the Bank of Japan and other central banks pulled the US dollar further up in the international currency markets. The NT dollar accordingly depreciated further against the US dollar. Moreover, Mainland China's missile tests and military exercises in July and August strengthened expectations of NT dollar depreciation. The NT dollar-US dollar exchange rate thus plunged from 25.829 at the end of June to 27.456 by the middle of August. ***The adjustment towards recovery*** • In order to dispel local expectations of further NT dollar depreciation due to political factors, the Bank intervened in the market to stabilize the exchange rate. In late September, a weakening of the US dollar in the international markets pulled the NT dollar up once again to 26.742.	**1998:2Q** *NT dollar appreciated by 1.31% in 1998:* • From early March to the end of June, the NT dollar once again depreciated sharply against the US dollar. The factors behind this depreciation, in addition to the troubles faced by neighboring Asian countries such as Indonesia and Japan, included a decline in exports and a shrinking trade surplus. On the eve of the Indonesian presidential election on March 11, the IMF decided to suspend the disbursement of funds agreed upon in 1997. The rupiah depreciated further followed by the currencies of other ASEAN countries. The Japanese yen also depreciated against the US dollar as huge problem loans dragged the Japanese economy into recession. As a result, non-delivery forward (NDF) transactions increased, which once again put pressure on the NT dollar depreciation. The Bank asserted publicly that the depreciation of the NT dollar was not consistent with economic fundamentals, and adopted measures, such as banning domestic juridical persons from engaging in NT dollar NDF transactions in May, to dampen foreign exchange speculation. The NT$/US$ exchange rate subsequently reached a low of 34.896 on June 10 and then gradually stabilized. • Afterwards, the NT dollar exchange rate kept fluctuating within a very narrow range from 33.867 to 34.867 until the end of September. This was mainly due to the international financial turmoil emerging again, especially the outbreak of the Russian financial crisis in July, which spread to the South American countries. The NT dollar appreciated sharply from the beginning of October onwards and reached 32.216 as of the end of 1998. The main reasons for the appreciation were the outbreak of the Long-Term Capital Management (LTCM) crisis in September and the subsequent cutting of the federal funds rate by the US on three occasions between September and November, which made the US dollar go on a downward trend. In addition, the sharp appreciation of the Japanese yen against the US dollar, the stabilized Asian financial markets, the measures to discourage foreign exchange speculation, as well as foreign capital inflow into R.O.C. reversed the expectations of the NT dollar depreciation. The Bank thus had to intervene in the foreign exchange market to slow down the pace of the NT dollar appreciation.

Table A2. (Continued)

(7) R.O.C., Taipei	
Earlier crises (1990, 1995)	***1997 crisis***
1990: 2Q • The exchange rate of the N.T. dollar faced large downward pressure in the first half of the year. The negative annual growth rates of exports that appeared in January, March, April and May, and sizable capital outflows stimulated strong depreciation expectations. The N.T. dollar depreciated by 3.87 percent in terms of the U.S. dollar on May 15, 1990. The depreciation expectations continued into June and then gradually disappeared ***The adjustment towards recovery*** • There were several factor in favor of a stable N.T. dollar in the second half of the year. These factors included a recommencement of positive annual growth rates of exports; declining capital outflows; the balance of payments in surplus; and the adoption by the Bank, on June 23, of a redeposit policy under which banks were required to place part of their foreign currency deposits and foreign exchange proceeds deposits with the Bank. The exchange rate of the N.T. dollar against the U.S. dollar fluctuated slightly within a narrow band in the second half of the year. As the exchange rate became stable, the Bank adjusted its redeposit policy on November 24 by reducing all redeposit ratios to zero.	**1997:4Q** • The R.O.C. economy started to feel the pinch of the Asian financial crisis during the second half of 1997. Fortunately, our economic fundamentals remained healthy. Although the NT dollar exchange rate, interest rates, and stock prices fluctuated, the magnitude of the fluctuation was far less severe than that experienced by other East Asian countries and stability was soon restored. Through out 1997, the Asian financial crisis mainly affected our financial markets, while the real economic sector remained largely intact. • Exchange rate: In July 1997, as the Asian financial crisis escalated, the NT dollar came under heavy pressure to depreciate. The Central Bank of China responded by actively defending the local currency. At the end of July, however, the Bank shifted to a hands-off policy, letting market forces determine the exchange rate. The NT dollar soon fell from 27.97 on July 28 to 28.7 on July 30 against the US dollar. From then until mid-October, the Bank aimed to maintain the NT dollar at a reasonable price after cautiously evaluating movements in trading partners' currencies, the real effective exchange rate of the NT dollar, as well as export conditions in domestic industries. Dollar became stronger and the Asian financial crisis showed no signs of abating, the Bank recognized the difficulties of fighting the wild trend of international speculation single-handedly. In order to prevent the real economic sector and other financial market from being affected by prolonged maneuvers in the foreign exchange market, from Oct. 17 onward, the Bank decided to let market forces determine the NT dollar exchange rate. The NT dollar then underwent a downward trend and reached its lowest point of 34.481 against the US dollar on January 12, 1998. It then rebounded along with the steady recovery of the Asian financial markets. By the end of February 1998, the NT dollar had re-ascended to 32.1 against the US dollar. • ***Reasons why the R.O.C. Economy was relatively insulated from the Asian Financial Turmoil:*** Prior to the crisis, our economic fundamentals remained strong, our current account was in surplus, our foreign reserves were abundant, and foreign debt was negligible. In addition, our enterprises improved their financial structures and increase their resilience. Bank soundness was enhanced and an orderly approach to liberalizing foreign capital was followed. Subsequently, the adverse effects of the crisis were minimized. • ***Lessons from the financial turmoil***: (1) Prudential macroeconomic policies and effective financial supervision should be implemented in order to strengthen economic fundamentals and to prevent financial crisis from happening. (2) The deepening the broadening of the financial markets should be promoted to enhance their resistance to future shocks. (3) We should seek every opportunity to participate in regional international cooperation projects. Through regular regional dialogues and joint surveillance, we can contain them in the early stages by close cooperation and by emergency bailout funds.

Note: Unless otherwise stated, the above views are from the questionnaire filled out by the Economic Research Department, the Central Bank of China.
Source: Annual Reports (1997, 1998), The Central Bank of China, Taipei.

Table A3: EWS for the Financial Institutions or the Currency Crisis

(1) INDONESIA		
Explicit EWS for financial institutions	*Explicit EWS for currency crisis within central bank*	*Limitations on implementing the EWS for currency*
Yes. • Management Information System of Bank Indonesia in Banking Sector (SIM-SPB) which is basically a banking sector data based. The system produces any kind information to support offsite supervision, onsite supervision, and information. • The resources process such information originated from monthly bank report, credit report of commercial banks, and weekly bank report. Outputs of such system covers monthly, quarterly and annually issues, for instance bank rating, financial statement, publication of Indonesian Banking information, Banking statistic publication and banking directory. • Information produced by the system is very much needed to support banking supervision function such as through implementation early warning system adopted by BI, which help bank supervisors to sensitively be aware of the existence of potential problem faced by banks. • On this case, the system will produce early detection indicators reflected by financial ratios of CAEL (Capital, Assets Quality, Earning ability and Liquidity) such as Capital Adequacy Ratio, Loan to Deposit Ratio, Cost Efficiency Ratio, or additional testing ratio to support financial ratios. Currently, BI keeps improving such a system in order to conduct banking supervision effectively.	• While Indonesia has no formal early warning system on currency crises, Bank Indonesia has strengthen and improved the monitoring system of foreign exchange transaction so as Bank Indonesia becomes able to closely watch on the capital movement. Banks and all economic agents that undertake transactions in foreign currency are obliged to report in detail to the central bank.	

Note: Unless otherwise stated, the above views are from the questionnaire filled out by the Department of Economic Research and Monetary Policy, BANK INDONESIA (November 10, 1999).

Table A3. (Continued)

(2) Korea		
Explicit EWS for financial institutions	***Explicit EWS for currency crisis within central bank***	***Limitations on implementing the EWS for currency***
Yes.	Yes. • The EWS for currency crisis started in April, 1999. • The Korea Center for International Finance is in charge of the system.	• There are two considerable limitations on implementing the EWS in Korea. 1. The first one is related to data availability, i.e. especially statistics regarding the real sector and the banking sector. 2. The second one is related to "data frequency". Most statistics are made out and released on quarterly or annually bases. In consideration of the comparatively fast capital movement at the present time and for assuring the timeliness of the EWS, it seems necessary to acquire monthly data for use in EWS.

Note: Unless otherwise stated, the above views are from the questionnaire filled out by the Bank of Korea.

Table A3. (Continued)

(3) MALAYSIA		
Explicit EWS for financial institutions	***Explicit EWS for currency crisis within central bank***	***Limitations on EWS***
• Though there is no EWS functioning at present, one is currently being developed (Nov. 10, 1999).	• In conjunction with technical assistance from the World Bank, an early warning system is currently being developed to enable better monitoring of the banking system. Hence, in so far as banking and currency crises are intertwined, then as argued by Kaminsky and Reinhart (1999), a banking crisis can help predict future currency crisis.	• Although it is possible to construct an early warning system (EWS) for a banking crisis or to detect problems in the economy, it may be more difficult to build an EWS to detect a currency crisis. • As we have seen in the Asian crisis, the exchange rate adjustments were far in excess of the change in fundamentals as reflected in key economic indicators or banking sector indicators. • In addition, a currency crisis could also be caused by variables that are less predictable and that do not exhibit trends. • Furthermore, the emergence of highly leveraged institutions adds another dimension to the problem. • Finally, as Barry Eichengreen pointed out, EWS models are like Richter scales registering the severity of earthquakes: they are not reliable predictive devices. However, Eichengreen further adds that, even if better economic models do not enable us to reliably predict financial crises, it will however improve our understanding of such phenomena.

Note: Unless otherwise stated, the above views are from the questionnaire filled out by Economics Department, Bank Negara Malaysia (Nov. 10, 1999).

Table A3. (Continued)

(4) THE PHILIPPINES		
Explicit EWS for financial institutions	***Explicit EWS for currency crisis within central bank***	***Limitations on EWS***
• The BSP completed the development of its first generation early warning signal (EWS) for commercial banks in November, 1999. The EWS is being reviewed by the concerned operating departments. A similar system is being developed for thrift and rural banks targeted to be completed in the first and second quarters of 2000. The EWS for commercial banks will work as follows: 1. The EWS is based on a statistical model that generates one-year ahead predictions of an individual bank's capitalization ratio and therefore directly measures its future solvency. The current predictions which are for August 2000 will be reviewed monthly. 2. A shortlist of potential problem banks is determined on the basis of the predicted level and change in capitalization ratio. 3. The other banks not identified as potential problem banks are ranked according to relative solvency risk to assist examining departments in focusing and prioritizing their limited supervisory resources. Ultimately, the judgement on the actual financial condition of a bank will depend on the full assessment of on-site examiners. 4. The predictions when aggregated also provide a basis for assessing prospective changes in the overall condition of the banking system. • The foregoing EWS is supported by two other new analytical reports: (a) the quarterly Bank Performance Report (BPR); and the (b) the quarterly Report on Top Borrowers. The BPR tracks three types of data for use in the financial analysis of a bank, namely: (a) individual bank's data; (b) data for a peer group of banks similar in size, location and industry grouping; and (c) ranking. • For the Report on Top Borrowers, the BSP monitors banks' top borrowers/loan accounts of banks to enable supervisors and examiners to determine the collectibility of their loans and obligations. This information will also be useful in determining the asset quality of the banking system. • The EWS is an initiative of the BSP and is meant to guide BSP's top management in their policy formulation.	• The EWS for the currency crisis is still in the drawing board. • Aside from the forgoing EWS for banks, the BSP is formulating a conceptual framework for an EWS for currency crisis using macroeconomic variables. The conceptual framework is due for completion in the second week of December, after which an operational model will drawn up. • In the absence of a formal EWS, the BSP has kept a close watch on a broad range of indicators in the areas of money, banking, credit, and external sector including: 1. Daily exchange growth of domestic credit, 2. The allocation of credit (i.e., productive vs. non-productive), 3. Type of capital inflow (direct investments vs. portfolio investments), 4. Composition of external debt (long term vs. short-term), 5. Debt ratios (e.g., debt-service ratio; 6. Ratio of short-term debt to international reserves), 7. Composition of imports (capital and raw materials vs. consumer goods), 8. Structure of exports (import dependency of raw materials), 9. Current account position (sustainability of a deficit as measured by the ratio of current position to GNP).	• The EWS for currency crisis is still being developed so we have no basis for determining its limitations.

Note: Unless otherwise stated, the above views are from the questionnaire filled out by the Department of Economic Research, Bangko Sentral ng Pilipinas (06 December 1999)

Table A3. (Continued)

(5) SINGAPORE		
Explicit EWS for financial institutions	***Explicit EWS for currency crisis within central bank***	***Limitations on EWS***
• The Monetary Authority of Singapore (MAS) had maintained high prudential and supervisory standards in its financial sector oversight even before the Asian financial crisis. However, in line with Singapore's goal to become a premier global financial centre, MAS has shifted its emphasis from regulation to supervision. The shift was from 'one-size-fits-all" regulation towards greater emphasis on supervision, which entails monitoring and examining institutions for compliance with laws and guidelines, and assessing asset quality and the adequacy of risk management systems. This approach is better suited to cope with the growing complexity of banks' activities and organizational structures, increased linkages with non-bank financial institutions and institutions abroad, and technological advancements. • As with the practice of supervisors in other major financial centres, MAS examinations were made more frequent and regular. On-site examinations were supplemented by off-site views, which involve continuous tracking of institutions, the review of statistical returns and audit reports submitted by banks, and regular meetings with bank management. • As part of the supervisory framework, MAS engages in regular dialogue with the external auditors, and the internal auditors upon the completion of their audits of the Singapore operations to discuss the internal control environment of the institution and issues of mutual concern. Auditors are required to submit audit reports to MAS on the institutions' internal controls, and compliance with prudential standards. In addition, external auditors are required to confirm the adequacy of provisions, in conjunction with their statutory audit. • With MAS' shift in emphasis from regulation to supervision, there was a need for greater transparency and a higher disclosure standard for local banks, to maintain confidence in the banking system. With effect from financial year 1998, local banks began to disclose data such as hidden reserves and non-performing loans. Changes in accounting practices were also introduced which were consistent with international standards, and the global trend towards greater transparency in both the banking and corporate sector.	• While there is no formal early warning system on currency crises, the MAS continually monitors developments in the real economy and financial system at various levels. • The MAS does not bring various macroeconomic and financial indicators (such as those in Table 3.9, section III) into a 'reduced-form" model, although it does monitor them closely for their information content. • Specifically, the MAS would place heavy emphasis on some of the 'external' indicators including those relating to the current and capital accounts in Table 4. As Singapore has thus far not has a problem with external indebtedness in either public or private sector; the relevant indicators do not show much short-run movement. • Financial sector indicators are tracked closely as part of MAS' overall supervisory responsibilities over the sector. In general, these indicators play a signaling function in the macro economic analysis work in the MAS. Should the value of the indicators exceed some average trend path, they alert us to the need for a more thorough analysis of developments in the particular sector.	• We feel that too strong an emphasis on an EWS can be restrictive, as the model is unable to capture important qualitative factors that can shed valuable light on the vulnerability of particular sectors in the economy. • Moreover, the EWS model is inherently restrictive in predictive content, as it derives from historical relationships, whereas crises tend to emerge in non-linear ways, which mark significant departures from past trends.

Note: Unless otherwise stated, the above views are from the questionnaire filled out by the Department of Economics, Monetary Authority of Singapore (Jan. 3, 2000).

Table A3. (Continued)

(6) THAILAND			
Explicit EWS for currency crisis within financial institutions	***Explicit EWS for financial institutions***	***Explicit EWS for currency crisis within central bank (Institution that is in charge of EWS)***	***Limitations on implementing the EWS for currency crisis***
• Following a long-period (13 years) of exchange rate stability, no explicit early warning system on currency crisis for financial institutions had been developed. The only major limit on banks' foreign exchange risk is the net foreign exchange position/capital ratio limit.	No. • During the pre-crisis years, Thai financial institutions had never released NPL figures, nor had the standard of asset classification been widely discussed. During the pre-crisis period, foreign analysts, as well as investors, did not seem to be concerned about the Thai system of asset classification and provisional requirements. • The key figures closely watched by foreign analysts and investors after 1997 crisis are: 1. NPL loan figures 2. Standard of asset classification 3. Provisional requirement	Yes. • It has been gradually developed since the beginning of the crisis. • The central bank is in charge of developing the EWS that related to currency matters. • Other indicators are also being developed by other economic-related government departments. a) CPI by the Ministry of Commerce; and b) Leading indicators by both the Ministry of Commerce and NESDB.	• The system has not been tested since its inception. • Based on earlier experiences in Thailand and globally, no two crises are alike. Hence, an effective early warning system in one crisis may not be so in others.

Note: Unless otherwise stated, the above views are from the questionnaire filled out by Economic Research department, Bank of Thailand.

Table A3. (Continued)

(7) R.O.C., Taipei		
Explicit EWS for financial institutions	***Explicit EWS for currency crisis within central bank***	***Limitations on EWS***
Yes. • There are two systems of EWS for financial institutions functioning in the R.O.C. The Central Bank of China (CBC) and the Central Deposit Insurance Corporation (CDIC) are in charge of these two systems, respectively. The two systems are similar and share information with each other to better monitor the operations of the financial institutions. • The *Financial Statement Auditing System*, which is developed by the CBC produces evaluation analyses from the financial statements submitted by the financial institutions to assist offsite or onsite supervision. The system is developed before the 1997 crisis. • The system will generate early detection indicators reflected by financial ratios of CARSEL (Capital Adequacy, Assets Quality, Regulations Compliance, Strategies and Stability, Earnings, Liquidity). • Information created by the system can help supervisors to identify potential problem financial institutions. Specifically, the CBC monitors the warning ranking of each financial institution from a peer group of financial institutions similar in size, location and industry grouping. A list of potential problem financial institutions is determined based on the evaluation analyses. In the end, the assessment on the actual financial condition of a financial institution will rely on the full assessment of on-site examiners.	Yes. • The feasibility of developing the explicit EWS model has been continually investigated since the eruption of 1997 crisis. • The Central Bank of China (CBC) is in charge of developing the EWS. • In addition to developing the formal EWS for currency crises, the CBC closely watches the abrupt changes in the economic and financial sectors. • Like most other countries, the CBC carefully tracks some external indicators relevant to the current and capital accounts. Moreover, the CBC would call attention to the unusual large amount of short-term capital flows.	• The unavailability of some important economic and financial data impinges on the effectiveness of the formal EWS. • The quantitative EWS model could miss some valuable qualitative factors that help explain the weakness of certain sectors in the economy. • The EWS model that is developed by using past relationship between the currency crises and some economic indicators could loose its forecasting power when the relationship between the two changes. • A quantitative EWS model estimated by using multi-country data may not forecast well for a particular country due to the country-specific factors.

Note: Unless otherwise stated, the above views are from the questionnaire filled out by the Economic Research Department, the Central Bank of China.

Source: Annual Reports (1997, 1998), The Central Bank of China, Taipei.

Table A4: Economic and Financial Variables

Variable	Expected Sign	Warning	Source
• M2 multiplier	+	Rapid credit growth resulting from the liberalization of domestic financial system and the elimination of the capital account restrictions.	Kaminsky (1998)
• Domestic credit to the private sector/ GDP	+		Pill and Pradhan (1995) Edwards (1989), Sachs et al (1996), Frankel and Rose (1996)
(Domestic credit growth)	+		
• Commercial bank credit to deposit ratio	+		Bank of Thailand annual report
• Domestic real interest rate	+	High real interest rate could bring about credit crunch. (Proxies for financial liberalization, which usually leads to high real rates and could then worsen bank balance sheets.)	Galbis (1993)
• M2 growth rate (M2/GDP)	+	Related to the money supply target, which will affect the level of interest rate.	Kaminsky (1998)
• Inflation	+	A proxy of macroeconomic misconduct; It could be related to high nominal interest rate.	Moreno (1995) and Demirgüç-Kunt and Detragiache (1998)
• Bank deposits	-	Bank run; Capital flight	Goldfajn and Valdés (1995) Kaminsky and Reinhart (1996)
• Exports	-	Loss of competitiveness	Kaminsky (1998)
(Export/GDP)	-		and Kumar et al. (1998)
• Imports	+		Kumar et al. (1998)
(Import /foreign reserves)	+		Esquivel and Larraín (1998)
(Trade balance)	-		
(Current account/GDP)	-		Kumar et al. (1998)
• Real exchange rate	+		Kaminsky (1998), Edwards (1989), etc.
• ¥/US$	-		Dornbusch and Werner (1994) Corsetti, Pesenti, and Rouini (1998); Huh and Kasa (1997)
• Reserves	-		Kaminsky (1998) Edwards (1989), etc.
• Real interest rate differential	+	High foreign interest rates could result in capital outflows.	Frankel and Rose (1996) and Esquivel and Larraín (1998)
• World real interest rate	+		Frankel and Rose (1996)
• Foreign direct investment/GDP	-	Unsustainable levels of debt	Frankel and Rose (1996)
• Foreign debt	+		Sach and Radelet(1998)
(Short-term foreign debt)	+		
(Foreign liability/GDP)	+		
• M2/Reserves	+	The vulnerability of a country, if sudden capital outflows occur.	Clavo (1996) Kaminsky (1998), and Sach et al. (1996)
• Output	-	Recessions and blowout of asset prices are ahead of financial crisis.	Calomiris and Gorton (1991)
(GDP growth rate)			Kaminsky (1998) Esquivel and Larraín (1998)
• OECD growth	-		Milesi-Ferretti and Razin (1998) Frankel and Rose (1996)
• Stock prices	-		Kaminsky (1998)

Table A4. (Continued)

Variable	Empirical Definition and Data Source
• M2 multiplier	M2/base money; M2 (IFS lines 34 and 35); Base money (IFS line 14).
• Domestic credit to the private sector/ GDP	Domestic credit (IFS lines 32d and 34d, etc) divided by CPI (IFS line 64), and then divided by real GDP (IFS line 99b.p. Except Korea and R.O.C., Taipei, the quarterly GDP data of other countries were interpolated from the annual data).
• Commercial bank credit to deposit rate	Commercial bank credit (IFS line 32d) divided by bank deposit (IFS line 24 and line 25).
• Domestic real interest rate	Money market rate (IFS line l60b), The Philippines (IFS l60c) and Taiwan (rmtd6@ist@v.q).
• M2 growth rate (M2/GDP)	M2 (IFS lines 34 and 35) divided by GDP (IFS line 99b.p. Except Korea and R.O.C., Taipei, the quarterly GDP data of other countries were interpolated from the annual data).
• M1 growth rate	M1 (IFS line 34).
• Inflation	Calculated by using CPI (line 64).
• Bank deposits	Bank deposits (IFS line 24 and line 25) deflated by CPI (IFS line 64).
• Exports (Export/GDP)	Export (IFS line 70). Export (IFS line 70) converted into domestic currency (using IFS line ae), and then divided by GDP (IFS line 99b.p. Except Korea and R.O.C., Taipei, the quarterly GDP data of other countries were interpolated from the annual data).
• Imports (Import /foreign reserves) (Trade balance)	(IFS line 71). Import (IFS line 71) divided by foreign reserves (IFS line 1L.d). Export (IFS line 70)-Import (IFS line 71).
• (Current account/GDP)	Current account (IFS line 178al.d) converted into domestic currency, and then divided by GDP (IFS line 99b.p. Except Korea and R.O.C., Taipei, the quarterly GDP data of other countries were interpolated from the annual data); The quarterly current account of Malaysia or Singapore was interpolated from the annual data.
• Real effective exchange rate	J.P. Morgan exchange rate database.
• □/US$	End of period rate (IFS line ae).
• Reserves	IFS (line 1L.d).
• Real interest rate differential	Money market rate (IFS line 60b) deflated by CPI (IFS line 64).
• World real interest rate	US-domestic or Japan-domestic real interest rate.
• Foreign direct investment/GDP	(IFS line 178be.d) converted into domestic currency (using IFS line ae) and then divided by GDP (IFS line 99b.p. Except Korea and R.O.C., Taipei, the quarterly GDP data of other countries were interpolated from the annual data); The quarterly foreign direct investment of Malaysia or Singapore was interpolated from the annual data.
• Foreign debt (Foreign liability/GDP)	(IFS line l4.d, line 17b.d and line 17f.d) converted into domestic currency (using IFS line ae) and then divided by GDP (IFS line 99b.p. Except Korea and R.O.C., Taipei, the quarterly GDP data of other countries were interpolated from the annual data); The quarterly foreign liability of Malaysia or Singapore was interpolated from the annual data.
• M2/Reserves	M2 (converted into US$, using IFS line ae) divided by Reserves (IFS line 1L.d).
• Output (GDP growth rate)	Take first difference of log (GDP). (IFS line 99b.p. Except Korea and R.O.C., Taipei, the quarterly GDP data of other countries were interpolated from the annual data).
• Stock prices	Stock price index (from Primark Datastream).

Note: Short-term rates deflated by the change in the CPI over three months (annualized).

Table A5: Estimates of Bivariate Logit Models (Quarterly Data: 1970:1Q-1995:4Q)

	Variable	Level		1-quarter % Change	
		Coeff.	P-value	Coeff.	P-value
1a	Export/GDP	-0.005	0.46	-0.009	0.60
1b	**Export**			**-0.047***	**0.04**
2	Import			-0.015	0.54
3	**Import/reserves**	0.089	0.73	**0.023***	**0.01**
4	Net export/Import	-0.051	0.94	-0.0001	0.60
5	Trade balance			-0.0001	0.57
6	M2/GDP	-0.094	0.56	0.014	0.19
7	logGDP				
8	Foreign liability/GDP	-0.001	0.27	0.010	0.27
9	Foreign direct investment/GDP	-0.049	0.14	-0.001	0.24
10	Current account/GDP	-0.008	0.16	0.0001	0.82
11	Domestic credit/GDP	-24.17	0.19	0.007	0.45
12	Domestic credit			-0.006	0.79
13	**Money multiplier**	-0.20	0.22	**0.067***	**0.02**
14	Reminbi			-0.013	0.75
15	□			0.03	0.47
16	**M2/reserves**	-0.071	0.76	**0.028***	**0.00**
17a	M2			0.021	0.70
17b	M1			-0.033	0.38
18	Inflation (level)			0.099	0.19
19	Bank deposit			-0.018	0.77
20	Domestic credit / bank deposit	-0.091	0.91	-0.005	0.83
21a	**Real effective exchange rate (detrend)**	**0.010***	**0.02**		
21b	**Real effective exchange rate**	**0.026***	**0.00**	-0.002	0.97
22	**Reserves**			**-0.048***	**0.00**
23	Domestic real interest rate (money market rate)	-0.033	0.25		
	US Real interest rate	**0.175***	**0.02**		
	Japan Real interest rate	0.033	0.56		
	US-domestic real interest rate differential	**0.051***	**0.04**		
	Japan-domestic real interest rate differential	0.038	0.16		
24	logUSGDP (differenced)			-13.23	0.59
	logJapanGDP (differenced)			-1.036	0.95
25	Stock price (%)			-0.019	0.52

Note: * indicates significant at the 5% level.

All variables were lagged by one period. Different forms are experimented for some variables: level and 1-quarter % change. Due to lack of data, for some countries the observations included in the panel may not cover the entire 1970:1Q-1995:4Q period.

Table A6: Estimates of Bivariate Logit Models (Quarterly Data: 1983:1Q-1995:4Q)

	Variable	Level		1-quarter % Change	
		Coeff.	P-value	Coeff.	P-value
1a	Export/GDP	-0.0002	0.54	0.021	0.45
1b	**Export**			**-0.09***	**0.01**
2	Import			-0.013	0.78
3	**Import/reserves**	0.004	0.83	**0.026***	**0.01**
4	Net export/Import	-0.966	0.54	-2.17E-05	0.96
5	Trade balance			-3.05E-05	0.94
6	**M2/GDP**	-0.117	0.65	**0.048***	**0.00**
7	logGDP				
8	Foreign liability/GDP	-0.001	0.68	0.012	0.27
9	Foreign direct investment/GDP	-0.043	0.27	-0.001	0.16
10	Current account/GDP	-0.010	0.16	0.0002	0.82
11	Domestic credit/GDP	-43.38	0.16	0.045	0.012
12	Domestic credit			-0.087	0.15
13	**Money multiplier**	-0.179	0.49	**0.102***	**0.00**
14	Reminbi			0.0053	0.90
15	□			0.036	0.55
16	**M2/reserves**	-4.14	0.60	**0.030***	**0.01**
17	M2			-0.0397	0.70
	M1			**-0.12***	**0.04**
18	Inflation				
19	Bank deposit			-0.128	0.17
20	Domestic credit / bank deposit	-0.68	0.63	-0.056	0.59
21a	**Real effective exchange rate (detrend)**	**0.029***	**0.00**		
21b	**Real effective exchange rate**	**0.035***	**0.00**	0.118	0.31
22	**Reserves**			**-0.065***	**0.00**
23	**Domestic real interest rate (money market rate)**	**-0.077***	**0.01**		
	US Real interest rate	**0.555***	**0.00**		
	Japan Real interest rate	0.316	0.09		
	US-domestic real interest rate differential	**0.084***	**0.00**		
	Japan-domestic real interest rate differential	**0.084***	**0.00**		
24	logUSGDP (differenced)			45.72	0.39
	logJapanGDP (differenced)			43.56	0.33
25	Stock price (%)			-0.021	0.55

Note: Same as Table A5.

Due to lack of data, for some countries the observations included in the panel may not cover the entire 1983:1Q-1995:4Q period.

Table A7: Estimates of Bivariate Models
(Quarterly Data: 1970:1Q-1997:4Q)

	Variable	Level		1-quarter % Change	
		Coeff.	P-value	Coeff.	P-value
1a	Export/GDP	6.46E-05	0.07		
1b	Export			-0.012	0.46
2	Import			-0.002	0.91
3	**Import/reserves**	0.0001	0.99	**0.023***	**0.00**
4	Net export/Import	-0.12	0.84	-8.78E-05	0.63
5	Trade balance			-9.77E-05	0.6
6	**M2/GDP**	**0.235**	**0.004**	0.007	0.48
7	logGDP (d)				
8	**Foreign liability/GDP**	**0.001***	**0.01**	0.011	0.15
9	Foreign direct investment/GDP	0.019	0.09	-0.0004	0.51
10	**Current account/GDP**	**-0.010**	**0.00**	0.0001	0.76
11	**Domestic credit/GDP**	**31.20***	**0.01**	0.004	0.63
12	Domestic credit			-0.001	0.95
13	**Money multiplier**	0.118	0.24	**0.056***	**0.01**
14	Reminbi			-0.026	0.48
15	□			0.023	0.47
16	**M2/reserves**	0.01	0.95	**0.021***	**0.01**
17a	M2			-0.009	0.86
17b	M1			**-0.067***	**0.03**
18	Inflation			0.036	0.63
19	Bank deposit			-0.014	0.78
20	Domestic credit / bank deposit	0.35	0.59	0.0004	0.98
21a	Real effective exchange rate (detrend)	-0.004	0.23		
21b	**Real effective exchange rate**	**0.013***	**0.03**	**-0.083***	**0.00**
22	**Reserves**			**-0.049***	**0.00**
23	Domestic real interest rate (money market rate)	0.0164	0.57		
	US Real interest rate	**0.1828***	**0.00**		
	Japan Real interest rate	-0.053	0.10		
	US-domestic real interest rate differential	0.014	0.60		
	Japan-domestic real interest rate differential	**-0.055***	**0.046**		
24	logUSGDP (differenced)			-32.03	0.13
	logJapanGDP (differenced)			**-0.51***	**0.00**
25	**Stock price**			**-0.034***	**0.04**

Note: Same as Table A5.

Due to lack of data, for some countries the observations included in the panel may not cover the entire 1970:1Q-1997:4Q period.

Table A8: Out-of sample Signals for 1996:1Q-1999:1Q

Probability cutoff point = 0.025																		
		Model									Model							
	True	1	2	3	4	5	6	7		True	1	2	3	4	5	6	7
Indonesia 96:1Q	0	1	1	0	0	0	0	0	Singapore 96:1Q	0	1	1	1	0	0	0	0
2	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0
3	0	0	0	0	1	1	1	1	3	0	0	0	0	0	0	0	0
4	0	1	1	0	0	0	0	0	4	0	0	1	0	0	0	0	0
97:1Q	0	0	0	0	0	0	0	0	97:1Q	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0
3	1	0	0	0	0	0	0	0	3	1	1	1	1	1	1	1	1
4	1	0	0	1	1	1	0	0	4	1	0	1	1	1	1	0	0
98:1Q	1	0	0	1	0	0	0	0	98:1Q	0	1	1	1	0	1	1	0
2	1	0	0	0	0	0	0	0	2	1	1	1	0	0	0	0	0
3	0	0	0	0	0	0	0	0	3	0	0	1	1	1	1	1	1
4	0	1	1	1	0	0	0	0	4	0	1	1	0	1	1	1	1
99:1Q	0	1	1	0	0	0	0	0	99:1Q	1	1	0	0	1	1	1	1
Korea 96:1Q	0	1	1	1	0	0	0	0	Thailand 96:1Q	0	1	1	1	0	0	0	0
2	0	0	0	0	1	1	0	0	2	0	0	0	0	0	1	0	0
3	0	0	0	0	1	1	1	1	3	0	0	0	0	1	1	0	0
4	0	1	1	1	0	0	0	0	4	0	0	1	0	0	0	0	0
97:1Q	0	0	0	0	1	1	1	1	97:1Q	0	0	1	0	0	0	0	0
2	0	1	1	0	1	1	1	1	2	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	3	1	1	1	1	1	1	0	0
4	1	1	1	1	0	0	0	0	4	1	0	0	1	1	1	1	1
98:1Q	0	0	0	1	1	1	0	0	98:1Q	0	0	0	1	0	1	0	0
2	0	0	0	0	0	0	0	0	2	1	1	1	1	1	1	0	0
3	0	0	0	0	0	1	0	0	3	0	0	1	0	1	1	0	0
4	0	0	0	0	0	0	0	0	4	0	1	1	1	0	0	0	0
99:1Q	0	1	1	1	1	1	0	0	99:1Q	0	0	1	0	0	0	0	0
Malaysia 96:1Q	0	1	1	1	0	1	0	0	R.O.C., Taipei 96:1Q	0	1	1	1	1	1	0	0
2	0	0	0	0	0	0	0	0	2	0	0	1	0	1	1	0	0
3	0	0	0	0	0	0	0	0	3	0	0	0	0	1	1	0	0
4	0	0	1	0	0	0	0	0	4	0	0	1	0	0	0	0	0
97:1Q	0	0	0	0	0	0	0	0	97:1Q	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0
3	1	1	1	1	0	1	1	1	3	0	0	1	1	0	0	0	0
4	1	0	1	1	1	1	1	1	4	1	1	1	1	1	1	0	0
98:1Q	0	0	0	1	1	1	0	0	98:1Q	0	0	0	1	1	1	0	0
2	1	1	1	1	1	1	1	1	2	1	1	1	1	0	0	0	0
3	0	0	0	0	1	1	0	0	3	0	0	1	0	0	0	0	0
4	0	1	1	1	1	1	1	1	4	0	1	1	0	1	1	0	0
99:1Q	0	0	0	0	0	0	0	0	99:1Q	0	1	1	0	0	0	0	0
The Philippines 96:1Q	0	1	1	1	0	0	0	0									
2	0	0	0	0	1	1	0	0									
3	0	0	0	0	0	0	0	0									
4	0	0	0	0	0	1	1	1									
97:1Q	0	1	0	0	0	0	0	0									
2	0	0	0	0	1	1	1	1									
3	1	1	1	1	1	1	1	1									
4	1	0	0	1	1	1	1	1									
98:1Q	0	1	1	1	1	1	0	0									
2	0	1	1	1	1	1	1	1									
3	0	0	0	0	1	1	0	0									
4	0	0	1	1	1	1	1	1									
99:1Q	0	1	1	0	0	0	0	0									

Table A8. (Continued)

Probability cutoff point = 0.03																		
		Model									Model							
	True	1	2	3	4	5	6	7		True	1	2	3	4	5	6	7
Indonesia 96:1Q	0	0	0	0	0	0	0	0	Singapore 96:1Q	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0
3	0	0	0	0	1	1	1	1	3	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0
97:1Q	0	0	0	0	0	0	0	0	97:1Q	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0
3	1	0	0	0	0	0	0	0	3	1	0	0	0	1	1	1	1
4	1	0	0	0	1	1	0	0	4	1	0	0	1	0	0	0	0
98:1Q	1	0	0	1	0	0	0	0	98:1Q	0	0	0	1	0	0	0	0
2	1	0	0	0	0	0	0	0	2	1	0	1	0	0	0	0	0
3	0	0	0	0	0	0	0	0	3	0	0	0	0	0	1	1	1
4	0	1	1	0	0	0	0	0	4	0	0	0	0	1	1	1	1
99:1Q	0	1	1	0	0	0	0	0	99:1Q	1	1	0	0	1	1	1	1
Korea 96:1Q	0	0	0	0	0	0	0	0	Thailand 96:1Q	0	0	0	0	0	0	0	0
2	0	0	0	0	0	1	0	0	2	0	0	0	0	0	0	0	0
3	0	0	0	0	1	1	1	1	3	0	0	0	0	0	0	0	0
4	0	1	1	0	0	0	0	0	4	0	0	0	0	0	0	0	0
97:1Q	0	0	0	0	1	1	0	0	97:1Q	0	0	0	0	0	0	0	0
2	0	0	0	0	1	1	1	1	2	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	3	1	1	1	1	0	0	0	0
4	1	1	1	1	0	0	0	0	4	1	0	0	1	1	1	0	0
98:1Q	0	0	0	1	1	1	0	0	98:1Q	0	0	0	1	0	0	0	0
2	0	0	0	0	0	0	0	0	2	1	1	1	0	1	1	0	0
3	0	0	0	0	0	0	0	0	3	0	0	0	0	0	1	0	0
4	0	0	0	0	0	0	0	0	4	0	1	1	0	0	0	0	0
99:1Q	0	1	1	0	1	1	0	0	99:1Q	0	0	0	0	0	0	0	0
Malaysia 96:1Q	0	1	1	0	0	0	0	0	R.O.C., Taipei 96:1Q	0	0	0	0	0	1	0	0
2	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0
97:1Q	0	0	0	0	0	0	0	0	97:1Q	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0
3	1	0	1	1	0	0	0	0	3	0	0	0	0	0	0	0	0
4	1	0	0	1	1	1	1	1	4	1	0	1	1	1	1	0	0
98:1Q	0	0	0	1	0	1	0	0	98:1Q	0	0	0	1	1	1	0	0
2	1	1	1	0	1	1	1	1	2	1	0	1	0	0	0	0	0
3	0	0	0	0	0	1	0	0	3	0	0	0	0	0	0	0	0
4	0	0	1	0	1	1	1	1	4	0	0	0	0	0	0	0	0
99:1Q	0	0	0	0	0	0	0	0	99:1Q	0	0	0	0	0	0	0	0
The Philippines 96:1Q	0	1	1	1	0	0	0	0									
2	0	0	0	0	0	0	0	0									
3	0	0	0	0	0	0	0	0									
4	0	0	0	0	0	0	0	0									
97:1Q	0	0	0	0	0	0	0	0									
2	0	0	0	0	1	1	1	1									
3	1	1	1	1	1	1	1	1									
4	1	0	0	1	1	1	0	0									
98:1Q	0	1	1	1	1	1	0	0									
2	0	0	1	0	1	1	0	0									
3	0	0	0	0	0	1	0	0									
4	0	0	0	1	1	1	1	1									
99:1Q	0	1	1	0	0	0	0	0									

Table A9: Out-of-sample Probability Forecasts for 1996:1Q-1999:1Q

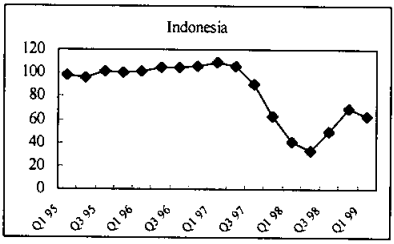
1996:1Q-1999:1Q								
	True	**Model 1**	**Model 2**	**Model 3**	**Model 4**	**Model 5**	**Model 6**	**Model 7**
Indonesia 96:1	0	0.026919	0.026842	0.021294	0.014825	0.017773	0.009057	0.008359
2	0	0.016258	0.018348	0.014475	0.006712	0.006907	0.003149	0.003075
3	0	0.018498	0.017153	0.024525	0.046142	0.046167	0.033581	0.033527
4	0	0.025672	0.026994	0.020469	0.019431	0.02223	0.015844	0.014788
97:1	0	0.01648	0.015062	0.016597	0.015962	0.016711	0.010846	0.0106
2	0	0.020457	0.022092	0.019074	0.020217	0.019596	0.012951	0.012843
3	1	0.023978	0.024446	0.023828	0.009741	0.010372	0.008841	0.008488
4	1	0.015166	0.016875	0.025352	0.034667	0.037436	0.018458	0.01804
98:1	1	0.021328	0.022919	0.036677	0.017965	0.02008	0.004405	0.004246
2	1	0.014689	0.014982	0.018351	0.015269	0.015905	0.002554	0.002448
3	0	0.00901	0.009229	0.014851	0.014357	0.016983	0.002192	0.002113
4	0	0.04561	0.084312	0.028394	0.017221	0.018948	0.003495	0.003388
99:1	0	0.040486	0.044155	0.020762	0.017645	0.018078	0.006085	0.00595
Korea 96:1	0	0.027754	0.02613	0.025245	0.014389	0.017217	0.005898	0.005824
2	0	0.01654	0.020114	0.01853	0.029044	0.030212	0.011224	0.010136
3	0	0.014667	0.014671	0.016249	0.060733	0.061174	0.03683	0.036618
4	0	0.03458	0.035937	0.029694	0.013839	0.015733	0.00608	0.005797
97:1	0	0.019754	0.019527	0.023498	0.05846	0.061615	0.026681	0.026669
2	0	0.02658	0.028437	0.023633	0.10874	0.107111	0.047766	0.04749
3	0	0.020612	0.022767	0.021388	0.018046	0.019341	0.010949	0.010797
4	1	0.036583	0.037713	0.030783	0.021872	0.023491	0.00921	0.009027
98:1	0	0.016694	0.019478	0.062276	0.060502	0.067687	0.01339	0.013674
2	0	0.01863	0.024076	0.010262	0.007556	0.007868	0.002507	0.002244
3	0	0.013685	0.01361	0.01428	0.024425	0.028996	0.010032	0.009776
4	0	0.023873	0.019768	0.018011	0.019558	0.021642	0.007367	0.007199
99:1	0	0.030073	0.030608	0.026745	0.043339	0.044642	0.01629	0.016017
Malaysia 96:1	0	0.032824	0.033195	0.028972	0.023039	0.027605	0.015723	0.015581
2	0	0.021926	0.022398	0.017514	0.013803	0.014272	0.008117	0.007948
3	0	0.016325	0.016878	0.015269	0.014485	0.0144	0.013331	0.013342
4	0	0.024397	0.025152	0.023311	0.020093	0.022962	0.019332	0.018865
97:1	0	0.02221	0.022487	0.021321	0.01425	0.014865	0.010322	0.010391
2	0	0.022148	0.023586	0.017843	0.012386	0.011954	0.009931	0.01082
3	1	0.02905	0.030699	0.039601	0.02376	0.02536	0.026348	0.027043
4	1	0.024835	0.026782	0.041211	0.049605	0.053422	0.030473	0.030734
98:1	0	0.021649	0.021751	0.04293	0.029762	0.033325	0.013213	0.012871
2	1	0.033185	0.042283	0.027716	0.096103	0.101054	0.059322	0.053962
3	0	0.01737	0.021567	0.021176	0.026781	0.03168	0.014305	0.013878
4	0	0.028805	0.031641	0.025572	0.092317	0.102457	0.06419	0.063562
99:1	0	0.015624	0.017938	0.017037	0.008274	0.008435	0.003844	0.003704
The Philippines 96:1	0	0.039478	0.035603	0.03345	0.019512	0.023324	0.013182	0.012872
2	0	0.015913	0.016725	0.016659	0.026639	0.027719	0.018918	0.018724
3	0	0.011954	0.013089	0.015129	0.02216	0.022124	0.023948	0.023518
4	0	0.017769	0.019146	0.019094	0.023355	0.026771	0.0272	0.026771
97:1	0	0.025724	0.022373	0.019038	0.011112	0.011579	0.009042	0.008849
2	0	0.02072	0.021227	0.021113	0.039944	0.038954	0.036426	0.036222
3	1	0.031966	0.035416	0.03519	0.044046	0.047279	0.054632	0.053864
4	1	0.018145	0.018614	0.045258	0.049571	0.053334	0.027615	0.027204
98:1	0	0.044284	0.040854	0.064494	0.037341	0.041686	0.017129	0.016724
2	0	0.025394	0.033419	0.025285	0.045403	0.047572	0.029201	0.02904
3	0	0.014033	0.016487	0.015538	0.025985	0.03083	0.02085	0.020675
4	0	0.02496	0.02829	0.033006	0.053979	0.059721	0.032679	0.033698
99:1	0	0.034782	0.037763	0.018719	0.00565	0.005733	0.003715	0.003765

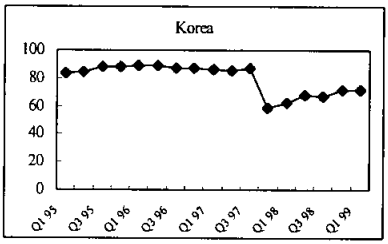
Table A9. (Continued)

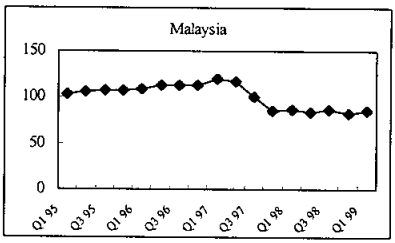
	True	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7
Singapore 96:1	0	0.025831	0.028017	0.026504	0.018204	0.021804	0.014415	0.014079
2	0	0.018947	0.020142	0.017252	0.022432	0.023299	0.016367	0.016154
3	0	0.017447	0.0182	0.016808	0.018435	0.018352	0.017975	0.017638
4	0	0.022295	0.025142	0.021715	0.019991	0.022862	0.02065	0.020443
97:1	0	0.020183	0.022017	0.022705	0.022538	0.023591	0.019828	0.019022
2	0	0.020493	0.020866	0.018484	0.015685	0.015169	0.012649	0.012398
3	1	0.025695	0.02872	0.028784	0.035216	0.037822	0.04733	0.046809
4	1	0.024774	0.028495	0.033726	0.02669	0.028684	0.023063	0.022398
98:1	0	0.026409	0.029516	0.032014	0.024607	0.027604	0.025124	0.024765
2	1	0.029923	0.030536	0.020493	0.018004	0.018761	0.021047	0.021315
3	0	0.023212	0.02658	0.029325	0.029581	0.03489	0.031188	0.031451
4	0	0.027173	0.028977	0.022379	0.077209	0.085809	0.092553	0.101047
99:1	1	0.037886	0.02307	0.021556	0.032812	0.033793	0.033495	0.033062
Thailand 96:1	0	0.026139	0.02837	0.027091	0.018042	0.021604	0.010655	0.010415
2	0	0.018228	0.018631	0.018799	0.024641	0.025591	0.013746	0.01348
3	0	0.017105	0.018556	0.015737	0.025277	0.025257	0.021054	0.020729
4	0	0.023818	0.027662	0.022559	0.016571	0.018918	0.013327	0.013038
97:1	0	0.023518	0.025108	0.020912	0.014584	0.01522	0.00951	0.009336
2	0	0.022484	0.024447	0.023686	0.018968	0.018333	0.011436	0.011233
3	1	0.045485	0.046638	0.036789	0.025825	0.027602	0.023582	0.023013
4	1	0.016137	0.018023	0.041864	0.061584	0.066385	0.026241	0.026287
98:1	0	0.018955	0.02203	0.035598	0.024565	0.027527	0.008937	0.009444
2	1	0.045272	0.051516	0.026519	0.0333	0.03479	0.01816	0.017631
3	0	0.022194	0.025937	0.018958	0.025358	0.030022	0.015383	0.015101
4	0	0.031965	0.034039	0.025783	0.020981	0.023144	0.012044	0.011683
99:1	0	0.024004	0.026919	0.018406	0.011633	0.011888	0.006488	0.006301
R.O.C., Taipei 96:1	0	0.026977	0.028929	0.025312	0.028972	0.034797	0.013883	0.013433
2	0	0.024295	0.027202	0.021757	0.02632	0.02731	0.009615	0.009535
3	0	0.01723	0.017585	0.018907	0.027916	0.027869	0.01405	0.013749
4	0	0.022697	0.026692	0.020382	0.019904	0.022776	0.010613	0.010258
97:1	0	0.021032	0.022487	0.022885	0.023547	0.024653	0.009708	0.009535
2	0	0.021584	0.022939	0.02329	0.021362	0.020675	0.008158	0.008109
3	0	0.024734	0.028245	0.029021	0.018115	0.019354	0.010908	0.01061
4	1	0.027437	0.032171	0.032944	0.044264	0.047747	0.022494	0.022147
98:1	0	0.021727	0.021777	0.035621	0.038771	0.043558	0.021485	0.021053
2	1	0.028514	0.032464	0.026781	0.021248	0.022112	0.011011	0.010974
3	0	0.021768	0.025387	0.024206	0.020867	0.024618	0.0108	0.012085
4	0	0.02623	0.028741	0.024801	0.026483	0.029273	0.014578	0.013798
99:1	0	0.025386	0.027099	0.023592	0.019122	0.01958	0.011339	0.011193

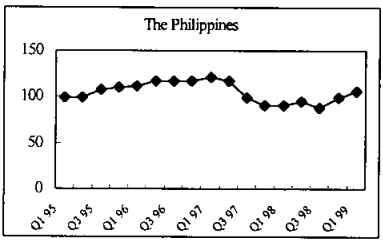
Figure A1: Graphs of Important Variables for 1995:1Q-1999:1Q

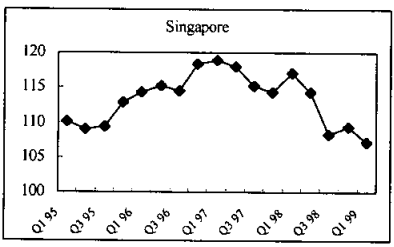
Real effective exchange rate

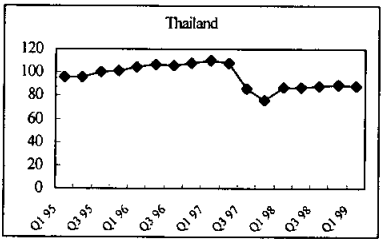












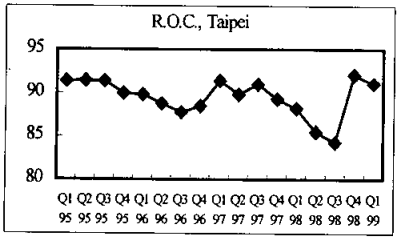


Figure A1 (continued)

Import/Foreign reserves (%)

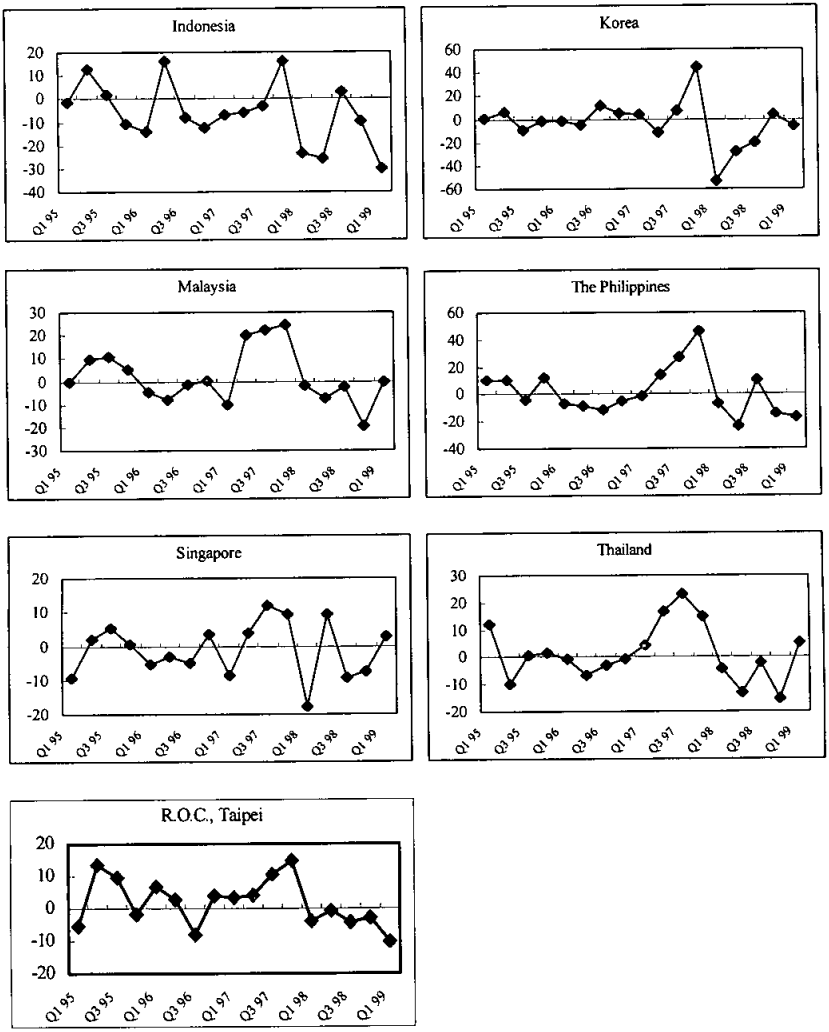
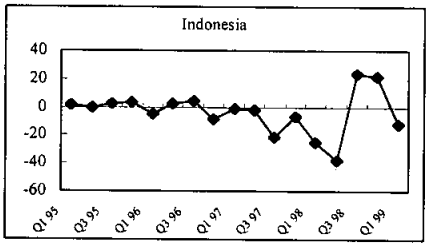
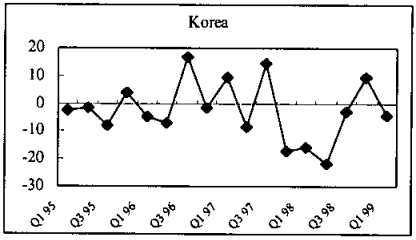
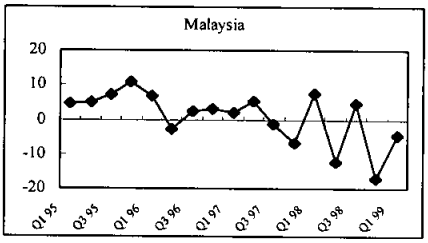


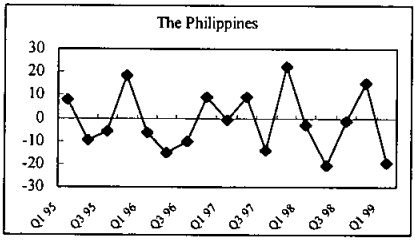
Figure A1 (continued)

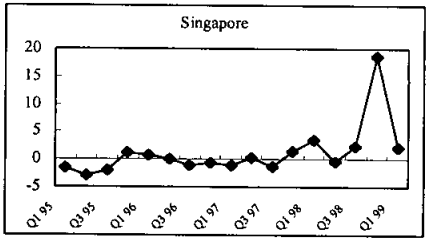
M2/Foreign reserves (%)

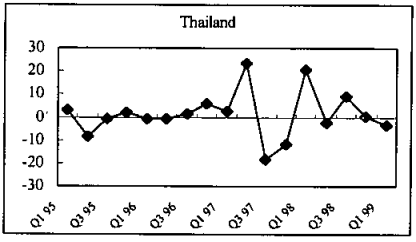












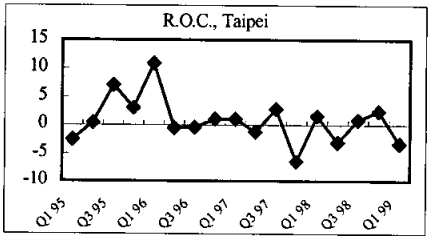
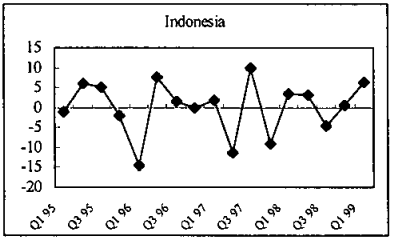
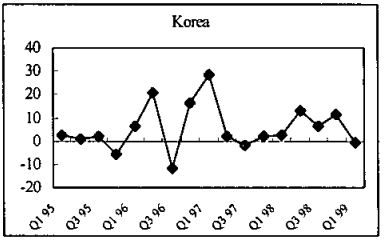
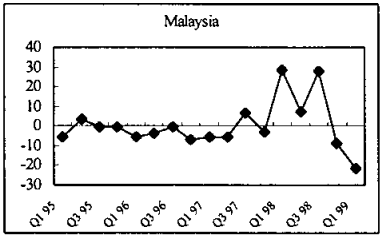


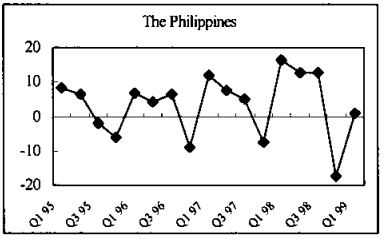
Figure A1 (continued)

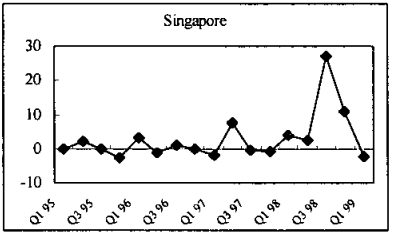
Money multiplier (%)

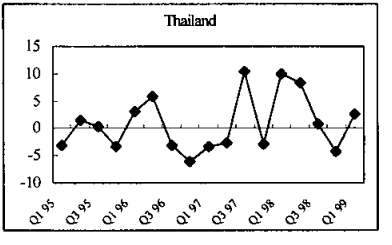












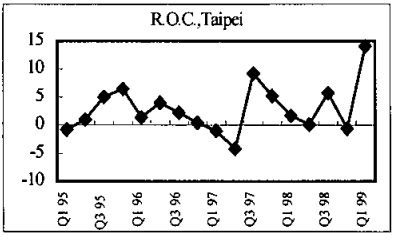
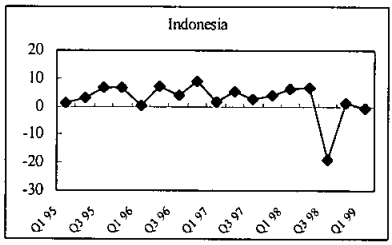
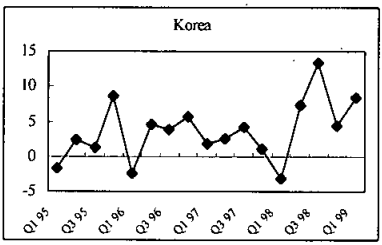
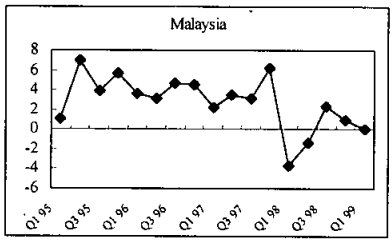


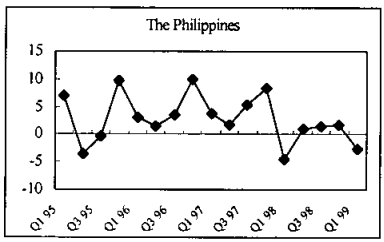
Figure A1 (continued)

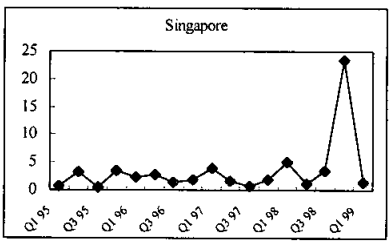
Bank deposit (%)

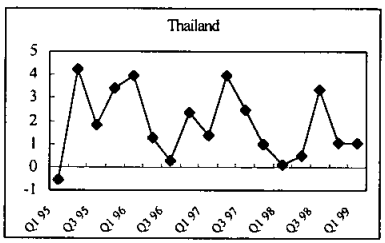












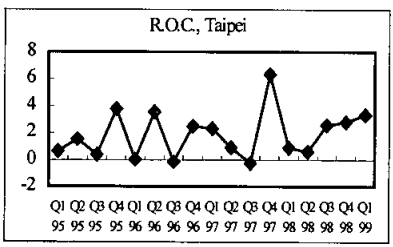


Figure A1 (continued)

Net export/Import (%)

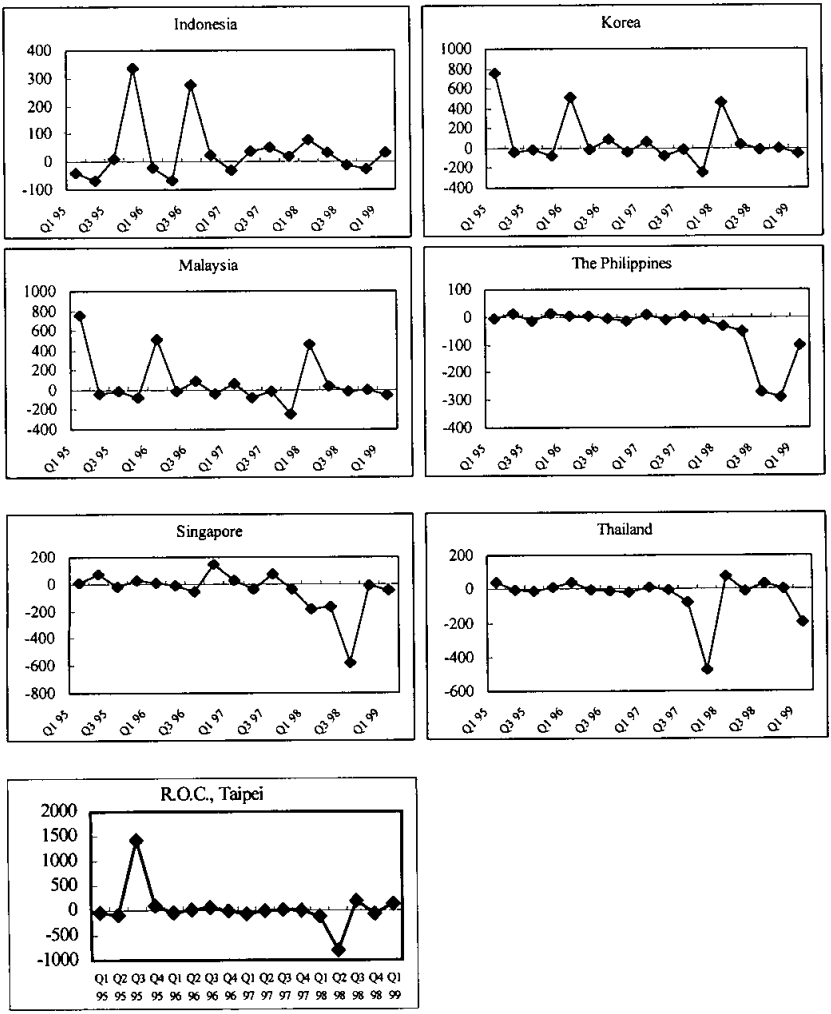
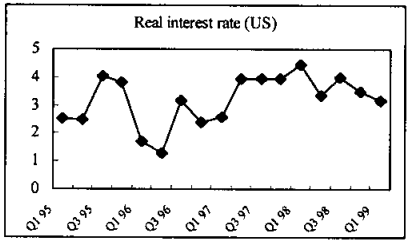
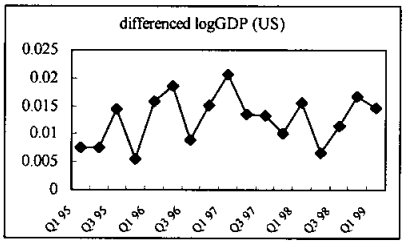
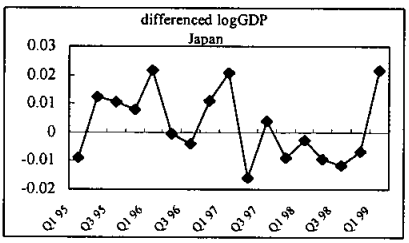


Figure A1 (continued)

Other







Dependent Variable: D(LRM3EK)
Method: Least Squares
Date: 04/07/00 Time: 13:35
Sample(adjusted): 1982:2 1999:3
Included observations: 70 after adjusting endpoints
D(LRM3EK)=C(1)+C(2)*D(LRGDPK(0))+C(3)*D(LINTK)+C(4)*EC05(-1)

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	0.033995	0.002792	12.17408	0.0000
C(2)	0.418315	0.112835	3.707317	0.0004
C(3)	-0.044355	0.017863	-2.483071	0.0156
C(4)	-0.078125	0.042583	-1.834668	0.0711

R-squared	0.217004	Mean dependent var	0.038424
Adjusted R-squared	0.181414	S.D. dependent var	0.015368
S.E. of regression	0.013904	Akaike info criterion	-5.657774
Sum squared resid	0.012760	Schwarz criterion	-5.529289
Log likelihood	202.0221	F-statistic	6.097221
Durbin-Watson stat	1.208418	Prob(F-statistic)	0.001001

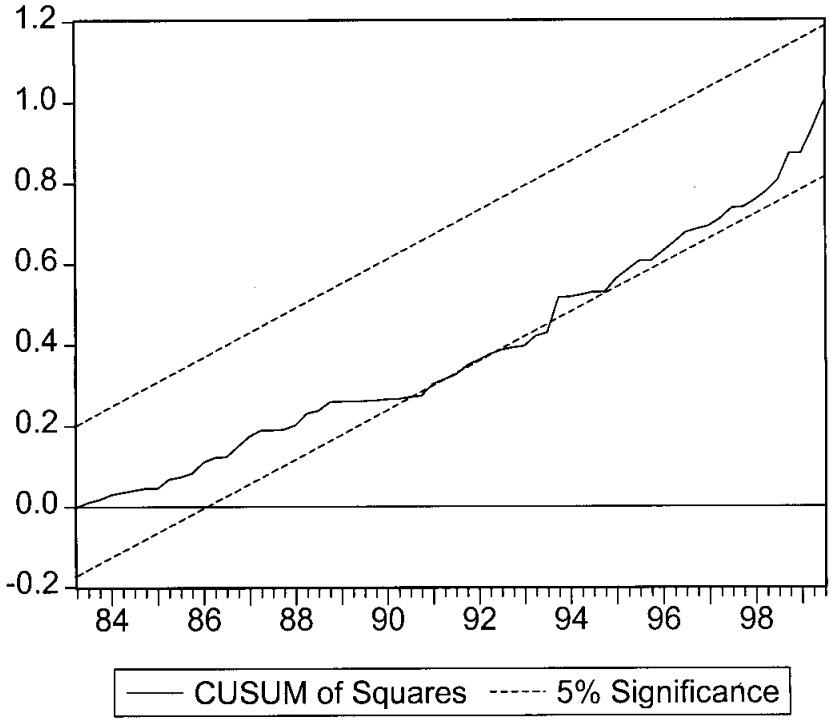
Chow Forecast Test: Forecast from 1996:4 to 1999:3

F-statistic	2.139809	Probability	0.029028
Log likelihood ratio	27.23041	Probability	0.007158

Test Equation:
Dependent Variable: D(LRM3EK)
Method: Least Squares
Date: 04/07/00 Time: 16:15
Sample: 1982:2 1996:3
Included observations: 58
D(LRM3EK)=C(1)+C(2)*D(LRGDPK(0))+C(3)*D(LINTK)+C(4)*EC05(-1)

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	0.038269	0.003696	10.35356	0.0000
C(2)	0.181549	0.168842	1.075260	0.2870
C(3)	-0.040601	0.023715	-1.712022	0.0926
C(4)	-0.001099	0.064558	-0.017028	0.9865

R-squared	0.064034	Mean dependent var	0.042237
Adjusted R-squared	0.012036	S.D. dependent var	0.012732
S.E. of regression	0.012655	Akaike info criterion	-5.835083
Sum squared resid	0.008648	Schwarz criterion	-5.692983
Log likelihood	173.2174	F-statistic	1.231477
Durbin-Watson stat	1.398490	Prob(F-statistic)	0.307249


1.2
1.0
0.8
0.6
0.4
0.2
0.0
-0.2
84
86
88
90
92
94
96
98
CUSUM of Squares
5% Significance