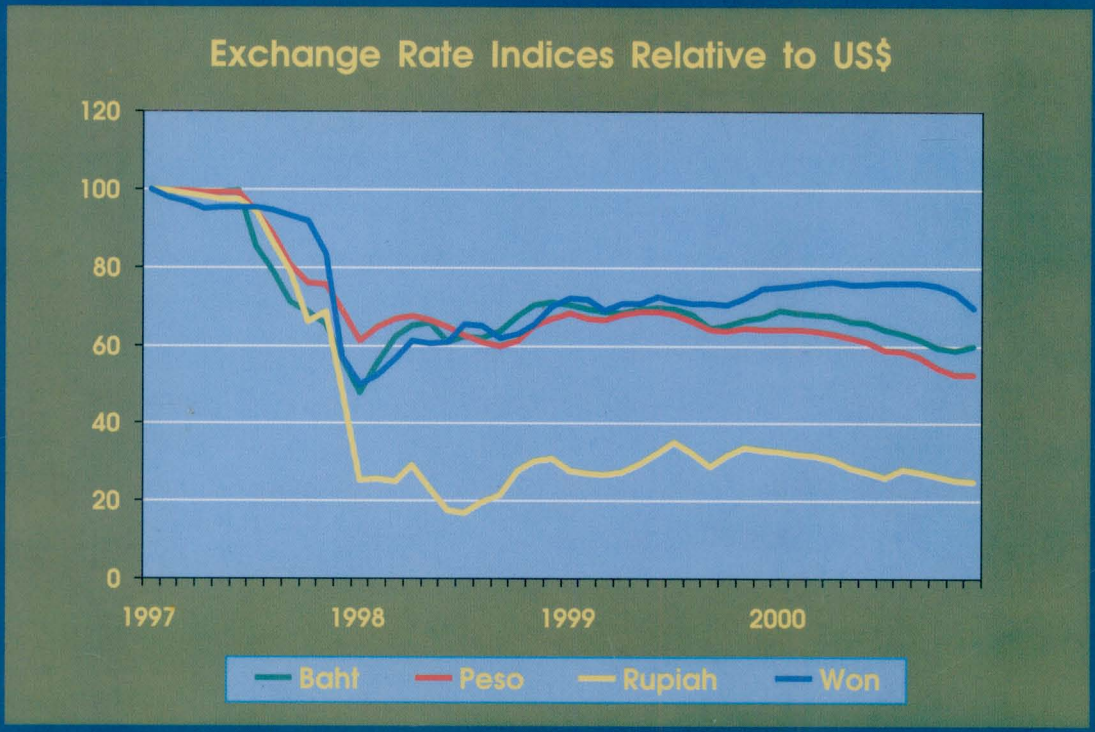
EADN Regional Project on Indicators and Analyses of Vulnerabilities to Economic Crises



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Preface

The papers in this volume are the results of an East Asian Development Network (EADN) regional research project on "Indicators and Analyses of Vulnerabilities to Economic Crises" coordinated by the Thailand Development Research Institute (TDRI). The aim of the project is to learn from the recent economic crisis that severely affected most economies in the region, and develop indicators that could be used to forewarn of future crises. While there have been much research on early warning indicators of economic crises, both within the region and globally, a research project on this topic by think tanks in the region can provide valuable independent assessments of the risks and vulnerabilities faced by each economy. This will complement work on economic surveillance taking place at the political level and by multilateral agencies.

Studies were carried out for six countries; China, Indonesia, Philippines, South Korea, Thailand and Vietnam, together with a synthesis report.* Four of the six countries were strongly affected by the 1997 crisis; Indonesia, the Philippines (mainly through contagion), South Korea and Thailand. For these countries, similar methodologies (signaling and probability approaches) were applied, and the studies also used the results to make assessments of the risks of crises under recent conditions. China and Vietnam did not go through a similar crisis to the other countries, so using similar methodologies to the other countries would not make much sense. The country authors therefore focused on specific issues that may create future vulnerabilities and risks to the economy. China focused on the problem of non-performing loans in the banking system, which is very high due to problem loans to state-owned enterprises. Vietnam focused on the problem of capital account sustainability. The studies for these two countries also attempted to assess the extent of the future risks for their economies and also identified necessary policy responses.

TDRI would like to thank the EADN for financial support of the project, and also the Global Development Network (GDN) which provides financial support to the EADN. Thanks also go to all the institutes and scholars that participated and contributed to the success of the project. During the course of the project a number of workshops were held, both at TDRI and at the EADN Annual meetings. Many useful comments at these workshops helped to improve the studies in the project. All those who participated are to be thanked, particularly Dr. Chia Siow Yue, the Regional Coordinator of EADN, who has supported the project throughout its duration.

Chalongphob Sussangkarn
President
Thailand Development Research Institute

* *There are two studies for Indonesia using different but complementary methodologies.*

Table of Contents

Page

Page

List of Tables and Figures

Page

Regional Project on Indicators and Analyses of Vulnerabilities to Economic Crises: Synthesis Report

Indicators and Analysis of Vulnerability to Currency Crisis: Thailand

Page

Building "An Early Warning System" for Indonesia With the Signal Approach

Macroeconomic Vulnerability in Indonesia

Page

Monitoring Economic Vulnerability and Performance: Applications to the Philippines

Indicators and Analysis of Vulnerability to Economic Crisis: Korea

How Far is China Away from a Financial Crisis

An Assessment of the Risks Associated with Vietnam's Balance of Payments

Regional Project on Indicators and Analyses of Vulnerabilities to Economic Crises: Synthesis Report

Chalongphob Sussangkarn
Pranee Tinakorn[*]

1. BACKGROUND

The East Asian economic crisis was generally unanticipated. Only a few years before the onset of the economic crisis in 1997, the East Asian miracle was a model put up for developing countries to follow. Victims of the crisis were supposedly countries with sound economic fundamentals. Countries like Thailand and South Korea were considered as role models of economic stability and growth for developing countries. The crisis occurred so suddenly that, on the eve of the crisis, few people could rationally expect it because there were few publicly available indicators signaling the vulnerabilities of affected economies. However, in hindsight, the nature of the crisis pointed to indicators that could have been good early warning indicators of the crisis, indicators that were not taken seriously enough before the crisis. Data such as that on the ratio of short-term foreign debt to foreign reserves as in Table 1.1 pointed to the high risk exposure of the three crisis affected countries that had to resort to IMF assistance; Indonesia, South Korea and Thailand. This shows that the nature of the crisis was not foreseen, and therefore crucial indicators directly related to the nature of the crisis were not scrutinized.

Table 1.1
Ratio of Short-term Foreign Debt to Official Reserves (Percent)

	1990	1991	1992	1993	1994	1995	1996
China	30.8	24.3	64.8	66.5	32.6	29.4	23.6
Hong Kong	23.4	21.7	18.2	17.2	16.4	16.4	22.2
India	164.7	104.1	73.2	26.8	18.5	23.4	28.3
Indonesia	*130.7*	*139.7*	*158.5*	*145.6*	*147.4*	*175.6*	*167.2*
Malaysia	19.3	18.8	21.0	25.4	24.2	30.4	40.8
Philippines	216.2	109.2	98.5	85.0	80.3	67.9	67.9
Singapore	2.7	2.7	2.3	2.0	1.7	1.8	2.6
South Korea	*72.9*	*81.6*	*69.5*	*60.2*	*123.1*	*142.5*	*195.4*
Taipei	20.0	18.9	19.6	21.8	20.3	20.4	20.1
Thailand	*58.3*	*67.8*	*69.5*	*89.0*	*96.4*	*119.4*	*110.3*

Source: Asian Development Bank, Key Indicators 2001.

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At the East Asian Development Network (EADN) annual meeting in June 2001 held in Singapore, the EADN decided to launch a Regional Research Project focusing on *Indicators and Analyses of Vulnerabilities to Economic Crises*.[1] The basic idea is that while there have been much research on early warning indicators of economic crises, both with the region and globally, a research project on this topic by think tanks within the region could provide additional valuable independent assessments of the risks and vulnerabilities faced by each economy. This would complement the work on economic surveillance taking place at the official level and by multilateral agencies. The availability of the international literature on the methodologies that can be employed to develop early warning indicators, such as the probability approach using probit or logit or the signaling approach of Kaminsky and Reinhart (1996), also provides a common framework that could be employed for countries that went through the 1997 crisis.

Six countries participate in the project; China, Indonesia, Philippines, South Korea, Thailand and Vietnam. All of these countries except for the Philippines achieved satisfactorily high rates of economic growth between 1990 and 1996 (see Table 1.2). The Philippines took some time to get over its debt crisis from the early 1980s and had low growths from 1990 to 1993, though its growth rate began to pick up between 1994 and 1996. The three countries that went through the financial crisis and had to resort to IMF assistance, Indonesia, South Korea and Thailand, ended up with a serious downturn in 1998 as a result of the financial crisis. The Philippines also suffer a mild recession in 1998 from the contagion from the other affected economies. On the other hand, China and Vietnam avoided any serious impacts from the crisis and still achieved high growth rates through the crisis period.

Table 1.2
Real GDP Growth

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
China	3.8	9.2	14.2	13.5	12.7	10.5	9.6	8.8	7.8	7.1	8.0	7.3
Indonesia	9.0	8.9	7.2	7.3	7.5	8.2	7.8	4.7	-13.1	0.8	4.8	3.3
Philippines	3.0	-0.6	0.3	2.1	4.4	4.7	5.8	5.2	-0.6	3.4	4.0	3.2
South Korea	9.0	9.2	5.4	5.5	8.3	8.9	6.7	5.0	-6.7	10.9	8.8	3.0
Thailand	11.2	8.6	8.1	8.4	9.0	9.3	5.9	-1.4	-10.8	4.2	4.4	1.8
Vietnam	5.1	5.8	8.7	8.1	8.8	9.5	9.3	8.2	5.8	4.8	6.8	5.8

Sources: Asian Development Bank, Key Indicators 2001 and Asia Recovery Information Center Website.

For the four countries that were significantly affected by the crisis, a similar methodology based on the probability and signaling approaches could be employed.[2] This will provide a useful comparison on the variables found to be good early warning indicators of a crisis for the various countries.[3] The other two countries, China and Vietnam, experienced slightly lower growth rates in 1998 and 1999, but did not really exhibit any symptom of a "crisis". This means that a similar methodology to the other four countries could not be employed. Instead the authors of these country studies were asked to identify key issues for their country that could be a major source of vulnerabilities to a crisis in the future. In the case of China, the problem of non-performing loans (NPL) in the banking sector was highlighted as the current NPL level is very high. For Vietnam, the issue concerns risks associated with the balance of payments and is an extension of a previous EADN study (Vo et al., 2001).

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[1] Modified from the proposal in Sussangkarn (2001).
[2] See Section 2 below.
[3] For the Philippines, the earlier crisis in the early 1980s is also included in the analysis.

One objective of the current project is to make forward looking assessments of the risks and vulnerabilities faced by each country. Though the crisis affected countries showed signs of clear improvements in 1999 and 2000, the ongoing recovery still appears fragile and uneven. Corporate and financial restructurings are still incomplete. The ratio of non-performing assets still remains fairly high. Capacity utilization is still low and new investment demand is limited. An important source of the recovery during 1999-2000 was the growth of exports (see Table 1.3). However, the slowdown in the US economy in 2001, continual weakness of the Japanese economy, and the downturn in the electronics cycle led to negative export growths for the four crisis affected countries in 2001, and much lower export growths in China and Vietnam. This led to a lowering of the real GDP growth rates for all the six countries in 2001 compared to 2000 (Table 1.2). Thus, while in 2000 most countries were expecting the V-shaped recovery to continue, there was much more caution within the region in 2001, and even though there are signs of improvement in the first part of 2002, uncertainties still remain.

Table 1.3
Growth of US$ Export Earnings (%)

	1999	2000	2001
China	6.2	27.7	7.0
Indonesia	-0.4	27.7	-10.0
Philippines	18.8	8.7	-15.6
South Korea	8.6	19.9	-12.7
Thailand	7.4	19.5	-6.9
Vietnam	23.2	25.2	6.5

Source: Asia Recovery Information Center Website.

For the four countries affected by the crisis, the probability or signaling approach will identify relevant early warning indicators based on previous crises together with the risks associated with a combination of values for these indicators. This can be applied to the current value of these variables in the various countries to assess the current risk of another crisis. For China and Vietnam, the approach will be more scenario oriented, analyzing the specific factors associated with the problems under focus and making some forward looking analyses of how these problems may be resolved in the future.

2. METHODOLOGY FOR EARLY WARNING INDICATORS

There are four countries in this research study that use a common methodology in their analyses of vulnerabilities to a crisis. The most commonly used methodologies are the signals analysis and probit estimates. However, for the case of Indonesia another different approach following Herrera and Garcia (1999) was also employed. All three approaches are briefly summarized in this section.

2.1 Definition of Crisis

The word "economic crisis" may be used to cover many specific types of crisis, but it usually connotes a situation where growth slows down or becomes negative and unemployment rises. Such a situation can occur as a result of crises occurring in the financial market (financial crisis), in the currency market (currency crisis), or from an external shock such as the oil crisis. Although a financial crisis or a currency crisis can lead to an economic crisis, past experiences have shown that this may not necessarily be the case. A good example

is the EMS (European Monetary System) currency crisis in the early 1990s which led the British government to devalue its currency instead of defending it with high interest rate policy. The pound devaluation helped British exports and the economy expanded while unemployment declined. This example demonstrated that perhaps we should be a little more specific when we talk of a crisis. For the four countries included in this research project, the crisis considered is specifically "currency crisis" which unfortunately led them all into an economic crisis in 1997.

The definition of a currency crisis used in all these studies follows the definition previously used by Western academics. The definition normally involves the percentage change (depreciation) in exchange rates and the loss of international reserves. In some cases where the monetary authority uses high interest rate policy to defend its currency, the definition also involves the percentage change in interest rates. However, they all have some variations on the same theme as summarized below.

Kaminsky, Lizondo and Reinhart (1998) constructed an index of currency market turbulence as follows.

$$I = \frac{\Delta e}{e} - \frac{\Delta R}{R} * \frac{\sigma_e}{\sigma_R} \quad \text{..... (1)}$$

A currency crisis occurs when I exceeds its mean plus three standard deviations. Other variations of I are the index of speculative pressure (ISP) as used by Adiningsih et al. (2002) for Indonesia, and the index of exchange market pressure (EMP) as used by Park (2002) for Korea or IEP as used by Tambunan (2002) for Indonesia.

$$ISP = \%\Delta \text{ exchange rate} + \Delta\% \text{ interest rate} - \Delta\% \text{ international reserves} \quad \text{..... (2)}$$

$$EMP = \frac{1}{\sigma_e}.\%\Delta e + \frac{1}{\sigma_i}\%\Delta i - \frac{1}{\sigma_R}.\%\Delta R \quad \text{..... (3)}$$

$$IEP = \%\Delta e - \%\Delta R \quad \text{..... (4)}$$

where Δe = change in nominal exchange rate
ΔR = change in international reserves
Δi = change in interest rate
σ_e = standard deviation of percentage change in exchange rate
σ_R = standard deviation of percentage change in international reserves
σ_i = standard deviation of percentage change in interest rates.

Country studies vary quite a bit on setting the cut-off point for a period to be classified as a crisis period. See the comparison in Table 2.1.

It can be seen that the studies for Indonesia and Korea followed Kaminsky and Reinhart's definition of an index of currency market pressure rather closely. The study for the Philippines identified a pressure period by the extreme movement in the nominal exchange rate, or in the international reserves, or in the interest differentials. For Thailand an index of currency market turbulence (I) was constructed by using the net international reserves instead of the gross reserves used in other studies. Tinakorn (2002) argued that the huge loss of reserves during the early months of speculative attacks was concealed by the swap operations conducted by the Bank of Thailand so the gross reserves would not reveal a serious problem. However, she found that the threshold of I > mean + 1.5 SD resulted in an inadequate number

of observations for probit estimates. So she resorted to using a similar approach to the Philippines study by defining a crisis period based on the irregular movement of the nominal exchange rate or the net international reserves.

The sample period covered by the studies for Indonesia, Korea and Thailand falls during the 1990's while the Philippines study also covered the 1980's period. Adiningsih, et al. (2002) and Yap (2002) also divided the sample into sub-periods for Indonesia and the Philippines. Details are shown in Table 2.2.

Table 2.1
Comparison of Crisis Definition

Country	Study	Index	Threshold for crisis
Indonesia	Tambunan (2002) Adiningsih, et al. (2002)	IEP ISP	IEP > mean + 1.1 SD ISP > mean + 1.5 SD
Korea	Park (2002)	EMP	EMP > mean + 1.1 SD EMP > mean + 2 SD
Philippines	Yap (2002)	Pressure period	Δe_t > mean + 2.5 SD or ΔR_t < mean + 2.5 SD or Δ interest differential > mean + 2.5 SD
Thailand	Tinakorn (2002)	I (with net international reserves instead of gross reserves)	I > mean + 1.5 SD But this definition resulted in too few observations for probit estimates. Used instead the following threshold: • accumulated 3 month %Δe (depreciation) > 15% or • accumulated 3 month loss in net reserves > 15%.

Table 2.2
Sample Period of Country Studies

Country study	Methodology	Sample period
Indonesia – Tambunan (2002) – Adiningsih, et al. (2002)	Signals analysis Herrera and Garcia (1999)	Jan. 1990 – Dec. 2001 May 1990 – May 2001 Also divided into four sub – samples: May 90 – Jan. 93 Feb. 93 – Oct. 95 Nov. 95 – July 98 Aug. 98 – May 01
Korea – Park (2002)	Signals analysis and Probit estimates	Jan. 1990 – Nov. 1997 The period Dec. 1997 – Dec. 2001 was used as an out-of-sample period to calculate probability of a crisis.
Philippines – Yap (2002)	Probit estimate Signals analysis	Jan. 1980 – April 2002 Sep. 1987 – Dec. 2001 Three periods: 1981-1983 1987-1990 1995-1997
Thailand – Tinakorn (2002)	Signals analysis and Probit estimates (including lags of up to 12 months)	Jan. 1992 – Dec. 2000 (The first 12 months are lost due to the calculation of year-on year changes.) The period Jan. 2001 – Dec. 2001 was used as an out-of-sample period to calculate probability of a crisis.

2.2 Signals Analysis

This is a non-parametric approach which compares the behaviors of indicators in the periods preceding a crisis with their behaviors in normal periods or control group. The periods preceding a crisis are sometimes called "a window" or "a signaling horizon" and is usually set at 12 months or 24 months. If an indicator exhibits deviations from its "normal" behavior beyond a certain threshold, it is considered to be sending out "signals" for an impending crisis within the signaling horizon.

Formally, if X is an indicator with a threshold established at X^*, then X_t is considered to be sending out a signal at time t if

$X_t > X^*$, when X has a "positive shock" or the increase of X over the threshold is likely to lead to a crisis;

or $X_t < X^*$, when X has a "negative shock" or the decrease of X below the threshold is likely to lead to a crisis.

For example, an "irregular increase" in the short-term external debt relative to international reserves may signal an impending currency crisis thus it is a "positive shock" while an "irregular decrease" in exports may also be giving a signal for crisis thus it is a "negative shock".

A threshold X^* for each indicator is found by scanning between 10-30 percentiles of the indicator's distribution (country studies vary in this range). The "optimal" threshold is the one that minimizes the adjusted "noise-to-signal ratio" where "noise" and "signal" can be briefly defined in the following matrix.

	Event (within 12 or 24 months)	
	Crisis	No crisis
Signal is issued	A	B
No signal is issued	C	D

A perfect indicator should issue signals only in A and no signals in D. B is considered "noise" because it consists of bad signals. The **ratio of** bad signals as a proportion of months in which bad signals could have been issued [B/(B+D)] **over** good signals as a proportion of months good signals could have been issued [A/(A+C)] is called "adjusted noise-to-signal" ratio ([B/(B+D)]/[A/(A+C)]). The lower this number is for an indicator, the better the indicator.

The 10-30 percentile range may appear arbitrary but it may be looked upon as the probability of rejecting the null hypothesis when it is true, or Type I error. We may regard the normal or tranquil period as our null hypothesis and take the export growth as our indicator, for example. If we find that 10 percent of the observations post an export growth below 1%, we then regard any export growth below 1% as a signal. Such reading of the indicator may be wrong if the null hypothesis (tranquility) is true, Therefore, setting the maximum 30 percentile as the upper limit implies that we are willing to accept at most 0.3 probability of calling a crisis when it is not true. See more details in Kaminsky, Lizondo and Reinhart (1998) and Kaminsky and Reinhart (1996).

2.3 Econometric Estimates

Among previous studies on crisis indicators, this method is more commonly used than the signals approach and involves estimation of the probability of a crisis by using either the logit or probit model. Since the country studies of the Philippines, South Korea and Thailand used probit estimates, a brief explanation of the methodology is provided here.

With the dependent variable (Y) being equal to 1 if a crisis occurs or 0 otherwise, the regression estimate of a linear model has many drawbacks and one usually resorts to either the logit or probit model. In a probit model an unobservable variable I_i is determined by a set of explanatory variables X_i as

$$I_i = \beta' X_i + u_i \quad \text{..... (5)}$$

where I_i = unobservable variable
X_i = vector of explanatory variables
β = vector of parameters to be estimated
u_i = random errors

Suppose the observed currency crisis variable (Y) behaves according to the following

$Y = 1$ if $I_i > I_i^*$
$Y = 0$ otherwise

The threshold I_i^*, like I_i, is not observable but if it is normally and identically distributed, it is possible to estimate the parameters. Given the assumption of normality, the probability that I_i^* is less than or equal to I_i can be computed from the standardized normal CDF as

$$P_i = P_r(Y=1) = \Pr(I_i^* \leq I_i) = F(I_i^*) \quad \text{..... (6)}$$

$$F(I_i^*) = \frac{1}{\sqrt{2\pi}} \int_{-\infty}^{I_i} e^{-t^2/2} dt = \frac{1}{\sqrt{2\pi}} \int_{-\infty}^{\beta' x_i} e^{-t^2/2} dt \quad \text{..... (7)}$$

where t is the standardized normal variable, i.e., $t \sim N(0, 1)$.

Since P_i represents the probability that an event will occur, it is measured by the area of the standard normal curve from $-\infty$ to I_i.[4] The vector of parameter, β, can be estimated by the least squares method but since they are known to be inconsistent, most statistical packages use OLS estimators as starting values for further algorithm and produces the maximum likelihood estimators as the final results.

While the country studies of Korea, the Philippines and Thailand used the probit estimation for the analysis of vulnerability to currency crisis, the study for Indonesia used a different method in its parametric approach. The Indonesian study by Adiningsih, Setiawati and Sholihah (2002) followed the model developed by Herrera and Garcia (1999) in which an index of macroeconomic vulnerability (IMV) is constructed and filtered through two types of transformations to generate signals. This method has a different approach from the signals and probit analysis. In both the signals and probit analyses, the method is employed to search for crisis leading indicators that send out signals (signals approach) or are statistically significant in generating crisis probability (probit estimate). The Herrera and Garcia model,

[4] See more details in Gujarati (1995).

on the other hand, presets four variables as crisis leading indicators and construct an index (IMV) from them. The index is then transformed to see if it generates signals for the crisis.

Herrera and Garcia's four leading indicators are

- M2/reserves (M2/R)
- real domestic credit growth (RDG)
- real effective exchange rate (REER)
- inflation rate (¶)

They are standardized to have zero mean and unit variance and then combined to form an IMV.

$$IMV = M2R + RDG + REER + \P \quad \ldots\ldots (8)$$

Signals are extracted from the behavior of the composite index IMV. This is quite in contrast to the Kaminsky and Reinhart's signals approach where signals generated by each leading indicator are aggregated into a composite index. Two types of signals generating mechanisms are applied to IMV: simple level model and ARIMA (Autoregressive Integrated Moving Average) residual model.

The simple model computed the standard deviation of the index from the conditional variance of the series estimated by the Generalized Autoregressive Conditional Heteroskedastic (GARCH) model. The GARCH (p, q) model is

$$IMV_t = a_0 + a_1 IMV_{t-1} + e_t \quad \ldots\ldots (9)$$

$$e_t = v_t \sqrt{h_t} \quad \ldots\ldots (10)$$

where v_t is white noise with $\sigma_v = 1$

and $$\hat{h}_t = \alpha_0 + \sum_{i=1}^{q} \alpha_i e_{t-i}^2 + \sum_{i=1}^{p} \beta_i h_{t-i} \quad \ldots\ldots (11)$$

The signal is flashed if IMV > mean + 1.5 standard deviation.

The ARIMA residual model applies the ARMA process to time series data that are non-stationary but are integrated of some order d. The process is denoted as ARIMA (p, d, q) where p is the order of the autoregressive process, d stands for the difference order of the series, e.g. if d = 2 then the series is I(2) and its second difference is I(0), and q stands for the order of moving average. For example, in ARIMA (2, 1, 2) the series has to be differenced once before it becomes stationary and the (first-differenced) stationary time series can be modeled as ARMA (2, 2) as

$$Y_t = \theta + \alpha_1 Y_{t-1} + \alpha_2 Y_{t-2} + \beta_0 u_t + \beta_1 u_{t-1} + \beta_2 u_{t-2} \quad \ldots\ldots (12)$$

The ARIMA method is most popularly known as the Box-Jenkins methodology.[5] The normal behavior of IMV is described by the estimated ARIMA model. A moving average of the residual is constructed and a signal is considered flashing when this statistic exceeds zero.

[5] See Gujarati (1995).

3. RESULTS FOR CRISIS AFFECTED COUNTRIES

3.1 Indicators Found to be Significant

Since the approach used by Adiningsih, et al. (2002) is not a common approach used by the other studies, we can briefly summarize their result first. As mentioned before, the Herrera and Garcia's model determines at the beginning that there are four leading indicators and then proceeds to test if they send out signals. These four variables are M2/reserves, real domestic credit growth, real effective exchange rate and inflation rate. The study by Adiningsih, et al. for Indonesia focused around time series analysis of the composite indicator IMV which is a weighted average of those four variables. Their conclusion is that in general the results from the simple model and the ARIMA residual model are the same and signals are issued within 24 months prior to the crisis period.

A summary of indicators found from signals analysis for four countries is shown in Table 3.1. Although Park's analysis for Korea included both the low threshold (EMP>mean + 1.1 SD) and high threshold (EMP>mean + 2 SD), only the results from the high threshold are brought into the synthesis here partly because it is closer to those used by other studies and partly because we want to avoid any confusion which may arise from too many results.

Similarly for the case of Thailand, Tinakorn presented indicators for both the 24-month and the 12-month windows. Since she did not find indicators to be overly sensitive to the length of the window (preferring the 12-month results, she proceeded to use them for the future assessment) only the results from the 12-month window are presented in Table 3.1.

The numbers reported in Table 3.1 represent the thresholds found for these indicators. Indicators found to be significant for the four crisis-affected countries are listed by category: whether they belong to the current account, capital account, financial sector or real sector. It appears that there are more variables in the current account and the financial sector that are found to be significant leading indicators than in the other categories. The most common indicators among these four countries are the following.

Current account

- terms of trade growth
- ratio of current account to GDP
- real exchange rate misalignment
- exports growth

Capital account

- ratio of short-term external debt to international reserves
- ratio of total external debt to international reserves

Financial variables

- domestic credit/GDP
- M2 multiplier
- spread between lending and deposit rates
- interest differential

Real sector variables

- stock prices
- inflation rate
- fiscal balance/GDP

Table 3.1
Indicators and Thresholds Found from Signals Approach

Indicators	Korea High threshold of crisis (%) (12-month window)	Thailand (%) (12-month window)	Indonesia (%) (12-month window)	Philippines (%) (36-month window)
Current Account				
- Terms of trade	-4.0	-8.6	-	-
- Current account/GDP	-1.0	-8.3	-	-
- REER	14.0	-5.3[1]	-	5.7[2]
- Exports	-10.0	-3.8	-	-11.9
- Depreciation of Asian competitors	14.0	-	-	-
- Imports	-	-	3.6	41.2
Capital Account				
- Capital account/GDP	12.0	-	-	-
- Short-term external debt/foreign reserves	-	128.4[3]	-	12.3
- Total external debt/foreign exchange reserves	2.0	-	-	15.9
- Foreign debt/total debt of monetary institution	3.0	-	-	-
- Foreign exchange reserves	-9.0	-	-	-38.8
Financial Variables				
- Dishonored bill ratio	12.0	-	-	-
- Interest differential	-	7.8	-	8.9
- Domestic credit	-	-	2.8	-
- Domestic credit/GDP	14.0	15.0	67.9	-
- M2 multiplier	12.0	9.6	-	14.4
- M2/international reserves	14.0	11.4	4.6	74.7
- S&P credit rating	1.0	-	-	-
- Spread between lending and deposit rate	-	9.6	-	12.0[4]
- Percentage excess real M1 balance	-	3.6	-	7.8
- Domestic interest rates	-	-	4.7	12.4[5]
- Outstanding domestic credit (real)	-	-	-	24.4
- Interbank loans (real)	-	-	-	97.9
Real Sector				
- Industrial production	-10.0	-	-	-
- Inventory index/shipment index	10.0	-	-	-
- Stock prices	-10.0	-42.5	-	-21.3
- Service price/manufacturing price	13.0	-	-	-
- Capacity utilization ratio in manufacturing	-15.0	-	-	-
- Real GDP growth	-	-1.0	-	-
- Inflation rate	-	6.5	1.03	-
- Fiscal balance/GDP	-14.0	-3.4	-	-
- Electricity consumption	-	-	-	6.6
- National government deficit/ electricity consumption	-	-	-	3.4
Other				
- Contagion dummy	-	-	-	✓

Notes: The scan for optimal threshold is between 10-25 percentiles for Indonesia, Korea and Thailand and 10-30 percentiles for the Philippines. Unless otherwise indicated, the numbers refer to year-on-year growth rate of the indicators.

[1] The real exchange rate misalignment is measured in terms of baht per US dollar. So the decline means overvaluation of the baht.

[2] The equilibrium real exchange rate ($/peso) was computed using the Hodrick-Prescott filler. The currency overvaluation is the percentage difference between the actual exchange rate and the equilibrium RER.

[3] The ratio is reported in percentage term. To be comparable to Korea's figure, this should be 1.284.

[4] Year-on-year growth rate of loan-to-deposit ratio

[5] Real interest rate

The fact that there are many common indicators flashing out signals for Korea, the Philippines and Thailand implies that these three countries were having more or less some similar fundamental problems prior to the currency attacks. The most notable common problems were their real exchange rate misalignment, and declines in exports and terms of trade. These were accentuated by their high ratios of external debt (short-term or total debt) to foreign exchange reserves. Their real sectors were also having some problems as evidenced by the decline in their stock prices and deterioration in their fiscal balances as a ratio to GDP. Although there appeared to be some financial problems in these countries prior to the speculative attacks, Tinakorn observed that some financial indicators for Thailand issued out signals after July 1997. Such behavior makes it unclear whether their abnormal behavior was influenced by the currency crisis and not vice versa.

It is notable that Tambunan (2002) could only find six significant indicators for Indonesia which are import, domestic credit, domestic credit/GDP, M2/international reserves, interest rate, and inflation. Two of these (domestic credit and inflation) were also used in the index of macroeconomic vulnerability (IMV) analyzed by Adiningsih, et al. (2002). Other variables investigated by Tambunan (2002) are M2/net international reserves, terms of trade, and bank loan/deposit ratio but they were not found to be significant.

Table 3.2 presents the list of indicators found to be significant in the probit estimates for Korea, Thailand and the Philippines. The explanatory variables included in the probit estimates for the Philippines are lagged from 2 to 8 months while those for Thailand are lagged from 3, 6, and 12 months. On the other hand, Park (2002:16) argued that it seemed almost impossible to identify the appropriate lag structure for each variable because the dynamic interaction between the market fundamentals and expectation was so complicated. So he only estimated how much influence the explanatory variables exerted on the exchange market pressure. For Korea, there were only three significant indicators from the probit estimate: exports, stock prices, and domestic credit/GDP.

Among the set of variables found to be significant in the probit estimates for Korea, the Philippines and Thailand as shown in Table 3.2, we can see that there are some common variables among these countries as follows.

- stock prices (in all 3 countries)
- exports (for Korea and Thailand)
- domestic credit (for Korea and the Philippines)
- fiscal deficit (for the Philippines and Thailand)

These indicators are also found to be flashing out signals prior to the crisis from the signals analysis.

Contagion is another topic of interest in the literature on currency crises. Kaminsky and Reinhart (2000) examined both trade links and financial sector links and found that susceptibility to contagion is highly nonlinear. A contagion dummy also was included in the econometric estimates for Indonesia, Korea and the Philippines. As for Thailand, the 1997 crisis initiated from her and later spread to other Asian countries. Although she could possibly have been affected by the Tequila crisis of 1994-95 from Mexico, there are insufficient observations to carry out a probit estimate.[6]

The contagion dummy for Korea turned out to be insignificant while for the Philippines the contagion dummy was significant in all 4 models estimated. For Indonesia, Adiningsih, et al. estimated a linear relationship between crisis and a set of macro variables

[6] The criterion for dummy variables in probit estimates is that there must be observations for which the left-hand-side variables takes both values 0 and 1 in both groups of the observations for the right-hand-side dummy variable.

with a dummy for contagion.[7] They found that by using the four variables contained in their IMV as the macro variables, the contagion dummy was significant but if they use 14 leading indicators (as reported by Kaminsky and Reinhart) to form a macro variable, the contagion dummy was not significant.

The finding from each individual country study that there were indicators flashing signs prior to speculative attacks on their currency lends more support to the "fundamental problems" hypothesis than the "investor panic" hypothesis. Such finding was also observed by an ADB study on the causes of the 1997 Asian financial crisis (Zhuang and Dowling 2002). It appeared that investors panicked when they learned of the fundamental problems.

Table 3.2
Indicators Found to be Significant from Probit Estimates

Korea	**Significant variables**			
1. Exports				
2. Stock price	✓			
3. Domestic credit/GDP	✓			
Thailand				
	Model 1		**Model 2**	
1. Growth of M2/reserves	✓		✓	
2. Deviation of real exchange rate	✓		✓	
3. Current account / GDP	✓		✓	
4. Growth of stock price index	✓		✓	
5. Growth of real GDP	✓			
6. Fiscal balance / GDP	✓		✓	
7. Export growth			✓	
Philippines				
	Model 1 Jan 1980 - Apr 2002	**Model 2 Sep 1987- Dec 2001**	**Model 3 Jan 1980 - Apr 2002**	**Model 4 Sep 1987- Dec 2001**
1. Growth of M2 multiplier	✓	✓	✓	✓
2. Growth of electricity consumption	✓	✓	✓	✓
3. Growth of stock prices	✓	✓	✓	✓
4. CONTAGION	✓	✓	✓	✓
5. Excess real M1 balance	✓		✓	
6. Foreign debt to foreign exchange reserves		✓		✓
7. Growth of domestic credit in real term		✓		✓
8. Growth of national government deficit / electricity sales		✓		✓
9. WTDER (Weighted average of month-on-month changes in the exchange rate of Indonesia, Malaysia and Thailand. The weights were based on the share of these three countries in US imports.)			✓	✓

[7] Their model is

$$Crisis_{j,t} = a\,(Dcrisis)_{i,t} + b\,(Macro)_{j,t} + e_t$$

where $Crisis_{j,t}$ = index of speculative pressure in country j
$Dcrisis_{i,t}$ = contagion dummy (crisis in country i)
$Macro_{j,t}$ = fundamental variable in country j
j = Indonesia
i = Korea, Malaysia, Philippines, Thailand

3.2 Assessment of Current Vulnerability

The application of probit estimates and signals analysis to assess current vulnerability was done for all four countries. The general impression seems to be that risks to speculative attacks have declined considerably but each country may have some different areas of concern. Park (2002) did not indicate any specific factors for Korea but observed that exchange market pressure stayed rather high despite its decreasing trend. The Korean economy was evaluated to be somewhat critical in early 2001 but seemed to improve afterwards.

Tambunan (2002) was concerned that an open capital account and internationally mobile capital could again bring about capital flights from Indonesia. Despite positive signs in some macroeconomic variables such as inflation, GDP growth and exchange rate, there are still some economic as well as political-social factors that can lead to another crisis. These are high outstanding loans, weak baking sector, misuse of funds, corruption, social unrest and ethnic conflicts, and political uncertainty.

Yap (2002) expected that exports and stock prices in the Philippines, which appeared to cross their thresholds during 2000 and 2001, would reverse in 2002 and the prospect of a currency crisis would decline. However, he remained concerned for the still high ratio of non-performing loans and some persistent structural problems, particularly inadequate infrastructures and lagging human development in the Philippines.

Tinakorn (2002) found that although the conditional probability of crisis for Thailand remained low during 2001 and the present time, there were certain signs for concern. These were the persistent negative growth in the terms of trade and exports. The fiscal stimulus also put the ratio of fiscal balance to GDP below its threshold value in the last four months of 2001. There also remain some structural problems in the financial and real sectors, and the high and rapidly rising public debt is a significant cause for concern. However, the recent oil price decline and the prospect of the world economy picking up are positive signs for Thailand's future exports.

4. STUDIES FOR CHINA AND VIETNAM

As earlier indicated, as China and Vietnam were not seriously affected by the crisis, the same methodology that was applied to the four crisis affected countries could not be applied to them. Instead, each country focused on a specific area of vulnerabilities that the country authors believe to be significant. In the case of China, this concerns the vulnerabilities of the banking sector, and for Vietnam the issue concerns balance of payments vulnerabilities.

4.1 China

He Fan (2002) points to the growing concerns in China about the potential instability and risk of the financial system. The ratio of NPL may be close to 30 percent, which is as high or higher than the ratios in the crisis hit countries before the onset of the 1997 crisis. The fragility of the banking sector is even more important given that the Chinese economy will be undoing a successive program of liberalization, given China's access to the WTO. He Fan's paper provides an empirical analysis of the Chinese financial sector, the NPL problem, and also tries to assess the likelihood of China falling into a financial crisis.

Banks are shown to play a dominant role in the Chinese financial system, with the four largest state-owned banks dominating the sector,[8] with a combined share of total banking asset of about 65% in 1999. However, it is noted that less than 20% of the total loan of the banking sector are extended to the non-state owned sector. Thus, the major clients of the banking system are the state-owned enterprises. The paper points to the triangular relationship between the government budget, the state-owned banks and the state-owned enterprises as the crucial determinant of the current banking structure in China. In the past period of centrally managed economy, the government provided financial support to the state-owned enterprises directly through the budget to support industrialization, particularly of heavy industries. Inefficiencies developed and provided the impetus for China to make the transition toward a more liberalized economy. In the transition phase, direct fiscal injections into state-owned enterprises declined in line with the decline in the share of government revenue in GDP. Instead, the state-owned banks were used to channel funds to the state-owned enterprises. The latter in turn had to play a major role in providing social safety nets and social welfare to the workers given that a modern social security system is still under construction.[9] This leads to a large financial burden on the state-owned enterprises, inefficiencies, and hence a high ratio of NPL to the state-owned enterprises.

The paper goes on to assess the likelihood of China getting into a financial crisis given the weak banking situation. The key point is whether China can absorb the fiscal burden of cleaning up the NPL situation. The conclusion is that given China's robust economic growth and strong external position in terms of export performance and large foreign reserves together with controls on the capital account, the fiscal burden in cleaning up the NPL should be manageable. A scenario analysis by Hu (2000) is cited where in the worse case scenario the clean up cost will drive the public debt to GDP ratio up to a peak of about 57.4% in 2006, and this ratio is still relatively low compared to that in many other East Asian countries.

Finally, if one looks at the international literature on early warning indicators for a banking crisis, e.g. Kaminsky (1999), sources associated with vulnerabilities that can lead to a banking crisis includes such factors as; over-borrowing cycle in association with capital account liberalization, declining external performance, capital account weaknesses and declining real economic performance. In the case of China, export growth is still satisfactorily high in spite of the slow down in the world economy and overall economic growth is still very high. Foreign reserves are very high and the capital account remains to be liberalized. These, together with the relatively low public debt ratio at present, help to offset the likelihood of a banking crisis given the high NPL ratio. Nevertheless, there appears to be an over-borrowing cycle, as the domestic credit to GDP ratio has been rising quite rapidly in recent years, from about 0.98 in 1996 to 1.31 in 2000. From the studies of banking crisis in various countries, this could be a source of potential weakness given that the banking sector is in the process of being liberalized over the next few years with foreign banks having greater access to the Chinese market. Thus, an effective solution to the NPL problem should be implemented in line with the financial liberalization process, whether this involves setting a modern social security system, market reforms of the state-owned enterprises and improved prudential regulations and supervision of the banking sector.

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8 These are the Bank of China, the Industrial and Commercial Bank of China, the Agriculture Bank of China and the Construction Bank of China.

9 A White Paper on "Labor and Social Security in China" was issued on April 29, 2002 by the Information Office of the State Council.

4.2 Vietnam

Like China, Vietnam is in the process of gradually liberalizing her economy and setting in place effective reforms and policy regimes. As a result of the crisis in 1997, attention has been focused on factors that have led to the crisis in other countries and examining the situation in Vietnam to make sure that Vietnam will not follow the same mistakes. Lessons from the crisis hit countries point to appropriate management of the exchange rate and capital account as well as effective regulations of the financial sector as being crucial.

Vo et al. (2002) focused on three inter-related issues; 1) the current account deficit and external debt sustainability, 2) macroeconomic policy consistency in dealing with capital flows and 3) the problem of double mismatch in the context of financial liberalization and capital account opening. These relate to concerns in Vietnam about the financing of the high current account deficit between 1993 and 1998 that have led to a large accumulation of external debt, the management of the capital flows which could trigger a similar crisis to the other affected countries, and the development of an effective monetary policy and exchange rate regime. In fact, data on external debt and foreign reserves appear to show that Vietnam does face some vulnerabilities (Table 4.1).

Table 4.1
Some External Indicators for Vietnam
(Million US$)

	1995	1996	1997	1998	1999	2000
Current Account Balance	-1,868	-2,418	-1,635	-288	1,253	563
Direct Investment	1,780	1,803	2,100	1,735	1,484	900
Foreign Reserves	1,323	1,673	1,858	1,995	2,947	
Total External Debt	25,427	26,257	21,780	22,502	23,260	
Long-term	21,777	21,964	18,986	19,918	20,529	
Short-term	3,272	3,754	2,342	2,193	2,376	
Use of IMF Credit	377	539	452	391	355	
Debt Service Transactions During the Year						
Principal Repayments on Long-term Debt	225	200	535	587	1,021	1,692
Interest on Long-term Debt	82	98	268	387	326	462
Interest on Short-term Debt	46	86	47	36	33	

Source: Asian Development Bank, Key Indicators 2001.

Foreign reserves are very low for Vietnam, especially in relation to the total external debt (US$ 2.95 billion compared to US$ 23.26 billion in 1999). The ratio of short-term external debt to foreign reserves was about 0.8 in 1999, and this ratio had been declining from a very high ratio of about 2.5 in 1995, so that the value for this ratio prior to the 1997 crisis was in a similar range to that in the countries that went through the crisis. An important difference could be that most of the short-term external debt in Vietnam were for trade credits rather than for medium to long-term investment financing. However, with the large total external debt, debt servicing amounted to a very high ratio of foreign reserves, about 47% in 1999, though this was offset by inflows through foreign direct investment. Another factor that helped Vietnam through the crisis period was the decision to devalue the exchange rate (in February and August 1998, by about 16.3% in total), and the introduction of a widening exchange rate band to give more flexibility. This probably helped to turn the current account deficit into surplus starting in 1999.

Based on the analysis in Vo et al. (2001) using the model by de Pines (1989), the Vietnam paper concluded that Vietnam's external debt situation appears to be sustainable. However, given the very low level of foreign reserves, there are obviously many crucial variables, such as future export growth and level of foreign direct investment, that are relative uncertain given the volatile external environment. Thus, this is an issue that will require continual and careful monitoring in the future.

A second issue studied in the paper is the degree of consistency between exchange rate policy and monetary policy. Based on some econometric analysis, it was concluded that, even thought there are diverse measures to control capital flows in Vietnam, the central bank nevertheless had difficulty in pursuing an independent monetary policy under the pegged exchange rate regime. One interesting issue is the significant increase in the degree of dollarization in the economy. The ratio of dollar deposit to M2 increased from about 21% in 1995 to 23.5% in 1998 and 28% in 2000, with the amount of dollar deposit increasing by almost 3 times between 1997 and 2000, from about US$ 1.5 billion to about US$ 4.3 billion. This high and increasing degree of dollarization may have in effect offset the capital control measures, so that pursuing an independent monetary policy under the pegged exchange rate regime become difficult. A question also arises about the risks stemming from dollarization, as the extent of dollar liquidity in the economy becomes an important concern. This is similar to the foreign exchange liquidity problem in having too much short-term external debt compared to reserves. If there are numerous claims on dollars in the economy through dollarization, it is important to have an adequate supply (or adequate claims on) dollars in the economy. If there is a perception that the supply may not be forthcoming, then panic could strike leading to a financial crisis in a similar way to some features of the Argentina crisis. This is an issue that should be further investigated.

A final question addressed in the paper is the existence of the double mismatch in Vietnam, i.e. maturity and currency mismatch. Both these mismatches are related to the liquidity issue mentioned above, as they could led to a liquidity problem for firms, banks or the country overall. It was found that symptoms of mismatches are in evident in Vietnam. Currency mismatches have been widening for banks, with more dollar deposits than loans. Firms also have currency mismatches with a high proportion of borrowings (about 35-40%) in foreign currency while most of the income are in local currency. Maturity mismatches are also present, given the relatively undeveloped capital market so that firms have to rely mainly on short-term borrowing.

From the various issues analyzed in the paper, it appears that there are indeed economic vulnerabilities for Vietnam. These need to be carefully monitored and tackled. The authors highlighted the need to strengthen the macroeconomic policy framework, appropriately sequence the capital account liberalization, deepen the capital market and enhance the efficiency and soundness of the banking system, so that Vietnam can lessen its vulnerabilities to a potential future crisis.

5. CONCLUSIONS

A general observation from the studies that have been carried out for this project is that each is an attempt to learn from the past, whether the past crisis that the country has gone through, or past patterns of crises that have occurred in other countries, in order to try to assess the risks and vulnerabilities that the country may face in the future. To that extent, the studies provide additional analyses and tools that can help each country to monitor the future risks of a crisis, and contribute to the various on-going surveillance activities. The signaling and probability approaches applied to the countries significantly affected by the crisis are backward looking analyses to identify indicators that could have forewarned of the crisis that occurred in the past. These are then applied to the current situation to assess future risks. The

studies for China and Vietnam focus on issues that have led to crises elsewhere and are issues in which each country may exhibit some symptoms similar to those that have led to crises in other countries. They then attempt to assess the extent of the risks for their countries and also identify necessary policy responses.

These analyses are useful in trying to make sure that each country does not make similar mistakes to those that have led to a crisis in the past, or similar mistakes to other countries that have led them to crises. However, one should always be aware that a future crisis is unlikely to be of exactly the same nature as past crises, given that there must be some learning from past experiences. Therefore, countries need to be continually vigilant in monitoring potential vulnerabilities and analyzing possible scenarios that may lead eventually to a crisis, even though these vulnerabilities may stem from very different factors than those that have led to crises in the past. The studies in this project should therefore be regarded as part of an on-going process in which think tanks and researchers in the region continue to be involved in the monitoring and surveillance process to prevent new crises from occurring in the future.

REFERENCES

Adiningsih, S., D.N. Setiawati, and Sholihah. 2002. "Early Warning System for Macroeconomic Vulnerability in Indonesia," Final Report. EADN Regional Project on Indicators and Analyses of Vulnerabilities to Economic Crises, June.

Gujarati, D. 1995. *Basic Econometrics,* 3rd edition. New York: McGraw-Hill, Inc.

He, Fan. 2002. "How Far is China Away from a Financial Crisis," Final Report. EADN Regional Project on Indicators and Analyses of Vulnerabilities to Economic Crises, June.

Herrera, S., and C. Garcia. 1999. "User's Guide to an Early Warning System for Macroeconomic Vulnerability in Latin American Countries." World Bank Working Paper, November.

Hu, Fred. 2000. "China's Banking Reform: A Long March." *International Economic Review* (Guoji Jingji Pinglun), July-August, pp. 5-12.

Kaminsky, Graciela. 1999. "Currency and Banking Crises: the Early Warnings of Distress." IMF Working Paper, WP/99/178. Washington D.C.: International Monetary Fund. December.

Kaminsky, Graciela, 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 System, March).

_____. 2000. "On Crises, Contagion, and Confusion." *Journal of International Economics,* 51: 145-168.

Kaminsky, G.L., S. Lizondo, and C.M. Reinhart. 1998. "Leading Indicators of Currency Crisis." *IMF Staff Paper*, Vol.45, No.1, March.

Park, Won-Am. 2002. "Indicators and Analysis of Vulnerability to Economic Crisis: Korea," Final Report. EADN Regional Project on Indicators and Analyses of Vulnerabilities to Economic Crises, June.

de Pines, Jaime. 1989. "Debt Sustainability and Overadjustment." *World Development*, Vol. 17, No. 1.

Sussangkarn, Chalongphob. 2001. "Regional Project on Indicators of Balanced and Sustainable Economic Development." Paper presented at the EADN meeting, Singapore, June 25-27.

Tambunan, Tulus. 2002. "Building an Early Warning System for Indonesia with the Signal Approach," Final Report. EADN Regional Project on Indicators and Analyses of Vulnerabilities to Economic Crises, June.

Tinakorn, Pranee. 2002. "Indicators and Analysis of Vulnerability to Currency Crisis: Thailand," Final Report. EADN Regional Project on Indicators and Analyses of Vulnerabilities to Economic Crises, June.

Vo et al. 2001. "The Sustainability of the Current Account Deficit and External Debt in Vietnam." *EADN Working paper no 10*, ISEAS, December.

_____. 2002. "An Assessment of the Risks Associated with Vietnam's Balance of Payments," Preliminary Report. EADN Regional Project on Indicators and Analyses of Vulnerabilities to Economic Crises, April.

Yap, Josef T. 2002. "Monitoring Economic Vulnerability and Performance: Applications to the Philippines," Final Report. EADN Regional Project on Indicators and Analyses of Vulnerabilities to Economic Crises, June.

Zhuang, J., and M. Dowling. 2002. "Causes of the 1997 Asian Financial Crisis: What Can an Early Warning System Model Tell Us?" Asian Development Bank, ERD Policy Brief Series, Economics and Research Department, Number 7.

Indicators and Analysis of Vulnerability to Currency Crisis: Thailand

Pranee Tinakorn[*]

1. INTRODUCTION

Thailand was the first of the Asian developing countries to experience the financial crisis in 1997. The crisis started with a series of currency attacks during late 1996 and mid-1997 which led to the collapse of Thailand's fixed exchange rate system (known as a basket of currency system). The subsequent severe fall in the baht value led to a tremendous increase in the liability side of the balance sheet for a significant number of enterprises that had borrowed heavily from international markets. Many financial institutions were faced with both liquidity and insolvency problems. The situation was aggravated by the contagion effect of currency depreciation which hit other Asian countries and had a feedback effect on the Thai economy. Furthermore, since the Bank of Thailand (BOT) had used up almost all of the international reserves through the swap operation to defend the baht value in vain, resulting in a net reserve of around 1 billion dollars in July 1997 (see Figure 1),[1] the country had to turn to the International Monetary Fund (IMF) for a stand-by credit of 17.2 billion dollars. The IMF package required the country to cut fiscal expenditure and raise interest rates mainly to restore international confidence. This in effect dried up whatever little domestic liquidity there was and the economy inevitably headed into a deep recession. Thailand's real GDP in 1998 contracted by –10.4 percent and the unemployment rate more than trippled the rate of 1997.

In fact, even without the IMF austerity package, Thailand had been heading for an economic downturn anyway as predicted by the composite leading indicator.[2] The composite leading indicator of Thailand had been following a downward trend since early 1996, with a leading time of six months on average. Although Thailand needed the IMF stand-by credit badly, the Thai authorities might have negotiated for a less contractionary package if they had had prior knowledge about the leading indicator of the economy and where it was heading. Similarly, the IMF might have yielded to a less contractionary package if they had known that the economic downturn in Thailand would have occurred anyway and such downturn would have helped correct the current account deficits without a strong contractionary package initially imposed by the IMF.

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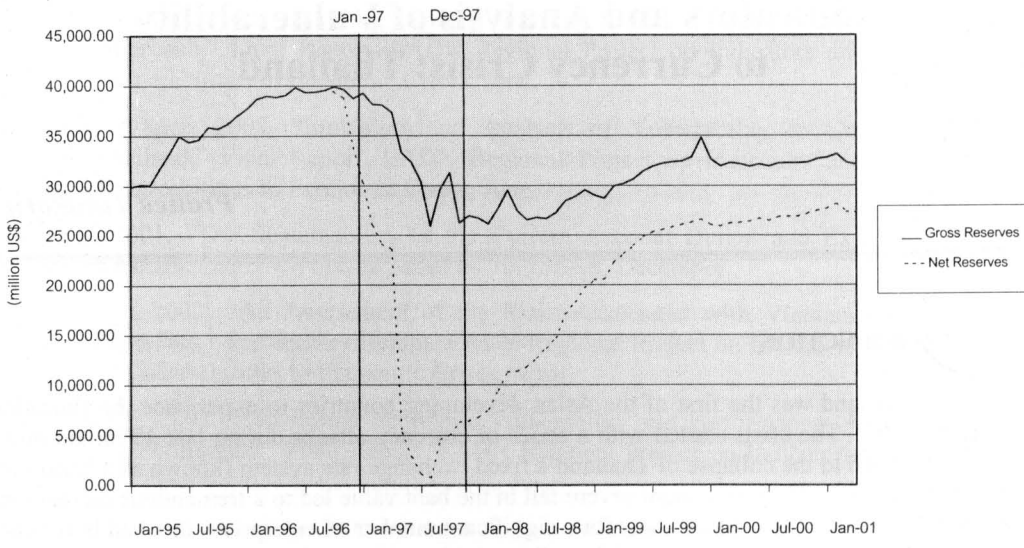
1 Ministry of Finance (1998). In the document, it was pointed out that Thailand's net international reserves decreased from 33.8 billion dollars in December 1996 to around 1 billion dollars in July 1997. Such a huge loss was concealed by the swap operation and did not show up in the gross reserves as can be seen in the plots of Thailand's gross and net international reserves in Figure 1.

2 The author of this report worked on a research study to construct a composite leading economic indicator for Thailand with financial support from the National Economic and Social Development Board and the study came out in September 1998, well after the IMF austerity package was concluded. See Pranee Tinakorn (1998).

Figure 1
Thailand's International Reserves: Gross and Net



Although the use of leading indicators as warning signals is widespread in most developed countries, especially those in the Organization for Economic Cooperation and Development (OECD), the situation is quite different for Thailand where many leading indicators are lacking and cannot be incorporated into the composite index. The author of this report is of the opinion that the concerned authorities should spend more efforts to gather the required data and try to improve the performance of the present composite leading indicator so that it can serve as a more reliable warning signal.

In addition to improving and monitoring a general leading economic indicator for the real sector activities, Thailand also needs some warning signals about the impending crisis in the financial sector and the balance of payments as well. Kaminsky and Reinhart (1999) found that problems in the banking sector typically precede a currency crisis and the currency crisis deepens the banking crisis. While it would be desirable to study leading indicators for both the banking crisis and currency crisis for Thailand, due to time and data constraints this study is focused on analyzing warning signals for the currency crisis alone.

Since the banking crisis and currency crisis are found to have strong links, many studies on currency crises also found that overstretched financial variables provide warning signals to currency crisis. By including several indicators from the financial sectors in the analysis of currency crisis, it is hoped that they will provide warning signals not only to currency crisis but also to financial problems. While most studies on currency crisis use international cross-section data to look for signals of crisis, this study will use the time series data on a monthly basis. Both non-parametric and parametric analysis will be explored. When some leading indicators are confirmed from statistical analysis, they can be used to assess future vulnerability of the Thai economy.

2. REVIEW OF SOME SELECTED STUDIES ON CURRENCY CRISIS

2.1 Theoretical Explanation of Currency Crisis

Prior to the Asian currency crises in the late 1990s, there were basically two models explaining the onset of currency attacks. They are known as the first- and second-generation models. The former model focused on the balance of payments problems created mainly through seignorage; the latter model viewed currency crisis not as a result of bad policy but of a shift in expectation and the model was called "self-fulfilling". However, the causes of speculative attacks on Asian currencies, with Thai currency being hit first, appeared to be different from those explained in the first- and second-generation models. Therefore, economists came up with a third-generation model to explain currency crisis. Kaminsky, Lizondo and Reinhart (1998) provided a summary of the main explanation of speculative attacks and Krugman (2001) provided a brief history of currency crisis modeling. The following summary draws heavily from both papers.

First-generation crisis models. Krugman (1979) explained that under a fixed exchange rate system, the expansion rate of domestic credit in excess of money demand growth led to persistent losses of international reserves which ultimately led to speculative attacks on the currency. The root cause of the crisis appeared to be poor government policy, i.e. excessive public sector deficit that becomes monetized under a fixed exchange rate system. The currency crises which took place in the early 1970s provided inspiration for the first-generation modeling.

Second-generation crisis models. The series of attacks on some European currencies under the European Monetary System (EMS) in 1992-93 could not be explained by the first-generation models. Seignorage was not an issue and it was not the depletion of reserves that led the authorities to abandon the parity. Rather, it was a matter of policy choice as they may have been concerned about the adverse consequences of policies needed to maintain the parity (e.g. the effect of higher interest rates on employment). Obstfeld (1996) offered several variants but the main theme seemed to focus on macroeconomic trade-offs and decisions, and the existence of multiple equilibria. If speculators question the credibility of the peg, they may attack and the result can be a self-fulfilling crisis of confidence. Within the second generation models, crises are no longer the result of irresponsible policy, but they occur because market participants expect them to.

Third-generation crisis models. The Asian crises in 1997 appeared to be the inspiration for several variant explanations. Krugman (2001) suggested that there were three versions: moral-hazard-driven investment, which leads to an excessive buildup of external debt and then to a collapse; bank-run; and balance-sheet implications of currency depreciation.

In addition to these three main reasons as explanation for currency crises, some papers also discuss "contagion effects". Gerlach and Smets (1995) explained that the devaluation by one country could lead its trading partners to devalue in order to avoid a loss of competitiveness. Other channels, such as financial linkages, can also serve as transmission of contagion effects. See Calvo and Reinhart (1996) and Eichengreen, Rose, and Wyplosz (1996) for further discussion.

Krugman (2001) also conjectured about a future "fourth-generation" crisis model which may not be a currency crisis model, but may be a more general financial crisis model in which other asset prices play the major role.

2.2 Some Recent Empirical Studies on Currency Crisis Indicators

The theoretical explanation of currency crisis contained in the first- and second-generation models implies that there are some fundamental variables or indicators that should help us assess the vulnerability of an economy to currency attacks. If speculative attacks are due to the "self-fulfilling" crisis of the second-generation model, the prospect of predicting its

occurrence from various economic indicators is rather dim because attacks may occur against a fundamentally sound economy. The Mexican crisis in 1994 and the Asian crisis in 1997 revived academic interest in looking for indicators that can help predict currency crisis. From the author's survey of literature that came out since 1997, the following studies are found and hereby summarized.[3]

Goldfajn and Valdes (1997) used the logit model to estimate the probability of a crisis and found that lagged overvalued exchange rate was a statistically significant variable. Esquivel and Larrain (1998) used the probit model and found the following variables to be significant: change in reserve money as a percentage of GDP, real exchange rate misalignment, current account, ratio of money supply (M2) to international reserves, change in terms of trade, growth in GNP per capita, and contagion effect. Kruger, Osakwe and Page (1998) also estimated the probit model and found three variables to be consistently linked to currency crises: a measure of lending booms, real exchange rate misalignment and the ratio of M2 over reserves. They also performed some sensitivity analysis and found that other macroeconomic variables did not have as robust a performance as these three.

The methodological approach used by Kaminsky, Lizondo and Reinhart (1998) is different from the above three studies. Their "signals" approach is a non-parametric method where leading indicators of currency crises are identified by their non-normal behaviour, i.e. signaling. Their study found the following variables to be particularly useful: international reserves, real exchange rate, domestic credit, credit to the public sector, and domestic inflation.

All of the above mentioned studies used cross-section data from different numbers of countries within the period between 1970 to 1997. Their sample size differs as do their methodology and definition of currency crisis. Table 1 provides some major comparison of these four studies.

The 1997 currency crisis also stimulated academic interest on this issue in Thailand. Table 2 summarizes the two pieces of study on early warning indicators of currency crisis for Thailand. Engwatana (1999) used both monthly and quarterly data during 1990-1998 while Poonpatpibul and Ittisupornrat (2001) used monthly data during 1990-2000. It is somewhat surprising that with the same methodology of probit analysis, they found different sets of significant indicators, except for one variable. This could be partly due to their different definitions of currency crisis. Engwatana (1999) used *"accumulated one month exchange rate change of 10% or more"* ***or*** *"deviation of forward premium from its three-month moving average by more than 10% in one month."* Poonpatpibul and Ittisupornrat (2001) "used an accumulated weakening of exchange rate of more than 15% in three months."

It is also notable that the latter study did not find short-term foreign debt to be a significant indicator in both the signals approach and probit model even though in reality excessive short-term foreign debt was a prominent factor in Thailand's 1997 currency crisis. Besides, there appears to be some inconsistency in Poonpatpibul and Ittisupornrat (2001)'s reporting of their sample data. They reported using monthly sample between January 1990 to December 1998 for probit analysis but their regression reported only 78 total observations instead of 108 observations. In addition, following their definition of a currency crisis, they reported having 16 observations of crisis (where the dependent variable was set to 1) but if one examines the exchange rate data, and using their definition, one will find only eight such observations (this can be verified by examining the data in Table 3).

Since the objective of this research study is to evaluate Thailand's future vulnerability to currency crisis, the author does not feel comfortable relying on the results found in other studies that still require data clarification. Therefore, this study will add to the pool of research work on Thailand's leading indicators of currency crisis.

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[3] The year 1997 was chosen just for being a convenient cut-off point. Otherwise, there is a significant number of related literature to be reviewed. Interested readers can see a comprehensive review of earlier literature in Kaminsky, Lizondo and Reinhart (1998).

Table 1
Summary Comparison of Four Studies on Leading Indicators of Currency Crises

	Goldfajn and Valdes (1997)	Esquivel and Larrain (1998)	Kaminsky, Lizondo and Reinhart (1998)	Kruger, Osakwe and Page (1998)
1. Sample	26 countries May 1984 - May 1997	30 countries 1975 – 1996	20 countries 1970 - 1995	19 countries 1977 – 1993
2. Definition of currency crisis	This paper follows 3 alternative procedures as follows: 1) Devaluation is a crisis when it is larger than (1) 1.96 times the standard deviation of the country's nominal exchange rate, and (2) 2% plus 1.5 times the devaluation rate of the previous month. Crises are required to be 2 months apart. 2) Given downward price rigidity, large jumps in the real exchange rate is associated as a crisis. 3) The index of currency market turbulence is more than 3 standard deviations above mean, where the index is a weighted average of monthly percentage changes in gross international reserves.	1) The accumulated 3 month real exchange rate change is 15% or more or 2) 1 month change in the real exchange rate is higher than 2.54 times country-specific standard deviation of real monthly growth rate, provided that it also exceeds 4%.	The index of currency market turbulence is more than 3 standard deviations abovemean, where the index is a weighted average of monthly percentage changes in exchange rate and monthly percentage changes in gross international reserves.	Exchange rate pressure index is 1.5 times standard deviations abovemean, where the index is defined as a weighted average of percentage changes in the nominal exchange rate and the negative of percentage changes in international reserves.
3. Methodology	Logit Model	Probit Model with Random Effect	Signals Approach	Probit Model
4. Variable found to be significant indicators	1) Overvalued real exchange rate	1) Change in reserve money as a percentage of GDP 2) Current account imbalance 3) Real exchange rate misalignment 4) Foreign exchange reserves 5) Terms of trade shock 6) Poor growth performance 7) Regional contagion	1) Real exchange rate 2) Banking crises 3) Exports 4) Stock prices 5) M2 / reserves 6) Output 7) Excess M1 balance 8) International reserves 9) M2 multiplier 10) Domestic credit /GDP 11) Real interest rate 12) Terms of trade 13) Real interest differential	1) M2 / international reserves 2) Ratio of bank claims on private sector to GDP (a measure of lending boom) 3) Real exchange rate misalignment

Table 2
Summary of Studies on Currency Crisis in Thailand

	Engwatana (1999)		Poonpatpibul and Ittisupornrat (2001)	
1. Sample	1990-1998		1990-2000	
2. Definition of currency crisis	(a) The accumulated one month nominal exchange rate change is 10 percent or more; or (b) The forward premium deviates from its three-month moving average by more than 10 percent in one month.		Accumulated 3-month depreciation in nominal exchange rate is 15% or more	
3. Methodology	(a) Probit Model (monthly data)	(b) Probit Model (quarterly data)	(a) Signals Approach	(b) Probit Model
4. Variables found to be significant indicators	1. Excessive domestic credit creation 2. High ratio of M2 to international Reserves 3. Low ratio of international reserves to monthly imports 4. Large domestic and foreign interest rate differentials 5. Real (effective) exchange rate overvaluation	1. High ratio of short-term foreign debt to international reserves 2. Large domestic and foreign interest rate differential 3. Large current account deficit 4. Reversal of portfolio investment capital inflow	1. Export growth 2. Change in real exchange rate 3. Terms of trade 4. Spread between lending rate and deposit rate	1. Export growth 2. Ratio of M2 to international reserves 3. Percentage change in credits (private sector) 4. Inflation rate

Table 3
Monthly Data on Exchange Rate and International Reserves

	Exchange rate		International reserves		Net forward position	IMF borrowing	Net reserves	
	Baht/US$	%change	million US $	%change	(mill $)	(mill $)	(mill $)	%change
Dec-92	25.47		21,181.5		0.0	0.0	21,181.5	
Jan-93	25.53	0.24	21,937.0	3.57	0.0	0.0	21,937.0	3.57
Feb-93	25.49	-0.16	21,634.9	-1.38	0.0	0.0	21,634.9	-1.38
Mar-93	25.42	-0.27	22,239.4	2.79	0.0	0.0	22,239.4	2.79
Apr-93	25.23	-0.75	22,611.6	1.67	0.0	0.0	22,611.6	1.67
May-93	25.22	-0.04	23,114.7	2.22	0.0	0.0	23,114.7	2.22
Jun-93	25.21	-0.04	23,979.8	3.74	0.0	0.0	23,979.8	3.74
Jul-93	25.31	0.40	23,919.7	-0.25	0.0	0.0	23,919.7	-0.25
Aug-93	25.18	-0.51	24,222.8	1.27	0.0	0.0	24,222.8	1.27
Sep-93	25.19	0.04	25,225.3	4.14	0.0	0.0	25,225.3	4.14
Oct-93	25.26	0.28	25,544.4	1.26	0.0	0.0	25,544.4	1.26
Nov-93	25.36	0.40	25,206.1	-1.32	0.0	0.0	25,206.1	-1.32
Dec-93	25.45	0.35	25,438.8	0.92	0.0	0.0	25,438.8	0.92
Jan-94	25.53	0.31	25,359.3	-0.31	0.0	0.0	25,359.3	-0.31
Feb-94	25.38	-0.59	26,251.3	3.52	0.0	0.0	26,251.3	3.52
Mar-94	25.29	-0.35	26,672.6	1.60	0.0	0.0	26,672.6	1.60
Apr-94	25.25	-0.16	26,592.8	-0.30	0.0	0.0	26,592.8	-0.30
May-94	25.21	-0.16	27,512.8	3.46	0.0	0.0	27,512.8	3.46
Jun-94	25.14	-0.28	28,340.5	3.01	0.0	0.0	28,340.5	3.01
Jul-94	24.97	-0.68	28,588.3	0.87	0.0	0.0	28,588.3	0.87
Aug-94	25.02	0.20	29,064.0	1.66	0.0	0.0	29,064.0	1.66
Sep-94	24.98	-0.16	29,950.2	3.05	0.0	0.0	29,950.2	3.05
Oct-94	24.96	-0.08	29,851.7	-0.33	0.0	0.0	29,851.7	-0.33
Nov-94	24.98	0.08	29,743.2	-0.36	0.0	0.0	29,743.2	-0.36
Dec-94	25.10	0.48	30,279.0	1.80	0.0	0.0	30,279.0	1.80
Jan-95	25.07	-0.12	29,906.1	-1.23	0.0	0.0	29,906.1	-1.23
Feb-95	25.02	-0.20	30,135.6	0.77	0.0	0.0	30,135.6	0.77
Mar-95	24.76	-1.04	30,119.5	-0.05	0.0	0.0	30,119.5	-0.05
Apr-95	24.56	-0.81	31,727.1	5.34	0.0	0.0	31,727.1	5.34
May-95	24.66	0.41	33,272.4	4.87	0.0	0.0	33,272.4	4.87
Jun-95	24.67	0.04	34,958.3	5.07	0.0	0.0	34,958.3	5.07
Jul-95	24.74	0.28	34,415.7	-1.55	0.0	0.0	34,415.7	-1.55
Aug-95	24.95	0.85	34,629.1	0.62	0.0	0.0	34,629.1	0.62
Sep-95	25.12	0.68	35,866.1	3.57	0.0	0.0	35,866.1	3.57
Oct-95	25.11	-0.04	35,731.4	-0.38	0.0	0.0	35,731.4	-0.38
Nov-95	25.16	0.20	36,204.4	1.32	0.0	0.0	36,204.4	1.32
Dec-95	25.16	0.00	37,026.7	2.27	0.0	0.0	37,026.7	2.27
Jan-96	25.29	0.52	37,721.2	1.88	0.0	0.0	37,721.2	1.88
Feb-96	25.24	-0.20	38,694.2	2.58	0.0	0.0	38,694.2	2.58
Mar-96	25.23	-0.04	38,982.5	0.75	0.0	0.0	38,982.5	0.75
Apr-96	25.27	0.16	38,862.3	-0.31	0.0	0.0	38,862.3	-0.31
May-96	25.29	0.08	39,053.8	0.49	0.0	0.0	39,053.8	0.49
Jun-96	25.35	0.24	39,830.0	1.99	0.0	0.0	39,830.0	1.99
Jul-96	25.34	-0.04	39,360.6	-1.18	0.0	0.0	39,360.6	-1.18
Aug-96	25.27	-0.28	39,370.3	0.02	0.0	0.0	39,370.3	0.02
Sep-96	25.36	0.36	39,537.0	0.42	0.0	0.0	39,537.0	0.42
Oct-96	25.46	0.39	39,902.5	0.92	-500.0	0.0	39,402.5	-0.34
Nov-96	25.45	-0.04	39,613.3	-0.72	-850.0	0.0	38,763.3	-1.62
Dec-96	25.56	0.43	38,724.5	-2.24	-4,890.0	0.0	33,834.5	-12.72

(Continued on page 26)

Table 3 (Continued)

	Exchange rate		International reserves		Net forward position	IMF borrowing	Net reserves	
	Baht/US$	%change	million US $	%change	(mill $)	(mill $)	(mill $)	%change
Jan-97	25.69	0.51	39,233.8	1.32	-8,860.0	0.0	30,373.8	-10.23
Feb-97	25.90	0.82	38,149.1	-2.76	-12,190.0	0.0	25,959.1	-14.53
Mar-97	25.92	0.08	38,065.6	-0.22	-13,960.0	0.0	24,105.6	-7.14
Apr-97	26.03	0.42	37,320.1	-1.96	-13,760.0	0.0	23,560.1	-2.26
May-97	25.84	-0.73	33,307.6	-10.75	-28,010.0	0.0	5,297.6	-77.51
Jun-97	25.75	-0.35	32,353.0	-2.87	-29,510.0	0.0	2,843.0	-46.33
Jul-97	30.16	17.13	30,424.2	-5.96	-29,280.0	0.0	1,144.2	-59.75
Aug-97	32.41	7.46	25,938.6	-14.74	-23,460.0	1,729.0	749.6	-34.49
Sep-97	36.27	11.91	29,612.2	14.16	-23,380.0	1,644.2	4,588.0	512.10
Oct-97	37.55	3.53	31,287.2	5.66	-24,430.0	1,804.8	5,052.4	10.12
Nov-97	39.30	4.66	26,253.6	-16.09	-18,280.0	1,663.6	6,310.0	24.89
Dec-97	45.29	15.24	26,967.7	2.72	-18,010.0	2,534.0	6,423.7	1.80
Jan-98	53.71	18.59	26,724.3	-0.90	-17,420.0	2,491.8	6,812.5	6.05
Feb-98	46.30	-13.80	26,156.1	-2.13	-16,340.0	2,245.1	7,571.0	11.13
Mar-98	41.33	-10.73	27,680.0	5.83	-15,740.0	2,504.6	9,435.4	24.62
Apr-98	39.48	-4.48	29,530.5	6.69	-15,630.0	2,638.3	11,262.2	19.36
May-98	39.14	-0.87	27,450.5	-7.04	-13,370.0	2,740.6	11,339.9	0.69
Jun-98	42.36	8.25	26,571.7	-3.20	-12,010.0	2,793.2	11,768.5	3.78
Jul-98	41.19	-2.77	26,776.3	0.77	-11,330.0	2,763.6	12,682.7	7.77
Aug-98	41.58	0.94	26,678.8	-0.36	-10,170.0	2,840.9	13,667.9	7.77
Sep-98	40.41	-2.80	27,290.8	2.29	-9,700.0	2,928.1	14,662.7	7.28
Oct-98	38.14	-5.62	28,482.1	4.37	-8,400.0	2,981.5	17,100.6	16.63
Nov-98	36.46	-4.40	28,891.4	1.44	-7,600.0	3,000.8	18,290.6	6.96
Dec-98	36.25	-0.58	29,535.9	2.23	-6,600.0	3,277.0	19,658.9	7.48
Jan-99	36.59	0.94	29,013.1	-1.77	-5,300.0	3,215.3	20,497.8	4.27
Feb-99	37.06	1.28	28,721.4	-1.01	-5,000.0	3,166.5	20,554.9	0.28
Mar-99	37.51	1.21	29,936.1	4.23	-4,600.0	3,132.2	22,203.9	8.02
Apr-99	37.60	0.24	30,203.8	0.89	-3,900.0	3,207.6	23,096.2	4.02
May-99	37.02	-1.54	30,637.2	1.43	-3,500.0	3,230.7	23,906.5	3.51
Jun-99	36.91	-0.30	31,433.9	2.60	-3,300.0	3,336.7	24,797.2	3.73
Jul-99	37.11	0.54	31,928.8	1.57	-3,200.0	3,408.3	25,320.5	2.11
Aug-99	37.98	2.34	32,216.1	0.90	-3,200.0	3,453.3	25,562.8	0.96
Sep-99	39.88	5.00	32,360.2	0.45	-3,000.0	3,565.4	25,794.8	0.91
Oct-99	39.47	-1.03	32,438.1	0.24	-3,000.0	3,384.5	26,053.6	1.00
Nov-99	38.77	-1.77	32,842.1	1.25	-3,100.0	3,446.6	26,295.5	0.93
Dec-99	38.18	-1.53	34,780.6	5.90	-4,800.0	3,367.9	26,612.7	1.21
Jan-00	37.35	-2.16	32,630.2	-6.18	-3,200.0	3,394.9	26,035.3	-2.17
Feb-00	37.71	0.96	31,953.8	-2.07	-2,700.0	3,369.7	25,884.1	-0.58
Mar-00	37.90	0.50	32,283.9	1.03	-2,700.0	3,358.9	26,225.0	1.32
Apr-00	37.97	0.18	32,166.0	-0.37	-2,600.0	3,302.2	26,263.8	0.15
May-00	38.95	2.58	31,904.2	-0.81	-2,200.0	3,314.0	26,390.2	0.48
Jun-00	39.06	0.28	32,142.0	0.75	-2,100.0	3,348.5	26,693.5	1.15
Jul-00	40.22	2.97	31,929.6	-0.66	-2,100.0	3,383.8	26,445.8	-0.93
Aug-00	40.87	1.62	32,232.4	0.95	-2,100.0	3,262.7	26,869.7	1.60
Sep-00	41.88	2.47	32,249.8	0.05	-2,100.0	3,270.6	26,879.2	0.04
Oct-00	43.21	3.18	32,244.7	-0.02	-2,100.0	3,253.3	26,891.4	0.05
Nov-00	43.73	1.20	32,316.1	0.22	-2,100.0	3,022.9	27,193.2	1.12
Dec-00	43.09	-1.46	32,661.3	1.07	-2,100.0	3,074.4	27,486.9	1.08
Jan-01	43.12	0.07	32,795.0	0.41	-2,100.0	3,009.4	27,685.6	0.72
Feb-01	42.64	-1.11	33,153.9	1.09	-2,100.0	2,858.5	28,195.4	1.84
Mar-01	43.90	2.95	32,294.7	-2.59	-2,200.0	2,732.2	27,362.5	-2.95
Apr-01	45.46	3.55	32,095.9	-0.62	-2,100.0	2,694.5	27,301.4	-0.22

Source: Bank of Thailand.

3. DEFINITION OF CURRENCY CRISIS AND METHODOLOGIES FOR IDENTIFYING ITS LEADING INDICATORS

From the summary of previous studies presented in Tables 1 and 2, we can see that researchers either use the multivariate logit/probit model or the signals approach in analyzing crisis. The most commonly used approach seemed to be the estimation of logit/probit models, and Kaminsky, Lizondo and Reinhart (1998) is the first to use the signals approach. For this research study, both methodologies are employed. The sample period is restricted by the availability of monthly data needed for this study, and covers the period: January 1992 to December 2000.[4]

3.1 Definition of Currency Crisis in this Study

The definition of currency crisis used in Engwatana (1999) and Poonpatpibul and Ittisupornrat (2001) focussed on what happened to the value of currency (including its forward premium in Engwatana). It is the author's opinion that his definition is not broad enough as speculative attacks may not change the value of the currency by much if the monetary authority could defend it with their international reserves. However, depletion of international reserves could lead to many other economic problems including the crisis of confidence. Therefore, we should regard the huge reduction of international reserves as an indication of currency crisis as well. Kaminsky, Lizondo and Reinhart (1998) defined a currency crisis as "a situation in which an attack on the currency leads to a sharp depreciation of the currency, a large decline in international reserves, or a combination of the two." From this definition, an index of exchange market pressure is constructed as a weighted average of monthly percentage changes in the exchange rate and the negative of monthly percentage changes in the gross international reserves.

In the case of Thailand, pressures on the exchange rate started around the end of 1996 and the Bank of Thailand (BOT) intervened to maintain the value of the baht. However, the amount of the BOT's selling of dollars to support the value of the baht in the market did not show up as a large depletion in the international reserves because it used the swap operation to buy back dollars (with an obligation to sell back dollars in the future). Some BOT officials argued that the swap operation helped ease the liquidity dry-up which would have occurred without it. We can see from Table 3 that a series of speculative attacks in the first half of 1997 resulted in the BOT's swap obligation of a huge amount, from around 4.890 billion dollars in December 1996 with gross international reserves standing at 38.725 billion dollars to a swap obligation of 29.510 billion dollars in June 1997. The gross international reserve at the end of June 1997 stood at 32.353 billion dollars while the net international reserves stood at only 2.843 billion dollars. The depletion in gross reserves did not look as severe as that in the net reserves because the swap operation concealed the problem by postponing it into the future. Therefore, the crisis index in this study will be based on the movements in net reserves and exchange rate.

An index of currency market turbulence (I) for Thailand was constructed based on the formula

$$I = \frac{\Delta e}{e} - \frac{\Delta R}{R} * \frac{\sigma_e}{\sigma_r} \quad \text{.....(1)}$$

where Δe = change in nominal exchange rate

ΔR = change in net international reserves

σ_e = standard deviation of $\Delta e/e$

σ_r = standard deviation of $\Delta R/R$

[4] However, for GDP, there are only quarterly data starting from the first quarter of 1993 and the monthly GDP data have to be estimated from a quarterly relationship of GDP and other variables as explained in Appendix C.

By defining a currency crisis as a situation when the index I exceeds its mean plus two standard deviation, the observations of crisis came to only three. And if we receded to defining the threshold at mean plus one and a half standard deviation, the observations on crisis still came to only four. (See Appendix A: Index of Currency Market Turbulence.) Such numbers may be adequate for the signals analysis but they are inadequate for the probit estimate which requires a minimum number of dependent variable not being equal to zero (or Y=1.0 when crisis occurs). Therefore, it is decided that a currency crisis is a situation where one of the following situations takes place.

1. There is an accumulated three-month depreciation in exchange rate of 15 percent or more;

Or

2. There is an accumulated three-month depletion in net international reserves of 15 percent or more.

With the above definition, the Thai economy fell within the episode of currency crisis during January 1997 up to February 1998. This gives us a total of 14 monthly observations of crisis from our sample during January 1992 and December 2000. However, for some indicators their year-on-year changes are used as signals which means the first 12 months of the sample are lost.

3.2 Set of Possible Leading Indicators

From a comprehensive survey of empirical studies on leading indicators of currency crises, Kaminsky, Lizondo and Reinhart (1998) found a large variety of indicators used among those studies, as many as 105 indicators were used. However, not all of them passed the statistical significance test. The choice of variables used in this study was dictated not only by economic reasoning but also by data availability on a monthly basis in Thailand. The set of potential leading indicators with available monthly observations during our sample period may be grouped as follows.

- **Current account variables**

  Export growth
  Import growth
  Trade balance (as a ratio to GDP)
  Current account (as a ratio to GDP)
  Terms of trade (growth)
  Real exchange rate (deviation from past average or trend)

- **Capital account variables**

  Spread between domestic and foreign interest rates
  Ratio of external debt to total debt of financial institutions
  Short-term external debt to international reserves
  Capital account balance (growth)

- **Financial variables**

  Real deposit rate
  Spread between lending and deposit rate
  Ratio of M2 to international reserves (growth)
  Ratio of domestic credit to GDP (growth)
  Excess real M1 balance

- **Real sector variables**

  Fiscal balance (as a ratio to GDP)
  Inflation rate
  GDP growth
  Change in stock prices (represented by SET index)

It should be pointed out that Thailand does not have monthly GDP data and the quarterly GDP data only go back to 1993. Since several indicators above should be measured as a ratio to GDP, we need to generate monthly GDP data from the quarterly data. This is done by making use of the quarterly relationship between GDP and other variables which are themselves available in monthly series. The estimated quarterly relationship between GDP and exports, indirect taxes, government expenditures and electricity consumption is used to estimate monthly GDP from the monthly data of these variables. The estimated monthly GDP is adjusted so as to make the sum of the estimated monthly series equal to the actual quarterly data. More details of the GDP monthly estimation are presented in Appendix B. The estimated monthly GDP series are also used to estimate the demand for money in order to calculate excess real M1 balance. In addition, the short-term external debt are also available on a quarterly basis until 1999 when monthly data became available. The monthly short-term debt is estimated by interpolation between two adjacent quarters.

3.3 Methodology

There are basically two approaches in the analysis of leading indicators for currency crisis. The parametric approach utilizes the qualitative dependent variable regression models (probit, logit) to identify leading indicators. The non-parametric approach uses the signals analysis proposed by Kaminsky, et al. (1998). This study applied both the signals analysis and the probit estimates to identify the leading indicators of currency crisis for Thailand.

Both approaches have been summarized in the synthesis report. But it should be mentioned here that for the signals analysis, this study starts with the "signaling horizon" of 24 months as used in Kaminsky, et al. (1998) and also performs a test on a 12-month signaling horizon to see if the results are sensitive to the choice of the horizon. The threshold value for each indicator is scanned between the 10-25 percentiles[5] of the indicator's distribution and the "optimal" threshold is the one that minimizes the adjusted "noise-to-signal" ratio where "noise" and "signal" can be defined in the following matrix.

	Event (within 12 or 24 months)	
	Crisis	No crisis
Signal is issued	A (good signal)	B (bad signal or noise)
No signal is issued	C	D

$$\text{Adjusted noise-to-signal ratio} = \frac{B/(B+D)}{A/(A+C)}$$

[5] The 10-25 percentile range may appear arbitrary but it may be looked upon as the probability of rejecting the null hypothesis when it is true, or Type I error. We may regard the normal or tranquil period as our null hypothesis and take the export growth as our indicator, for example. If we find that 10 percent of the observations post an export growth below 1%, we then regard any export growth below 1% as a signal. Such reading of the indicator may be wrong if the null hypothesis (tranquility) is true. Therefore, setting the maximum 25 percentile as the upper limit implies that we are willing to accept one fourth probability of calling a crisis when it is not true. It is found in this study that for some indicators the percentile at which the adjusted noise-to-signal ratio is minimum is far below the 25th percentile.

See more details on methodology in Kaminsky and Reinhart (1999).

The parametric approach employed in this study is the probit estimates. One advantage of this approach is that it summarizes information from all significant variables in one useful number, the probability of a crisis. However, it also has some drawbacks as the estimates may have to exclude some important indicators due to multicollinearity problem. Its summary nature, on the other hand, makes it unclear which variables are sending out alarm unless we keep a close watch on the movement of all significant variables.

4. EMPIRICAL RESULTS

4.1 Crisis Indicators from Signals Approach

Based on the signaling horizon of 24 months and the scan between the 10-25 percentiles, the optimal threshold for each indicator is found and presented in Table 4 together with its adjusted noise-to-signal ratio. A change of signaling horizon to 12 months is also preformed to gauge the sensitivity of our indicators and the information is presented in Table 5. It can be seen that changing the signaling horizon has a significant effect on the performance of some variables, such as import growth, M2 money multiplier, real GDP growth, and ratio of fiscal balance to GDP. For most other variables, the threshold levels and the adjusted noise-to-signal ratio are not greatly affected.

Since the performance of these indicators are indicated by their adjusted noise-to-signal ratio, Tables 6 and 7 rank these indicators from low to high ratios. It can be noticed that the ratio of trade balance to GDP is not present in these two tables because its effect is already included within the ratio of current account to GDP. The same goes for the ratio of private short-term external debt to international reserves the effect of which is already included in the ratio of total short-term external debt to international reserves. In fact, during the period covered in this study the private short-term external debt is very close to the total short-term external debt because the public short-term external debt was insignificantly small in comparison to that of the private sector. It would be redundant to have duplicate measures of the same effect.

Comparing the rank and the adjusted noise-to signal ratio of the indicators in Tables 6 and 7, we can see that there are few indicators the performance of which is rather sensitive to the choice of signaling horizon. Based on an evaluation of the magnitude change in threshold levels and in the noise-to-signal ratio, the following two indicators appear to be rather sensitive to the choice of horizon: import growth and the growth of money multiplier. For import growth, no signals were found for the 12-month signaling horizon. For growth of money multiplier, the threshold and the adjusted noise-to-signal ratio changed from 8.5 and 1.18 for the 24-month horizon to 9.6 and 0.68 for the 12-month horizon. The changes in thresholds and noise-to-signal ratios of other variables are not so large as to cause concern.

Table 4
Performance of Indicators Based on 24-month Signaling Horizon

Indicator	Threshold (%)	Adjusted Noise-to-Signal Ratio
Current Account		
• Import growth in US$ (%)	30.2	0.45
• Export growth in US$ (%)	-6.9	0.95
• Ratio of current account to GDP	-8.1	0.13
• Ratio of trade balance to GDP	-9.3	0.18
• Terms of trade growth	-8.6	0.26
• Real exchange rate misalignment (deviation from previous 60-month average)	-5.9	0.06
Capital Account		
• Difference between domestic (MLR) and foreign interest rates (LIBOR on $)	7.8	0.48
• Ratio of private short-term external debt to international reserves	127.0	0.00
• Ratio of total short-term external debt to international reserves	126.0	0.04
Financial Variables		
• Spread between lending and deposit rates	9.6	0.95
• Growth of M2/international reserves	11.4	0.53
• Growth of domestic credit/GDP	14.8	0.43
• Percentage excess real M1 balance	6.6	0.47
• Growth of money multiplier (M2)	8.5	1.18
Real Sector		
• Real GDP growth	-1.0	1.05
• Ratio of fiscal balance to GDP	-3.4	1.01
• Growth of stock prices (SET index)	-42.5	0.29
• Inflation rate	6.5	0.42

Table 5
Performance of Indicators Based on 12-month Signaling Horizon

Indicator	Threshold (%)	Adjusted Noise-to-Signal Ratio
Current Account		
• Import growth in US$ (%)	*	*
• Export growth in US$ (%)	-3.8	0.55
• Ratio of current account to GDP	-8.3	0.42
• Ratio of trade balance to GDP	-8.5	0.52
• Terms of trade growth	-8.6	0.25
• Real exchange rate misalignment (deviation from previous 60-month average)	-5.3	0.85
Capital Account		
• Difference between domestic (MLR) and foreign interest rates (LIBOR on $)	7.5	0.52
• Ratio of private short-term external debt to international reserves	138.0	0.05
• Ratio of total short-term external debt to international reserves	128.4	0.13
Financial Variables		
• Spread between lending and deposit rates	9.6	0.51
• Growth of M2/international reserves	11.4	0.28
• Growth of domestic credit/GDP	15.0	0.42
• Percentage excess real M1 balance	3.6	0.69
• Growth of money multiplier (M2)	9.6	0.68
Real Sector		
• Real GDP growth	-1.0	0.57
• Ratio of fiscal balance to GDP	-3.4	0.55
• Growth of stock prices (SET index)	-42.5	0.15
• Inflation rate	6.5	0.42

Note:* No signals were found between 10-25 percentiles with the 12-month horizon for import growth.

Table 6
Indicators Ranked According to their Performance (24-month horizon)

Rank	Threshold (%)	Adjusted Noise-to-Signal Ratio
1. Ratio of total short-term external debt to international reserves	126.0	0.04
2. Real exchange rate misalignment	-5.9	0.06
3. Ratio of current account to GDP	-8.1	0.13
4. Terms of trade growth	-8.6	0.26
5. Growth of stock prices	-42.5	0.29
6. Inflation rate	6.5	0.42
7. Growth of domestic credit/GDP	14.8	0.43
8. Import growth (in US$)	30.2	0.45
9. Percentage excess real M1 balance	6.6	0.47
10. Difference between domestic and foreign interest rates (MLR-LIBOR on $)	7.8	0.48
11. Growth of M2/international reserves	11.4	0.53
12. Export growth (in US$)	-6.9	0.95
13. Spread between lending and deposit rates	9.6	0.95
14. Ratio of fiscal balance to GDP	-3.4	1.01
15. Real GDP growth rate	-1.0	1.05
16. Growth of money multiplier (M2)	8.5	1.18

Note: The indicators "trade balance/GDP" and "private short-term external debt/GDP" are excluded from this table as their effect is already inclusive in "current account/GDP" and "total short-term external debt/GDP" respectively.

Table 7
Indicators Ranked According to their Performance (12-month horizon)

Rank	Threshold (%)	Adjusted Noise-to-Signal Ratio
1. Ratio of total short-term external debt to international reserves	128.4	0.13
2. Growth of stock prices	-42.5	0.15
3. Terms of trade growth	-8.6	0.25
4. Growth of M2/international reserves	11.4	0.28
5. Ratio of current account to GDP	-8.3	0.42
6. Growth of domestic credit to GDP	15.0	0.42
7. Inflation rate	6.5	0.42
8. Spread between lending and deposit rates	9.6	0.51
9. Difference between domestic and foreign interest rates (MLR-LIBORON $)	7.8	0.52
10. Export growth (in US$)	-3.8	0.55
11. Ratio of fiscal balance to GDP	-3.4	0.55
12. Real GDP growth	-1.0	0.57
13. Growth of money multiplier (M2)	9.6	0.68
14. Percentage excess real M1 balance	3.6	0.69
15. Real exchange rate misalignment	-5.3	0.85
16. Import growth (in US$)	-	-

Note: The indicators "trade balance/GDP" and "private short-term external debt/GDP" are excluded from this table as their effect is already inclusive in "current account/GDP" and "total short-term external debt/GDP" respectively.

From the author's judgement, the following indicators appear to be least sensitive to the change of signaling horizon:

- the ratio of total short-term external debt to international reserves
- terms of trade growth
- growth of stock prices
- inflation rate.

The remaining indicators appear to be sensitive but their sensitivity appears moderate and does not warrant as much concern as the import growth and the growth of money multiplier.

It is the opinion of the author that a signaling horizon of 24 months may be rather extended as an irregular movement over the threshold at a certain date can be read as a signal for crisis in the following 24 months. Signals obtained from a 12-month horizon analysis may be better if we take the viewpoint that the shorter time span between the occurrence of signals and a possible impending crisis may compel us to be more alert about tracking the monthly movement of these indicators.

Based on the 12-month signaling horizon we can see from Table 7 that there are 15 variables that may be used as leading indicators of currency crisis for Thailand. From historical experience they have issued relatively fewer bad signals (noise) than good ones as evidenced by their adjusted noise-to-signal (N-T-S) ratio of less than one. Their movement can be seen in Figures 2 and 3. However, upon detailed examination of the data's monthly movement, it was found that for some variables their signals were issued after July 1997. Such observation makes it unclear whether their abnormal behavior was in fact caused by the crisis and not vice versa. These are mainly some of the financial variables: spread between lending and deposit rates, difference between domestic and foreign interest rates, growth of money multiplier and excess real M1 balance. Eliminating these from the list of our leading indicators for currency crisis, the remaining 11 indicators are deemed to have satisfactory performance. They are grouped here as indicators with positive and negative shocks.

Indicators with positive shocks are the ones when their increase over a threshold may lead to or add to the possibility of a currency crisis. From the signals analysis, there are four such indicators:

- ratio of total short-term external debt to international reserves
- growth of M2/international reserves
- growth of domestic credit/GDP
- inflation rate.

The ratio of total short-term external debt to international reserves reflects a constraint on the country's liquidity in international transactions: the higher the ratio, the more likely the crisis. The threshold level for this ratio with minimum adjusted N-T-S ratio is 128.4 percent, found at the 21st percentile. So if the amount of total short-term external debt is higher than reserves by more than 28.4 percent, it should trigger concern from the policy maker.

The growth of M2/international reserves indicates the rate of monetary expansion in the economy which can create a harmful inflationary environment. This ratio can also grow due to the decline in foreign exchange reserves. The threshold level for the growth of this ratio with minimum adjusted N-T-S ratio is 11.4 percent, found at the 12th percentile.

The growth of domestic credit/GDP reflects the rate of credit expansion relative to real economic activities. If this growth is excessive, it can lead to bubbling asset prices and inflationary demand due to the wealth effect. The threshold with minimum adjusted N-T-S ratio of this growth rate is 15 percent, found at the 20th percentile.

Figure 2
Movement of Indicators with Negative Shocks (Threshold from 12-month Horizon)

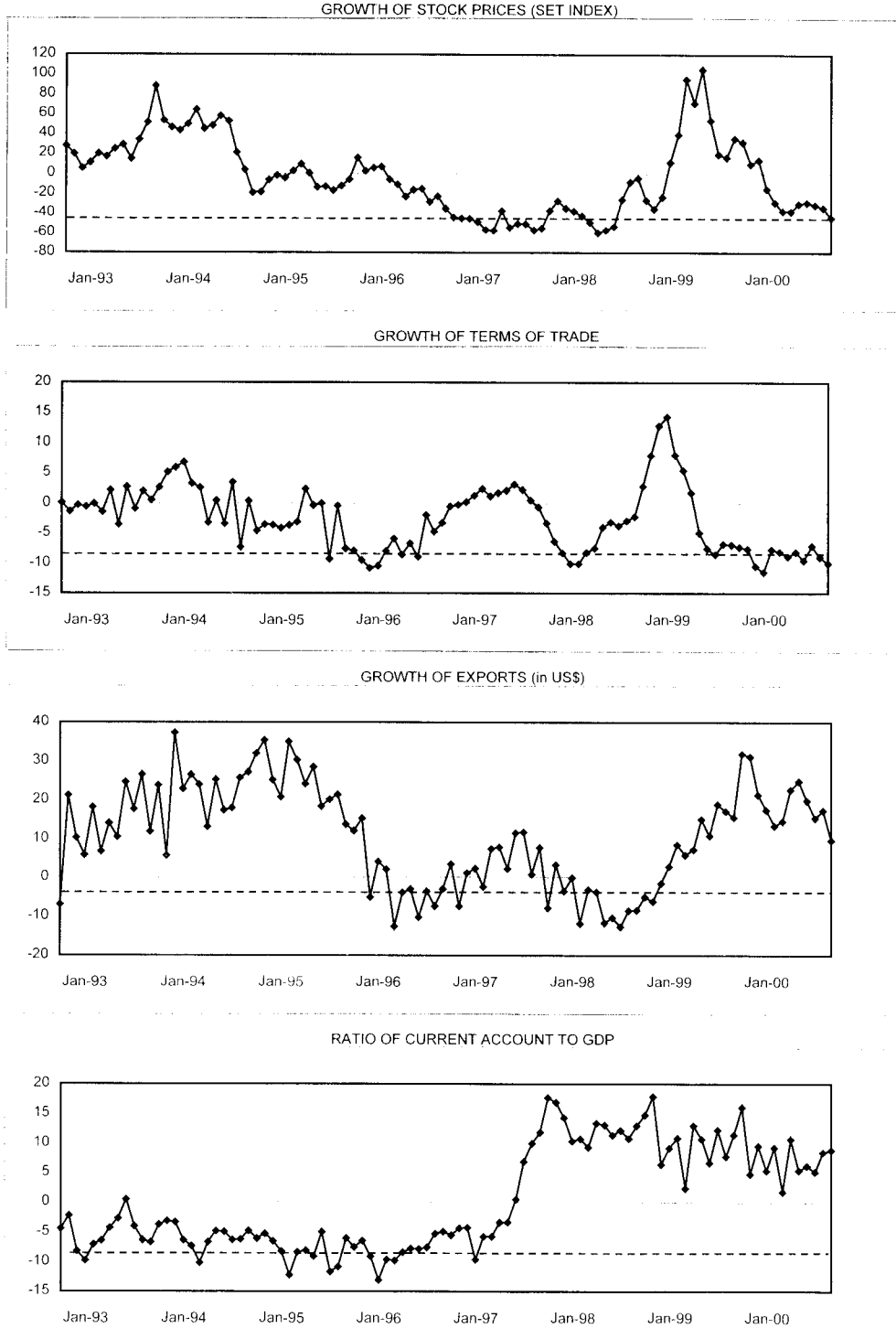


Figure 2 (Continued)

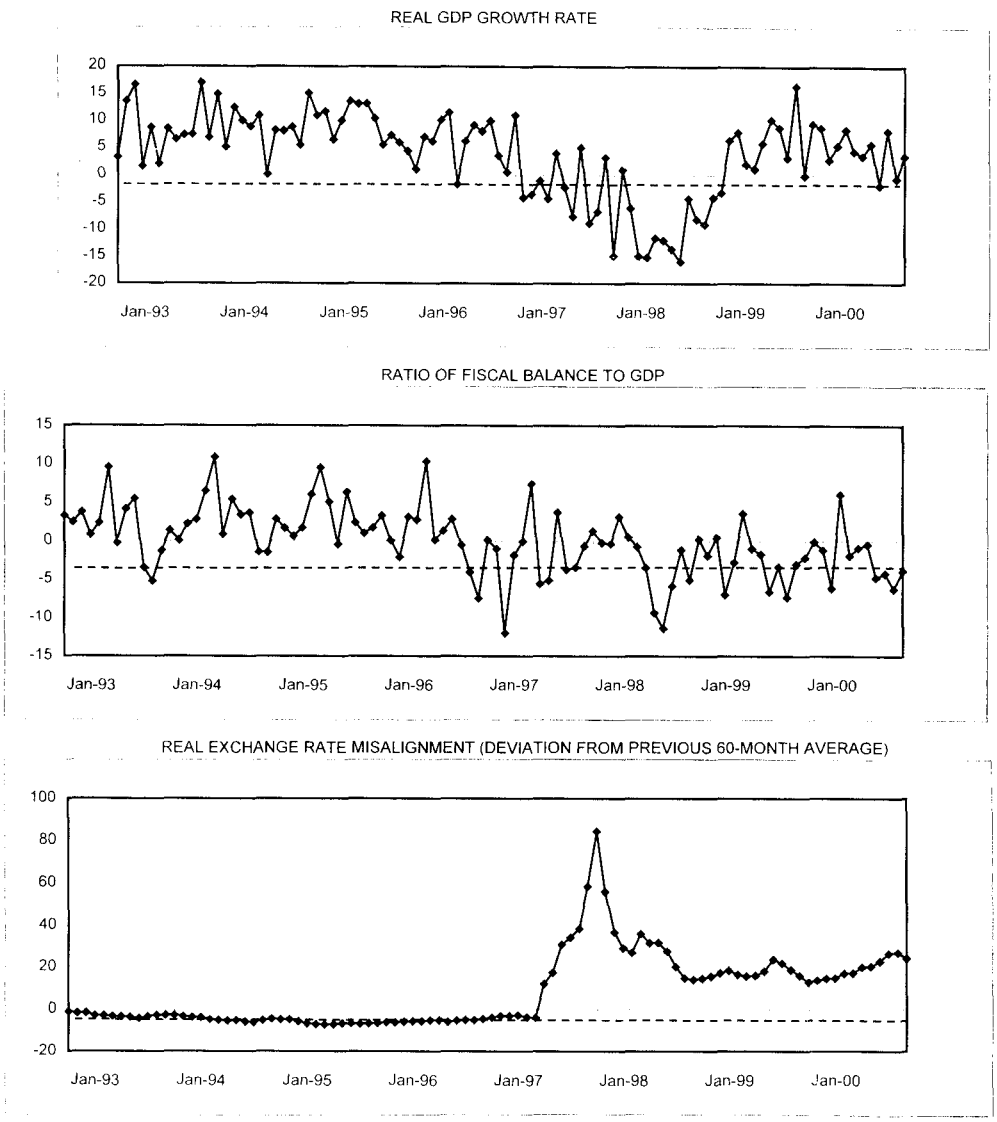


Figure 3
Movement of Indicators with Positive Shocks (Threshold from 12-month Horizon)

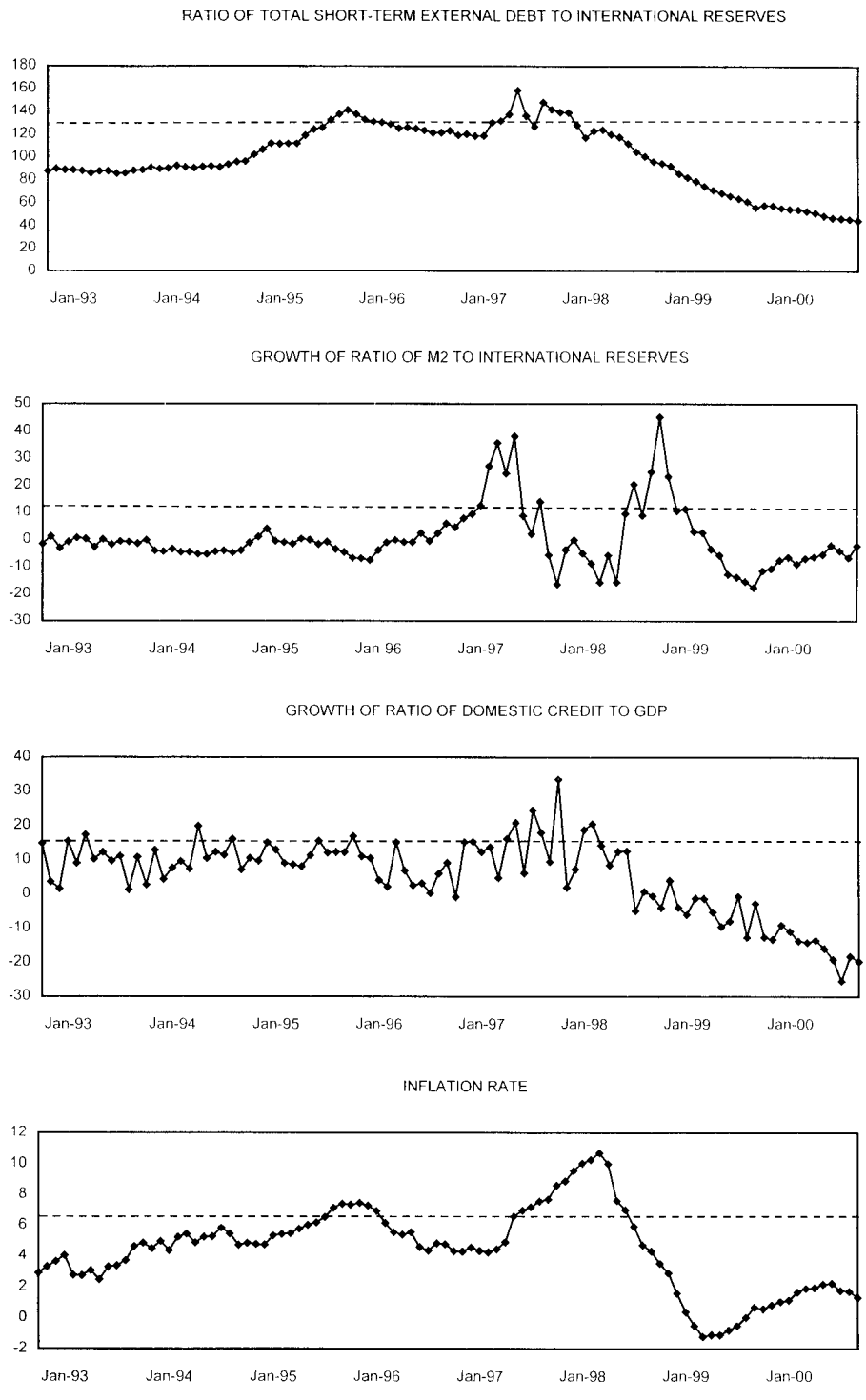
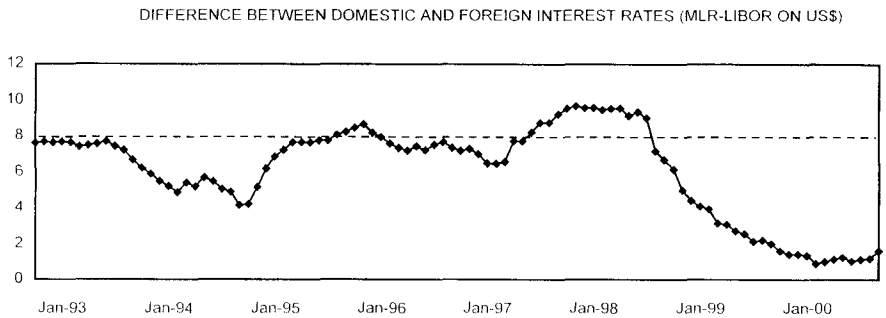
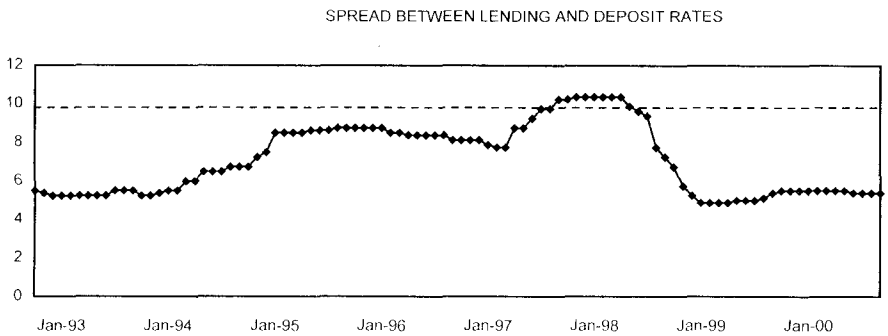
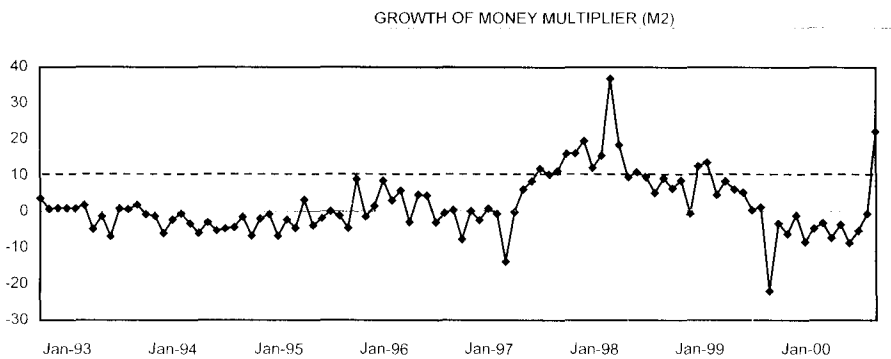
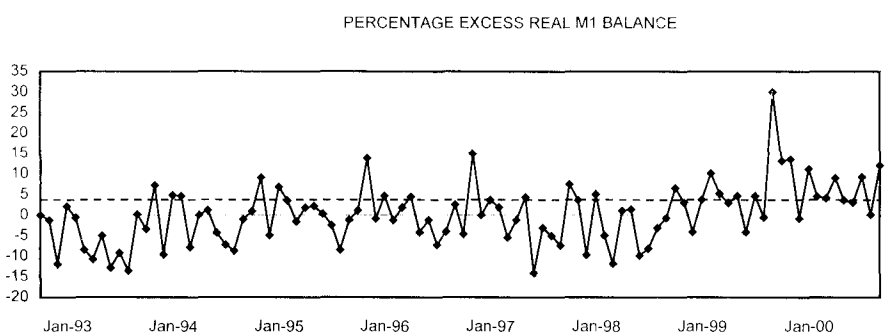


Figure 3 (Continued)









The inflation rate may be a result of excessive expansionary policies, or a rapid increase in demand, or from higher imported prices of inputs. Whatever its cause, its excessive rate erodes the competitiveness of the country and increases the vulnerability to crisis. The threshold of inflation rate with minimum adjusted N-T-S ratio is 6.5 percent, found at the 24th percentile.

Indicators with negative shocks are the ones when their decrease below a threshold may lead to or add to the possibility of a currency crisis. There are seven such indicators.

- growth of stock prices
- terms of trade growth
- export growth
- ratio of current account to GDP
- real GDP growth rate
- ratio of fiscal balance to GDP
- real exchange rate misalignment.

The negative growth in stock prices reflects lower expectation of future earnings and lower confidence in the domestic economy. The stock prices as measured by the SET index is also found to be an important component of Thailand's composite leading indicator by Tinakorn (1998). The threshold with minimum adjusted N-T-S ratio for the SET index is –42.5 percent, found at the 18th percentile. This number appears to be of a rather large magnitude if the SET index hovers around 200-300 points as at present. But during the sample period, the range of the SET index was between 1,528.83 (October 1994) and 214.3 (August 1998) and the rate of year-on-year decline went up to almost 60 percent for some months.

The terms of trade is the ratio of export price over import price. A decline in this ratio means imports are relatively more expensive than exports which will have a negative impact on the trade and current account, and ceteris paribus, the balance of payments. In a cross-country study by Kaminky and Reinhart (1999), it is found that crises are preceded, on average, by a deterioration of the terms of trade with an annual decline that is about 10 percent deeper than those observed in tranquil times prior to balance-of-payments crisis. For the case of Thailand, the threshold of the annual decline in the terms of trade with the minimum adjusted N-T-S ratio is –8.6 percent, found at the 10th percentile.

Exports account for more than 50 percent of GDP in Thailand. Therefore its decline has grave implications for the real sector as well as the position of the current account and the balance of payments. The threshold with the minimum adjusted N-T-S is the export growth at –3.8 percent,[6] found at the 20th percentile.

The current account includes the international exchange of both goods and services and the current account deficit has a negative impact on the foreign exchange earnings. This variable is measured as a ratio of GDP and its threshold with minimum adjusted N-T-S ratio is found to be –8.3 percent, at the 15th percentile meaning that current account deficit that runs in excess of eight percent of GDP is a warning for increased vulnerability of the economy.

Both the real GDP growth rate and the ratio of fiscal balance to GDP are found to be rather sensitive to the choice of signaling horizon. Their performance improves when the 12-month horizon is used. The threshold for GDP growth rate is –1.0 percent, at the 25th percentile and that for the ratio of fiscal balance to GDP is –3.4 percent, at the 19th percentile. Although the deterioration in these two indicators increases the economy's vulnerability, it is also the case that these two indicators tend to deteriorate after the onset of crisis if the currency crisis evolves into economic crisis.

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[6] It is notable that this number is quite different from the threshold of 5.6 found in Poonpatpibul and Ittisupornrat (2001) which used the same signals approach. Such difference cannot be attributed to their using a 24-month horizon because in this study the threshold from the 24-month horizon for export growth is –6.9.

The evolution of real exchange rate has a significant implication for the country's competitiveness. Kaminsky and Reinhart (1999) found that during the year before the balance-of-payments and banking crises, the real exchange rate shows evidence of being overvalued. This is also the case for Thailand. In this study, the real exchange rate is measured in terms of baht per US dollar adjusted by the ratio of US consumer price index over Thai consumer price index. Therefore a decline in this variable means an appreciation of the baht which will have a negative impact on export earnings and increase the vulnerability of the economy. The misalignment of the real exchange rate is measured as a deviation from its previous 60-month average. The threshold of this deviation with minimum adjusted noise-to-signal ratio is –5.3 percent, at the 25th percentile.

4.2 Composite Indicator and Probability of Crisis from Signals Approach

One way of combining the signals sent out by all the above eleven indicators is simply by counting the number of individual indicators that have crossed their threshold in a particular month as in equation (2):

$$I_t^{(1)} = \sum_{j=1}^{n} S_t^j \quad \text{.....(2)}$$

where S_t^j = 1 if variable j crosses the threshold in period t

S_t^j = 0, otherwise

However, $I_t^{(1)}$ does not take into account the fact that each variable has different forecasting accuracy as depicted by its adjusted noise-to-signal ratio. For example, the low noise-to-signal ratio of 0.1 of variables X contains information that it has more forecasting accuracy than variable Y with a noise-to-signal ratio of 0.9. Therefore, the composite indicator should give more weight to the signal sent out by X than that by Y. This leads us to a weighted composite indicator based on the adjusted noise-to-signal ratio of each variable.

$$I_t^{(2)} = \sum_{t=1}^{n} S_t^j . \frac{1}{w^j} \quad \text{..... (3)}$$

where w^j = the adjusted noise-to-signal ratio of variable j.

Kaminsky (1999) also experimented with two other composite indicators, and found the weighted composite indicator presented in equation (3) to perform the best when predicting both currency and banking crisis.[7] In this study, the weighted composite index ($I_t^{(2)}$) is computed and used to calculate the conditional probability of currency crisis in the formula:

$$\text{Prob (crisis/I=X)} = \frac{\text{(No. of months the composite index = X and currency crisis actually occurred within 12 months)}}{\text{No. of months the composite index = X}}$$

where X is the value of the composite index. It was found that, in general, the increase in the composite indicator results in higher conditional probability of crisis. However, there were a few cases where the value (x) of the composite index was high but crisis did not actually occurred within 12 months and vice versa. This can be seen in Figure 4 (panel a) which plots

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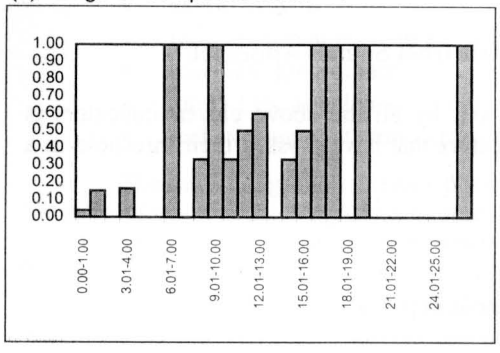
[7] The other two composite indicators considered by Kaminsky (1999) are the following cases:
a) extreme signals are given more weight than mild signals;
b) a time horizon of 8 months is taken into account when adding up signals because not all indicators issue signals jointly in the same month.
See more details in Kaminsky (1999).

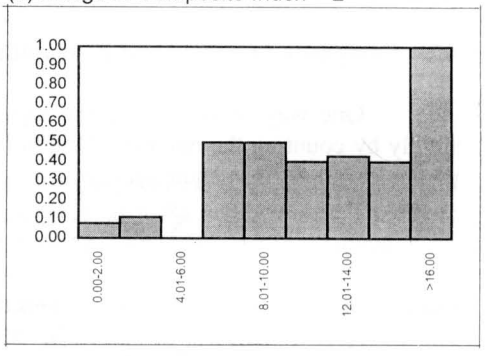
the conditional probability of a crisis given the value of the composite index. To obtain a smoother increasing function of probability as the composite index increases requires some grouping of the composite index. It appears that a grouping with a range of six (panel *f* in Figure 4) renders a smooth increasing function of probability as the composite index increases. The result of such grouping is presented in Table 8.

Figure 4
Plot of Conditional Probability of Crisis Given the Value of the Composite Index

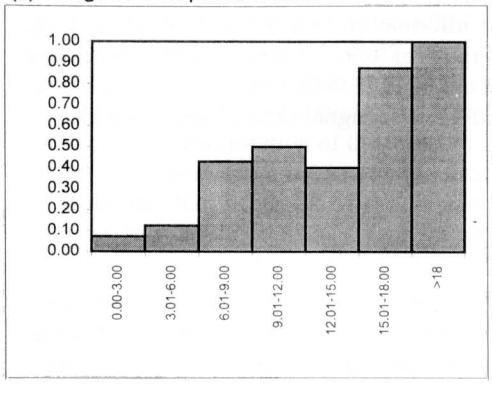
(a) Range of Composite Index = 1



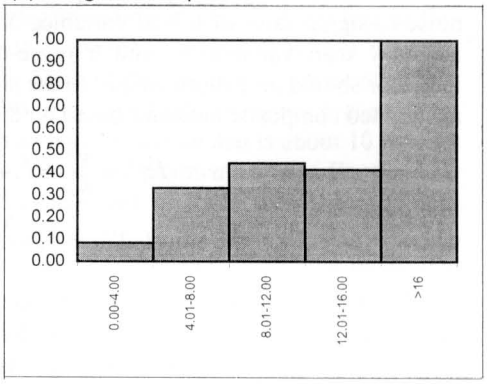
(b) Range of Composite Index = 2



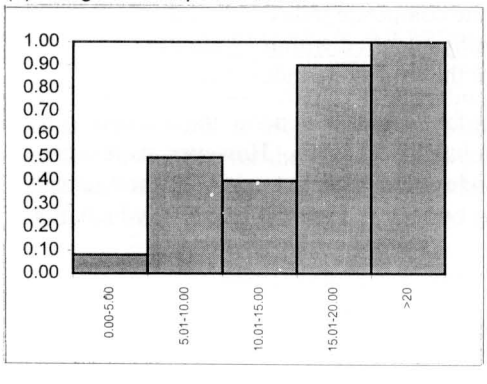
(c) Range of Composite Index = 3



(d) Range of Composite Index = 4



(e) Range of Composite Index = 5



(f) Range of Composite Index = 6

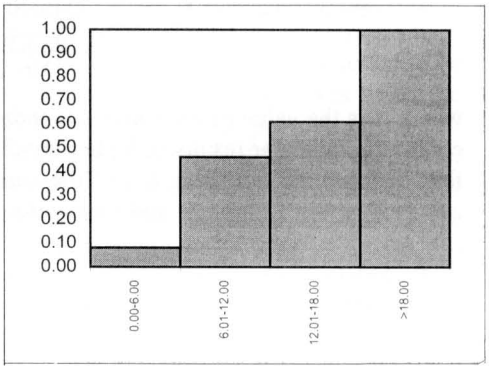


Table 8
Composite Index and Conditional Probability of Currency Crisis

Value of composite index (X)	No. of months the index = X	No. of months the index = X and currency crisis occurred within 12 months	Conditional probability of currency crisis
0.00 – 6.00	49	4	0.08
6.01 – 12.00	13	6	0.46
12.01 – 18.00	18	11	0.61
>18.00	4	4	1.00
*Quadratic Probability Score (QPS) = 0.266			

Note*: QPS = $\frac{1}{T}\sum_{t=1}^{T} 2(P_t - R_t)^2$

Where P_t = probability of crisis between t and t + h conditional on information provided by the composite indicator

R_t = realization which equals one if a crisis occurs between t and t + h and equals zero otherwise

h = time horizon, e.g. 12 months

QPS ranges from 0 to 2, with a score of 0 corresponding to perfect accuracy. See Kaminsky (1999).

Based on the above conditional probability we may look at the value of the composite index computed from those 11 indicators and predict that the probability of a crisis in the next 12 months is about 0.61 if the value exceeds 12. And if the value of the composite index exceeds 18, it is most likely that a crisis is coming as the conditional probability is equal to one.

4.3 Probit Estimates

The set of indicators used as explanatory variables in the probit estimation is the same as that used for signals analysis. However, all of the indicators cannot be simultaneously put into an estimation as the presence of multicollinearity among some variables results in large variances and insignificant t-statistics. Two of the most acceptable sets of estimates are shown in Tables 9, and 10. These two models are chosen based on the signs of coefficients that conform to economic reasoning, and also on their statistical significance and predictive performance. There appears to be a common set of core variables that can explain the probability of crisis. Their coefficients have the correct (expected) signs and the coefficients are statistically significant at 95% confidence level (one-tail test). These variables are summarized below:

Variables	Model 1	Model 2
1. growth rate of the ratio M2/reserves	√	√
2. deviation of real exchange rate	√	√
3. ratio of current account to GDP	√	√
4. growth of stock price index	√	√
5. growth of real GDP	√	-
6. ratio of fiscal balance to GDP	√	√
7. export growth	-	√

Even though these two models seem to be about equal on statistical grounds, the frequencies of actual and predicted outcomes appear to be in favor of Model 2. Based on a cut-off probability of 0.5, Model 2 made a correct prediction of 1's for 13 observations out of 14 outcomes during the crisis period and made an incorrect prediction of 1's for 7 observations during the tranquil period. On the other hand, Model 1 made fewer numbers of correct prediction for crisis and more numbers of incorrect prediction during the tranquil time.

Table 9
Probit Estimate for Currency Crisis: Model 1 (1994.1-2000.12)

Variable	Coefficient (partial derivatives)	Std. Error	b/Std.Err	P[| Z| >z]	x-bar
M2RESG6	0.0072	0.0034	2.133	0.0329	0.7728
DRER603	-0.0137	0.0035	-3.905	0.0001	8.8105
CAGDP6	-0.0180	0.0082	-2.201	0.0277	0.3084
SETG6	-0.0026	0.0014	-1.796	0.0726	-2.3993
FBGDP12	-0.0217	0.0101	-2.145	0.0320	0.2302
RGDP6	-0.0253	0.0078	-3.226	0.0013	3.5784

Log-likelihood -27.1393
Chi-squared 21.4158
(Significance level 0.0007)

Frequencies of actual and predicted outcomes: (cut-off probability = 0.5)

	Actual		
Predicted	**1 (Crisis)**	**0 (No crisis)**	**Total**
1 (signal)	11	8	19
0 (no signal)	3	62	65
Total	14	70	84

Proportion of correct prediction = 0.869
Adjusted noise-to-signal ratio = 0.145

Definition of variables:

M2RESG6 = growth in the ratio of M2 over reserves (lagged 6 months)
DRER603 = deviation of real exchange rate from previous 60-month average (lagged 3 months)
CAGDP6 = ratio of current account to GDP (lagged 6 months)
SETG6 = growth rate of stock price index (lagged 6 months)
FBGDP12 = ratio of fiscal balance to GDP (lagged 12 months)
RGDPG6 = growth rate of real GDP (lagged 6 months)

Table 10
Probit Estimate for Currency Crisis: Model 2 (1994.1-2000.12)

Variable	Coefficient (partial derivatives)	Std. Error	b/Std.Err	P[|Z|>z]	x-bar
M2RESG6	0.0059	0.0031	1.911	0.0560	0.7728
DRER603	-0.0097	0.0035	-2.788	0.0053	8.8105
CAGDP6	-0.0121	0.0069	-1.752	0.0798	0.3084
SETG3	-0.0030	0.0015	-1.950	0.0511	-4.3632
X$G6	-0.0136	0.0039	-3.438	0.0006	10.0784
FBGDP12	-0.0234	0.0104	-2.250	0.0244	0.2302

Log-likelihood -19.28912
Chi-squared 37.11604
(Significance level 0.0000)

Frequencies of actual and predicted outcomes: (cut-off probability = 0.5)

	Actual		
Predicted	**1 (Crisis)**	**0 (No crisis)**	**Total**
1	13	7	20
0	1	63	64
Total	14	70	84

Proportion of correct prediction = 0.905
Adjusted noise-to-signal ratio = 0.108

Definition of variables:

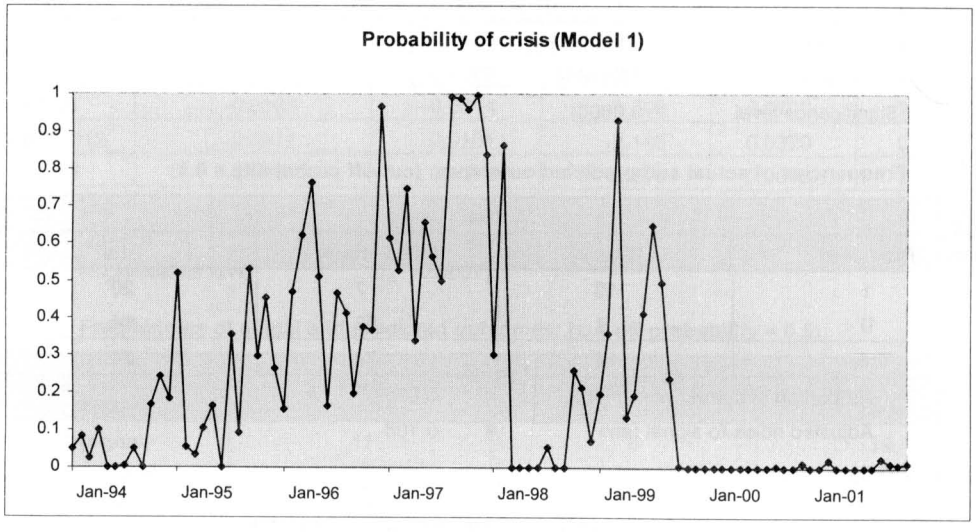
M2RESG6 = growth in the ratio of M2 over reserves (lagged 6 months)
DRER603 = deviation of real exchange rate from previous 60-month average (lagged 3 months)
CAGDP6 = ratio of current account to GDP (lagged 6 months)
SETG3 = growth rate of stock price index (lagged 3 months)
X$G6 = export growth in US $ (lagged 6 months)

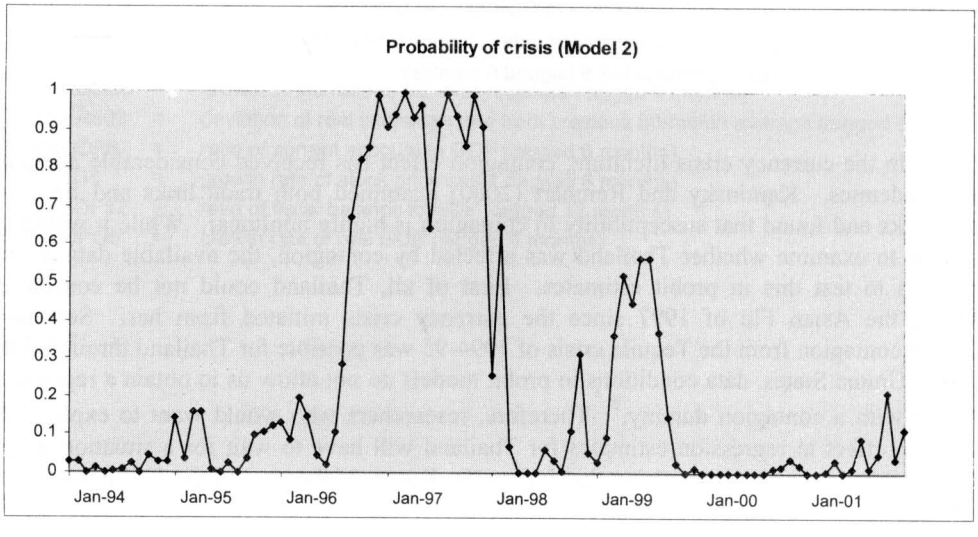
In the currency crisis literature, contagion effect has received considerable attention from academics. Kaminsky and Reinhart (2000) examined both trade links and financial sector links and found that susceptibility to contagion is highly nonlinear. While it would be desirable to examine whether Thailand was affected by contagion, the available data do not permit us to test this in probit estimates. First of all, Thailand could not be considered catching the Asian Flu of 1997 since the currency crisis initiated from her. Secondly, although contagion from the Tequila crisis of 1994-95 was possible for Thailand through links with the United States, data conditions in probit models do not allow us to obtain a regression estimate with a contagion dummy.[8] Therefore, researchers who would want to explore the contagion effect in regression estimates for Thailand will have to wait for a situation where Thailand falls into a similar position that Indonesia, Korea, Malaysia and the Philippines were in during 1997.

[8] The criterion for dummy variables in probit estimates is that there must be observations for which the left-hand-side variable takes both values 0 and 1 in both groups of the observations for the right-hand-side dummy variable. See Greene (1995:416).

If we regard the probit prediction of 1 as a signal for crisis, then we can regard the incorrect signal as noise. With this perspective, the adjusted noise-to-signal ratio can be calculated for each model and the ratios are also presented in Tables 9 and 10. The adjusted noise-to-signal ratios of Models 1 and 2 are, respectively, 0.145 and 0.108. Therefore, the in-sample predictive performance appears to be in favor of Model 2. It should also be pointed out that during the crisis period, the probability of a crisis from probit estimate is very high and it is low during the non-crisis period. The plots of the probability of crisis from Models 1 and 2 are presented in Figure 5.

Figure 5
Plot of Probability of Currency Crisis from Probit Estimates





4.4 Assessment of Future Vulnerability

We can use both the signals analysis and the probit estimates to assess the future vulnerability of Thailand to currency crisis. However, the data requirement of these two methods is somewhat different. From the signals approach, we may use the present available data to compute the index of currency crisis and make use of the conditional probability in Table 8 to assess the likelihood of a crisis within the next 12 months. Forecast by the probit estimation, on the other hand, can be made for only 3 months ahead since the lags of explanatory variables vary from 3 to 12 months. So for the probit estimate, we only check its out-of sample predictive performance, given the data for 2001.

Table 11 presents the out-of-sample forecast for the probability of a crisis from probit models during 2001. It can be seen that both models predicted very low probability of a currency crisis during 2001. There appeared to be a rise in this probability during the month of July, September and October but the probability dropped afterwards. Overall, the probability predicted by probit models was low and there was no currency crisis in 2001. If we want to assess future vulnerability, then we have to first forecast the values of the indicators in probit models, which is at present beyond the scope of this report. But we can do it with the signals approach, given that the signals approach helps predict a crisis within the next 12 months. We can use the available data in December 2001 to say something about the prospect of a crisis up to December 2002.

Table 11
Probability of a Currency Crisis from Probit Estimates (out-of-sample forecast)

Year 2001	Model 1	Model 2
January	.0001	.0001
February	.0001	.0001
March	.0202	.0030
April	.0018	.0325
May	.0003	.0000
June	.0018	.0109
July	.0002	.0914
August	.0003	.0134
September	.0244	.0482
October	.0137	.2110
November	.0084	.0351
December	.0104	.1149

Table 12 presents the composite index ($I^{(2)}$) of 11 variables found to be leading indicators of currency crisis for Thailand in this study. The composite index for 2001 lies between 1.82 and 7.64 with probability of a crisis between 0.08 and 0.46. Using 0.5 as a cut-off point, the composite index implies that a currency crisis is not likely in the next 12 months. Nevertheless, we should be watchful of these indicators because the terms of trade have had a negative growth in the past 12 months and export growth in dollar value also has continuously registered negative growth below its threshold value of -3.8 percent since July 2001. The fiscal balance has also been mostly in deficit due to the stimulus fiscal policy. As a consequence, the ratio of fiscal balance to GDP has been running below its threshold value in the last four months of 2001.

Table 12
Composite Index and Conditional Probability of a Currency Crisis within 12 Months

	Total short term debt/reserves		SET index		Terms of trade		M2 / reserves	
	(ratio)	Signal	(growth)	Signal	(growth)	Signal	(growth)	Signal
Threshold	128.4		-42.5		-8.6		11.4	
Adj n-t-s	0.13		0.15		0.25		0.28	
Jan-01	44.47	0	-30.32	0	-12.76	1	-9.31	0
Feb-01	43.67	0	-13.12	0	-14.60	1	-10.38	0
Mar-01	44.50	0	-27.07	0	-13.80	1	-8.53	0
Apr-01	45.30	0	-22.99	0	-12.53	1	-10.70	0
May-01	45.97	0	-4.07	0	-11.81	1	-8.68	0
Jun-01	47.10	0	-0.96	0	-10.64	1	-6.35	0
Jul-01	45.82	0	4.57	0	-7.97	0	-6.21	0
Aug-01	43.99	0	9.01	0	-6.45	0	-5.05	0
Sep-01	43.08	0	-0.09	0	-4.75	0	-1.74	0
Oct-01	41.55	0	1.20	0	-6.01	0	-2.20	0
Nov-01	40.37	0	8.89	0	-6.95	0	0.00	0
Dec-01	39.73	0	12.88	0	-6.09	0	1.06	0

	Domestic credit/GDP		Deviaiton of RER from 60 months		Current account/GDP		Inflation	
	(growth)	Signal	(%)	Signal	(ratio)	Signal	(own level)	Signal
Threshold	15.0		-5.3		-8.3		6.5	
Adj n-t-s	0.42		0.85		0.42		0.42	
Jan-01	-22.32	0	23.67	0	2.79	0	1.31	0
Feb-01	-17.29	0	21.20	0	8.68	0	1.46	0
Mar-01	-17.54	0	24.15	0	2.77	0	1.39	0
Apr-01	-19.70	0	27.00	0	1.61	0	2.55	0
May-01	-21.44	0	26.03	0	3.95	0	2.78	0
Jun-01	-20.49	0	24.93	0	5.59	0	2.31	0
Jul-01	-25.67	0	24.50	0	3.50	0	2.15	0
Aug-01	-23.48	0	21.72	0	10.53	0	1.38	0
Sep-01	-0.30	0	19.32	0	3.65	0	1.37	0
Oct-01	-14.86	0	19.53	0	5.13	0	1.38	0
Nov-01	-10.70	0	17.83	0	5.59	0	0.99	0
Dec-01	-10.06	0	15.47	0	11.05	0	0.77	0

	Exports (in US$)		Real GDP		Fiscal balance/GDP		Composite index of currency crisis	Conditional probability of currency crisis
	(growth)	Signal	(growth)	Signal	(ratio)	Signal		
Threshold	-3.8		-1.0		-3.4			
Adj n-t-s	0.55		0.57		0.55			
Jan-01	-3.91	1	5.35	0	-3.18	0	5.82	0.08
Feb-01	-3.70	0	-0.86	0	-2.65	0	4.00	0.08
Mar-01	3.59	0	0.66	0	-2.56	0	4.00	0.08
Apr-01	-8.02	1	1.61	0	-5.00	1	7.64	0.46
May-01	6.81	0	2.92	0	5.19	0	4.00	0.08
Jun-01	-0.96	0	0.94	0	2.67	0	4.00	0.08
Jul-01	-14.18	1	7.60	0	-1.75	0	1.82	0.08
Aug-01	-7.59	1	5.70	0	1.13	0	1.82	0.08
Sep-01	-11.38	1	-8.18	1	-5.94	1	5.39	0.08
Oct-01	-14.16	1	6.09	0	-10.09	1	3.64	0.08
Nov-01	-12.30	1	0.86	0	-5.00	1	3.64	0.08
Dec-01	-13.70	1	-0.70	0	-3.72	1	3.64	0.08

There also remain some structural problems in the financial and real sectors, and the high and rapidly rising public debt is a significant cause for concern. However, the recent oil price decline and the prospect of the would economy picking up are positive signs for Thailand's future exports.

5. CONCLUSIONS

Based on Thailand's available monthly data during 1992-2000, it is found in this study that there are several leading indicators of currency crisis that we should keep track of. The signals analysis based on the 12-month signaling horizon yielded 11 indicators that seem to have good performance. A subset of these indicators also performed well with probit estimates, which yielded high probability of crisis during the crisis period and very low probability otherwise. These variables can be grouped by sector as follows:

Indicators	Signals Approach	Probit Estimates
External sector variables		
Terms of trade growth	√	
Export growth	√	√
Ratio of current account to GDP	√	√
Real exchange rate misalignment	√	√
Ratio of short-term external debt to international reserves	√	
Financial variables		
Growth of M2/international reserves	√	√
Growth of domestic credit/GDP	√	
Real sector variables		
Ratio of fiscal balance to GDP	√	√
Inflation rate	√	
Real GDP growth rate	√	√
Change in stock prices	√	√

In fact, these variables indicate the general health of the macroeconomy and they should be kept track of by the concerned authorities. One can notice that the above list runs a little short of financial variables. Since there seems to be a vicious cycle in which currency crisis and banking crisis feed back on each other, an in-depth analysis of Thailand's banking troubles and their causes in the past is recommended.

There are some weaknesses in this study that should be pointed out to the readers. The first one is that the sample period included in this study actually covered only one episode of currency crisis, running continuously from January 1997 to early 1998. It would have been more desirable to cover another episode of currency crisis in 1984 when the baht had to be devalued by about 14.7 percent. However, several important indicators are not available on a monthly or even a quarterly basis prior to the 1990s. The 1984 currency crisis episode is precluded from this study since it is the author's opinion that the availability of important indicators has a priority over another episode of crisis. Secondly, even when the sample period is restricted to the 1990s, there are still some important variables that are available only

at the quarterly level. These are GDP and short-term external debt and their quarterly data were used to estimate the monthly data as already explained in the text.

Given the above mentioned weakness, the result from both the signals analysis and probit estimates conducted in this study appear quite satisfactory on both theoretical and statistical grounds. In hindsight, the fact that there were signals for and high probability of a currency crisis for the 1997 event indicated that there were some fundamental problems with the Thai economy that led speculators to attack the baht. The concerned authorities should be more watchful on the movements in all leading economic indicators than in the past. Another equally important measure is to try to update these data as quickly as possible because leading indicators that are collected late may not be able to alert us in time enough to take any mitigating actions, if there are possible mitigating actions to take.

APPENDIX A
INDEX OF CURRENCY MARKET TURBULENCE

	Exchange rate		International reserves			Index of currency market turbulence			
		%change		%change	I	I+2sd	I > I+2SD.	I+1.5sd	I > I+1.5SD.
Jan-93	25.53	0.24	21,937.00	3.57	-3.60	12.60	0	9.47	0
Feb-93	25.49	-0.16	21,634.90	-1.38	1.33	12.60	0	9.47	0
Mar-93	25.42	-0.27	22,239.40	2.79	-3.28	12.60	0	9.47	0
Apr-93	25.23	-0.75	22,611.60	1.67	-2.55	12.60	0	9.47	0
May-93	25.22	-0.04	23,114.70	2.22	-2.43	12.60	0	9.47	0
Jun-93	25.21	-0.04	23,979.80	3.74	-4.07	12.60	0	9.47	0
Jul-93	25.31	0.40	23,919.70	-0.25	0.67	12.60	0	9.47	0
Aug-93	25.18	-0.51	24,222.80	1.27	-1.88	12.60	0	9.47	0
Sep-93	25.19	0.04	25,225.30	4.14	-4.41	12.60	0	9.47	0
Oct-93	25.26	0.28	25,544.40	1.26	-1.08	12.60	0	9.47	0
Nov-93	25.36	0.40	25,206.10	-1.32	1.82	12.60	0	9.47	0
Dec-93	25.45	0.35	25,438.80	0.92	-0.64	12.60	0	9.47	0
Jan-94	25.53	0.31	25,359.30	-0.31	0.65	12.60	0	9.47	0
Feb-94	25.38	-0.59	26,251.30	3.52	-4.37	12.60	0	9.47	0
Mar-94	25.29	-0.35	26,672.60	1.60	-2.08	12.60	0	9.47	0
Apr-94	25.25	-0.16	26,592.80	-0.30	0.16	12.60	0	9.47	0
May-94	25.21	-0.16	27,512.80	3.46	-3.88	12.60	0	9.47	0
Jun-94	25.14	-0.28	28,340.50	3.01	-3.51	12.60	0	9.47	0
Jul-94	24.97	-0.68	28,588.30	0.87	-1.62	12.60	0	9.47	0
Aug-94	25.02	0.20	29,064.00	1.66	-1.59	12.60	0	9.47	0
Sep-94	24.98	-0.16	29,950.20	3.05	-3.44	12.60	0	9.47	0
Oct-94	24.96	-0.08	29,851.70	-0.33	0.27	12.60	0	9.47	0
Nov-94	24.98	0.08	29,743.20	-0.36	0.47	12.60	0	9.47	0
Dec-94	25.10	0.48	30,279.00	1.80	-1.46	12.60	0	9.47	0
Jan-95	25.07	-0.12	29,906.10	-1.23	1.21	12.60	0	9.47	0
Feb-95	25.02	-0.20	30,135.60	0.77	-1.03	12.60	0	9.47	0
Mar-95	24.76	-1.04	30,119.50	-0.05	-0.98	12.60	0	9.47	0
Apr-95	24.56	-0.81	31,727.10	5.34	-6.55	12.60	0	9.47	0
May-95	24.66	0.41	33,272.40	4.87	-4.83	12.60	0	9.47	0
Jun-95	24.67	0.04	34,958.30	5.07	-5.41	12.60	0	9.47	0
Jul-95	24.74	0.28	34,415.70	-1.55	1.95	12.60	0	9.47	0
Aug-95	24.95	0.85	34,629.10	0.62	0.18	12.60	0	9.47	0
Sep-95	25.12	0.68	35,866.10	3.57	-3.16	12.60	0	9.47	0
Oct-95	25.11	-0.04	35,731.40	-0.38	0.36	12.60	0	9.47	0
Nov-95	25.16	0.20	36,204.40	1.32	-1.23	12.60	0	9.47	0
Dec-95	25.16	0.00	37,026.70	2.27	-2.44	12.60	0	9.47	0
Jan-96	25.29	0.52	37,721.20	1.88	-1.50	12.60	0	9.47	0
Feb-96	25.24	-0.20	38,694.20	2.58	-2.97	12.60	0	9.47	0
Mar-96	25.23	-0.04	38,982.50	0.75	-0.84	12.60	0	9.47	0
Apr-96	25.27	0.16	38,862.30	-0.31	0.49	12.60	0	9.47	0
May-96	25.29	0.08	39,053.80	0.49	-0.45	12.60	0	9.47	0
Jun-96	25.35	0.24	39,830.00	1.99	-1.90	12.60	0	9.47	0
Jul-96	25.34	-0.04	39,360.60	-1.18	1.23	12.60	0	9.47	0
Aug-96	25.27	-0.28	39,370.30	0.02	-0.30	12.60	0	9.47	0
Sep-96	25.36	0.36	39,537.00	0.42	-0.10	12.60	0	9.47	0
Oct-96	25.46	0.39	39,902.50	0.92	-0.60	12.60	0	9.47	0
Nov-96	25.45	-0.04	39,613.30	-0.72	0.74	12.60	0	9.47	0
Dec-96	25.56	0.43	38,724.50	-2.24	2.85	12.60	0	9.47	0

(Continued on page 50)

APPENDIX A (Continued)

	Exchange rate		International reserves			Index of currency market turbulence			
		%change		%change	I	I+2sd	I > I+2SD.	I+1.5sd	I > I+1.5SD.
Jan-97	25.69	0.51	39,233.80	1.32	-0.91	12.60	0	9.47	0
Feb-97	25.90	0.82	38,149.10	-2.76	3.79	12.60	0	9.47	0
Mar-97	25.92	0.08	38,065.60	-0.22	0.31	12.60	0	9.47	0
Apr-97	26.03	0.42	37,320.10	-1.96	2.53	12.60	0	9.47	0
May-97	25.84	-0.73	33,307.60	-10.75	10.84	12.60	0	9.47	1
Jun-97	25.75	-0.35	32,353.00	-2.87	2.74	12.60	0	9.47	0
Jul-97	30.16	17.13	30,424.20	-5.96	23.54	12.60	1	9.47	1
Aug-97	32.41	7.46	25,938.60	-14.74	23.32	12.60	1	9.47	1
Sep-97	36.27	11.91	29,612.20	14.16	-3.33	12.60	0	9.47	0
Oct-97	37.55	3.53	31,287.20	5.66	-2.56	12.60	0	9.47	0
Nov-97	39.30	4.66	26,253.60	-16.09	21.97	12.60	1	9.47	1
Dec-97	45.29	15.24	26,967.70	2.72	12.31	12.60	0	9.47	1
Jan-98	53.71	18.59	26,724.30	-0.90	19.56	12.60	1	9.47	1
Feb-98	46.30	-13.80	26,156.10	-2.13	-11.51	12.60	0	9.47	0
Mar-98	41.33	-10.73	27,680.00	5.83	-17.00	12.60	0	9.47	0
Apr-98	39.48	-4.48	29,530.50	6.69	-11.67	12.60	0	9.47	0
May-98	39.14	-0.87	27,450.50	-7.04	6.71	12.60	0	9.47	0
Jun-98	42.36	8.25	26,571.70	-3.20	11.69	12.60	0	9.47	1
Jul-98	41.19	-2.77	26,776.30	0.77	-3.60	12.60	0	9.47	0
Aug-98	41.58	0.94	26,678.80	-0.36	1.33	12.60	0	9.47	0
Sep-98	40.41	-2.80	27,290.80	2.29	-5.27	12.60	0	9.47	0
Oct-98	38.14	-5.62	28,482.10	4.37	-10.31	12.60	0	9.47	0
Nov-98	36.46	-4.40	28,891.40	1.44	-5.95	12.60	0	9.47	0
Dec-98	36.25	-0.58	29,535.90	2.23	-2.98	12.60	0	9.47	0
Jan-99	36.59	0.94	29,013.10	-1.77	2.84	12.60	0	9.47	0
Feb-99	37.06	1.28	28,721.40	-1.01	2.37	12.60	0	9.47	0
Mar-99	37.51	1.21	29,936.10	4.23	-3.34	12.60	0	9.47	0
Apr-99	37.60	0.24	30,203.80	0.89	-0.72	12.60	0	9.47	0
May-99	37.02	-1.54	30,637.20	1.43	-3.09	12.60	0	9.47	0
Jun-99	36.91	-0.30	31,433.90	2.60	-3.10	12.60	0	9.47	0
Jul-99	37.11	0.54	31,928.80	1.57	-1.15	12.60	0	9.47	0
Aug-99	37.98	2.34	32,216.10	0.90	1.38	12.60	0	9.47	0
Sep-99	39.88	5.00	32,360.20	0.45	4.52	12.60	0	9.47	0
Oct-99	39.47	-1.03	32,438.10	0.24	-1.29	12.60	0	9.47	0
Nov-99	38.77	-1.77	32,842.10	1.25	-3.11	12.60	0	9.47	0
Dec-99	38.18	-1.53	34,780.30	5.90	-7.88	12.60	0	9.47	0
Jan-00	37.35	-2.16	32,630.20	-6.18	4.49	12.60	0	9.47	0
Feb-00	37.71	0.96	31,953.80	-2.07	3.19	12.60	0	9.47	0
Mar-00	37.90	0.50	32,283.90	1.03	-0.61	12.60	0	9.47	0
Apr-00	37.97	0.18	32,166.00	-0.37	0.58	12.60	0	9.47	0
May-00	38.95	2.58	31,904.20	-0.81	3.46	12.60	0	9.47	0
Jun-00	39.06	0.28	32,142.00	0.75	-0.52	12.60	0	9.47	0
Jul-00	40.22	2.97	31,929.60	-0.66	3.68	12.60	0	9.47	0
Aug-00	40.87	1.62	32,232.40	0.95	0.60	12.60	0	9.47	0
Sep-00	41.88	2.47	32,249.80	0.05	2.41	12.60	0	9.47	0
Oct-00	43.21	3.18	32,244.70	-0.02	3.19	12.60	0	9.47	0
Nov-00	43.73	1.20	32,316.10	0.22	0.97	12.60	0	9.47	0
Dec-00	43.09	-1.46	32,661.30	1.07	-2.61	12.60	0	9.47	0
Mean	31.43	0.63	31,050.33	0.53	0.06				
SD	7.46	4.13	4,835.86	3.84	6.27				

APPENDIX B
ESTIMATES OF MONTHLY GDP FROM QUARTERLY DATA

In Thailand, there are no monthly time series for GDP and the quarterly GDP data put out by the National Economic and Social Development Board (NESDB) only go back as far as 1993. Since estimates of monthly GDP data are needed in this research study, the relationship pf quarterly GDP with other quarterly data that are also available in monthly series is used to obtain estimates of monthly GDP as hereby explained.

There are many variables that are related to GDP and they are available on both quarterly and monthly basis. Examples of such variables are exports, imports, government expenditure, taxes money supply, electricity consumption, etc. If we can find an econometrically acceptable relationship between GDP (left-hand-side variable) and a set of the above variables (right-hand-side variables) at the quarterly level, we can use that relationship to make projections of GDP at the monthly level given monthly data of the right-hand-side variables.

Both nominal and real GDP monthly data have to be projected since nominal GDP is needed to calculate some ratios (such as domestic credit/GDP or current account/GDP) and real GDP is needed to calculate GDP growth. It was found in several trial estimations that the best estimates are from the nominal GDP relationship and the GDP deflator relationship. The deflator is then used to obtain real GDP. Table B.1 and B.2 present estimates of the quarterly relationship found for nominal GDP and its deflator respectively.

The estimated monthly GDP is adjusted so that the summation of GDP in three months is equal to the actual quarterly GDP. Similarly, the estimated monthly GDP deflator is adjusted so that the series match the quarterly data. In both cases, the adjustment was not significantly large and was, on average, less than 5 percent of the actual quarterly data. Both the nominal GDP and deflator series are then used to compute the real GDP. The estimated monthly data of these three variables are shown in Table B.3. Their actual quarterly data are presented in Table B.4.

Table B.1
Estimated Quarterly Relationship between GDP and Related Variables

Dependent Variable: GDPN
Method: Least Squares
Sample: 1993:1 2000:4
Included observations: 32

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	59750.72	85536.03	0.698544	0.4908
INDTAX	3.924801	0.924100	4.247163	0.0002
X	0.353489	0.102089	3.462555	0.0018
G	0.933136	0.470498	1.983296	0.0576
ELEC	13.53422	8.861275	1.527345	0.1383

R-squared	0.916026	Mean dependent var	1077742
Adjusted R-squared	0.903586	S.D. dependent var	149519.5
S.E. of regression	46426.76	Akaike info criterion	24.47174
Sum squared resid	5.82E+10	Schwarz criterion	24.70076
Log likelihood	-386.5479	F-statistic	73.63232
Durbin-Watson stat	1.829999	Prob(F-statistic)	0.000000

where GDPN = nominal GDP
INDTAX = indirect taxes
X = value of exports
G = government expenditure
ELEC = electricity consumption

Table B.2
Estimated Quarterly Relationship between GDP Deflator and Related Variables

Dependent Variable: LOG(DEF)
Method: Least Squares
Included observations: 32 after adjusting endpoints
Convergence achieved after 6 iterations

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-3.620348	0.193476	-18.71208	0.0000
LOG(CPI)	0.264359	0.114841	2.301952	0.0293
LOG(PPI)	0.548931	0.111553	4.920814	0.0000
AR(1)	0.508331	0.169143	3.005330	0.0057

R-squared	0.988558	Mean dependent var	0.408535
Adjusted R-squared	0.987287	S.D. dependent var	0.089908
S.E. of regression	0.010137	Akaike info criterion	-6.225263
Sum squared resid	0.002775	Schwarz criterion	-6.040233
Log likelihood	100.4916	F-statistic	777.5839
Durbin-Watson stat	2.026845	Prob(F-statistic)	0.000000

Inverted AR Roots	.51		

Where DEF = GDP deflator
CPI = consumer price index
PPI = producer price index

Table B.3
Monthly Estimates of GDP and Deflator

	GDP (million baht)		Deflator
	Nominal	Real (1988 = 100)	(1988 = 100)
Jan-92	229,332	186,580	124.1
Feb-92	208,778	169,826	124.2
Mar-92	228,558	185,676	124.3
Apr-92	231,197	186,555	125.1
May-92	226,528	181,785	125.9
Jun-92	245,802	197,053	125.9
Jul-92	240,851	191,895	126.7
Aug-92	238,838	190,210	126.8
Sep-92	247,548	198,890	125.6
Oct-92	242,685	195,685	125.2
Nov-92	243,297	197,062	124.6
Dec-92	247,501	201,355	124.0
Jan-93	241,001	192,682	125.2
Feb-93	243,136	192,962	126.2
Mar-93	271,417	216,591	125.5
Apr-93	243,177	189,517	128.3
May-93	254,178	197,633	128.6
Jun-93	258,218	200,987	128.5
Jul-93	270,052	208,214	129.5
Aug-93	263,243	202,653	129.7
Sep-93	277,823	213,499	129.9
Oct-93	269,421	210,310	127.9
Nov-93	296,631	230,652	128.4
Dec-93	276,925	215,209	128.5

(Continued on page 53)

Table B.3 (Continued)

	GDP (million baht)		Deflator
	Nominal	Real (1988 = 100)	(1988 = 100)
Jan-94	291,870	221,512	131.2
Feb-94	269,923	202,862	132.5
Mar-94	324,310	243,611	132.7
Apr-94	280,499	208,457	134.7
May-94	290,336	215,162	135.0
Jun-94	300,129	222,954	134.7
Jul-94	281,887	208,456	134.6
Aug-94	299,324	219,288	135.9
Sep-94	315,625	230,740	136.2
Oct-94	310,032	228,942	135.0
Nov-94	328,844	243,257	134.8
Dec-94	336,562	247,732	135.5
Jan-95	345,157	245,804	139.8
Feb-95	320,623	226,618	140.8
Mar-95	368,076	259,441	141.3
Apr-95	323,208	229,415	140.3
May-95	345,385	244,601	140.7
Jun-95	357,773	252,261	141.3
Jul-95	337,109	235,887	142.7
Aug-95	346,669	242,175	142.9
Sep-95	349,079	243,446	143.2
Oct-95	352,220	245,685	143.3
Nov-95	369,742	257,773	143.4
Dec-95	371,174	258,630	143.4
Jan-96	361,897	248,425	145.3
Feb-96	352,503	242,577	144.9
Mar-96	402,152	275,425	145.7
Apr-96	373,419	252,712	147.5
May-96	404,421	272,857	148.0
Jun-96	368,254	248,100	148.1
Jul-96	370,535	250,532	147.7
Aug-96	392,938	264,434	148.4
Sep-96	390,801	263,042	148.4
Oct-96	404,890	270,186	149.8
Nov-96	399,458	266,948	149.6
Dec-96	389,773	260,100	149.8
Jan-97	413,466	275,829	149.9
Feb-97	347,265	232,625	149.3
Mar-97	397,354	265,665	149.6
Apr-97	379,228	250,100	152.1
May-97	396,712	261,101	152.4
Jun-97	389,777	257,990	151.6
Jul-97	368,302	244,930	147.5
Aug-97	379,822	244,314	152.5
Sep-97	433,896	276,230	154.4
Oct-97	390,612	246,263	156.9
Nov-97	400,832	249,139	159.2
Dec-97	435,344	268,429	160.6

(Continued on page 54)

Table B.3 (Continued)

	GDP (million baht)		Deflator
	Nominal	Real (1988 = 100)	(1988 = 100)
Jan-98	392,922	234,887	167.4
Feb-98	398,126	234,822	169.7
Mar-98	419,779	249,596	168.3
Apr-98	357,281	212,823	166.7
May-98	372,598	221,501	167.1
Jun-98	387,241	228,091	168.6
Jul-98	363,707	215,529	168.9
Aug-98	356,563	211,089	169.0
Sep-98	391,790	232,281	168.8
Oct-98	398,532	235,772	170.6
Nov-98	382,894	229,050	168.8
Dec-98	405,014	244,243	167.3
Jan-99	364,383	225,292	162.0
Feb-99	366,489	227,270	161.5
Mar-99	427,754	265,429	161.4
Apr-99	371,172	229,515	161.8
May-99	364,394	225,871	161.4
Jun-99	372,398	230,642	161.5
Jul-99	367,359	228,046	160.6
Aug-99	374,924	232,633	160.7
Sep-99	408,794	252,568	161.4
Oct-99	390,742	243,314	160.1
Nov-99	429,539	266,883	160.5
Dec-99	394,183	244,058	161.0
Jan-00	392,977	246,632	158.4
Feb-00	396,746	247,049	159.7
Mar-00	439,904	272,826	160.4
Apr-00	393,091	241,916	162.1
May-00	399,968	244,773	163.0
Jun-00	393,688	240,707	163.2
Jul-00	387,845	236,033	163.3
Aug-00	406,840	245,861	164.5
Sep-00	412,421	247,889	165.4
Oct-00	432,819	263,149	165.2
Nov-00	436,054	265,242	165.2
Dec-00	412,373	252,584	164.1
Jan-01	426,072	259,829	163.9
Feb-01	402,787	244,924	164.3
Mar-01	451,381	274,620	164.3
Apr-01	413,040	245,808	168.0
May-01	425,276	251,925	168.7
Jun-01	409,462	242,968	168.5
Jul-01	431,392	253,979	169.7
Aug-01	441,612	259,871	169.8
Sep-01	387,157	227,623	170.0
Oct-01	460,544	279,171	165.5
Nov-01	439,987	267,529	165.0
Dec-01	410,933	250,823	164.4

Table B.4
Actual Quarterly Data of GDP and Deflator

	GDP (million baht)		GDP Deflator
	Nominal	Real (1988 = 100)	(1988 = 100)
Q1:1993	755,554	602,234	125.5
Q2:1993	755,573	588,137	128.5
Q3:1993	811,118	624,366	129.9
Q4:1993	842,977	656,171	128.5
Q1:1994	886,103	667,985	132.7
Q2:1994	870,964	646,573	134.7
Q3:1994	896,836	658,485	136.2
Q4:1994	975,438	719,930	135.5
Q1:1995	1,033,855	731,863	141.3
Q2:1995	1,026,365	726,277	141.3
Q3:1995	1,032,857	721,508	143.2
Q4:1995	1,093,135	762,088	143.4
Q1:1996	1,116,552	766,427	145.7
Q2:1996	1,146,094	773,668	148.1
Q3:1996	1,154,274	778,008	148.4
Q4:1996	1,194,121	797,235	149.8
Q1:1997	1,158,084	774,119	149.6
Q2:1997	1,165,717	769,190	151.6
Q3:1997	1,182,021	765,475	154.4
Q4:1997	1,226,788	763,831	160.6
Q1:1998	1,210,828	719,305	168.3
Q2:1998	1,117,120	662,415	168.6
Q3:1998	1,112,059	658,899	168.8
Q4:1998	1,186,440	709,065	167.3
Q1:1999	1,158,626	717,991	161.4
Q2:1999	1,107,965	686,028	161.5
Q3:1999	1,151,077	713,247	161.4
Q4:1999	1,214,464	754,255	161.0
Q1:2000	1,229,627	766,507	160.4
Q2:2000	1,186,746	727,395	163.2
Q3:2000	1,207,106	729,782	165.4
Q4:2000	1,281,246	780,975	164.1
Q1:2001	1,280,240	779,373	164.3
Q2:2001	1,247,778	740,702	168.5
Q3:2001	1,260,160	741,473	170.0
Q4:2001	1,311,464	797,524	164.4

APPENDIX C
PROBIT ESTIMATES

Probit Estimate: Model 1

```
--> sample;1-84$
--> probit;Lhs=crisis;Rhs=m2resg6,drer603,cagdp6,setg6,fbgdp12,rgdpg6;hold(IM...
```

```
+----------------------------------------------------------------------+
| Dependent variable is binary, y=0 or y not equal 0                   |
| Ordinary    least squares regression    Weighting variable = none    |
| Dep. var. = CRISIS   Mean=   .1666666667    , S.D.=   .3749163227    |
| Model size: Observations =      84, Parameters =   6, Deg.Fr.=     78 |
| Residuals:  Sum of squares= 8.317253033    , Std.Dev.=         .32654 |
| Fit:        R-squared=  .287093, Adjusted R-squared =          .24139 |
| Model test: F[  5,     78] =    6.28,    Prob value =          .00006 |
| Diagnostic: Log-L =    -22.0665, Restricted(b=0) Log-L =     -36.2794 |
|             LogAmemiyaPrCrt.=   -2.169, Akaike Info. Crt.=       .668 |
+----------------------------------------------------------------------+
```

Variable	Coefficient	Standard Error	b/St.Er.	P[|Z|>z]	Mean of X
M2RESG6	.9993881222E-02	.33971012E-02	2.942	.0033	.77279971
DRER603	.4817804874E-02	.25684196E-02	1.876	.0607	8.8104684
CAGDP6	-.1511973361E-01	.60850721E-02	-2.485	.0130	.30836533
SETG6	-.3628859300E-02	.11423042E-02	-3.177	.0015	-2.3992535
FBGDP12	.7127875843E-02	.90324083E-02	.789	.4300	.23023155
RGDPG6	.9605873525E-02	.53602251E-02	1.792	.0731	3.5783917

Normal exit from iterations. Exit status=0.

```
+-----------------------------------------------+
| Binomial Probit Model                         |
| Maximum Likelihood Estimates                  |
| Dependent variable                  CRISIS    |
| Weighting variable                     ONE    |
| Number of observations                  84    |
| Iterations completed                     7    |
| Log likelihood function          -27.13927    |
| Restricted log likelihood        -37.84714    |
| Chi-squared                       21.41575    |
| Degrees of freedom                       5    |
| Significance level               .6758759E-03 |
| Results retained for SELECTION model.         |
+-----------------------------------------------+
```

Variable	Coefficient	Standard Error	b/St.Er.	P[|Z|>z]	Mean of X
	Index function for probability				
M2RESG6	.4813334390E-01	.19339554E-01	2.489	.0128	.77279971
DRER603	-.9116313157E-01	.27570742E-01	-3.307	.0009	8.8104684
CAGDP6	-.1196541091	.42749698E-01	-2.799	.0051	.30836533
SETG6	-.1715091791E-01	.82319466E-02	-2.083	.0372	-2.3992535
FBGDP12	-.1449420896	.63381804E-01	-2.287	.0222	.23023155
RGDPG6	-.1686526327	.44891807E-01	-3.757	.0002	3.5783917

```
[0,0]ix:
```

```
+-----------------------------------------+
| Partial derivatives of E[y] = F[*]  with |
| respect to the vector of characteristics. |
| They are computed at the means of the Xs. |
| Observations used for means are CRI=1     |
+-----------------------------------------+
```

Variable	Coefficient	Standard Error	b/St.Er.	P[|Z|>z]	Mean of X
	Index function for probability				
M2RESG6	.3479301376E-02	.23964041E-02	1.452	.1465	-1.4750913
DRER603	-.6589694034E-02	.36435410E-02	-1.809	.0705	9.1722895
CAGDP6	-.8649154054E-02	.58639097E-02	-1.475	.1402	1.5582287
SETG6	-.1239747905E-02	.92112940E-03	-1.346	.1783	4.6927862
FBGDP12	-.1047708659E-01	.72166788E-02	-1.452	.1466	.14955921
RGDPG6	-.1219099463E-01	.72471492E-02	-1.682	.0925	3.8692914

Partial derivatives of E[y] = F[*] with respect to the vector of characteristics. They are computed at the means of the Xs. Observations used for means are CRI=0

Variable	Coefficient	Standard Error	b/St.Er.	P[|Z|>z]	Mean of X
	Index function for probability				
M2RESG6	.1337951251E-01	.53455386E-02	2.503	.0123	12.012255
DRER603	-.2534040148E-01	.10441119E-01	-2.427	.0152	7.0013629
CAGDP6	-.3325997156E-01	.10270003E-01	-3.239	.0012	-5.9409516
SETG6	-.4767400351E-02	.19681829E-02	-2.422	.0154	-37.859452
FBGDP12	-.4028921207E-01	.19673078E-01	-2.048	.0406	.63359327
RGDPG6	-.4687997603E-01	.16230042E-01	-2.888	.0039	2.1238931

Partial derivatives of E[y] = F[*] with respect to the vector of characteristics. They are computed at the means of the Xs. Observations used for means are All Obs.

Variable	Coefficient	Standard Error	b/St.Er.	P[|Z|>z]	Mean of X
	Index function for probability				
M2RESG6	.7220857728E-02	.33851317E-02	2.133	.0329	.77279971
DRER603	-.1367609124E-01	.35025899E-02	-3.905	.0001	8.8104684
CAGDP6	-.1795024464E-01	.81541581E-02	-2.201	.0277	.30836533
SETG6	-.2572942748E-02	.14328879E-02	-1.796	.0726	-2.3992535
FBGDP12	-.2174389150E-01	.10137744E-01	-2.145	.0320	.23023155
RGDPG6	-.2530089471E-01	.78422529E-02	-3.226	.0013	3.5783917

Marginal Effects for Probit

Variable	CRI=1	CRI=0	All Obs.
M2RESG6	.0035	.0134	.0072
DRER603	-.0066	-.0253	-.0137
CAGDP6	-.0086	-.0333	-.0180
SETG6	-.0012	-.0048	-.0026
FBGDP12	-.0105	-.0403	-.0217
RGDPG6	-.0122	-.0469	-.0253

Frequencies of actual & predicted outcomes
Predicted outcome has maximum probability.

	Predicted		
Actual	0	1	Total
0	62	8	70
1	3	11	14
Total	65	19	84

Probit Estimate: Model 2

```
--> sample;1-84$
--> probit;Lhs=crisis;Rhs=m2resg6,drer603,cagdp6,setg3,xsg6,fbgdp12;hold(IMR=...
```

```
+----------------------------------------------------------------------+
| Dependent variable is binary, y=0 or y not equal 0                   |
| Ordinary    least squares regression    Weighting variable = none    |
| Dep. var. = CRISIS   Mean=    .1666666667    , S.D.=    .3749163227   |
| Model size: Observations =       84, Parameters =    6, Deg.Fr.=     78 |
| Residuals:  Sum of squares= 7.858738791    , Std.Dev.=          .31742 |
| Fit:        R-squared=  .326394, Adjusted R-squared =          .28321 |
| Model test: F[  5,     78] =    7.56,    Prob value =          .00001 |
| Diagnostic: Log-L =    -19.6848, Restricted(b=0) Log-L =     -36.2794 |
|             LogAmemiyaPrCrt.=   -2.226, Akaike Info. Crt.=       .612 |
+----------------------------------------------------------------------+
```

Variable	Coefficient	Standard Error	b/St.Er.	P[|Z|>z]	Mean of X
M2RESG6	.1140487044E-01	.33187393E-02	3.437	.0006	.77279971
DRER603	.3753815184E-02	.28431377E-02	1.320	.1867	8.8104684
CAGDP6	-.1695524589E-01	.58648003E-02	-2.891	.0038	.30836533
SETG3	-.3814128716E-02	.10278681E-02	-3.711	.0002	-4.3632224
XSG6	.4336343863E-03	.25189685E-02	.172	.8633	10.078435
FBGDP12	.3706723345E-02	.88865476E-02	.417	.6766	.23023155

Normal exit from iterations. Exit status=0.

```
+-------------------------------------------+
| Binomial Probit Model                     |
| Maximum Likelihood Estimates              |
| Dependent variable              CRISIS    |
| Weighting variable                ONE     |
| Number of observations             84     |
| Iterations completed                7     |
| Log likelihood function       -19.28912   |
| Restricted log likelihood     -37.84714   |
| Chi-squared                    37.11604   |
| Degrees of freedom                    5   |
| Significance level             .0000000   |
| Results retained for SELECTION model.     |
+-------------------------------------------+
```

Variable	Coefficient	Standard Error	b/St.Er.	P[|Z|>z]	Mean of X
	Index function for probability				
M2RESG6	.3787165867E-01	.18204596E-01	2.080	.0375	.77279971
DRER603	-.6199348653E-01	.27388980E-01	-2.263	.0236	8.8104684
CAGDP6	-.7762293414E-01	.36946584E-01	-2.101	.0356	.30836533
SETG3	-.1909951390E-01	.96321423E-02	-1.983	.0474	-4.3632224
XSG6	-.8714664566E-01	.20671092E-01	-4.216	.0000	10.078435
FBGDP12	-.1502193307	.78174681E-01	-1.922	.0547	.23023155

```
[0,0]ix:
```

```
+-----------------------------------------+
| Partial derivatives of E[y] = F[*]   with |
| respect to the vector of characteristics. |
| They are computed at the means of the Xs. |
| Observations used for means are CRI=1     |
+-----------------------------------------+
```

Variable	Coefficient	Standard Error	b/St.Er.	P[|Z|>z]	Mean of X
Index function for probability					
M2RESG6	.2412322763E-02	.16915628E-02	1.426	.1538	-1.4750913
DRER603	-.3948818297E-02	.21877237E-02	-1.805	.0711	9.1722895
CAGDP6	-.4944372058E-02	.38189972E-02	-1.295	.1954	1.5582287
SETG3	-.1216587648E-02	.80288486E-03	-1.515	.1297	3.8259886
XSG6	-.5551006859E-02	.32530832E-02	-1.706	.0879	12.330625
FBGDP12	-.9568567198E-02	.56777346E-02	-1.685	.0919	.14955921

Partial derivatives of E[y] = F[*] with respect to the vector of characteristics. They are computed at the means of the Xs. Observations used for means are CRI=0

Variable	Coefficient	Standard Error	b/St.Er.	P[|Z|>z]	Mean of X
Index function for probability					
M2RESG6	.6030605154E-02	.31226985E-02	1.931	.0535	12.012255
DRER603	-.9871715487E-02	.58698691E-02	-1.682	.0926	7.0013629
CAGDP6	-.1236051663E-01	.69380004E-02	-1.782	.0748	-5.9409516
SETG3	-.3041367371E-02	.14035587E-02	-2.167	.0302	-45.309277
XSG6	-.1387705289E-01	.72435306E-02	-1.916	.0554	-1.1825147
FBGDP12	-.2392061774E-01	.14387380E-01	-1.663	.0964	.63359327

Partial derivatives of E[y] = F[*] with respect to the vector of characteristics. They are computed at the means of the Xs. Observations used for means are All Obs.

Variable	Coefficient	Standard Error	b/St.Er.	P[|Z|>z]	Mean of X
Index function for probability					
M2RESG6	.5907658772E-02	.30910233E-02	1.911	.0560	.77279971
DRER603	-.9670460112E-02	.34689423E-02	-2.788	.0053	8.8104684
CAGDP6	-.1210852189E-01	.69114077E-02	-1.752	.0798	.30836533
SETG3	-.2979362796E-02	.15275864E-02	-1.950	.0511	-4.3632224
XSG6	-.1359414042E-01	.39537629E-02	-3.438	.0006	10.078435
FBGDP12	-.2343294638E-01	.10413887E-01	-2.250	.0244	.23023155

Marginal Effects for Probit

Variable	CRI=1	CRI=0	All Obs.
M2RESG6	.0024	.0060	.0059
DRER603	-.0039	-.0099	-.0097
CAGDP6	-.0049	-.0124	-.0121
SETG3	-.0012	-.0030	-.0030
XSG6	-.0056	-.0139	-.0136
FBGDP12	-.0096	-.0239	-.0234

Frequencies of actual & predicted outcomes
Predicted outcome has maximum probability.

	Predicted		
Actual	0	1	Total
0	63	7	70
1	1	13	14
Total	64	20	84

REFERENCES

Calvo, G., and C. Reinhart. 1996. "Capital Flows to Latin America: Is there Evidence of Contagion Effects?" Pp. 151-171 in G. A. Calvo, M. Goldstein, and Eduard Hochreiter, eds., *Private Capital Flows to Emerging Markets.* Washington, DC.: Institute for International Economics.

Eichengreen, B., A. Rose, and C. Wyplosz. 1996. Contagious Currency Crisis. Centre for Economic Policy Research Discussion Paper No.1453, August.

Engwatana, Pipat. 1999. Early Warning Indicators of Currency Crisis: A case study of Thailand. M.A. Thesis, Faculty of Economics, Thammasat University.

Esquivel, Gerardo, and Felipe Larrain. 1998. "Explaining Currency Crises." *Development Discussion Paper*, No.666. (Massachusetts, Harvard Institute for International Development), November.

Gerlach, S., and F. Smets. 1995. "Contagious Speculative Attacks." *European Journal of Political Economy*, 11: 45-63.

Goldfajn, Ilan, and Rodrigo O. Valdés. 1997. "Are Currency Crises Predictable?" *IMF Working Paper*, WP/97/159, December.

Greene, W. H. 1995. *LIMDEP Version 7.0 User's Manual.* New York: Econometric Software, Inc.

Gujarati, D. 1995. *Basic Econometrics*, 3rd edition. New York: McGraw-Hill, Inc.

Kaminsky, G. L. 1999. "Currency and Banking Crises: The Early Warnings of Distress." *IMF Working Paper*, WP/99/178, December.

Kaminsky, G. L., and C. M. Reinhart. 1999. "The Twin Crises: The Causes of Banking and Balance-of-Payments Problems." *American Economic Review*, Vol.89, No.3, June.

_____. 2000. "On Crises, Contagion, and Confusion." *Journal of International Economics*, 51: 145-168.

Kaminsky, G. L., S. Lizondo, and C. M. Reinhart. 1998. "Leading Indicators of Currency Crisis." *IMF Staff Paper*, Vol.45, No.1, March.

Kruger, M., P. N. Osakwe, and J. Page. 1998. "Fundamentals, Contagion and Currency Crises: An Empirical Analysis." *Bank of Canada Working Paper*, WP/98/10, July.

Krugman, P. 1979. "A Model of Balance of Payments Crisis." *Journal of Money, Credit and Banking*, Vol.11 (August): 311-25.

_____. 2001. Crises: The Next Generation? Paper prepared for Razin conference, Tel Aviv University, March.

Ministry of Finance. 1998. "Directions of monetary and fiscal measures to solve economic problems," a mimeograph, July (in Thai).

Obstfeld, M. 1996. "Model of Currency Crises with Self-fulfilling Features." *European Economic Review*, Vol. 40, Nos.3-5 (April): 1037-1047.

Poonpatpibul, Chaipat, and Anotai Ittisupornrat. 2001. "Early Warning System." *BOT Working Paper*, WP/05/2001, June (in Thai).

Tinakorn, Pranee. 1998. "Analysis of Leading Economic Indicators for Thailand." A TDRI research report in the project *Short-Term Economic Model and Forecast,* financed by the National Economic and Social Development Board, September (in Thai).

Building "An Early Warning System" for Indonesia With the Signal Approach

Tulus Tambunan[*]

INTRODUCTION

As the East Asian economies recover from the 1997 financial crisis, there is increasing concern about the possibility that the economies may be slipping into a situation that is bound to end up in a new crisis. Especially in Indonesia in which economic growth has slowed since 2000 after it recovered a little bit in 1999, the progress of corporate and financial reform has been patchy, and the ratio of foreign debt to gross domestic product (GDP) has increased to more than 100%. In particular, there is a question as to whether the symptoms of currency crises can be detected with sufficient advance so as to allow governments to adopt pre-emptive measures. So, this concern has underscored not only the need to understand the nature of the recent crisis but also to develop and improve upon an early warning system for macroeconomic vulnerability to detect the possibility of a currency crisis in the future. While accurately forecasting the timing of currency crises is likely to remain an elusive goal for academics and policymakers alike, there is no question about the this need that helps monitor whether a country may be facing a new crisis.

The objective of this study is to develop an early warning system for Indonesia that can provide early indications of a currency crisis. The system is based on the "signals" approach proposed by Kaminsky et al. (1997), which essentially involves monitoring the evolution of a number of pre-selected economic indicators that tend to exhibit systematically an unusual behavior in the periods preceding a crisis. Previous work has already been done in this area, mainly by Kaminsky et al. (1997), Kaminsky (1998), Herrera and Garcia (1999), Yap and Lamberte (2001), and Park (2001).

DEFINITION OF CRISIS

A study of Kaminsky et al. (1997) provides a survey of literature or empirical studies on currency crises. The studies vary with respect to how a crisis is defined. Most of the studies focus exclusively on devaluation episodes. Some of them examine large and infrequent devaluation, while others include in their sample small and frequent devaluation that may not fit the mold of a full-blown currency crisis. A few studies included in Kaminsky et al.'s survey adopt a broader definition of crises. They include, in addition to devaluation, episodes of unsuccessful speculative attacks, i.e. attacks that were averted without devaluation, but at

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the cost of a large increase in domestic interest rates and/or a sizable loss of international reserves.

Based on the above studies surveyed, Kaminsky et al. (1997) conclude that *A crisis is defined as a situation in which an attack on the currency leads to a sharp depreciation of the currency, large decline in international reserves, or a combination of the two. A crisis so defined includes both successful and unsuccessful attacks on the currency. The definition is also comprehensive enough to include not only currency attacks under a fixed exchange rate but also attacks under other exchange rate regimes. For example, an attack could force a large devaluation beyond the established rules of a prevailing crawling-peg regime or exchange rate band* (page 15).

For Indonesia, the recent economic crisis was begun with or caused by the collapse of the fixed exchange rate system of the rupiah. In the mid of 1997, the country's currency started to depreciate first in a low rate, but shortly after that suddenly it accumulated in a high speed with a higher rate that at last forced the government to abandon the parity. So, the definition of a crisis period adopted in this study involves the speed and the extent of the rates of depreciation of the rupiah against the US dollar in combination with a large increase in domestic interest rates; though not with a sizable loss in the country's international reserves. In other words, the recent crisis in Indonesia is a currency crisis.

METHODOLOGY

There are essentially two alternative methodologies that could serve as the basis for an early warning system of currency crises: the probability model using limited dependent variables estimation and the signals approach of Kaminsky and Reinhart (1996), who propose the monitoring of a number of indicators that show drastic changes prior to a crisis.

The probability model is based on regression estimates using limited dependent variables. While the explanatory variables have been quite varied, the estimation technique has been quite uniform. The advantage of this approach is that it summarizes all information in one useful number, that is the probability of a crisis. Also, this approach considers all variables simultaneously, and disregards those that do not contribute information that is independent from that provided by other variables already included in the analysis. Whereas, an important limitation of this methodology is that it does not provide a metric for ranking indicators according to their ability to accurately predict crises and avoid false signals, since a variable either enters the regression significantly or it does not.[1]

The signals approach compares the behavior of selected variables in the period preceding crises with their behavior in a control group, and to identify those variables whose distinctive behavior could be used to help assess the likelihood of a crisis. The particular variant of this approach is developed by Kaminsky and Reinhart (1996) which has progressed to construct a warning system based on signals issued by those selected indicators. This "signals" approach is developed to address the shortcomings of the probability approach.[2]

As mentioned above, this approach involves monitoring the evolution of a number of economic variables that tend to exhibit an unusual behavior in the periods preceding a crisis. Kaminsky and Reinhart (1996) choose 15 indicators based on the theoretical considerations and by the availability of information on a monthly basis. They include international reserves, imports, export, the terms of trade, deviations of the real exchange rate from trend, the differential between foreign and domestic real interest rates on deposits, net real money balances, the money multiplier of M2, the ratio of domestic credit to GDP, the real interest

[1] Further discussion on other limitations of this approach, see Kaminsky et al. (1997), or it is also addressed comprehensively in Yap and Lamberte (2001).

[2] This approach is discussed extensively in Kaminsky et al. (1997), Kaminsky and Reinhart (1996), Goldstein (1996) and Yap and Lamberte (2001).

rate on deposits, the ratio of nominal lending to deposit interest rates, the stock of commercial bank deposits, the ratio of broad money to gross international reserves, an index of output, and an index of equity prices. For all these variables,[3] the indicator on a given month was defined as the percentage change in the level of the variable with respect to its level a year earlier.

Kaminsky and Reinhart define a currency crisis as a situation in which an attack on the currency leads to a sharp depreciation of the currency, a large decline in international reserves, or a combination of the two. So, for each country, currency crises are identified (ex-post) by the behavior of an index of "exchange market pressure" (IEP), This index is a weighted average of monthly percentage changes in the exchange rate (defined as units of domestic currency per U.S. dollar or other foreign currencies, depending on which they are the relevant) and (the negative of) monthly percentage changes in international reserves (measured in U.S. dollars):[4]

$$IEP = \Delta\% \text{ ER} - \Delta\% \text{ IR}$$

where ER = exchange rate, and IR = international reserves.[5]

So, when the nominal exchange rate depreciates and international reserves fall, exchange market pressure is greater: the index increases reflecting stronger selling pressure on the domestic currency.

In the empirical application, the monthly percentage change of these two indicators are standardized to have mean zero and unit variance. A crisis is identified thus by the behavior of the index. Periods in which the index is above its mean by more 1.1 times standard deviation are defined as crises:

$$IEP > u + 1.1 \text{ SD}$$

Where u is the sample mean and SD is the standard deviation of the IEP.[6]

Indicator Model for Indonesia

Identification of Crisis

This study uses the indicator model proposed by Kaminsky et al. (1997), which is composed of identification of crisis and monitoring of a number of indicators based on the theoretical background and predictability of a crisis. For currency crises, they construct the so-called the index of exchange market pressure (IEP). They use only two variables: real exchange rate and gross international reserves. In this study domestic interest rate is also included to identify the crisis period through the behavior of IEP, and it is represented by one month discount rate of SBI (Certificate of Bank of Indonesia). The index was constructed by taking a weighted average of monthly depreciation of the rupiah against the US dollar, and percentage changes in the other two indicators, and all were standardized to have mean zero and unit variance. In the empirical application, a crisis is identified by the behavior of the IEP: extreme values of this index signal currency crises. In Kaminsky and Reinhart's model, the

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[3] With the exception of some of the variables, i.e. the deviation of the real exchange rate from trend, the excess of real M1 balances, and the three variables based on interest rates. See further Kaminsky et al. (1997).

[4] The weights are the inverse of the standard deviation of each variable.

[5] In Eichengreen, et al. (1995) as well as in Herrera and Garcia (1999) domestic interest rates are also included in their IEP, because the authorities could also resort to increases in interest rates to defend the currency. However, this indicator was not included in the IEP used in Kaminsky and Reinhart (1996) because the data on market-determined interest rates in developing countries do not span the entire sample period.

[6] Kaminsky, et al. (1997) apply the 3 SD, while in Park's study (2001) 1.1 and in Herrera and Garcia (1999) 1.5.

extreme values are three or more times standard deviation (SD) above the mean. In this study, periods in which the index is above its mean by more than 1.5 SD are defined as crises.

"Early" in this study is defined following the Kamisnky and Reinhart's definition. As its signaling horizontal for currency crises, they define "early" as between 1 month and 24 months before the beginning of the crisis, that is the period within which the indicators would be expected to have an ability for anticipating crises.[7] In this study, the model is evaluated using a 12-month window prior to a crisis.

Sample and Indicators

The sample period was determined, namely from January 1990 to December 2001. The sample period was then divided into tranquil and crisis or pressure periods based on the following procedure. An arbitrary band was constructed simply by taking the mean of percentage changes in the selected indicators plus or minus 1.5 times the standard deviation (SD) of changes in the indicators. Those periods in which percentage changes in the indicators or when the exchange market pressure exceeds 1.5SD band of that particular index are then included as crisis periods. In Kaminsky et al.'s (1997) study, they apply the 3 SD, while in Park's (2001) study he does the 1.1 SD. In this study, 1.5SD as threshold is used for analyzing the exchange market pressure (in some cases also 1.1 SD to see whether there is a significant difference).

A number of potential early warning indicators were selected. The choice of indicators was dictated by theoretical considerations on currency crises and by the availability of data on a monthly basis. The variables include such M2/net international reserves, domestic interest and inflation rates, values of imports, terms of trade, and total bank loans. There is a wide set of options regarding which variables to use and how to use them. In the World Economic Outlook 1998 from IMF, it narrowed the list of potential leading indicators to only 3, namely M2/international reserves, real domestic credit growth, and the real effective exchange rate.

Signal and Crisis

Knowing the distribution of each of the selected indicators, the critical cutoff for each indicator was defined at which a fluctuation in an indicator makes a crisis almost unavoidable. The signaling state can be characterized as $S_{jt} = 1$; and $S_{jt} = 0$ if no signal of an impending crisis in period t.[8] The critical cutoffs for each of the indicators were determined in relation to percentiles of the frequency distribution of observations of the indicators. Following the Kaminsky's methodology, this procedure was repeated using a grid of reference percentiles between 10 percent and 25 percent, and the 'optimal' threshold values were defined for each of the indicators as the ones that minimized the noise-to signal ratio, i.e., the ratio of false signals to good signals.

To facilitate analysis and make the early warning system tractable that indicates when the economy is becoming fragile, the information provided by all the indicators are then combined to assess the likelihood of an upcoming crisis. The indicators are then compressed

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[7] The period interval of 24 months is the most common size for the window. The results don't change dramatically if an 18-month window is used, but a noticeable improvement is achieved with the wider window (Herrera and Garcia, 1999). For banking crisis, Kaminsky and Reinhart define early as between 1 month to 12 months before the start of the crisis or up to 12 months after the beginning of the crisis. The difference is due to the fact that a banking crisis frequently lasts much longer (i.e. several years) than a currency crisis (less than a year) and because the peak of a banking crisis often takes place several years after it starts.

[8] S_{jt} is written in absolute value as because some of the variables will signal an upcoming crisis by a large decline while others may be growing excessively on the eve of a crisis.

into a composite indicator (I_t) which is calculated as the weighted sum of each indicator. In Kaminsky (1998), the composite index is defined as follows:[9]

$$I_t = \sum_{t=1}^{m} S_{jt}/w_j$$

where w_j is the noise-to-signal ratio of indicator$_j$.

After the composite index is built, its optimal critical value is defined in assessing when the composite index has reached an "anomalous" level. Withouit having a well defined optimal critical level, its simple evolution of the composite index will not give enough information about the possibility of a crisis.

In order to examine the effectiveness of individual indicators, the model is evaluated based on 4 criteria: the sizes of Type I and Type II errors, the noise-to-signal ratio, and the probability of a crisis given that a signal was produced within a 12-month window. In Table 1, A is the number of months in which the indicator issued a good signal, B is the number of months in which the indicator issued a bad signal or a noise, C is the number of months in which the indicator failed to issue a signal and D is the number of months in which the indicator refrained from issuing a signal (which would have been a bad signal). A perfect indicator would only produce observations that belong to A and D.

Table 1
Signal and Crisis

	Crisis within 12 months	No crisis within 12 months
Signal was issued (S=1)	A	B
No signal was issued (S=0)	C	D

If H_0 = crisis occurs and H_1= no crisis occurs, then the size of Type I error is the probability of rejecting H_0 while H_0 is true (crisis occurs), or the probability of not anticipating a crisis, computed as 1-[A/(A+C)]. The size of Type II error is the probability of not rejecting H_0 while H_0 is false, or the probability of sending a false signal (noise), computed as B/(B+D). The lower ratio of [B/(B+D)]/[A/(A+C)] indicates a better indicator.

Results

* *Development of Selected Indicators*

As discussed before, the empirical literature on the assessment of potential indicators of currency crisis show that indicators that have proved to be particularly useful include M2/international reserves, domestic credit, credit to the public sector, and domestic inflation. Other indicators that have received support include export performance, growth of imports, money (M2) growth, real GDP growth, bank deposit, and the fiscal deficit. Whereas, Kaminsky et al.'s (1997) suggested that variables that have track record in anticipating currency crises in the context of the "signal" approach (a warning system) include development of exports, deviations of the real exchange rate from trend, and changes in the

[9] Kaminsky (1998) suggests the inverse of the noise-to-signal ratio as weights. While, in Park (2001) for the Korean case, the weight is one minus the noise/signal ratio. This modified weights are used since the noise/signal ratio of some indicators are zero.

ratio of broad money to gross international reserves, output, and equity prices. Their own evidence does not provide support for some of the other indicators that were considered, including growth of imports, the differential between foreign and domestic real deposit interest rates, the ratio of lending to deposit interest rates, and bank deposit.

Although the empirical literature on currency crises suggests that an effective warning system should consider a broad variety of indicators, since currency crises seem to be usually proceeded by multiple economic problems (and sometimes political and social problems), due to lack of time series data or because of "growths of variables are different than expected theoretically, not all of the suggested indicators can be tested or included in this study. Instead, only changes in domestic inflation and interest rates, bank loans, money supply (M2) to international reserves, import values, and growth of real domestic credits as well as the ratio of domestic credit to GDP are included in this study. While other variables such as stock market index (SMI), output value of industry, export value and ratios of current account, capital account and state budget to GDP are not included as leading indicators.

Data on exchange rate of the rupiah show that deviations of the currency against US dollar from its parity during the crisis period were significant which began to depreciate since August 1997 and culminated on May 1998 after a brief respite in period between February and April (Graph 1). Due to heavy speculative attacks on the currency, at last the Indonesian monetary authority was forced to abandon its system of managed floating on August 1997. Since then the value of the rupiah declined very rapidly until June 1998 (with a little improvement between February and April 1998) when it turned upward again. On January 1998 the value of the rupiah depreciated by more than 100%.

This process experienced by Indonesia, i.e. from the beginning of the crisis until the policy action to abandon the parity, does provide support to the theoretical literature on balance-of-payments or currency crises. However, the Indonesian case does not support the earlier models of balance of payments with respect to international reserves,[10] as the movements in the country's international reserve leading to and during the crisis shows a positive rather than a negative trend (Graph 4). In March 1996 it increased significantly until it reached its peak in May 1997 several months before the crisis emerged. Afterwards, it declined very rapidly until May 1998 when it turned upward against, The year 1998 was the climax period of the crisis, especially in May in which the fall of the exchange rate of the rupiah against the US dollar was the worst (Graph 1).

So, it could not say that the depreciation of the rupiah was caused by a persistent loss of the country's international reserves. The earlier models of balance of payments problems were inspired by the Latin American style of currency crises of the late 1970s. In these models unsustainable money-financed fiscal deficits lead to a persistent loss of international reserves and ultimately ignite a currency crash. Instead, the Indonesian evidence supports the more recent models of currency crises that were stimulated by the EMS collapse in 1992 and 1993. These models have stressed that the depletion of international reserves might not be at the root of currency crises (Obstfeld, 1996).

For the Indonesian case, this contradictory evidence is not really unexpected on account of the fact that besides from its export revenues, another important part of annual sources of the country's foreign currencies is from foreign debts, and during the crisis Indonesia has received a huge loan from the International Monetary Fund (IMF). Fortunately, this IMF loan has been able to compensate the decline in international reserves due to capital flights that happened especially in the first months of the crisis, and thus avoiding the reserves from depleting. This capital flight experienced by Indonesia is generally expected as a "normal" behavior during a crisis or a period approaching it. In the literature on capital inflow problems, it is argued that another potential source of currency crises is sudden reversals in

[10] See explanation about these models from, amongst others, Krugman (1979) and Bilson (1979).

capital flows.[11] This argument is based on the experiences of the debt crises in the Latin America in the 1980s and 1990s and the Asian crisis in 1997-98 which show that capital inflows can come to a sudden stop and even can sharply reverse their course and become capital outflows. Based on these experiences, Kaminsky (1998) argued that the sudden reversal, prompted, in large part, by fluctuations in interest rates in industrialized countries, is more abrupt when capital inflows are in the form of portfolio flows or short-term capital movements rather than direct foreign investment. The liberalization of capital account transaction, by allowing this type of short-term capital flows, as also happened in Indonesia since the early 1980s, may contribute to the instability of the flow of international reserves and the ability of the country to peg the domestic currency or to maintain its fixed exchange rate system.

But, the above experiences are different with the Indonesian experience when capital inflows also include foreign official debts. The onset of the rupiah crisis was also characterized obviously by the coexistence of inverse private capital flows to the country and become capital outflows, especially in the first months of the crisis. Foreign investors stopped their investment in or pulled back their money from Indonesia and external private creditors become unwilling to provide short-term credits anymore to domestic companies in the country. At the same time, domestic residents (i.e. investors, businessmen as well as ordinary people) who have gained or wanted to protect their wealth from the weakening of the rupiah invested their money in international capital markets. But, the inflows of official foreign debts, including annual loans from CGI did not decline, they even increased since 1998 due to a special loan provided by the IMF for the Indonesian government for its recovery programs.

With respect to domestic credit, due to data problem, in this Indonesian case the development of total bank loans is compared to that of total deposits, instead of the demand for money. The evolution of the ratio does not show an abnormal behavior, as it was more or less stable around its "normal" (high) level in many years preceding the crisis. But, on January 1998 it began to decline and started to stabilize since May 1999 at a much lower level than that of the pre-crisis period (Graph 5). The decline in domestic credit during the crisis period was due to the collapse of the banking sector in the country. Whereas, relatively to GDP, the ratio increased steadily during the pre-crisis period and accumulated significantly in early 1998 (Graph 21).

As regard to domestic interest rates, the Indonesian evidence does support the Krugman's findings showing that domestic Interest rates would increase as a currency crisis becomes more likely. The movements of domestic interest rates in Indonesia, represented by the movements of one month discount rate of Certificate of Bank Indonesia (SBI) show an abnormal behavior as it started upward significantly in around May 1998 and afterwards it declined very rapidly until June 1999 (Graph 3). This evidence may suggest that the evolution of interest rates could also be used as a leading indicator of a currency crisis. The rapid increase of interest rates was a reflection of the government's monetary policy in that time in its effort to try to strengthen again the rupiah or at least to stop it from further falling. It was hope that higher domestic interest rates than foreign rates or smaller difference between domestic interest rate and that in US would be resulted in more capital inflow or at least capital flight could be avoided. But the Indonesian experience during 1998 and 1999 show that this policy was failed to reach its objective. Increased capital flows out of the country during that years were not motivated by differences between domestic and foreign interest rates but mainly because of uncertainty in the country. In fact, the Indonesian experience of the continued instability of rupiah since May 1998 up to recently may create concern about the

[11] See, for example, Montiel and Reinhart (1997) for a comprehensive review of the literature.

evolution of non-economic variables such as politic violence and social disorder. So, leading indicators may also include political and social variables.[12]

An increase in domestic interest rates needed to maintain a fixed exchange rate or to keep capital inside the country may result in higher financing costs for the government. Also, higher interest rates may weaken further the banking system in the country which was already in trouble soon after the crisis started, and that means the government has to incur cost of a bailout that could result from an explicit or implicit official guarantee on the banking system liabilities (Obstfeld, 1996).[13] This concern about the fiscal and banking consequences of its exchange rate policy and the concern for the increased cost of servicing the public debt may be reasons behind the government's decision to reduce the SBI's discount rate after the big up in May 1998

With respect to domestic inflation, it does receive ample support as a useful indicator of a currency crisis (Graph 2). But, whether inflation rate has a good predictive power in anticipating currency crises, it is a questionable. As can be seen in Graph 2, the pre-crisis behavior of inflation rate in Indonesia does not depart significantly from its "normal" level in the period preceding the crisis. After May 1997, it did start to increase, but culminated only on January 1998.

With respect to M2/net international reserves (Graph 6), the findings may suggest that the ratio cannot be considered as a good leading indicator of a possible crisis, at least in this Indonesian case. According to the traditional model of balance of payments crises, the period preceding a currency crisis would be characterized by, on one hand, a gradual but persistent decline in international reserves and, on the other hand, a rapid growth of domestic credit relative to the demand for money, leading to excessive money creation (M2 increases). Similar with other indicators like real interest rate differential, world real interest rate, foreign debt, capital flight and short-term foreign debt, the M2/international reserves also issues a positive critical-shock sign in the period preceding a balance of payments or currency crisis. So, following this traditional approach, the M2/international reserves in Indonesia should increase significantly in the period preceding the 1998 crisis, not declined as shown in Graph 6.

With respect to development of import value, the finding suggests that this variable (can be considered as a good leading indicator of a possible currency crisis, as it increased steadily in approaching the crisis (Graph 8). In fact, one factor that made the depreciation of rupiah in 1997 become the economic crisis in Indonesia was indeed the country's highly import dependency.

The Exchange Market Pressure

Graph 9 and Graph 10 exhibit the movements in the exchange market pressure (IEP), which began to increase significantly on February 1997 and culminated on September-October 1997 and further on February 1998 after a significant decline between that two periods. Afterwards it declined very rapidly until October 1998 when it turned upward again though slowly. The crisis is defined to occur when the exchange market pressure exceeds 1.5SD of exchange market pressure. The difference between Graph 9 and Graph 10 is on variables included in the model to determine the IEP. Without using domestic interest rates, Graph 10 shows that the fragility during the pre-crisis period shows a more stable pattern, especially within October 1991 and September 1994, than in Graph 9. The comparison between these two graphs also shows that with domestic interest rate, the exchange market pressure is stronger than without it.

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[12] In empirical studies of such as Edwards and Santaella (1993), Eichengreen et al. (1995), Milesi-Ferretti and Razin (1995), these non-economic variables are included as leading indicators of currency crises.

[13] See for instance Velasco (1987) and Calvo (1995) who link balance of payments crises to problems in the banking sector.

The above two graphs are based on a model with the whole period as the sample period. For Graph 11, the period is divided as follows: the sample period is between January 1990-December 1997, and the period of January 1998-December 2001 is reserved for out-of-sample forecasts. Although the domestic currency started to depreciate significantly by the end of 1997, the crisis in Indonesia reached its climax in 1998 in which the country's gross domestic product (GDP) decline by –13,3%. By the end of that year movement of some variables such as exchange rate of the domestic currency, inflation and short-term interest rates started to show some improvements, and since 1999 the country's GDP growth rates were positive, for instance 0,3% in 1999 and i4,8% in 2000. So, for the analysis purpose, the crisis period to be forecasted is 1998, and the period between1999 onwards is considered as "tranquil" time. The "crisis window", or the pre-crisis period that is between a signal issued and the crisis within the 24-month interval is between January 1996-January 1998.A crisis is defined as a period in which IEP in that period crosses the predetermined threshold, i.e. u + 1.1SD. Table 2 shows the number of signals when the IEP surpasses its threshold which was predetermined for two different periods.

Graph 12, Graph 13, and Graph 14 exhibit the movements of each of the three variables of the exchange market pressure (IEP), and the number of signals issued by the individual indicators when they surpassed their predetermined threshold are given too in Table 2. Different thresholds were calculated for different periods for the individual indicators.

Table 2
Numbers of Signals of the IEP and its Individual Indicators by Two Different Periods

Indicator	Deb.1990-Dec. 1997		Jan.1998-Dec.2001	
	Threshold	Number	Threshold	Number
Exchange rate	4.97	5	26.54	3
Domestic interest rate	10.88	5	16.71	4
Net International reserves	4.57	5	5.37	3
IEP	2.34	5	1.87	6

The Leading Indicators

Table 3 lists the leading indicators and shows their individual predictability during the sample period of January1990-December 1997. As explained before, the optimal threshold for each indicator is chosen between the upper 25% and upper 10% distribution to minimize noise-to-signal ratio during the sample period. The threshold for crisis is set to 1.5 SD of exchange market pressure over its mean and the window is set to 12 months.

The first column of the table shows an alternative measure of the tendency of each of the indicators to issue good signals. It shows the number of good signals issued by the individual indicators, expressed as a percentage of the number of months in which good signals could have been issued (A/(A+C). 100% in this column would require that a signal be issued every month during the 12 months prior to each crisis. The second column measures the performance of the individual indicators regarding sending bad signals. It shows the number of bad signals issued by the indicators, expressed as a percentage of the number of months in which bad signals could have been issued (B/(B+D). Other things equal, the lower the number in this column the better is the indicator. The third column shows the optimal threshold values for each of the indicators.

Table 3
Performance of Each of the Indicators

	A/(A+C)	B/(B+D)	Optimal threshold values	Noise/signal ratio [B/(B+D)]/[A/(A+C)]	Pc = A/(A+B)
Domestic Inflation Rate	42.0	22.6	1.03	0.54	21.0
M2/Net International Reserves	25.0	25.0	4.9	1.00	12.5
M2/Total International Reserves	33.0	18.0	4.6	0.55	21.0
Domestic Credit/GDP	100.0	7.7	67.9	0.08	80.0
Growth of Real Domestic Credit	33.0	18.0	2.83	0.55	21.0
Import	33.3	7.1	3.6	0.21	40.0
Domestic Interest Rate	16.6	9.5	4.7	0.57	20.0
Terms of Trade	8.3	27.4	1.07	3.30	4.2
Bank Loans/Deposit Ratio	8.3	27.4	113.7	3.30	4.2

The information about the indicators' ability to issue good signals and to avoid bad ones can be combined into a measure of the "noisiness" of the indicators. The fourth column of Table 3 shows the "adjusted" noise-to-signal ratio, which is obtained by dividing false signals measured as a proportion of months in which false signals could have been issued, by good signals measured as a proportion of months in which good signals could have been issued. Other things constant, the lower is the number in this column the better is the indicator. The fourth column of Table 3 shows the conditional probability of a crisis.

Other variables that in are suggested in the literature as good leading indicators, namely development of export value, SMI, output value of industry, and ratios of current account, capital account and state budget to GDP are not included in this table due to either lack of time series/consistent data or "inverse development". For instance, the value of export (Graph 7) continued to increase in the period before and during the crisis in 1998. The increase during the crisis period was stimulated further by the weakening of rupiah which improved the price competitiveness of certain export commodities As a result of such development pattern, either at 10% or 25%, A/(A+C) for export variable is zero (0.0), and so its calculated noise/signal ratio is unlimited large. Similarly problem in the case of SMI. Since September 1991 up to June 1997 it shows a positive growth trend, and since July 1997 it started to decline until it reached its minimum level in September 1998, although it is still higher as compared to its minimum level in September 1991 (Graph 19). So, with the set of 10% tail or more of its frequency distribution (i.e. the size of the critical region), SMI as an indicator does not show any signal.

Current deficit-GDP ratio is not included in this model also because it declined, instead of increased in the period approaching the crisis, and capital account-GDP ratio is not taken as a leading indicator simply because of data problem, especially with respect to income. State budget is also not included because the Indonesian government implements the so-called 'balanced budget policy". Annual deficit is covered by foreign loan, and the latter is considered as "income" for the government.

With respect to output of industry, only annual data are available up to 1994, and from 1995 onwards three-month data. Nevertheless, as shown by the quarterly data, output of industry increased, instead of decreased during the pre crisis period (Graph 20).

Composite Index

Based on the results in Table 3, the composite indicator is calculated as the weighted sum of the number of signals from all indicators. Following the Kaminsky (1998) method, the inverse of the noise/signal ratio is used as weights. Graph 23 and Graph 24 show that with 1.5 times standard deviation (SD) as the crisis threshold, the number of signals was highest in 1997. So, as the crisis period is confined to 1998, it can be seen that the composite index warned early for the crisis, as it peaked in 1997.

The Risks of Crises for Indonesia at the Present Time

As shown in Graphs 9 to 11, the exchange market pressure (IEP) varied in a wide margin before and after the crisis. After declined during February-December 1998, the index began to show a positive growth trend up to mid 2000 and then declined slowly toward the end of 2001. It is interesting to see the comparison the movements of the composite index along with those of the IEP. The composite index built using the pre-crisis information on the choice of variables as the leading indicators and their noise-to-signal ratios performed very well to show the vulnerability of the Indonesian economy. The movements of the composite index matches very well with that of the crisis index of the exchange market pressure.

The movements of both the IEP and the composite index after the crisis period indicate that economic vulnerability of Indonesia declined. However, one still cannot be sure 100% in anticipating economic crisis in the future. One still cannot say that Indonesia is safe from the volatile movements of foreign capitals. With an open capital account and internationally mobile capital, an economy can experience a sudden increase in net capital outflows even if it has no large current account deficit. This was the case with the speculative outflow against the Hong Kong dollar after the floating of the Thai bath. It is an important part of the Indonesian story of the crisis, where domestic capital flight appears to have been quantitatively more important to the crisis than the repatriation of foreign capital.

In other words, the prospects of the Indonesian economy in the near term remain a subject of conjecture and controversy. The uncertainty with respect to Indonesian economic prospects seems to influence not only the business community engaged in assessing specific business risks and opportunities but large multilateral lenders as well. In fact, unfortunately, not every one is bullish about the Indonesian market. Despite positive signs of development of some key macroeconomic variables such as inflation, GDP growth and exchange rate (as compared to the crisis period) in the last two years, powerful multilateral lenders, with an insider's access to comprehensive economic data, have tended to characterize the Indonesian economic situation as "fragile". The IMF recently went as far as to say that one should interpret the projected over 3% GDP growth with caution. Anticipated GDP growth was based on a consumption driven recovery. Until now, there is as yet little sign of a turnaround in investment.

At the present time, there are still some economic as well as political-social factors that can create a serious risk of a new crisis for Indonesia Two important economic factors are the extremely high outstanding foreign loans (more than 100% of the country's GDP) and weak banking sector. The banking sector in Indonesia is still in a fragile situation, as since the crisis started in 1997 up to now the process of restructuring and recapitalisation of the banking sector has been very slow. Since its establishment up to the present time, the performance of the bank restructuring agency, IBRA, in relation to asset recoveries, has not been so good. As a result, many insolvent banks are still not resolved, while the cost of bank recapitalisation and restructuring has increased significantly, and it is now the highest in recent economic history, and probably the largest ever. Based on data of 2000 the cost of banking sector reform in Indonesia was already 70.8% of GDP, in comparison with the relative cost in Argentina in 1980-82, at 55% of GDP. Even during the severe Mexican currency crisis of 1994, the total

costs of banking sector reform in the country came to a fraction of what is envisaged in Indonesia (Mishra, 2000).

It is now very doubtful about the government's ability to cover that cost, as government financial deficit is also exploded and to a larger part is being financed by foreign borrowing. The Mexican crisis of 1982 shows that in the eve of that crisis, the exploding government deficit was being financed by foreign borrowing at the time that Mexican residents, doubtful about the public sector's ability to honor its debt, were sharply increasing their investment overseas, created a huge capital outflow. This capital flow, which is often measured by variations in assets held abroad by domestic residents and has been dubbed "capital flight", was at the center of the Mexican crisis of 1982.

There is no doubt that reform of the financial sector together with the removal of structural weakness in other areas are essential for avoidance of future crisis. With the banking sector still in a fragile situation and at the same time the country's outstanding foreign loans are higher than the country's GDP, the task of maintaining the stability of the domestic currency becomes more difficult and may lead to the eventual collapse of the domestic currency.

Besides that, there are other non-economic factors such as misuse of funds and various forms of corruption that continue to hamper economic recovery. Also, the social unrest and ethnic conflicts in many part of the country and bomb explosion are reminders of the current serious lack of security that makes more difficult for Indonesia to recover.

In addition to the above factors that should be taken into account when one is trying to predict the future crisis in Indonesia, Garnaut (1998) argues that the extraordinary collapse of the Indonesian economy cannot be explained without reference to an additional factor: incoherence in the political and policy response, leading to uncertainty, higher risk premia and, after the emergence of political instability, doubts about the security of contractual and other property rights.

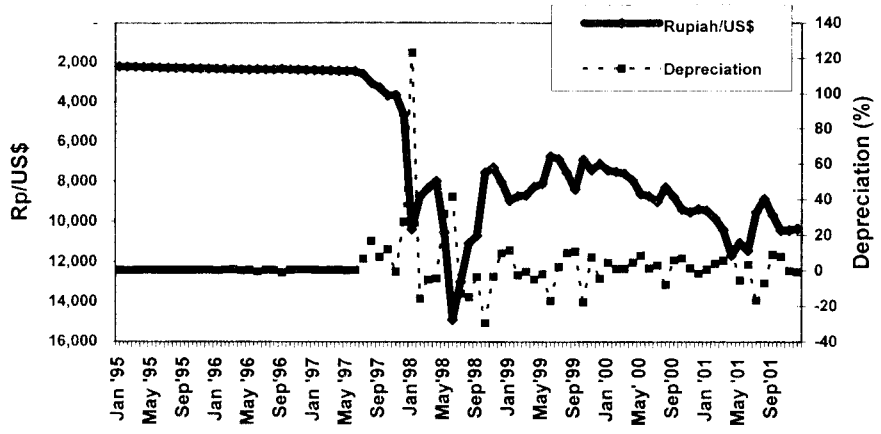
It is generally expected that in approaching the presidential election in 2004, the country will face again a political uncertainty with respect to political succession, and as the past has shown, this can create serious outbreak of social violence. All these social and political factors will increase uncertainty. The consequences of another round of political and economic mishaps such as those that occurred under former President Abdulrahman Wahid may be too much for Indonesia to bear in its current highly vulnerable condition.

From outside, one factor that may threat seriously for the stability of rupiah is the contagion effect of speculative attacks in neighbour countries' currencies. The result of Zhang's (2001) study on the contagion effect in the Asian crisis, using the Auto-regressive Conditional Hazard (ACH) model strongly support the hypothesis that the probability of one currency being attacked in one period is influenced by the frequency of speculative attacks in other countries before the period. So, this means that the stability of rupiah in the near future also depends on the stability of neighbour countries' currencies.

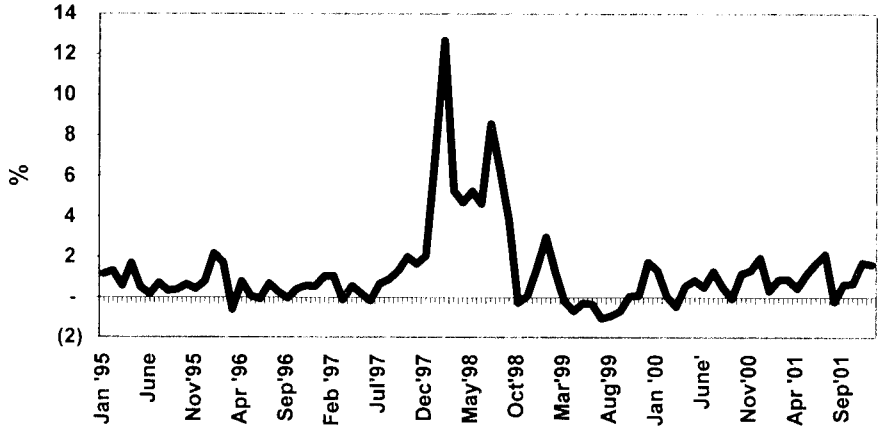
At last, Indonesia's recovery is directly linked to the restoration of the private sector confidence, domestically as well as foreign investors. Since the economic crisis that followed by social and political crises, the market confidence has become very sensitive to political as well as social development in the country. These non-economic factors and economic factors such as inflation, increasing interest rates, and exchange rate volatility have been among the key contributors to business pessimism in Indonesia.

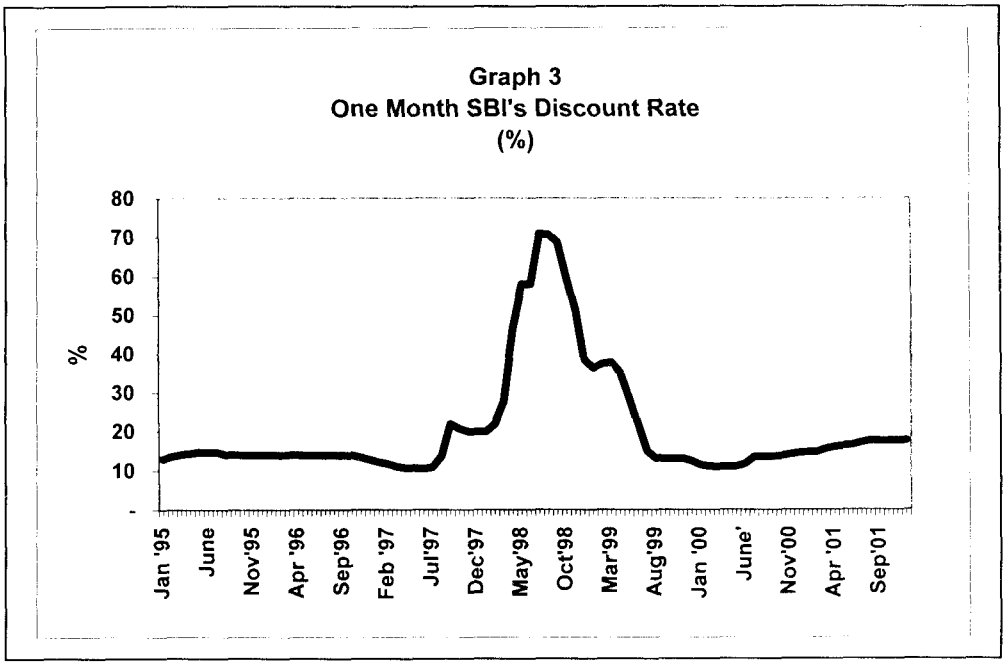
EMPIRICAL RESULTS

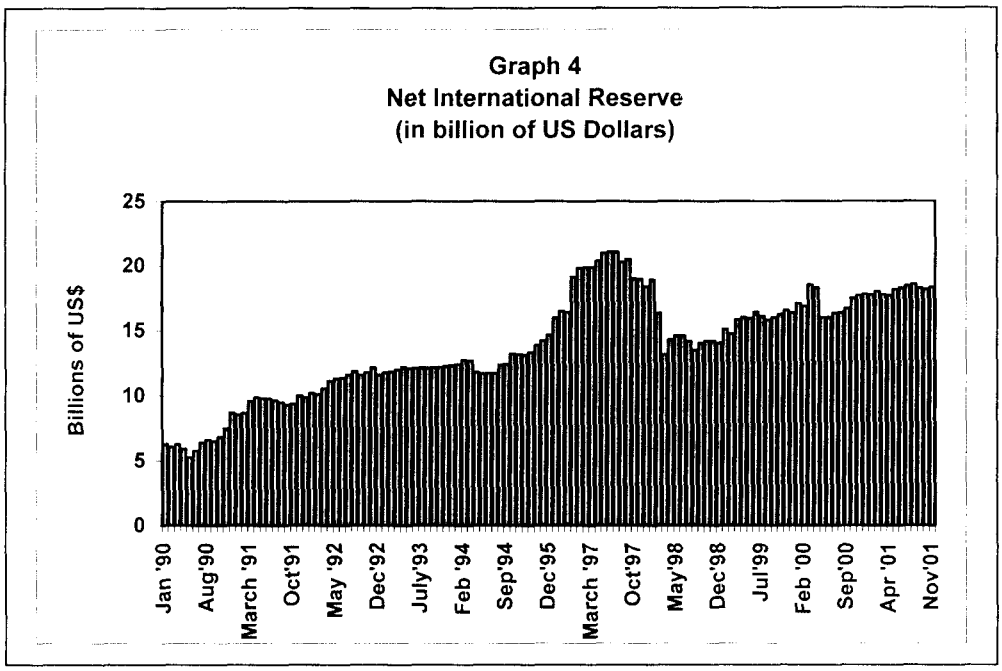
Graph 1
Middle Rate of Rupiah/US$ and Depreciation of Rupiah Against US$
January 1995 - December 2001



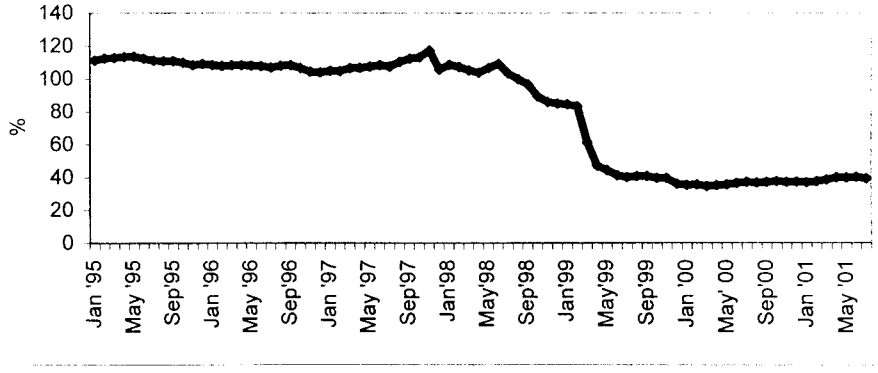
Graph 2
Inflation Rate
(%)



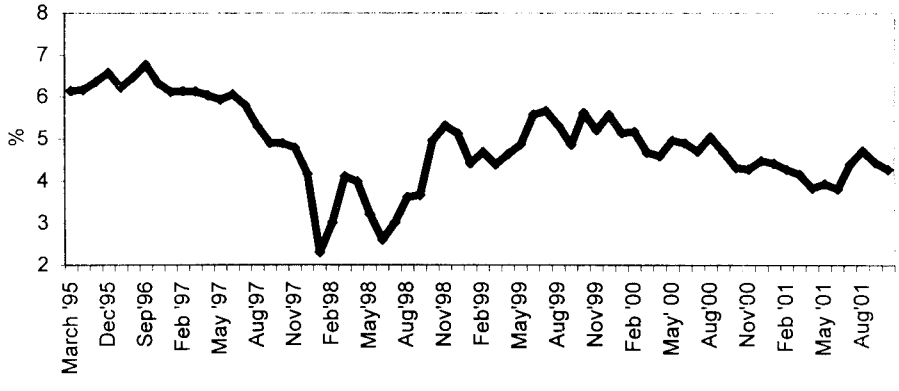

Graph 3
One Month SBI's Discount Rate
(%)
%
80
70
60
50
40
30
20
10
-
Jan '95
June
Nov'95
Apr '96
Sep'96
Feb '97
Jul'97
Dec'97
May'98
Oct'98
Mar'99
Aug'99
Jan '00
June'
Nov'00
Apr '01
Sep'01

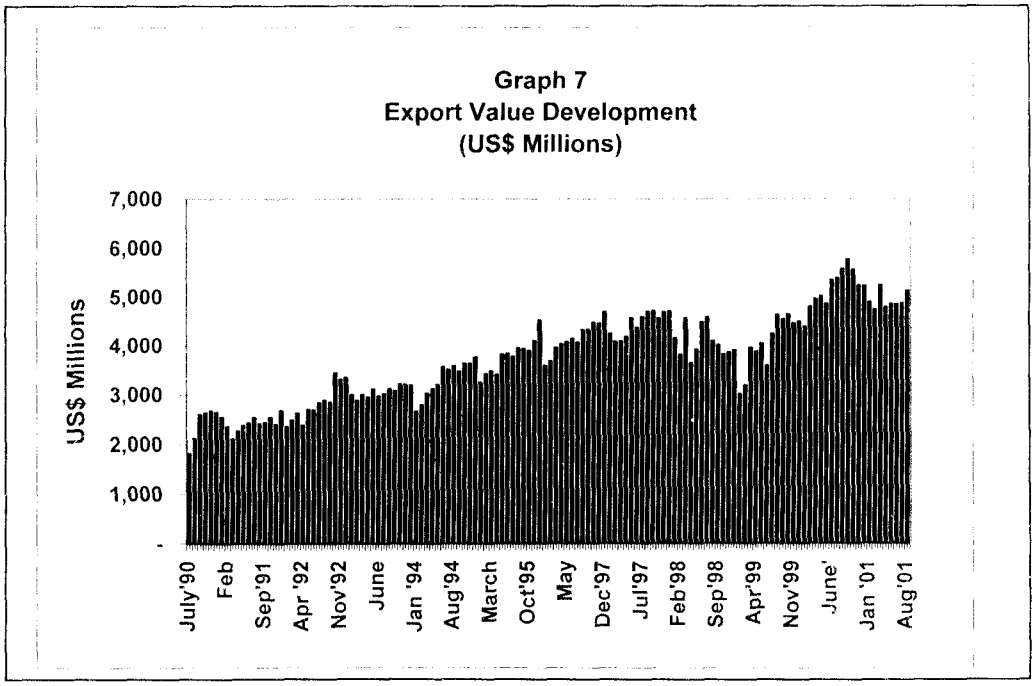

Graph 4
Net International Reserve
(in billion of US Dollars)
Billions of US$
25
20
15
10
5
0
Jan '90
Aug'90
March '91
Oct'91
May '92
Dec'92
July'93
Feb '94
Sep'94
Dec'95
March '97
Oct'97
May'98
Dec'98
Jul'99
Feb '00
Sep'00
Apr '01
Nov'01

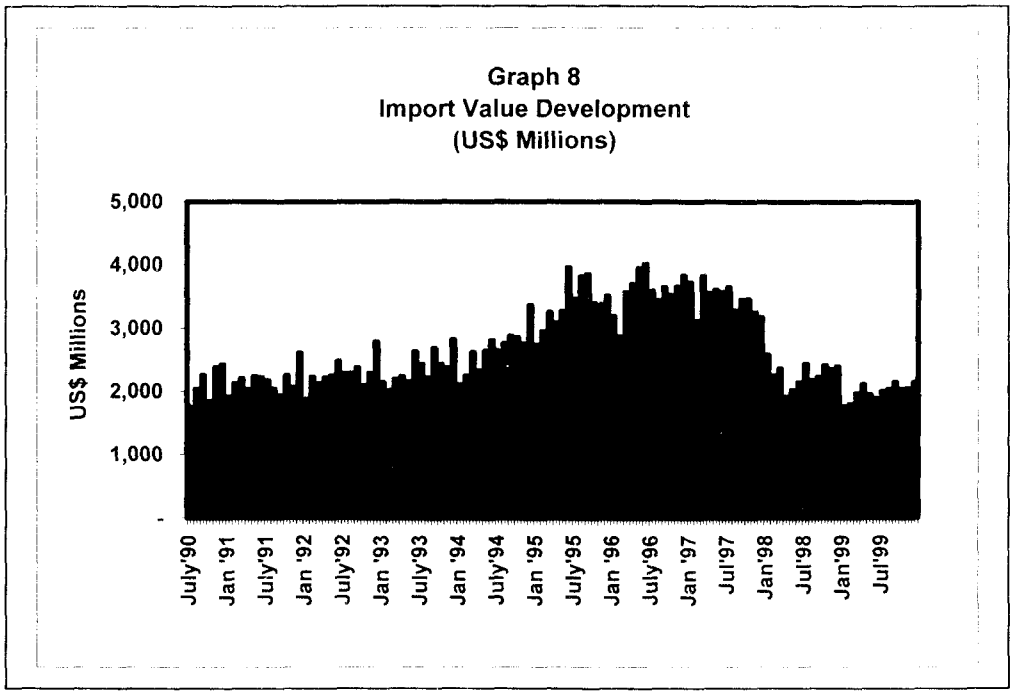
Graph 5
Total Bank Loan/Total Deposits
(%)



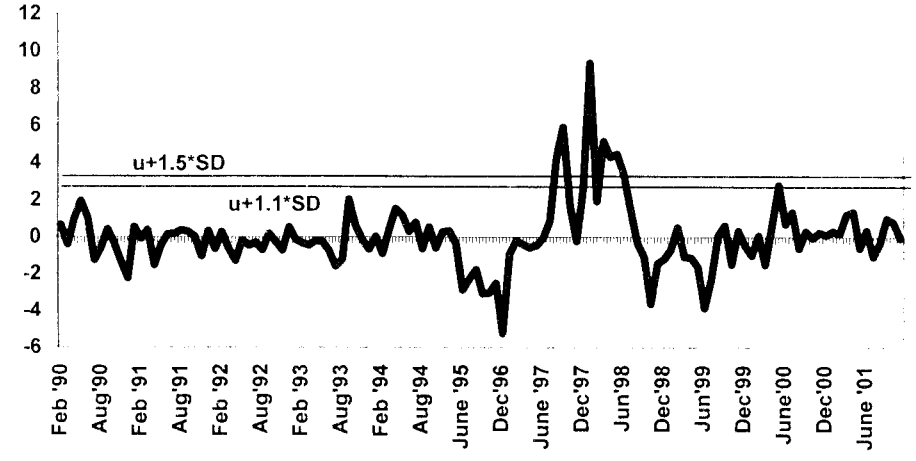
Graph 6
M2/Net International Reserve
(%)



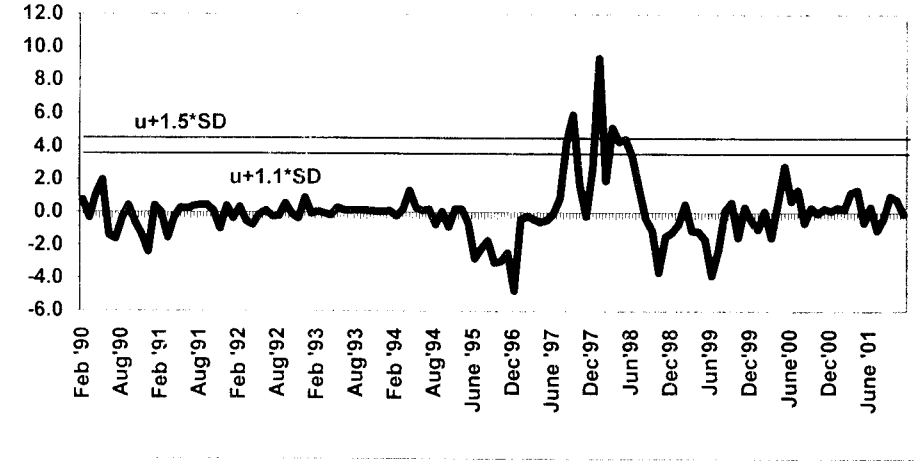

Graph 7
Export Value Development
(US$ Millions)
US$ Millions
7,000
6,000
5,000
4,000
3,000
2,000
1,000
-
July'90
Feb
Sep'91
Apr '92
Nov'92
June
Jan '94
Aug'94
March
Oct'95
May
Dec'97
Jul'97
Feb'98
Sep'98
Apr'99
Nov'99
June'
Jan '01
Aug'01


Graph 8
Import Value Development
(US$ Millions)
US$ Millions
5,000
4,000
3,000
2,000
1,000
-
July'90
Jan '91
July'91
Jan '92
July'92
Jan '93
July'93
Jan '94
July'94
Jan '95
July'95
Jan '96
July'96
Jan '97
Jul'97
Jan'98
Jul'98
Jan'99
Jul'99

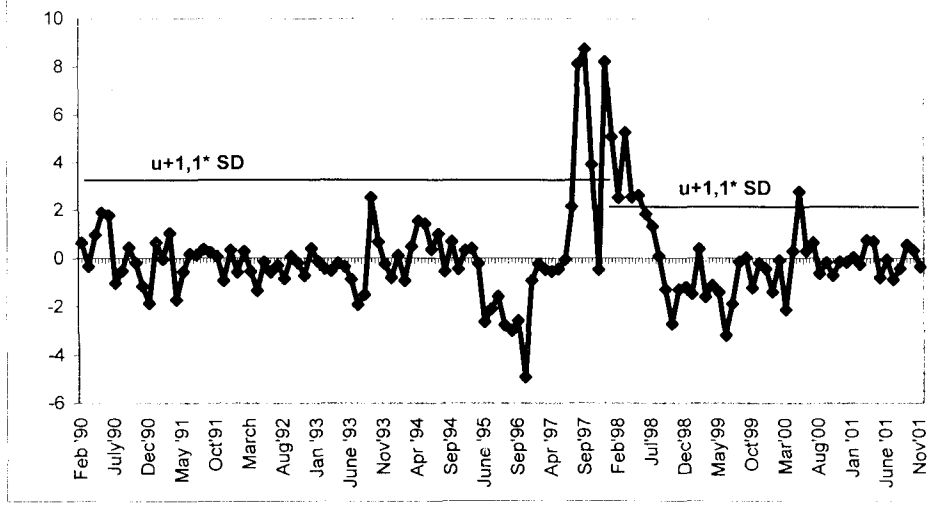
Graph 9
Exchange Market Pressure and Crisis
(IEP = ^%ER+^%IR-^%NIR)



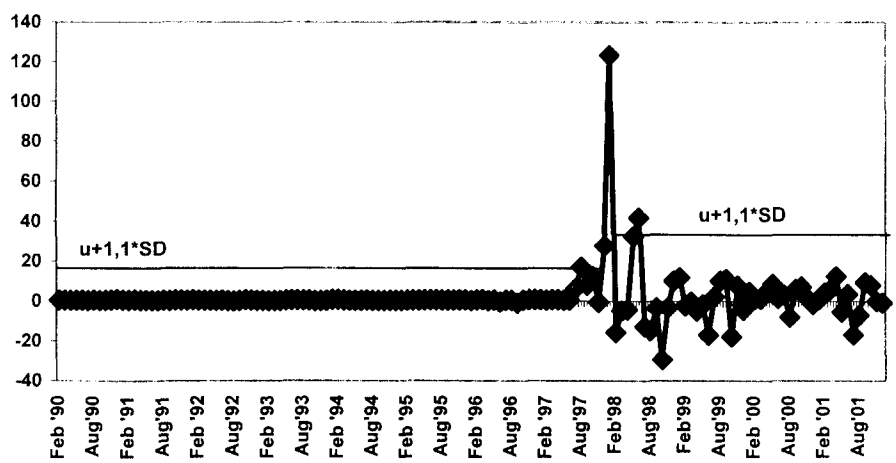
Graph 10
Exchange Market Pressure and Crisis
(IEP = ^%ER - ^%NIR)



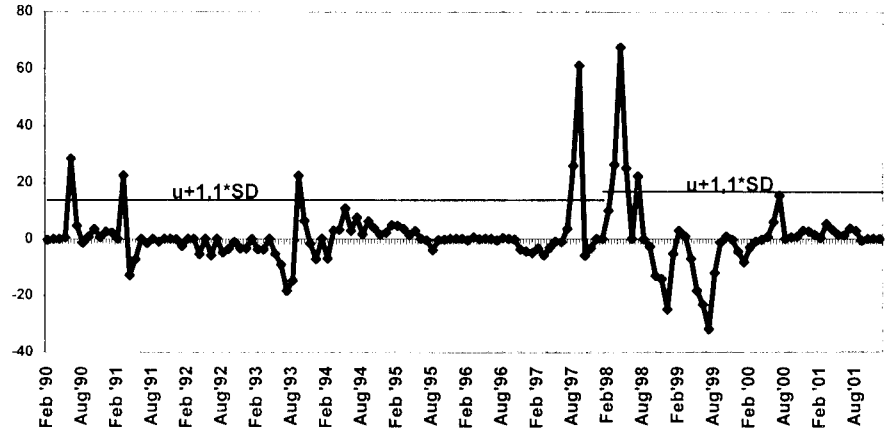
Graph 11
Exchange Market Pressure and Crisis
(Jan'90-Dec'97, Jan'98-Dec'01)



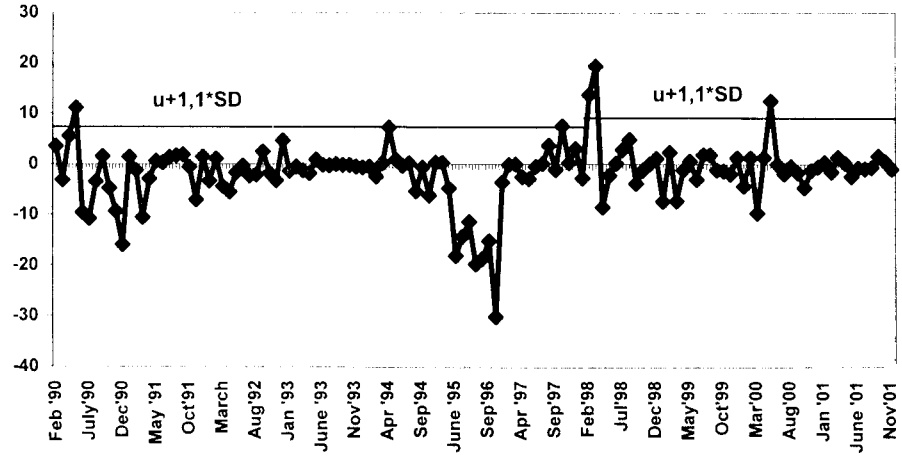
Graph 12
Depreciation of Rupiah



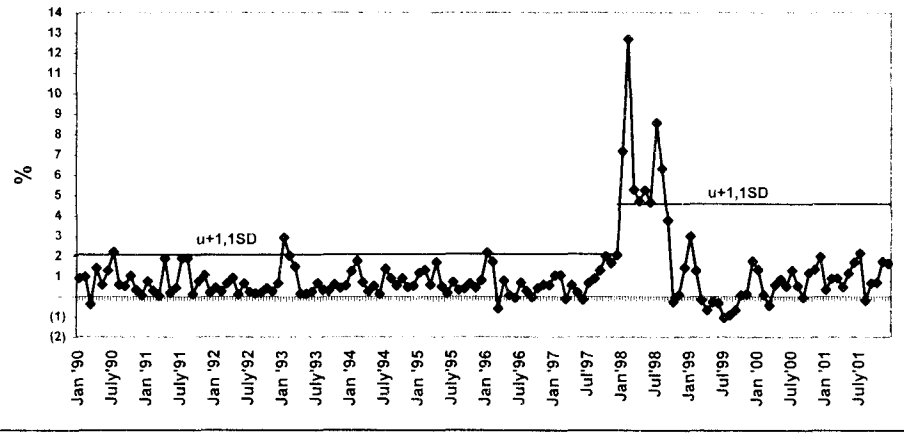
Graph 13
Percentage Change of Interest Rate



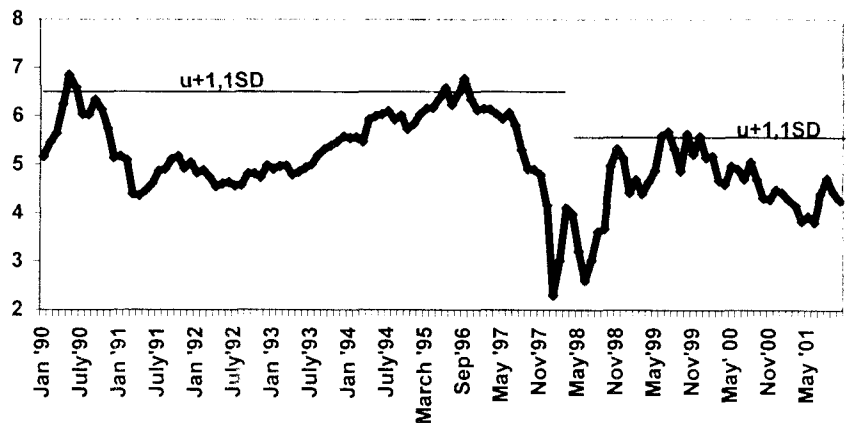
Graph 14
Percentage Change of Decreased Net International Reserve



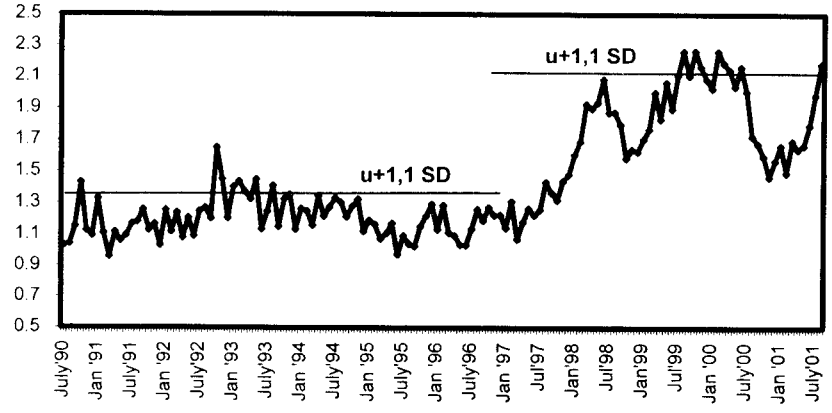
Graph 15
Inflation Rate
(%)



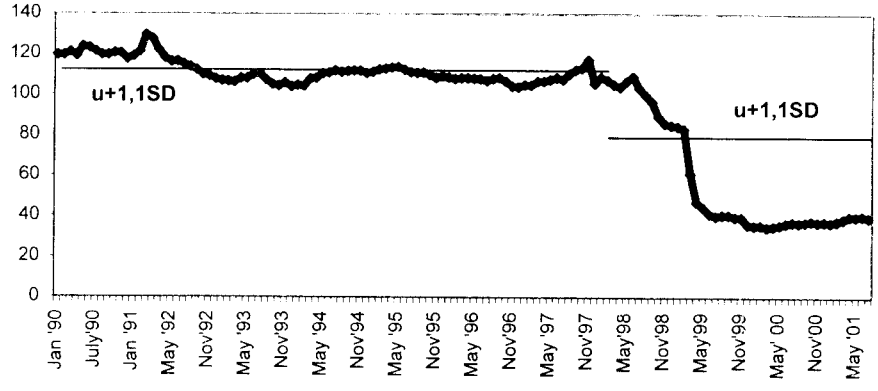
Graph 16
M2/Net International Reserve



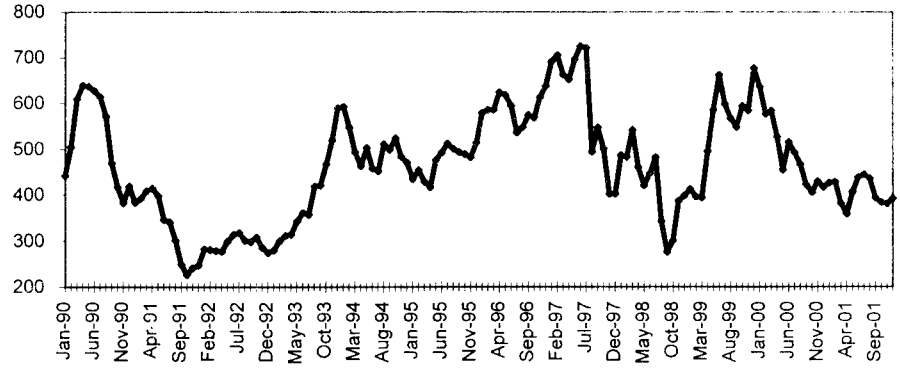
Graph 17
Term of Trade



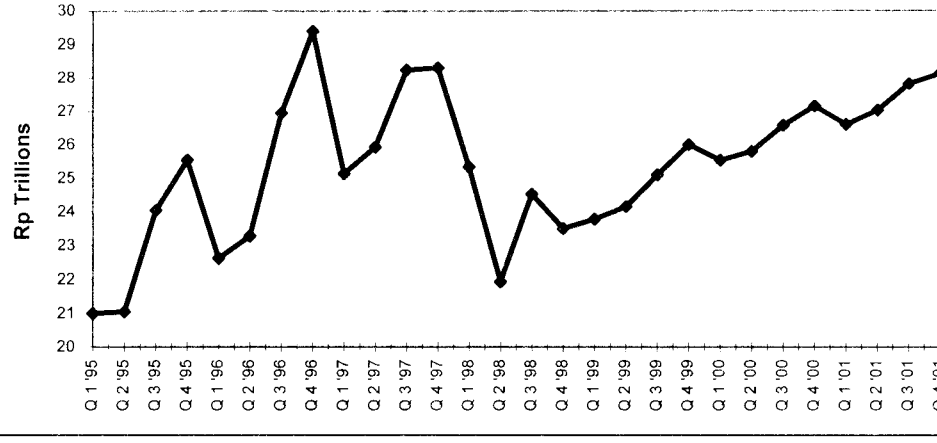
Graph 18
Total Bank Loan/Total Deposits
(%)



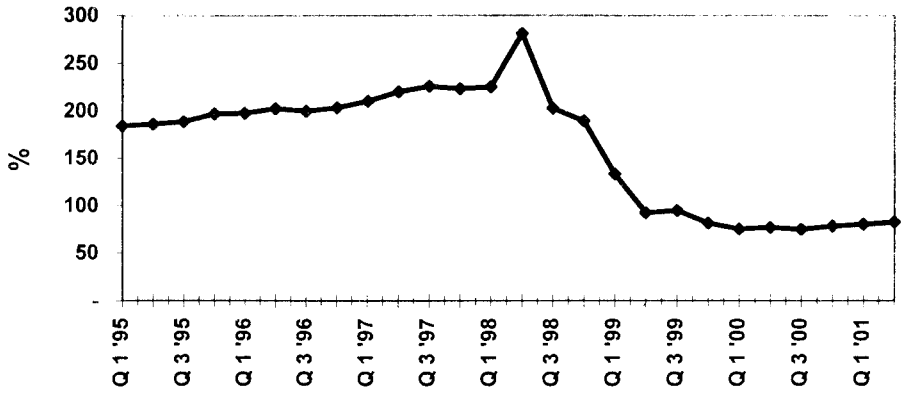
Graph 19
Jakarta Stock Market Index



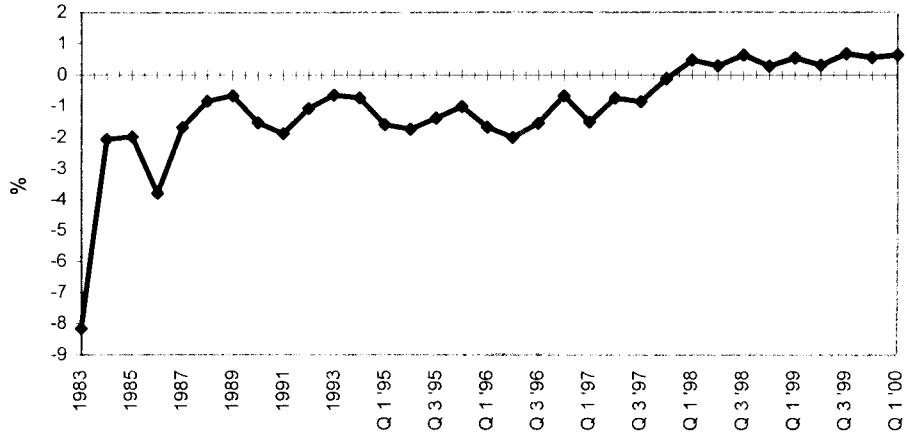
Graph 20
Value Added of Manufacturing Industry
(Rp Trillions)



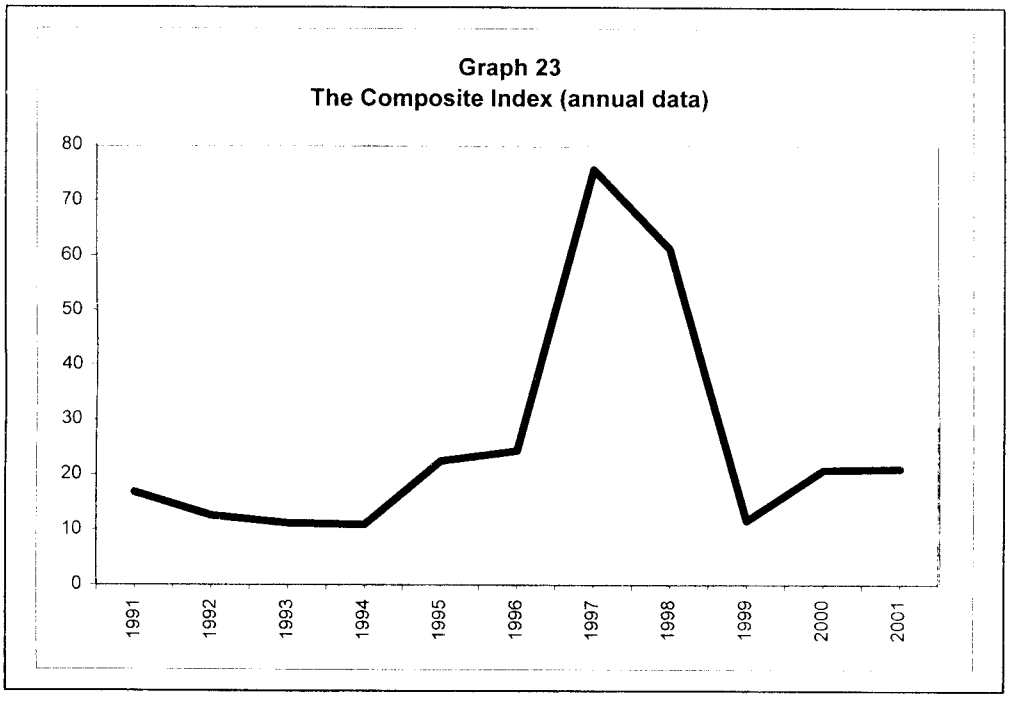
Graph 21
Total Bank's Loan - GDP
(%)



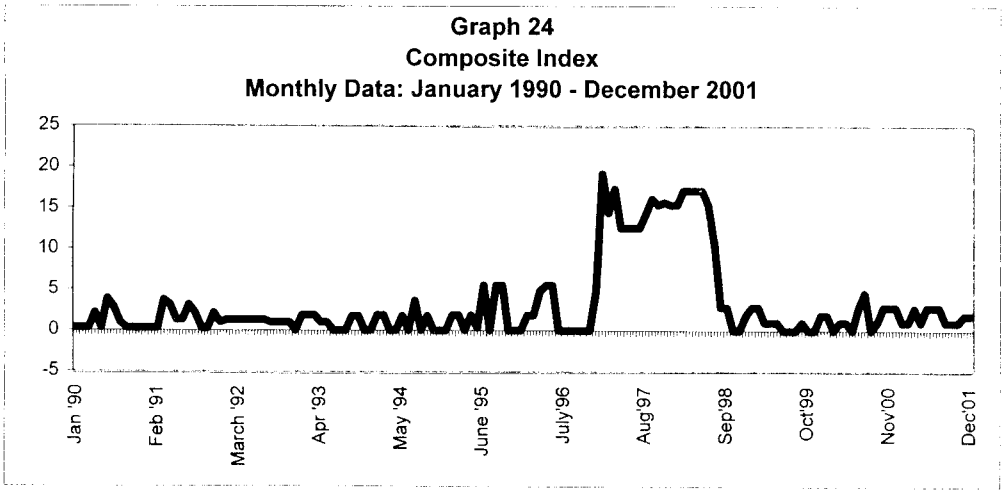
Graph 22
Current Account - GDP
(%)



Graph 23
The Composite Index (annual data)



Graph 24
Composite Index
Monthly Data: January 1990 - December 2001



REFERENCES

Bilson, John F.O. 1979. "Leading Indicators of Currency Devaluations." *Columbia Journal of World Business*, 14 (Winter).

Calvo, Guillermo A. 1995. "Varieties of Capital-Market Crises." Center for International Economics, Working Paper No.15 (November). College Park: University of Maryland.

Collins, Susan M. 1995. "The Timing of Exchange Rate Adjustment in Developing Countries." Seminar paper. Washington, D.C.: Georgetown University.

Demirguc-Kunt, Asli, and Enrica Detragiache. 1997. "The Determinants of Banking Crises: Evidence from Developing and Developed Countries." IMF Working Paper 97/106 (September). Washington, D.C.: International Monetary Fund.

Edin, Per-Anders, and Anders Vredin. 1993. "Devaluation Risk in Target Zones: Evidence from the Nordic Countries." *The Economic Journal*, 103 (January).

Edwards, Sabastian, and Julio Santaella. 1993. "Devaluation Controversies in the Developing Countries: Lessons from the Bretton Wood Era." In Michael D. Bordo and Barry Eichengreen (ed.), *A Retrospective on the Bretton Woods System: Lessons for International Monetary Reform.* Chicago: University of Chicago Press.

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

_____. 1996. "Contagious Currency Crises: First Tests." *Scandinavian Journal of Economics*, 98, 4.

Goldstein, Morris. 1996. "Presumptive Indicators/Early Warning Signals of Vulnerability to Financial Crises in Emerging Market Economies." Washington, D.C.: Institute for International Economics.

Hardy, Daniel C., and Ceyla Pazarbasioglu. 1998. "Leading Indicators of Banking Crises: Was Asia Different?" IMF Working Paper No.98/91. Washington, D.C.: International Monetary Fund.

Herrera, Santiago, and Conrado Garcia. 1999. User's Guide to an Early Warning System for Macroeconomic Vulnerability in Latin American Countries. Paper presented in the XVII Latin American Meeting of the Econometric Society, Cancun. August.

International Monetary Fund (IMF). 1998. *World Economic Outlook 1998.* Washington, D.C.: International Monetary Fund.

Kaminsky, Graciela. 1998. "Currency and Banking Crises: The Early Warnings of Distress." International Finance Discussion Po.629 (October). Washington, D.C.: Board of Governors of the Federal Reserve System.

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

Kaminsky, Graciela, Saul Lizondo, and Carmen M. Reinhart. 1997. "Leading Indicators of Currency Crises." IMF Working Paper 97/79 (July). Washington, D.C.: International Monetary Fund.

Klein, Michael W., and Nancy Marion. 1994. "Explaining the Duration of Exchange-Rate Pegs." NBER Working Paper No.4651 (February). Cambridge, Mass.: National Bureau of Economic Research.

Krugman, Paul. 1979. "A Model of Balance of Payments Crises." *Journal of Money, Credit, and Banking*, 11 (August).

Milesi-Ferretti, Gian Maria, and Assaf Razin. 1995. *Current Account Sustainability*. Washington, D.C.: International Monetary Fund.

Mishra, Satish. 2000. "Systematic Transition in Indonesia: Implications for Investor Confidence and Sustained Economic Recovery." Working Paper: 06/00/03, March, Jakarta: UNSFIR.

Montiel, P., and C. Reinhart. 1997. "The Dynamics of Capital Movements to Emerging Economies During the 1990s." Mimeo, July, University of Maryland.

Obstfeld, Maurice. 1996. "Rational and Self-Fulfilling Balance-of-Payments Crises." *The American Economic Review*, 76 (March).

Otker, Inci, and Ceyla Pazarbasioglu. 1994. "Exchange Market Pressures and Speculative Capital Flows in Selected European Countries." IMF Working Paper WP/94/21 (February). Washington, D.C.: International Monetary Fund.

_____. 1995. "Speculative Attacks and Currency Crises: The Mexican Experience." IMF Working Paper WP/95/112 (November). Washington, D.C.: International Monetary Fund.

Park, Won-Am. 2001. "An Indicators on the Sustainable Development of Korea." Paper prepared for the East Asian Development and ISEAS Networking meeting, Singapore, June 25-27.

Velasco, Andres. 1987. "Financial and Balance of Payments Crises: A Simple Model of the Southearn Cone Experience." *Journal of Development Economics*, 27, October.

Yap, Josef T., and Mario B. Lamberte. 2001. "Monitoring Economic Vulnerability and Performance: Applications to the Philippines." Paper presented at the East Asian Development Network Third Forum, June. Singapore: Institute of Southeast Asian Studies.

Zhang, Zhiwei. 2001. "Speculative Attacks in the Asian Crisis." IMF Working Paper, WP/01/189. Washington, D.C.: International Monetary Fund.

Macroeconomic Vulnerability in Indonesia

Sri Adiningsih
Dini N. Setiawati, and
Sholihah[*]

1. INTRODUCTION

1.1 Background

The financial crisis that swept over East-Asian countries since the latter part of 1997 has quickly deteriorated into an economic and social crisis. East Asia's crisis foretells a continuing loss in human potential that echoed for years after this crisis has passed[1]. Moreover, the crisis has changed the political life in the East Asian countries instantly.

However, The East Asian countries immediately took steps to solve the crisis. Asian Development Bank[2] reported that countries throughout the region are moving fast to recover their economic performances by enacting new policies and adopting more transparent ways of doing business. They made a significant progress in addressing the various policy issues that is faced by them. As Asian Development Bank reported, in 1998, the five countries most affected by the Asian financial crisis continue to recover. Growth accelerated rapidly past after the crisis in Indonesia and Malaysia, and more moderately in the Philippines and Thailand. In the Republic of Korea, growth decelerated slightly but remained strong.

Three years since the financial crisis began, Indonesia has achieved considerable political reform, re-establish Indonesian democracy, and focus on the challenge of broadly based political, economic, and military reform. Indonesia has made a significant progress in addressing the various policy issues. However, there are still many problems faced by Indonesia. This makes the economic recovery in Indonesia left behind by other crisis countries in the region.

Nevertheless, publications such as *The Economist*[3] and *Far Eastern Economic Review*[4] in 2001 reported that there are several dangerous signals/symptoms to recession in Asia, particularly in Japan, Singapore, and Taiwan. Japan continuous to struggle with its own problem of a dis-functional financial system and weak consumer demand. Singapore and Taiwan have both experienced two quarters of shrinking GDP. Singapore's has fallen at an annual rate of 11% in the first half of the year and Taiwan's at a rate of 6%. South Korea's economy also has slowed sharply, while the second-quarter figures for Malaysia and Thailand are likely to show that they face a more immediate problem: the wrenching collapse in international demand for their exports.

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1 The effects of the crisis are acute in Indonesia, and severe in Thailand, Korea, Malaysia, and The Philippines. The World Bank (1998) "East Asia :The Road to Recovery", reported the crisis is likely to have many dimensions, falling incomes, rising absolute poverty, declining public services, threats to educational and health status, and increased crime and violence.

2 Asian Development Bank (2001).

3 "A Global Game of Dominoes", *The Economist* (2001).

4 "Asia's Economic Future: Choices That Will Shape The Recovery", *Far Eastern Economic Review* (2001).

The 1997 crisis and the forthcoming recession as reported by some publications showed us that the economy in the world is becoming more integrated and as consequence the interdependence among economies will grow stronger. In this case, a shock in an economy will be immediately transferred to the others. Although the shock happened in a well-performed economy, it doesn't mean that the developing countries are not influenced. Moreover, it is possible that developing countries such as Indonesia will be affected more badly due to the weakness of its economic fundamental.

Finally, we can construe that it is needed to develop such a mechanism to detect any early symptoms on economic crisis so that crisis possibilities can be detected and anticipated. In this case, early warning system for economic fragility is one of the methods to identify and anticipate crisis in the future. Development of an early warning system is very crucial for every country and it is not easy to construct an early warning system that can be applied for every country due to the unique characteristics of each country.

The purpose of this study is to develop an early warning system for macroeconomic vulnerability in Indonesia. While the Government of Indonesia has indicated the focus to set right and improve economic performance, it is quite thoughtful of need to detect and anticipate the crisis in the future. As the development of economic progresses, detection and anticipation will be made by taking into account overall changes on economic situation in Indonesia. The early warning system that is developed must be suitable and have a high predictive power for Indonesian economic condition.

1.2 Theoretical Background

The need to develop a good surveillance device to detect and anticipate the economic shock is becoming important after economic crisis occur in many areas (Adiningsih, 2001). So far, there are several researchers that have developed an early warning system, for instance Kaminsky and Reinhart (1997 and 1999)[5] and Herrera & Garcia (1999).[6] In the early stage, Kaminsky specifically developed an early warning system for financial crisis possibilities. Kaminsky and Reinhart (1997) have examined the potential causes and the symptoms of currency crises whether those symptoms can be detected with sufficient advance so as to allow governments to adopt pre-emptive measures. Kaminsky and Reinhart examine the available evidence on currency crises to propose a specific early warning system. They narrow its focus to identifying the various indicators suggested by alternative explanations of currency crises. They compare the relative merits of alternative approach in providing early indicators of currency crisis and based on this comparison, propose a specific methodology for the design of an early warning system.

Otherwise, a study that has been done by Tjahjono[7], which used Kaminsky and Reinhart approach, has failed to identify crisis in Indonesia. Also, there were several bad signals on the countries that are assumed to be "no crisis countries", that is Singapore and Hong Kong.

Meanwhile, Herrera and Garcia (1999) developed an early warning system (EWS) of a country's macroeconomic fragility. The idea of Herrera & Garcia is to have an instrument that helps policy makers identify and anticipate situation in which crises are more likely to happen.

There are three main basic differences between Herrera & Garcia's model and Kaminsky (1997) that are:

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5 Kaminsky, Lizondo and Reinhart (1997)"Leading Indicators of Currency Crises", IMF Working Paper, International Monetary Fund. Also, Kaminsky, Graziela L and Carmen M. Reinhart (1998) "The Twin Crises: The Causes of Banking and Balance of Payment Problems". American Economic Review. November.

6 Herrera, Santiago and Conrado Garcia (1999) "User's Guide to an Early Warning System for Macroeconomic Vulnerability in Latin American Countries". World Bank Working Paper. November.

7 Tjahjono, Dwi Endy. 1998. Economic Fundamental, Contagion Effect, and Asian Crisis. Buletin Ekonomi Moneter dan Perbankan, September.

1. The main interest of Herrera & Garcia's model is to have an operational tool. The ultimate objective is to build the simplest possible early warning system to be updated monthly at the lowest feasible cost.
2. The aggregation method of the individual leading indicators into a composite index and the way this index is used as a signaling device, because Herrera & Garcia believe that for a crisis to take place the set of leading indicators must jointly drift in the same direction over some period of time.
3. The exclusive focus on Latin American Countries, estimating the models and showing details on a country-by-country basis.

Contagion effect is suspected to play an important role in Asian economic crisis, since the crisis started from Thailand and swap over the region. So, knowing whether contagion really plays an important role in the crisis is important.

World Bank (2000) defines contagion as the cross-country transmission of shocks or the general cross-country spillover effects (broad definition). Contagion can take place both during "good" times and "bad" times. Then, contagion does not need to be related to crises. However, contagion has been emphasized during crisis times. Meanwhile, the restrictive definition of contagion is the transmission of shocks to other countries or the cross-country correlation, beyond any fundamental link among the countries and beyond common shocks.

Contagion is conveyed through several links. *Financial links* exist when two economies are connected through the international financial system. One example of financial link is when open-end mutual funds forecast future redemptions after there is a shock in one country. Mutual funds need to raise cash, and consequently they sell assets in third countries. *Real links* have been usually associated with international trade. When two countries trade among themselves or if they compete in the same foreign markets, a devaluation of the exchange rate in one country deteriorates the other country's competitive advantage. As a consequence, both countries will likely end up devaluing their currencies to re-balance their external sectors. Other types of real links, like foreign direct investment across countries, may also be present.

There are a lot of studies on contagion effect. Eichengreen, Rose, and Wyplosz (1996)[8] analyzed the role of contagion on currency crises. Using thirty years of panel data from 20 industrialized countries, they examined contagion in foreign exchange markets by using a framework that distinguished two channels of international transmission of speculative attacks. The first channel is trade link, and the second channel is macroeconomic similarities. They found evidence that speculative attack elsewhere increase the probability of an attack on domestic currency. Contagion effect appears to spread more easily to countries that are closely tied by international linkages than to countries in similar macroeconomic conditions. Kaminsky and Reinhart (2000)[9] analyzed how fundamental based contagion could rise because of both trade links and financial links. They examined the role of various creditors, including international banks and mutual funds, trader's potential cross-market hedging, and bilateral and third party trade in spread of crises. They found evidence that contagion is more regional than global. The probability of domestic crisis rises sharply if a core group of country is already infected. It is difficult to distinguish the channel of transmission, because most countries that are linked in trade are also linked in finance. From the analysis of two potential victims of contagion, which are Argentina after Mexico and Indonesia after Thailand, the results indicate that financial linkages were the more likely causes. Meanwhile, Tjahjono (1998) examined the contagion effect on Asian crises by using Probit model. The result indicated that both economic fundamental condition and contagion effect significantly had

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[8] Barry Eichengreen, Andrew K. Rose, and Charles Wyplosz, 1996, "Contagious Currency Crises), NBER working Paper, No. 5681.

[9] Graciela L. Kaminsky and Carmen M. Reinhart, 2000, "On Crises, Contagion, and Confusion", *Journal of International Economics* 51.

contribution on currency crisis. Indeed, the contagion effect had larger contribution than the fundamental condition.

2. METHODOLOGY

2.1 Model Selection

To construct Indonesian early warning system, we follow the model that has been developed by Santiago Herrera and Conrado Garcia (1999) as explained above. The reason for adopting the Herrera & Garcia model is based on the advantages of the model as follow:

- the model is the simplest model for early warning system
- the model can be updated monthly
- the model has the lowest feasible cost
- the model aggregating the variables and then generating the signals depending on the behavior of the composite index. The reason for adopting this strategy is that to take place the set of leading indicators for an economic crisis must jointly drift in the same direction over some period of time.

2.2 The Stages of Herrera & Garcia's Model

2.2.1 Determining the crisis period

To determine the crisis period, Herrera-Garcia define an Index of Speculative Pressure (ISP) as follows:

ISP = Δ% exchange rate + Δ% interest rates - Δ% international reserves

All the variables (monthly percentage changes) were standardized to have mean zero and unit variance. A crisis is defined as period in which ISPt > $\mu + 1{,}5\sigma$ (where μ is the sample mean and σ is the standard deviation of the ISP)

2.2.2 Determining leading indicator of crisis

The variables used are adopted from Herrera-Garcia's model. The Herrera & Garcia's leading indicators are:

1. M2 / Reserves
2. Real domestic credit growth
3. Real effective exchange rate
4. Inflation rate (there is consistency of this variable as determinants of banking crises according to Demirguc-Kunt and Detragiache[10])

Besides, the variables used since they are similar with the result of leading indicator of Indonesian economic crisis using Kaminsky and Reinhart approach (1999)[11]. Susatyo (2002)[12] has investigated leading indicator of Indonesian economic crisis using the Kaminsky-Reinhart approach. The results show that the variables chosen here are good variables as leading indicators. This can be seen from their low noise to signal ratio.

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[10] Demirguc-Kunt and Enrica Detragiache (1997)"Banking Crises around the World: Are there Common Threads?"

[11] Kaminsky and Reinhart, 1997, "Leading Indicators of Currency Crises, IMF Working Paper, July.

[12] Using data period 1990-2000 with monthly basis, the study used 14 variables to identify leading indicators. The variables are as follow (respectively from the best performance as leading indicator): real exchange rate, M2/reserves, inflation, real domestic credit growth, international reserves, real interest rate, stock price, ratio of lending rate to deposit rate, commercial bank deposits, ratio of domestic credit to GDP, export, import, and M2 multiplier.

Characteristic / Performance of Indicators

Indicator	Threshold[13]		Signal[14]				Good Signal A / (A+C)	Bad Signal B / (B+D)	Noise / signal[15]
	Upper	Lower	91-96	96-99	99-01	Σ			
Real exchange rate	48.088	-6.391	0	16	6	22	44.44	6.74	0.15
M2/Reserve	8.799		1	8	2	11	22.22	3.37	0.15
Real domestic credit growth	0.657	-0.410	4	20	4	28	55.56	8.99	0.16
Inflation	0.515	-0.929	5	14	1	20	38.89	6.74	0.17
International reserves		-9.770	2	4	0	6	11.11	2.25	0.20
Real interest rate	21.810	10.177	7	21	4	32	58.33	12.36	0.21
Stock market price	14.585	-13.523	3	9	2	14	25.00	5.62	0.22
Credit interest rate/deposit rate	11.601	-11.188	4	9	1	14	25.00	5.62	0.22
Commercial bank deposits		-1.755	3	5	0	8	13.89	3.37	0.24
Domestic credit/GDP	4.088		2	6	2	10	16.67	4.49	0.27
Export		-14.111	2	4	1	7	11.11	3.37	0.30
GDP		-1.719	4	5	0	9	13.89	4.49	0.32
Import	29.755		2	2	0	4	5.56	2.25	0.40
M2 multiplier	11.281	-10.489	5	4	4	13	11.11	10.11	0.91

Source: Susatyo (2002) and calculated.

[13] The threshold is mean ± 2 standard deviation ($\mu + 2\sigma$).
[14] Estimation period is from January 1991 until May 2001.
[15] Ratio of bad signal to good signal [B / (B+D)] / [A / (A+C)].

Herrera-Garcia then constructed an index of macroeconomic vulnerability (IMV) with the variables, standardized to have mean zero and unit variance, circumventing the issue of weighting the individual indicators differently. The IMV is computed as the sum of standardized variables.

$$IMV = REER + RDG + M2/R + \Pi$$

REER = Real effective exchange rate
RDG = Real Domestic Credit Growth
M2/R = M2/International reserves
Π = Inflation

The signals will be extracted from the behavior of the composite index (while in the Kaminsky case, each individual variable generates signals that are then aggregated into the composite index). The assumption for the aggregation procedure is that the leading variables drift more or less in the same direction or have common element in their behavior prior to the crisis. If this is not the case, it will not be a good indicator.

2.2.3 Signal-generating mechanism

We apply 2 transformations or filters to the IMV to generate signal[16]:

1. The levels model (simple model)
2. The ARIMA residual model

2.2.3.1 The Levels Model (Simple Model)

A characteristic of all the computed IMV is that their volatilities change through time. The index is particularly volatile, so the standard deviations used are computed from the conditional variance of the series estimated by a Generalized Autoregressive Conditional Heteroskedastic (GARCH) model. The feature of these types of models is that the variance of the IMV is taken to be an ARMA process that is estimated simultaneously with the mean of the series. The GARCH (p,q) model that is used is:

$$IMV_t = a_0 + a_1 IMV_{t-1} + e_t$$

$$e_t = v_t \sqrt{h_t} \quad , \; v \text{ is white noise with } \sigma_v = 1$$

$$\text{and } \hat{h}_t = \alpha_0 + \sum_{i=1}^{q} \alpha_i e_{t-i}^2 + \sum_{i=1}^{p} \beta_i h_{t-i}$$

with the conditional standard deviations, the threshold was computed and the signaling device is complete.

[16] The reason for choosing these models is, based on Herrera-Garcia's research in 8 developing countries in Latin American Countries (Argentina, Brazil, Chile, Colombia, Ecuador, Mexico, Peru, and Venezuela), simple model performs the best in signaling the crisis in Latin American Countries and ARIMA residual model performs second best (Herrera-Garcia, 1999). Moreover, we choose ARIMA model because this method is popular for its success in forecasting. The forecast obtained from this method are more reliable than those obtained from the traditional econometric modeling, particularly for short-term forecast (Gujarati, 1995).

Signal-generating mechanism of simple model

In the Simple Model, signal-generating mechanism is conducted by constructing the threshold for the IMV with the conditional standard deviations of GARCH Model. The signal is flashed if IMV $> \mu + 1{,}5\sigma$ (the IMV exceeds the mean plus 1,5 standard deviations).

The steps of Simple Model

- Compute the IMV index.
- Construct the thresholds for the IMV with the conditional standard deviations of GARCH[17] model.

The signal is flashed if IMV $> \mu + 1{,}5\sigma$ (the IMV exceeds the mean plus 1,5 standard deviations).

2.2.3.2 The ARIMA residual model

In the regression and exponential smoothing models, it was assumed that Y_t was statistically independent, that is, the error terms (et) were random. If this had not been the case, we should use in our model past values of the time-series variable and/or current and past values of the error terms (Gaynor & Kirkpatrick, 1994). The ARIMA model is a procedure for accomplishing this. The ARIMA model consists of extracting the predictable movements (pattern) from the observed data through a series of iterations.

This model is also known as Box-Jenkins methodology. The assumption for this model is the time series has to be stationer (the mean and variance are constant). An ARIMA model describes the normal or regular behavior for the IMV, so the residuals summarize the deviations from normal behavior. We then construct a moving average of the residuals and a signal is generated when this statistic exceeds zero.

Signal-generating mechanism of ARIMA Residual Model

Meanwhile, in the ARIMA Residual Model, signal-generating mechanism occurs when the residuals of the model summarize the deviations from normal behavior and a signal is generated when this statistic exceeds zero.

The steps of ARIMA Residual Model

1. Determine a tentative ARIMA model

We determine the values of p and q in the ARMA process to be fitted by computing the ACF and PACF of stationary time series. If we have to difference a time series *d* times to make it stationary and then apply the ARMA (p,q) model to it, we say that the original time series is ARIMA (p,d,q). This tentative model is then estimated.

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[17] Developed by Engle,R.(1982) "Autoregressive Conditional Heteroscedasticity with estimates of the variance of UK inflation", *Econometrica*, 50,987-1007; and Bollerslev, T. "Generalized Autoregressive Conditional Heteroscedasticity", *Journal of Econometrics*, 31, 307-327.

GARCH (Generalized Autoregressive Conditional Heteroscedasticity) is a generalization of the ARCH model, in which the conditional variance of u at time t is dependent not only on past squared disturbances but also on past conditional variances).

2. Choosing the best model

We choose the goodness of fit of the model by using diagnostic checking. We choose the model with the least number of parameters and smallest root mean square error (RMSE). The smaller RMSE, the better the overall fit of the model and the future forecast can be more accurate.

The diagnostic checking is conducted through 3 steps of checking.

- *Analyzing the residual*

  To see if the residuals estimated from this model are white noise (stochastic error terms, that has zero mean, constant variance, and non-autocorrelated). If they are not, the process is started all over again (therefore, the Box-Jenkins method is iterative).

- *Testing the parameters by using t test*

$$t = \frac{\text{point estimate of parameter}}{\text{standard error of estimation}}$$

  t ratio should be significantly greater than a predetermined critical value. Terms whose t ratios are not significant should be dropped and the model recalculated with the remaining terms.

- *Testing the parameter of redundancy*

  The best Box-Jenkins model is always the one with the least number of parameters. Redundancy occurs when higher-order models are used when a lower-order model would suffice. The correlation matrix for estimate parameter provides a means for recognizing the existence of parameter redundancy.

After selecting the best model, the next step is to conduct a signal-generating mechanism. Signal will generate if the residuals of the model summarizes the deviations from normal behavior and a signal is generated when this statistic exceeds to zero.

2.3 Model for Contagion Effect

Meanwhile, to evince the existence of contagion effect for Indonesian economic crisis, we develop a model as below:

$$Crisis_{j,t} = aD(Crisis_{i,t}) + bMacro_{j,t} + e$$

Where:

$Crisis_{j,t}$ = dummy variable for country j in period t, which determination is based on ISP (Index of Speculative Pressure).

$Crisis_{j,t} = 1$ if $ISP > \mu + 1.5\,\sigma$ and $Crisis_{j,t} = 0$ otherwise

$D(Crisis_{i,t})$ = contagion variable

$D(Crisis_{i,t}) = 1$, if there is speculative attack in country i,

$D(Crisis_{i,t}) = 0$, otherwise, which determination is based on ISP

$Macro_{j,t}$ = economic fundamental of country j in period t

j = Indonesia

i = other countries in Asia region, especially Thailand, Malaysia, Korea, the Philippines

$$Macro_{j,t} = \sum AK_{n,t}.B_n$$

where:

$Ak_{n,t}$ = credit quantity of indicator n in period t
B_n = weigh of indicator n, counted by inverse ratio of noise to signal in each indicator

To illustrate economic fundamental of Indonesia (variable of economic fundamental), we use 14 economic indicators that is assumed as the most appropriate indicator in detecting crisis signal. Kaminsky and Reinhart (1999) showed that each indicator performed differently in detecting possibility of crisis. Each indicator therefore are weighted based on the inverse of noise to signal ratio (NSR). The bigger the weigh the bigger it is in inducing crisis. Then each indicator is classified into 4 levels, based on maximum and minimum value of change in each indicator. Each level has credit quantity. The bigger the credit quantity, the better the condition will be. The 4 levels are level 1 (strong) with credit quantity 4, level 2 (medium) with credit quantity 3, level 3 (risky) with credit quantity 2, and level 4 (weak) with credit quantity 1.

For variable of contagion, this study identify the possibility of speculative attack from speculators in Thailand, Malaysia, Korea, and the Philippines, since the crises in these countries occur earlier than the crisis in Indonesia. We identify the speculative attacks by using Index of Speculative Pressure (ISP).

3. DATA ANALYZING

3.1 Data Collection & Sources of Data

The data is collected mainly from the Bank Indonesia with monthly basis. Meanwhile the sample period is 1990:05 - 2001:05.

3.2 Determining Crisis Period

The first step of the research is determining the crisis period by using Index of Speculative Pressure. The variables of ISP are interest rate, exchange rate, international reserves and each of them expressed in monthly percentage changes. All the variables were standardized to have mean zero and unit variance. A period is defined as crisis in which $ISPt > \mu + 1{,}5\sigma$ (where μ is the sample mean and σ is the standard deviation of the ISP).

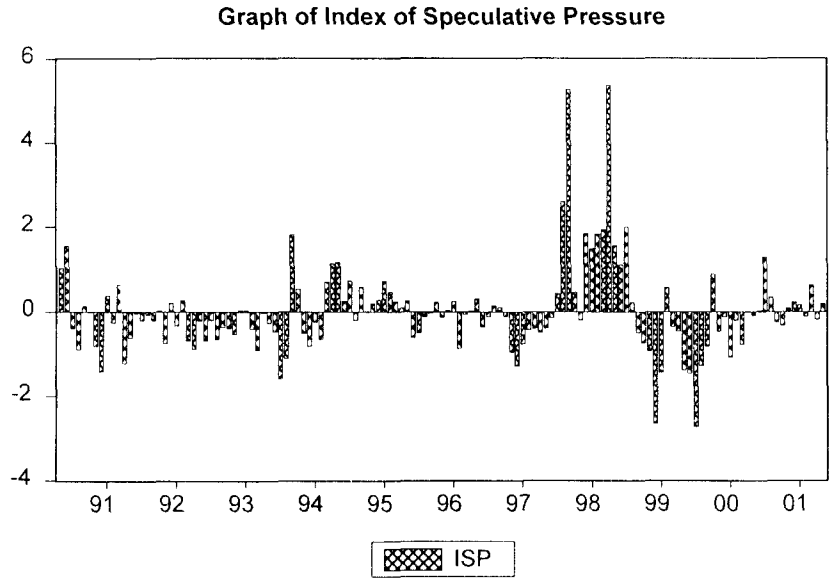
Table 1 below summarizes the dates when the ISP surpasses the threshold.

A total of 8 crises resulted within ten years (1990.05 up to 2001.05) and will be used in the analysis.

Table 1
The Crisis Period in Indonesia

1990:05 – 2001:05	
Year	**Month**
1993	September
1997	August, September, December
1998	February, March, April, July

Meanwhile, Herrera and Garcia stated that if a crisis occurs within 4 months of another one, they are counted as one episode. From the table above, it can be seen that Indonesian crisis in 1997 (8,9,12) and 1998 (2,3,4,7) happened within 2 months of another one. Therefore, we concluded that Indonesian crisis in 1997 and 1998 is one episode of crisis.



3.3 Leading Indicator

The Index of Macroeconomic Vulnerability (IMV) was standardized to have mean zero and unit variance. The variables are:

IMV	=	REER + RDG + M2/R + $\prod$
REER	=	Real effective exchange rate
RDG	=	Real Domestic Credit Growth
M2/R	=	M2/International reserves
$\prod$	=	Inflation

The signals are extracted from the behavior of the composite index (while in the Kaminsky case, each individual variable generates signals that are then aggregated into the composite index). The assumption for the aggregation procedure is that the leading variables drift more or less in the same direction or have common element in their behavior prior to the crisis. If this is not the case, it will not be a good indicator.

3.4 Signal-Generating Mechanism of the Simple Model

The reason for using GARCH Model (Simple Model) is that the volatilities of IMV through time. In this model, the standard deviations used are computed from the conditional variance of the series estimated by a Generalized Autoregressive Conditional Heteroskedastic (GARCH). The feature of these types of models is that the variance of the IMV is taken to be an ARMA process that is estimated simultaneously with the mean of the series. The GARCH (p,q) model that is used is:

$$IMV_t = a_0 + a_1 IMV_{t-1} + e_t$$

$$e_t = v_t \sqrt{h_t} \quad , v \text{ is white noise with } \sigma_v = 1$$

$$\text{and } \hat{h}_t = \alpha_0 + \sum_{i=1}^{q} \alpha_i e_{t-i}^2 + \sum_{i=1}^{p} \beta_i h_{t-i}$$

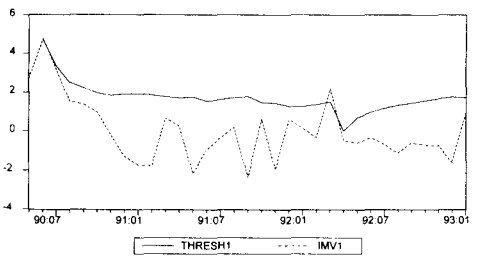
The threshold for the IMV is constructed with the conditional standard deviations of GARCH Model. The signal is flashed if IMV $> \mu + 1{,}5\sigma$ (the IMV exceeds the mean plus 1,5 standard deviations).

We use two approaches to analyze the data, first, by dividing the data into 4 sub samples. Second, by analyzing the data as a whole. Below are the results of both analyses.

3.4.1 Result of the Simple Model 1 (data divided into 4 sub samples, normalized per sub sample)

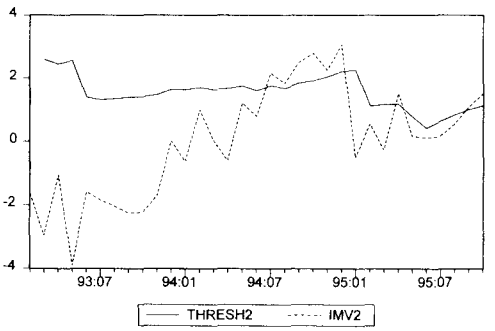
First Sub sample
(1990:05 – 1993:01) N=33

GARCH's combination for the first sub sample is (1,0). The result can be seen in the right side. Signals for crisis will be generated if the IMV exceeds the threshold.



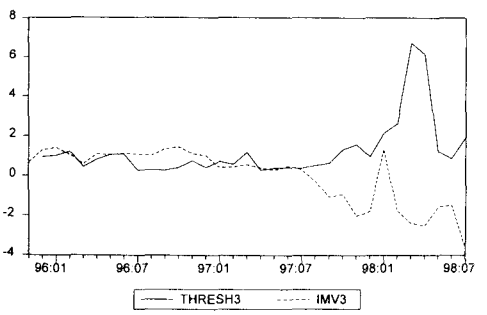
Second Sub sample
(1993:02 – 1995:10) N=33

GARCH's combination for the second sub sample is (1,1).



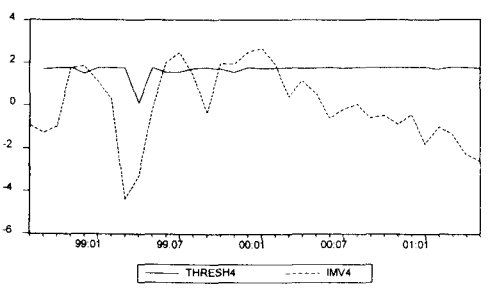
Third Sub sample
(1995:11 – 1998:07) N=33

GARCH's combination for the third sub sample is (2,0).



Fourth Sub sample
(1998:08 – 2001:05) N=34

GARCH's combination for the fourth sub sample is (0,1). The result can be seen below.

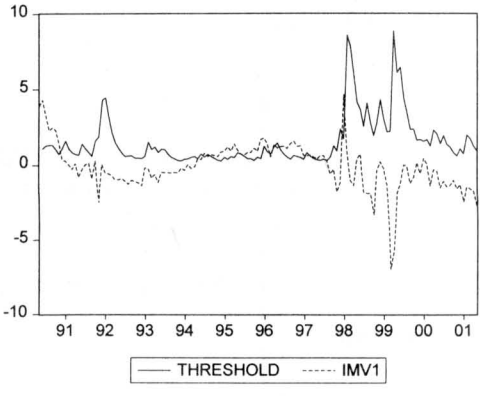


Signal generated by this approach then will be evaluated using a 24-month window prior to each crisis. Signal called as a good signal if the signal turns out within 24 months prior to each crisis. And false signal will happen if it turns out outside of 24 months prior to each crisis.

Index of Speculative Pressure	**24-month window prior to each crisis**	**Signal generated by Simple Model**	**False/good signal**
1993 (9)	1991 (9) – 1993 (8)	1990 (6) 1992 (3)	2 signals generated, 1 of them is false signal.
1997 (8,9,12) 1998 (2,3,4,7)	1995 (8) – 1997 (7)	1994 (7,8,9,10,11,12) 1995 **(4,9,10,12)** 1996 **(1,3,4,6,7,8,9,10,11,12)** 1997 **(1)**	21 signals generated by Simple Model within 3 years. 14 signals are good signals.

3.4.2 Result of the Simple Model 2 (data is not divided)

GARCH's combination for this approach is (1,1). The result can be seen below. Signals for crisis will be generated if the IMV exceeds the threshold. There are 40 signals for crisis generated in this approach.



Signal generated by this approach then will be evaluated using a 24-month window prior to each crisis. Signal called as a good signal if the signal turns out within 24 months prior to each crisis. And false signal will be happened if it turns out outside of 24 months prior to each crisis.

Index of Speculative Pressure	**24-month window prior to each crisis**	**Signal generated by Simple Model**	**False/good signal**
1993 (9)	1991 (9) – 1993 (8)	1990 (6,7,8,9,10,11)	6 signals generated, all of them are false signals.
1997 (8,9,12) 1998 (2,3,4,7)	1995 (8) – 1997 (7)	1994 (7,9,10,11,12) 1995 (1,2,3,4,5,6,7,**8,9,10,11,12**) 1996 (**1,2,4,5,6,7,8,9,10,11,12**) 1997 (**1,3,4,5,6,7**)	34 signals generated by Simple Model. 22 signals are good signals.

3.5 Signal-Generating Mechanism of ARIMA Residual Model

Signal-generating mechanism in this model occurs when the residuals summarize the deviations from normal behavior and a signal is generated when this statistic exceeds to zero.

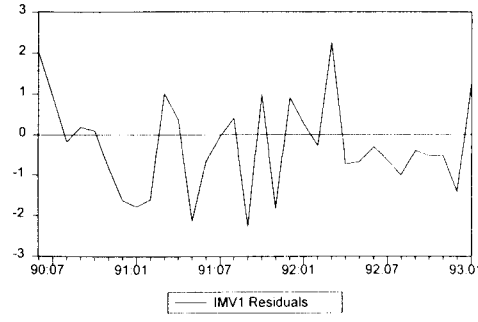
As in Simple model, we also use two approaches to analyze the data, first, by dividing the data into 4 sub samples. Second, by analyzing the data as a whole. Below are the results of both analyses.

3.5.1 Result of the ARIMA Residual Model 1 (data divided into 4 sub samples, normalized per sub sample)

Since the number of sample in this study is quite large, we decide to divide the sample into four sub samples.

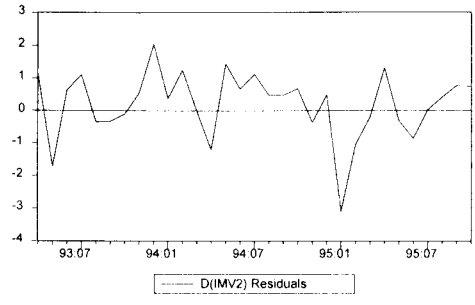
First Sub sample
(1990:05 – 1993:01) N=33

ARIMA's combination for the first sub sample is (1,0,1). The result can be seen in the right side. Signals for crisis will be generated if statistic value exceed zero (positive) and it's mean generate signal for crisis.



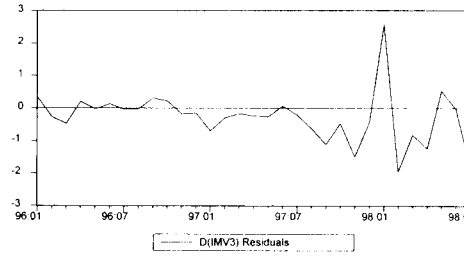
Second Sub sample
(1993:02 – 1995:10) N=33

ARIMA's combination for the second sub sample is (1,1,0). The result can be seen in the right side.



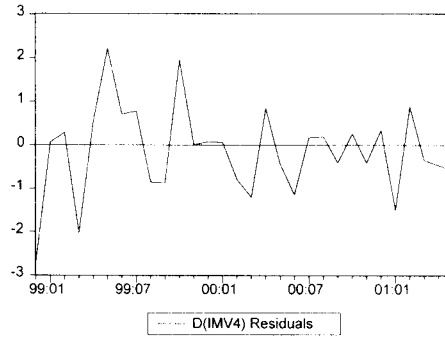
Third Sub sample
(1995:11 – 1998:07) N=33

ARIMA's combination for the third sub sample is (1,1,2). Signals for crisis will be generated if statistic value exceed zero (positive) and it's mean generate signal for crisis.



Fourth Sub sample
(1998:08 – 2001:05) N=34

ARIMA's combination for the first sub sample is (3,1,3).



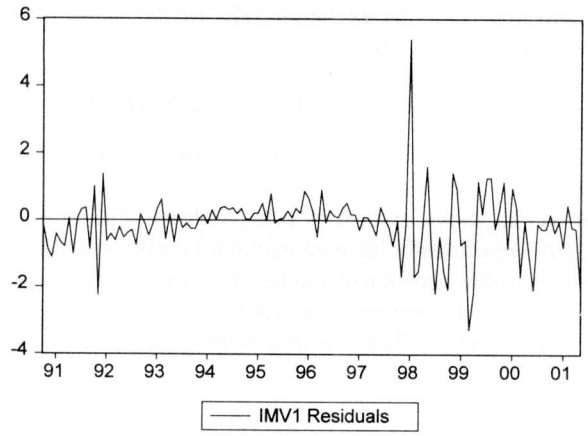
Signal generated then will be evaluated using a 24-month window prior to each crisis. Signal called as a good signal if the signal turns out within 24 months prior to each crisis. And false signal will happen if it turns out outside of 24 months prior to each crisis.

Index of Speculative Pressure	**24-month window prior to each crisis**	**Signal generated by ARIMA**	**False/good signal**
1993 (9)	1991 (9) – 1993 (8)	1990 (6,7,9,10) 1991 (3,4,8,**10,12**) 1992 (**3**) 1993 (**1,4,6,7,**11,12)	16 signals generated by ARIMA Residual, 7 signals are good signals. 9 signals are false signals.
1997 (8,9,12) 1998 (2,3,4,7)	1995 (8) – 1997 (7)	1994 (1,2,5,6,7,8,9,10,12) 1995 (4,7,**8,9,10**) 1996 (**1,4,6,9,10**) 1997 (**6**)	20 signals generated by ARIMA Residual, 9 signals are good signals.

3.5.2 Result of the ARIMA Residual Model 2 (data is not divided)

The combination of the ARIMA model for this approach is {(1,5),0, (8,14)}. The result can be seen below. Signals for crisis will be generated if the IMV exceeds the threshold. Signal generated by this approach then will be evaluated using a 24-month window prior to each crisis. Signal called as a good signal if the signal turns out within 24 months prior to each crisis. And false signal will be happened if it turns out outside of 24 months prior to each crisis.

Graph of ARIMA Residual Model (Data not divided)



Index of Speculative Pressure	24-month window prior to each crisis	Signal generated by ARIMA Model	False/good signal
1993 (9)	1991 (9) – 1993 (8)	1991 (4,6,7,8,**10,12**) 1992 (**9**) 1993 (**1,2,4,6,**11,12)	13 signals generated, 7 of them are good signals.
1997 (8,9,12) 1998 (2,3,4,7)	1995 (8) – 1997 (7)	1994 (2,3,4,5,6,7,8,9,10,11,12) 1995 (1,2,4,6,7,**8,9,10,11,12**) 1996 (**1,2,4,6,7,8,9,10,11,12**) 1997 (**2,3,6,7**)	35 signals generated by Simple Model. 19 signals are good signals.

3.5.3 Result of Contagion Effect

Using Probit model as explained above, the result is as follow:

Crisis = 3.052 – 0.022 FUND + 0.619 CONTA

z stat (-3.4395) (1.3645)

From the result above, it can be seen that with neither $\alpha = 5\%$ nor $\alpha = 10\%$, only variable of economic fundamental significantly affect the crisis or speculative attacks in Indonesia. The coefficient of variable economic fundamental is negative, meaning that the stronger the economic fundamental of a country, the less possibility of speculative attack to occur. While contagion variable, with neither $\alpha = 5\%$ nor $\alpha = 10\%$, do not significantly affect crisis or speculative attacks in Indonesia.

Next, this study use only 4 economic indicators that is used as leading indicators in early warning system, that are: real exchange rate, M2/Reserve, inflation, and real domestic credit growth. The result is as follows:

Crisis = 0.7563 - 0.264FUNDA4 + 0.7089 CONTA

z stat (-2.5905) (1.6580)

From the results above, with $\alpha = 10\%$, both variable of economic fundamental and variable of contagion, significantly have contribution on the speculative attacks. The negative sign in fundamental variable coefficient implies that the stronger economic fundamental of a country, the less possibility that speculative attacks to occur. Whereas the contagion factor has a positive sign, this implies that the crisis in a country will induce speculators to attack other countries.

4. CONCLUSIONS

1. In general, the results of detecting Indonesian early warning system with the Simple Model and ARIMA residual model (using the split data and not split data) are the same.

2. We can predict the crisis period because within 24 months prior to the crisis the signals have issued (the model flashed warning sign).

3. There are some signals flashed with relatively high intensities but not followed by crisis in 1993 and 1994. However, it doesn't mean that the signals are false. The Indonesian economic condition at that time was still strong (this can be noticed from economic growth, inflation, international reserves, etc) and had good non-economic stability. In addition, the government capability to control national economic was still high because market liberalization has not been fully opened yet, where at this time the regional economic condition was strong as well (high economic growth of Asian countries).

4. Meanwhile, the result of identifying contagion effect by using 14 variables of economic fundamental and three countries for variables of contagion showed that only variables of economic fundamental affect significantly to the crisis or speculative attack in Indonesia.

5. Whereas by using 4 variables of economic fundamental, with α =10%, both variables of economic fundamental and contagion factor significantly have contribution in speculative attacks.

6. The four leading indicators that are used as leading indicator to detect economic crisis in Indonesia also perform well as a means to find out if there is a role of contagion effect in economic crisis in Indonesia.

BIBLIOGRAPHY

Adiningsih, Sri. 2001. "Economic Indicators as Early Warning System: the Indonesian Case." Presented at East Asian Development Network Third Annual Meeting, Singapore.

Demirguc-Kunt, Asli, and Enrica Detragiache. 1997. Banking Crises around the World: Are there Common Threads?

The Economist. 2001. "A Global Game of Dominoes."

Eichengreen, B., Rose, A., and Wyplosz, C. 1996. "Contagious Currency Crises." *NBER, Working Paper*, No. 5681.

Engle,R. 1982. "Autoregressive Conditional Heteroscedasticity with Estimates of The Variance of UK Inflation." *Econometrica*, 50, 987-1007.

Far Eastern Economic Review. 2001. "Asia's Economic Future: Choices That Will Shape The Recovery."

Gujarati, Damodar N. 1995. *Basic Econometrics,* 3rd Edition. New York: McGraw-Hill Book Company.

Hardy, Daniel C., and Ceyla Pazarbasioglu. 1998. *Leading Indicators of Banking Crises: Was Asia Different?* IMF Working Paper. June.

Herrera, Santiago, and Conrado Garcia. 1999. *User's Guide to an Early Warning System for Macroeconomic Vulnerability in Latin American Countries*. World Bank Working Paper. November.

Kaminsky, Graciela L. 1999. *Currency and Banking Crises: The Early Warnings of Distress*. IMF Working Paper 178.

Kaminsky, Graciela L., and Carmen M. Reinhart. 1998. "The Twin Crises: The Causes of Banking and Balance of Payment Problems." *American Economic Review*, November.

_____. 2000. "On Crises, Contagion, and Confusion." *Journal of International Economics* 51.

Kaminsky, Graciela L., S. Lizondo, and C.M. Reinhart. 1997. *Leading Indicators of Currency Crises*. IMF Working Paper, July.

Kawai, Masahiro, Richard Newfarmer, and Sergio Schmukler. 2001. *Crisis and Contagion in East Asia: Nine Lessons*. World Bank Working Paper, February.

Simone, Alejandro. 2001. *In Search of Coincident and Leading Indicators of Economic Activity in Argentina*. IMF Working Paper, March.

Tjahjojo, Endy. 1998. "Economic Fundamental, Contagion Effect, and Asian Crisis." *Buletin Ekonomi Moneter dan Perbankan*, September.

_____. 1998. *East Asia, The Road to Recovery*, The World Bank.

_____. 2001. *Asian Development Outlook*. The Asian Development Bank.

Monitoring Economic Vulnerability and Performance: Applications to the Philippines

Josef T. Yap[*]

ABSTRACT

The recent spate of banking and currency crises has underscored the need to develop early warning systems. These are based on economic indicators of vulnerability, which can be identified from models and theories of crises. First generation models focus on the inconsistency of macroeconomic policies and the exchange rate peg. Examples of economic indicators derived from this framework are the fiscal deficit, growth of money supply, current account balance and the level of foreign exchange reserves. Second generation models revolve around the possibility of self-fulfilling crises and multiple equilibria. Meanwhile, the 1997 East Asian financial crisis spawned research on third-generation models, which integrated balance sheets of banks and corporations in the framework of second-generation models. The next step is then to combine all the variables in a meaningful way that will allow the prediction of economic crises. There are two popular approaches: the probability model using limited dependent variables estimation and the signals approach of Kaminsky and Reinhart. Both these methodologies have their own advantages and disadvantages but their usefulness is constrained by the availability and timeliness of high-frequency data.

Key words: currency and banking crisis, early warning system, economic vulnerability

I. INTRODUCTION

As the East Asian economies recover from the 1997 financial crisis, there is increasing concern about a possible relapse. Economic growth in the five countries most affected by the crisis slowed in 2001 (Table 1) and the progress of corporate and financial reform has been patchy. To address this concern, it is necessary to understand the nature of the recent crisis and implement appropriate policies that will minimize chances of similar incidents in the future. At the very least, a system must be developed that will help policymakers anticipate future crises.

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Table 1
GDP Growth Rates for 5 Most Affected East Asian Countries

	Indonesia	Korea	Malaysia	Philippines	Thailand
2000	4.8	8.8	8.3	4.0	4.4
2001	3.3	3.0	0.4	3.4	1.8

Source: Asia Recovery Information Center.

This paper looks at empirical work on early warning systems, particularly those that have been applied to the Philippine case. The theoretical underpinnings of these methodologies are discussed in Section II. There are two more popular approaches to modeling early warning systems, one where the probability of a crisis is estimated, and the signals approach of Kaminsky and Reinhart (1996). These two approaches will be discussed in more detail in Section III. The probability approach was applied by Gochoco-Bautista (2000) using Philippine data while Yap (2001) used the Kaminsky-Reinhart methodology. These studies will be discussed in Sections IV and V, respectively. The sixth section looks at macroprudential indicators as possible signals of vulnerability to a currency crisis. Empirical results using updated data and new indicators are then discussed in Section VII. The last section looks at structural indicators that affect the medium-to-long term economic growth prospects of the Philippines.

II. Causes of Currency Crises

Interest in early warning systems has been revived after the spate of currency and banking crises in the 1990s. By monitoring key economic variables, policy makers would be able to anticipate a crisis, enabling them to avoid it or at very least, minimize its adverse impact. The contrasting view is that predicting a balance of payments (BOP) crisis or financial crisis is like predicting an earthquake, implying that an early warning system is practically useless. However, such an analogy refers only to the actual timing of the crisis whereas an early warning system is designed to signal an impending crisis. The exact moment is not crucial if there is sufficient lead time to react to the warning.

The variables used in an early warning system are normally derived from theories of the causes of banking and BOP (or currency) crises. The literature distinguishes three types or, more precisely, three generations of models of BOP crises. The first generation models have their roots in Krugman's 1979 seminal paper, which stressed that crises are caused by weak economic fundamentals that become inconsistent with a pegged exchange rate. Typically, the source of deteriorating fundamentals is a fiscal deficit that is financed by a continuous expansion of domestic credit. The peg is sustained by a positive stock of foreign exchange reserves, but in a small open economy, these reserves are gradually depleted as agents buy foreign currency owing to the imbalance between the expanding domestic credit and the stable money demand. The persistent loss of international reserves ultimately forces authorities to abandon the fixed exchange rate regime and the currency depreciates over time to reflect the expansion in domestic credit.

The description of the foregoing model suggests specific indicators that could be monitored. Prior to the onset of the currency crisis, there may be a gradual but continual decline in the level of international reserves accompanied by rapid growth in Central Bank domestic credit and a widening fiscal deficit. It would also be useful to monitor the growth rate of domestic credit in excess of growth in money demand.

Other models have extended Krugman's analysis and suggest more indicators for monitoring. With some degree of stickiness in the price of traded goods, expansionary fiscal

and monetary policies would raise the demand for traded goods, which worsens the trade balance. Demand for nontraded goods would also rise, which raises their relative prices and leads to an appreciation of the real exchange rate (Calvo, 1987). Meanwhile, by introducing some degree of uncertainty, the timing of the devaluation cannot be exactly predicted and a "peso problem" emerges, that is, a persistent divergence between nominal domestic and foreign interest rates owing to the expectation of an impending devaluation.[1]

Following the collapse of the European Monetary System (EMS) in 1993, later models of currency crises dealt with cases where the depletion of international reserves might not be at the root of currency crises. The second-generation models conjecture that speculative attacks can occur even when policies are consistent and economic fundamentals are strong (Obstfeld 1986, 1996). These models focus on the role of agents' expectations in the formulation of the different, and oftentimes conflicting, policies of government policymakers. The public, in turn may base its actions on expected fundamentals conditional on an attack taking place, rather than current economic fundamentals absent an attack. Such situations give rise to the possibility of self-fulfilling hypotheses.

In a regime of soft pegs, the important feature is the relationship between the public's expectations and the government's assessment of the costs of maintaining the peg. For example, for the twin goals of reducing inflation and achieving a target economic growth rate, fixed exchange rates may help achieve the first goal but at the cost of a loss of competitiveness and a recession. If the government senses that the public expects an abandonment of the peg, it may raise interest rates to defend the currency. This will raise the cost to the government of defending the peg and once this becomes too high, the peg would likely be abandoned. If the public correctly anticipated the abandonment of the peg, the result would be a self-fulfilling prophecy. However, it is also possible that the expected attack on the currency is unsuccessful or that the government incorrectly diagnosed the mood of the public, resulting in the maintenance of the peg. The contingent nature of second-generation models gives rise to multiple equilibria and non-uniqueness.

Indicators related to second-generation models can be derived from the objectives of economic policy. Hence, currency depreciation pressures would increase when output is sluggish, domestic inflation is relatively high, or there are deficits in the current account. Investor sentiment would also influence the viability of the peg. Stock prices are a good gauge of future profits while market surveys directly reflect the expectations of economic agents.

Corollary to the possibility of self-fulfilling crises is the role of contagion effects. It is useful to distinguish between fundamentals-based contagion, which arises when a crisis country is linked to others via trade or finance, and pure contagion. The latter emanates from actions of investors and is therefore more closely related to the second-generation models of BOP crises.

Kaminsky and Reinhart (2000) analyzed various forms of fundamentals-based contagion. One, is through a common international bank creditor, wherein a bank reacts to a rise in the nonperforming loans in one country by pulling out of high risk projects elsewhere, most likely in other emerging markets. Another mechanism is through liquidity channels, mutual funds and cross-market hedging, which has been described as an indirect financial channel (Kim, et al. 1999). Losses in one country could lead international investors to pull out their investment in other developing countries to meet a specified capital-adequacy ratio or margin calls, or to resolve their liquidity constraints. A contagious crisis can take place if these international investors suddenly and simultaneously change their investment positions in several countries.

The contagion mechanism that has received most attention is via trade channels. Two types of trade links were examined by Kaminsky and Reinhart. One is bilateral trade among

[1] Quoted from Berg, et al. (1999), page 26.

other countries and the crisis country. The other is involves competition in a common third market and is more difficult to quantify.

Meanwhile, pure contagion is related to changes in the behavior of international investors, which are not caused by systemic or mechanical changes in their portfolio composition but by shifts in their perception toward market risks (Kim, et al. 1999). One theory in this category assumes that international investors follow "herd behavior" in portfolio and risk allocations. This is brought about by the incentive scheme among fund managers, which penalizes those who deviate on the low end from the average performance of a regional portfolio.

Another form of pure contagion is what is termed "informational cascade," wherein instead of evaluating countries individually, investors tend to lump them in one group. Hence investors pay little heed to countries' economic fundamentals and do not discriminate properly among countries. Thus, for instance, if investors pull out their investment from Thailand, they would simultaneously lower their portfolio investment in Southeast Asia.

Recent empirical work has focused on incorporating an appropriate measure of contagion (Kaminsky and Reinhart, 2000; Zhang, 2001). Some approaches will be discussed in Section VII.

The 1997 East Asian crisis has been classified as a second-generation type due to the sudden shift in investor sentiment. The abrupt and large withdrawal of foreign capital in anticipation of economic difficulties led to an actual deterioration of the economies. Contagion has figured prominently in the analysis, too. However, Yoshitomi and Ohno (1999) argued that the depth and duration of the Asian crisis could not be explained sufficiently by the second-generation model. The Asian crisis reveals a need to incorporate the problems of the financial sector with its balance sheet effects, a sharp reversal of capital flows, a plunge in absorption, and a free fall of the exchange rate. In a recent paper, Krugman (2001) discusses several variants of future models of BOP crises, but emphasizes the balance-sheet effects of a currency depreciation.

The relevant indicators that can be derived from this analysis are related to the double mismatch problems of the banking system: a mismatch in terms of maturity and currency. A maturity mismatch is generally inherent in the banking industry but this was amplified during the 1997 crisis because a significant amount of capital inflows into East Asia was short-term. On the other hand, the currency mismatch resulted from substantial unhedged foreign borrowing. Hence, indicators to monitor are the ratio of short-term debt to foreign exchange reserves and the ratio of foreign exchange liabilities to total liabilities.

BOP crises can also be a direct consequence of banking crises the causes of which are not related to macroeconomic imbalances. As a matter of fact, many of the recent currency crises were preceded by banking crises (Kaminsky and Reinhart, 1996). The need to bail out the financial system may result in excessive domestic credit growth leading to a speculative attack on the currency. Thus, a review of the literature on banking crises would also yield useful indicators to monitor. This would include many financial soundness indicators like the capital adequacy ratio, sectoral credit concentration, loans-to-deposit ratio, bank profitability ratio, and debt-equity ratios of bank borrowers.

III. METHODOLOGY

Literature on the different indicators and various methodologies employing them is aptly reviewed by Kaminsky et al. (1998). They also provide a list of the main indicators used in empirical work classified by category (capital account, debt profile, current account, international variables, financial liberalization, real sector, fiscal variables, institutional/ structural factors, and political variables).

Four methodological categories are cited in the review paper. Two of them have been prominent in recent literature. The first estimates the probability of a devaluation, or more broadly, the probability of a crisis, based on regression estimates using any one of the limited dependent variables techniques. One such application is that of Demirguc-Kunt and Detragiache (1998) who studied factors associated with the emergence of systemic bank crises in a large sample of developed and developing countries using a multivariate logit model. Some of the variables they found significant are real interest rates, economic growth, inflation, and M2/reserves ratio. In some variations of their regression model, they found institutional variables, such as the presence of deposit insurance and law and order, significant.

An earlier probability model was that of Frankel and Rose (1996), which was motivated by the Mexican crisis. They applied a probit model to test the hypothesis that certain characteristics of capital flows are associated with currency crashes. Unfortunately, their use of annual data limits the use of their model as an early warning system.

Meanwhile, the IMF estimated a probit model to determine which variables contribute to the probability of a crisis occurring within the following 24 months. It has been termed the Developing Country Studies Division (DCSD) model. As argued by Berg, et al. (1999), the probability model has two advantages: the model can aggregate predictive variables more satisfactorily into a composite probability, taking account of correlations among variables; and it is easy to test for the statistical significance of individual variables. In addition, it is possible to allow the risk of a crisis to increase linearly with the predictor variables.

Nevertheless, this methodology has some important limitations. First, it is argued, albeit incorrectly, that the probability approach does not provide a metric for ranking indicators according to their ability to accurately predict crises and avoid false signals, since a variable either enters the regression significantly or it does not. While measures of statistical significance can help pinpoint the more reliable indicators, they provide no information on whether the relative strength of a particular indicator lies in accurately predicting a high proportion of crises at the expense of sending numerous false alarms, or instead missing a large share of crises but seldom sending false alarms. However, by calculating the slope coefficient in the estimated equations, one can rank the variables in terms of their influence on the probability of a crisis.

Second, this method does not provide a transparent reading of where and how widespread macroeconomic problems are. Within this approach, it is difficult to assess which of the variables is "out of line," making it less than suited for surveillance and pre-emptive action.[2] Third, there is evidence that the ability of the probability approach to generate accurate forecasts tapers off quickly as the forecast horizon moves beyond one period ahead. Finally, in order to function as an early warning system, a suitable lag framework must be incorporated in the estimation procedure. This may cause problems if the lag variables are not significant or if the degrees of freedom are substantially reduced.

The shortcomings of the probability approach are addressed by the "signals" approach developed by Kaminsky and Reinhart (1996). The step-by-step procedure has been discussed extensively (Kaminsky et al. 1998, Kaminksy and Reinhart 1996) and we adopt the discussion of Goldstein (1998).

First, a sample of countries must be identified. It is possible to base the analysis on just one country, but the limited number of crises will prevent a robust generalization on the usefulness of indicators.

Second, the definition of a crisis must be delineated. Kaminsky and Reinhart define a bank crisis in terms of bank runs, closures, and mergers, or large-scale public sector takeovers of important financial institutions. For currency crises, they construct an index of exchange market pressure by taking a weighted average of changes in nominal exchange rates and

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[2] The discussion on the limitations of the probability approach is quoted from Kaminsky et al. (1998).

changes in international reserves; when the nominal exchange rate depreciates and international reserves fall, exchange market pressure is greater. Extreme values of this index—that is, readings of three or more standard deviations above the mean—signal currency crises.

Third, the term "early" must be defined. For currency crises, Kaminsky and Reinhart define early as between 1 month and 24 months before the beginning of the crisis. For banking crises, a laxer definition is adopted, namely, either 1 month to 12 months before the start of the crisis or up to 12 months after the beginning of the crisis. This is because banking crises frequently last 4 to 5 years—much longer than currency crises (typically less than a year)—and because the peak of a banking crisis often takes place several years after it starts.

The signals approach has been criticized as being arbitrary in delineating a period that is considered "early" (Demirguc-Kunt and Detragiache 1998). Corollary to this, it should be noted that indicators have different lags in their impact on the economy. Hence, the definition of an "early" period may vary from country to country. The definition of Kaminsky and Reinhart was retained in this study.

The fourth task is to pick out a list of potential early warning indicators. Knowledge of the theoretical causes of currency and banking crises provides a basis for identifying possible indicators that signal a crisis. For example, based on Generation 1 models (which emphasize macroeconomic variables out of line), economic variables to watch out for are excessive monetary growth, deteriorating fiscal balances, and rapidly depleting international reserves. Another criterion used for selecting an indicator is the availability of high-frequency data. A list of indicators used by Kaminsky and Reinhart that were applied by Yap (2001) is presented in Table 4, Section V below. The list includes a brief explanation of each variable.

Given the indicators, step number five is to find an optimal threshold for each indicator that, once reached, will give an accurate signal of a future crisis. The point at which an indicator signals a crisis must be set. Thresholds are determined using an iterative procedure. Given an indicator X, an arbitrary tail of the frequency distribution for X—say the 10 percent tail—is set. Depending on the nature of X, it can be the upper or lower tail. Any observation that falls in the 10 percent tail of the time series of X is regarded as a signal. It is considered a true signal if a currency crisis occurs within 24 months after the signal was given, and a false signal (or noise) if no crisis occurs within that early-warning time frame. Various thresholds are then experimented with until the optimal one is found. The optimal threshold maximizes the number of true signals and minimizes the number of false signals. The tail that minimizes the noise-to-signal ratio is used. Optimal thresholds as determined by Kaminksy and Reinhart were used by Yap (2001).

After applying the basic steps of the signals approach, the data for the indicators X_{jt}—indicator j at time t—are transformed in the following manner:

S_{jt} = 1 if the value of X_{jt} crosses the threshold
= 0 if otherwise.

According to the definition of Kaminsky and Reinhart the indicator is considered good if in most of the cases when S_{jt} is 1, a BOP crisis occurs during the period t + 24 months. As mentioned earlier, a laxer definition is adopted for banking crises—S_{jt} assumes a value of 1 when X_{jt} crosses the threshold either 1 month to 12 months before the start of the crisis or up to 12 months after the beginning of the crisis.

The early warning system should enable policymakers to determine when the economy is becoming fragile. One way to facilitate analysis and make the system tractable is to compress the various indicators into a composite index. The most straightforward procedure is a simple count of flashing signals, which is the composite index labelled S by Kaminksy (1998) and defined as:

$$S_t = \sum_j S_{jt}$$

This statistic, however, does not fully use the information provided by univariate indicators because it does not account for the different forecasting accuracy of each variable. One way of combining this information is to weight the signals of different variables by the inverse of their noise-to-signal ratio. The second composite index, labelled K, is defined as:

$$K_t = \sum_j \frac{S_{jt}}{n_j}$$

where n_j is the noise-to-signal ratio of indicator $_j$. In this exercise we applied the noise-to-signal ratios calculated by Kaminksy and Reinhart.

The above composite leading indicators assign the same weight to a signal provided by a mild anomalous behavior of a variable and that provided by an extreme aberrant behavior of that variable. To account for this distinction, two different thresholds can be defined for each indicator: a mild threshold Y_m and an extreme threshold Y_e. $|Y_m| < |Y_e|$ and based on the criterion defined earlier, $S_{jt} = 1$ when $|X_{jt}| > |Y_{mj}|$. Y_{mj} is the mild critical threshold for indicator $_j$.

An extreme signal D is then defined based on Y_e such that $D_{jt} = 1$ when $|X_{jt}| > |Y_{ej}|$. Note that $S_{jt} = 1$ whenever $D_{jt} = 1$. The third composite indicator that accounts for the intensity of the signal of each univariate indicator, labelled W, is defined as:

$$W_t = \sum_j \left(S_{jt} + D_{jt}\right)$$

Time series probability forecasts are then computed to evaluate the reliability of each of these composite indices. We can construct a sample-based vector of conditional probabilities:

$$\Pr(Ct,_{t+h} \mid S_t = I) = \frac{\text{Months with } S_t = I \text{ and a crisis within h months}}{\text{Months with } S_t = I}$$

$$\Pr(Ct,_{t+h} \mid K_t = I) = \frac{\text{Months with } K_t = I \text{ and a crisis within h months}}{\text{Months with } K_t = I}$$

$$\Pr(Ct,_{t+h} \mid W_t = I) = \frac{\text{Months with } W_t = I \text{ and a crisis within h months}}{\text{Months with } W_t = I}$$

IV. Application of the Probability Approach to the Philippine Case

The methodology used by Gochoco-Bautista (2000) is quite straightforward. First, she identifies relevant indicators based on the aforementioned models of economic crises. Second she divides the sample period into tranquil and crisis or pressure periods based on the following procedure. An arbitrary band is constructed by taking the mean of percentage changes in the nominal exchange rate plus or minus 1.5 times the standard deviation of changes in the exchange rate. Those periods in which percentage changes in the exchange rate fall outside the 1.5 times the standard deviation band are included as pressure periods. From the remaining non-selected observations, periods where percentage changes in gross international reserves are outside the 1.5 times standard deviation band are selected as pressure periods. From the remaining non-selected observations after this, periods where changes in logs of short-term interest differentials between the Philippine 91-day Treasury bill rate and the US 3-month Treasury bill rate are outside the 1.5 times standard deviation band

are selected as pressure periods. The remaining non-selected observations are identified as periods of tranquility.

So as not to identify an ongoing speculative episode as a new one, a five-month exclusion window is used. For example, periods identified by changes in gross-international reserves were not treated as a separate speculative episode if they fell within the five-month window of an episode previously identified by changes in the exchange rate.

The third step is to examine whether there are differences in the behavior of the indicator variables during tranquil periods and pressure periods. This is done by comparing the mean values of month-to-month changes in these variables. A selection of the variables and the results are shown in Table 2. Gochoco-Bautista stresses that it is important to test the robustness of the findings with respect to how the pressure periods are selected and to see whether the story told by the mean values of the variables is consistent across these periods. This is done by first calculating the mean values of the variables using pressure periods identified using only the percentage changes in the exchange rate (Case A in Table 2). Next, the same exercise is repeated using both percentage changes in the exchange rate and in gross international reserves to identify the pressure periods (Case B). Finally the mean values of the indicator variables are calculated when pressure periods are identified using percentage changes in the exchange rate, in gross international reserves, and changes in the logs of short-term interest rate differentials (Case C).

Gochoco-Bautista argues that if there are differences in the behavior of these variables during tranquil periods and during periods of speculative pressures, then there may be some evidence to show inconsistent macroeconomic policies. On the other hand, if there are no discernible differences in the means of these variables during tranquil periods and during periods of speculative pressures, then it is possible that arbitrary shifts in expectations are largely responsible for currency pressures.

The fourth step is to use a probit model to formally test the statistical significance of the indicator variables on the probability that speculative currency pressures will occur. The dependent variable distinguishes between pressure periods and tranquil periods. It is 1 during periods of currency pressure and 0 during tranquil periods. Currency pressure periods are not distinguished by whether they are depreciation pressure periods or appreciation pressure periods. Three different specifications of the dependent variable are used, depending on how the currency pressure periods were identified. The dependent variables D1, D2, and D3 correspond to Case A, Case B and Case C as defined earlier. An example of estimation results is presented in Table 3.

Based on her findings, Gochoco-Bautista outlines the following conclusions:

1. Indicator variables such as the M3 multiplier, growth in total domestic credit, growth in domestic credit to the private sector, growth in total bank deposits, M3/GIR, M3/GIR growth, growth of GIR, and growth of National Power Corporation (NPC) sales tell a consistent story. It is that overly expansionary policies are associated with depreciation pressure periods.

2. There is little evidence for second-generation models, in which stylized facts reflect economic conditions that make it costly for the government to maintain a peg. In particular, the results suggest that inflation is higher and output growth lower during appreciation pressure periods. If the authorities were trying to counteract recession, for example, they would pursue expansionary policies which would lower domestic interest rates and raise inflation, but which lead to depreciation rather than appreciation pressures.

3. Overly expansionary monetary and fiscal polices, and increasing overvaluation of the domestic currency are associated with depreciation pressures. The findings suggest that weak economic fundamentals resulting from policies inconsistent with exchange rate stability, rather than arbitrary shifts in expectation, are probably more important in explaining the probability of pressures on the domestic currency.

4. In general, the full sample results of the probit estimation show that economic fundamentals matter as far as the probability of currency pressures arising is concerned. Among the indicators, those representing capital account developments, such as changes in gross international reserves, and short-term interest differentials between domestic and foreign rates, current account developments, such as (contemporaneous) changes in the real exchange rate, real sector indicators, such as output growth proxied by sales of the National Power Corporation, and fiscal variables such as the growth of domestic credit to the public sector have a statistically significant effect on the probability of currency pressures occurring.

Table 2
Stylized Facts: Behavior of Indicator Variables (partial)

Indicator Variable	Tranquil Period Mean	Depreciation Pressure Mean	Appreciation Pressure Mean
Change in Nominal Exchange Rate			
A	0.28%	14.51%	-6.55%
B	0.27%	11.46%	-1.88%
C	0.29%	8.16%	-1.70%
M3 Multiplier			
A	3.10	3.30	2.83
B	3.11	3.23	2.84
C	3.11	3.22	2.84
Growth in Total Domestic Credit			
A	1.45%	3.98%	-1.04%
B	1.58%	3.23%	-1.54%
C	1.55%	3.19%	-1.54%
Growth in Total Bank Deposits			
A	1.43%	4.30%	1.93%
B	1.39%	3.86%	2.20%
C	1.37%	3.30%	2.14%
Inflation			
A	0.91%	1.45%	1.23%
B	0.89%	1.27%	1.35%
C	0.89%	1.13%	1.53%
GIR Growth			
A	1.48%	-6.45%	12.08%
B	0.81%	-10.09%	24.59%
C	0.71%	-5.99%	22.46%
Interest Rate Differential			
A	8.70%	13.66%	18.83%
B	8.59%	12.38%	14.02%
C	8.70%	10.74%	12.67%
M3/GIR			
A	4.42	6.90	5.41
B	4.36	6.50	5.58
C	4.40	5.75	5.16
Trade Balance (USD mil.)			
A	-334	-368	-199
B	-344	-322	-154
C	-347	-309	-151
Nat'l. Power Corp. Sales Growth			
A	0.66%	1.21%	0.15%
B	0.77%	0.83%	-1.25%
C	0.68%	1.28%	-0.44%

Source: Gochoco-Bautista (2000), p. 133.

Table 3
Example of Results Using Probit Estimation

Dependent Variable	Indicator Variable	Coefficient	t-stat	Probit Slope Coefficient	Durbin Watson	Likelihood Ratio
D3	IDIFF(-1)	3.30	2.01	0.65	2.02	0.47
	GIRG(-1)	-1.55	-1.58	-0.31		
	NPCG(-1)	-3.55	-1.88	-0.71		
D3	IDIFF(-1)	4.06	2.27	0.78	2.04	0.49
	GIRG(-1)	-2.34	-2.21	-0.45		
	NPCG(-1)	-3.37	-1.71	-0.65		
	DCPUBG(-1)	3.40	2.61	0.65		

DIFF – interest rate differential;
GIRG – month-on-month growth in international reserves;
NPCG – month-on-month growth in NPC sales;
DCPUBG – month-on-month growth in credit to public sector.

Note: Since probit coefficients are not easily interpretable, the probit slope coefficients are given. They show the effects of one unit changes in regressors on the probability of currency pressures arising, evaluated at the mean of the data.

Source: Gochoco-Bautista (2000), Table 4, p. 146.

The empirical tests in this study consistently apply only one lag period for the explanatory variables. This would not allow the results to be used as an early warning system, a shortcoming of the probability approach that was cited in Section III. It would also seem inappropriate to use as explanatory variables indicators that were used to define the dependent variable. For example, in Table 3, the variable D3 was defined based on exchange rate movements, the growth of international reserves and the interest rate differential. However, the probit equation uses IDIFF and GIRG as explanatory variables and raises the possibility that the results are spurious.

The regression results also represent an "average" of the behavior over the sample period, which does not necessarily apply to the 1997 crisis episode. The explanatory variables should be examined individually to determine if there was abnormal behavior prior to July 1997. While the estimated probability of a crisis did rise at this time, it would be difficult to judge whether or not this was already a reaction to the brewing regional crisis. An explicit variable accounting for the possibility of contagion must therefore be included.

V. Application of the Kaminsky-Reinhart Methodology to the Philippines

The indicators that were used by Yap (2001) are listed in Table 4. The probability tables obtained using the three composite indicators described in Section II are shown in Table 5.

Table 4
Indicators of Currency and Financial Crises

Financial sector

1. **M2 multiplier**: A higher multiplier indicates higher growth in money supply which may lead to higher inflationary expectations and expectations of a future devaluation of the currency.
2. **Domestic credit**: A larger amount of credit increases the chances of bad loans and bank failures. Higher credit also implies a larger amount of money supply.
3. **M2/Reserves**: Economic agents fearing a devaluation may substitute local currency for foreign currency. The M2/Reserves ratio is an indication of the extent to which the Central Bank can withstand this pressure.
4. **Lending/Deposit rate**: A higher spread indicates that the Central Bank is increasing interest rates to stem credit growth. Higher lending rates increase the chances of bad loans.
5. **Deposits**: A decline in the deposit base increases the chances of a bank run.
6. **Real interest rate**: Higher interest rates increase the probability of loan defaults.
7. **Excess money balances**: Equilibrium real M1 balance was estimated using the Hodrick-Prescott filter. The difference between actual and equilibrium values is equal to the excess money balances.

External sector

Note that variables from the external sector can be leading indicators of a banking crisis because of the relationship of a BOP crisis and banking crisis.

1. **Exports**: Lower export growth may signal problems with the trade balance.
2. **Imports**: Higher import growth may signal problems with the trade balance.
3. **Real exchange rate**: The equilibrium real exchange rate is estimated using the Hodrick-Prescott filter that allows for stochastic trends. The difference between the actual value and the equilibrium value is a measure of the degree of overvaluation. The real exchange rate published by JP Morgan was used in the computations.
4. **Reserves**: This is the classic indicator based on Krugman's seminal paper on BOP crises. A low level of reserves—below a critical threshold—may trigger a speculative attack against the currency.
5. **Interest rate differential**: This is defined to be foreign interest rates (as measured by the 90-day US Treasury Bill rate) less domestic interest rate (91-day Treasury Bill rate). The higher the differential, the larger is the probability of an outflow of reserves.

Real sector

1. **Output growth**: Lower output growth indicates a deceleration of the economy prior to a crisis. A modification would be to take the first difference of output growth to reflect more accurately an economic deceleration. The value index of manufacturing output was used and this was deflated by the consumer price index (CPI) to obtain an index in real terms.
2. **Stock market prices**: A decline in the growth rate of asset prices may lead to loan defaults. It also signals a loss of investor confidence. This index was not included in this paper because of lack of data prior to 1987.

Note: Due to data constraints the last two indicators were not incorporated in Yap (2001).

Table 5
Probability Tables for Composite Indices

S Composite Index	
Sj	Pr(BOP Crisis)
0	0.07
1	0.12
2	0.29
3	0.43
4-5	.67
Brier's QPS: 0.29	

W Composite Index	
Wj	Pr(BOP Crisis)
0	0.07
1	0.07
2	0.21
3	0.51
4	0.14
5	0.60
6 and above	0.20
Brier's QPS: 0.19	

K Composite Index	
Kj	Pr(BOP Crisis)
0.0 - < 1.0	0.07
1.0 - <2.0	0.10
2.0 - <3.0	0.18
3.0 - <5.0	0.34
5.0 - < 7.0	0.67
7.0 – above	0.87
Brier's QPS: 0.21	

The Brier's quadratic probability score is a measure of goodness-of-fit and the results indicate that the K index is the better indicator among the three.

Empirical results using Kaminsky-Reinhart methodology indicate that the economic fundamentals of the Philippines were much sounder prior to the 1997 crisis than in the 2-year interval prior to the October 1983 BOP crisis. In another paper (Yap 1999) the methodology was extended to 11 other countries: Indonesia, Korea, Malaysia, Thailand, Denmark, Finland, Norway, Sweden, Mexico, India, and Pakistan. The first four countries plus the Philippines comprise the Asian 5, the economies hardest hit by the crisis. Key results can be summarized by ranking the cases based on the number of indicators flashing on a regular basis:

1. The Asian 5 during their respective economic crises prior to the 1997 debacle (e.g., the Philippines in 1983).
2. The Scandinavian countries during their crises in the late 1980s and early 1990s.
3. The Mexican crisis in 1994.
4. Pakistan prior to the 1997 crisis.
5. The Asian 5 prior to the 1997 crisis.

Results generally indicated that fundamentals cannot explain the depth of the 1997 crisis because the other episodes did not have as severe an impact—especially in the number of countries involved—and yet the fundamentals were weaker. This is another indication that a contagion variable must be included in the analysis.

VI. Other Indicators of Vulnerability

A weakness of both the studies of Gochoco-Bautista and Yap is that the variables directly related to the 1997 crisis were not included in the methodology. Examples are the amount of short-term foreign debt and the exposure of domestic banks to the real estate sector. Unfortunately these variables are not available on a high frequency basis, which is the reason

why they were not included. If, indeed, the next generation crises would revolve around balance sheets of firms and other economic entities (including the government) then effort must be exerted to gather the relevant data. Not only will frequency be an issue, but timeliness of reporting as well.

A useful transitional step would be to improve on macroprudential indicators (MPIs), which are broadly defined as indicators of the health and stability of the financial system. They comprise both macroeconomic indicators that affect the financial system (e.g. fiscal deficit) and aggregated microprudential indicators. The latter are obtained by aggregating indicators of individual financial institutions while the former are already covered by indicators used by Gochoco-Bautista and Yap.

One commonly used framework for analyzing the health of financial institutions using aggregated microprudential indicators is the so-called CAMELS framework (IMF 2000). This involves the analysis of six group of indicators as follows:

- Capital adequacy
- Asset quality
- Management soundness
- Earnings
- Liquidity
- Sensitivity to market risk.

Theoretically, the variables will not be of equal importance. However, the overriding criterion for choice would be data availability.

A. Capital Adequacy

Capital adequacy and availability ultimately determine the robustness of financial institutions to shocks to their balance sheets. The most commonly used indicator in this respect is the aggregate risk-based capital ratio (the ratio of capital to risk-adjusted assets). A declining trend in this ratio may signal increased risk exposure and possible capital adequacy problems. In addition to adequacy, it may also be useful to monitor indicators of capital quality. Bank capital consists of different elements that have varying availability and capability to absorb losses.

B. Asset Quality Indicators

Risks to the solvency of financial institutions often derive from impairment of assets, so it is important to monitor indicators of asset quality. These include indicators at the level of the lending institution, and indicators at the level of the borrowing institutions.

1. Sectoral Credit Concentration. A large concentration of aggregate credit in a specific economic sector or activity, especially real estate, may signify an important vulnerability to the financial system to developments in this sector or activity (e.g. fall in profit due to overinvestment). Data showing the disaggregation of outstanding credit across various sectors is generally available. The share of manufacturing and real estate are reported when data are available.

2. Foreign currency denominated lending. Several financial crises have been preceded by periods of fast growth of foreign-currency denominated credit to domestic firms that frequently lacked a stable source of foreign exchange reserves. Another situation is when banks intermediate foreign capital inflows, thus increasing their foreign exchange liabilities.

3. Nonperforming loans. An increasing trend in the ratio of nonperforming loans to total loans signals a deterioration in the quality of credit portfolios and consequently, in financial institutions' cash flows, net income and solvency.

4. Indicators at the Level of the Borrowing Entity. This subgroup refers to indicators that take into account the likelihood that borrowers can repay their loans. The most common are corporate debt-equity ratios. Unfortunately, these data are not readily available.

C. Management Soundness Indicators

Indicators of the quality of management are primarily applicable to individual institutions and cannot be easily aggregated across the sector. Although aggregated indicators can be used, they are more likely to reflect financial sector structure and/or the country's economic situation, than management quality.

Bloomberg reports an efficiency ratio for a selected number of banks for the five countries. The efficiency ratio is equivalent to the expense ratio suggested by the IMF document. The data are available only on an annual basis.

D. Earnings and Profitability Indicators

It is important to monitor indicators of profitability because chronically unprofitable financial institutions risk insolvency. On the other hand, unusually high profitability may be a sign of excessive risk taking. However, it should be noted that similar to management soundness indicators, aggregation across individual banks may not yield useful numbers.

Bloomberg reports two common profitability indicators: return on assets and return on equity. These ratios are aggregated across the top ten reporting banks using total assets as weights.

E. Liquidity Indicators

Initially solvent financial institutions may be driven toward closure by poor management of short-term liquidity, so it is important to monitor liquidity indicators. On the liability side, indicators should cover funding sources, including interbank and central bank credits.

1. Central Bank Credit to Financial Institutions. A large increase in central bank credit to banks and other financial institutions—as a proportion of their capital or their liabilities—often reflects severe liquidity problems in the financial system. Because of data considerations, we obtain the ratio of central bank credit to financial systems (or the private sector) to the monetary base.

2. Loans-to-Deposits Ratios. The ratio of credit to total deposits may give indications of the ability of the banking system to mobilize deposits to meet credit demand. A high ratio may indicate stress in the banking system and a low level of liquidity to respond to shocks.

F. Sensitivity to Market Risk Indicators

This set of indicators looks at the various components of market risk, the most significant of which are interest rate and foreign exchange risk. The latter is captured to a certain extent by the share of foreign liabilities of the banking system to total liabilities. The IMF document does not give a specific indicator to measure interest rate risk.

G. Market-Based Indicators

Market-based assessments of the financial sector as implied by the prices (yields) of financial instruments and the creditworthiness ratings of financial institutions and large corporations, are also useful indicators of financial system vulnerability. Another useful

market-based indicator, which is readily available, is the stock prices of the financial sector relative to average stock prices.

The CAMELS system, particularly the capital adequacy ratio, has been described as inadequate for emerging market economies by Rojas-Suarez (2001). Two reasons are cited. One, because of severe deficiencies in the accounting and regulatory framework and the high concentration of wealth in emerging markets, the meaning of traditional ratios is extremely limited. Because of poor or unrealistic accounting standards, for example, there will a divergence between the market value of an asset and its book value. Two, bank ratios become less effective when liquid markets for bank shares, subordinated debt and other bank liabilities and assets are not available to validate the "real" worth of a bank as opposed to its accounting value.

Rojas-Suarez then proposes alternative indicators for banking problems in emerging markets based on the general principle that good indicators of banking problems are those that reveal the "true" riskiness of individual banks because they are based on markets that work rather than just relying on accounting figures. The indicators that she proposes are: 1) implicit interest rate paid on deposits; 2) spread between lending and deposit rates; 3) rate of loan growth; and 4) growth of interbank debt. Significant changes in these variables indicate a change in the risk-taking behavior of banks.

The methodology applied by Rojas-Suarez is a two-step approach, which she applies to six countries: Mexico, Venezuela, Colombia, Thailand, Korea and Malaysia. The means of the variables are computed for tranquil and crisis periods and it determined whether the differences are significant. Rojas-Suarez then applies a modified version of the Kaminsky-Reinhart signals approach to determine the ability of each indicator to predict a crisis. The empirical results show that interest paid on deposits and interest rate spreads have proven to be strong performers by showing a high degree of accuracy in predicting bank problems.

Given the possibility of self-fulfilling crises, another important indicator for monitoring and surveillance can be derived by undertaking regular market surveys among economic agents to obtain a feel of their sentiments and expectations. In addition Harding (1998) suggests that multiple equilibria in modeling time series be explicitly accounted for. Nonlinear models that account for endogenous changes in asset prices will be useful.

VII. UPDATED EMPIRICAL RESULTS

In this section, we present the results of empirical tests which use updated data and attempt to address the shortcomings of the studies of Gochoco-Bautista and Yap (2001). The areas of improvement include consideration of more indicators, including a measure of contagion.

Measures of Contagion

A significant improvement in this study over previous ones on the Philippines is the explicit consideration of contagion. Many recent studies have incorporated a measure of contagion in the empirical analysis. For example, Eichengreen, Rose and Wyplosz use panel data to test the existence of contagion effect by estimating the following model:

$$\text{Crisis}_{j,t} = \alpha D(\text{Crisis}_{i,t}) + \lambda \text{Macro}_{j,t} + \varepsilon_{j,t}$$

where $\text{Crisis}_{j,t}$ is a dummy variable for country j at time t, constructed using a procedure similar to that of identifying pressure periods; $D(\text{Crisis}_{i,t})$, the contagion variable, takes the value of 1 if the crisis dummy for any country i (i j) in the sample is 1; $D(\text{Crisis}_{i,t})$ is 0 otherwise; and $\text{Macro}_{j,t}$ contains current and lagged macroeconomic variables for country j.

Other studies are surveyed by Zhang (2001), who also proposed his own methodology. This revolves around the use of a duration variable to capture the changes in the frequency of attacks, which might be an important factor influencing investors' expectations. However, implementing Zhang's proposal requires using the Autoregressive Conditional Hazard (ACH) model, which—given the existing econometric software packages—is not a straightforward procedure.

Instead we use a variant of the Eichengreen, Rose and Wyplosz approach in the context of the channels of contagion identified by Kaminsky and Reinhart. In this case the Philippines is affected through the bank credit channel by crises originating in Latin American countries since the bulk of their liabilities are to US-affiliated banks. On the other hand, Japanese banks are the main creditors to China, Indonesia, Korea, Malaysia and Thailand.

Meanwhile, asset prices of the Philippines, particularly the stock index, are more highly correlated with neighboring East Asian economies. The same is true with regard to third party trade. The Philippines has similar patterns in terms of commodity structure and trade partners with Thailand and Malaysia, and to a certain extent Korea. This analysis reveals that currency crises originating in Latin America and East Asia will likely have an impact on the Philippines.

The contagion variable is defined as follows: $CONTAGION_t$ equals 1 if there is a crisis originating in a Latin American or East Asian economy at time t, and zero otherwise. The timing of external crises is based on a list provided by Goldstein, Kaminsky and Reinhart (2000).[3] If a particular crisis occurs within 3 months of an identified pressure period in the Philippines then t is adjusted to be equal to the timing of the pressure period. The 3 month window is reduced to one month after 1992, at which time the capital account of the Philippines was liberalized. Both these time spans are arbitrary. This definition of the contagion variable is a bit loose since it does distinguish between fundamentals-based contagion and pure contagion and also does not distinguish among the different channels of fundamentals-based contagion. However, it is still an improvement over earlier analyses that completely ignored this factor.

A more direct consideration of contagion is to include exchange rate movements of competing countries in the empirical tests. In this study, we used a weighted average of month-on-month changes in the exchange rate of Indonesia, Malaysia and Thailand. The weights were based on the share of these three countries in US imports.

Identifying Pressure Periods

Zhang's proposal to identify pressure periods is based on the behavior of exchange rates and reserves. The Crisis dummy takes on the value of 1 if

$$\Delta e_t > 3\sigma_{\Delta e,t} + M_{\Delta e,t} \quad \text{or}$$

$$\Delta r_t < -3\sigma_{\Delta r,t} + M_{\Delta r,t}$$

where Δe_t and Δr_t are the changes in the nominal exchange rate and level of foreign exchange reserves respectively. $\sigma_{\Delta e,t}$ is the standard deviation of Δe_t in the sample (t-36, t-1) and $M_{\Delta e,t}$ is the mean of Δe_t in the same sample. $\sigma_{\Delta r,t}$ and $M_{\Delta r,t}$ are the corresponding statistics for foreign exchange reserves. In this context, pressure periods are those months when changes in the exchange rate or foreign exchange reserves take on extreme values. The time varying feature of the threshold is designed to avoid the regime changes.

[3] Tables 2.1 and 2.2, pages 22-25.

This methodology is modified to include changes in the interest rate differential and a 2.5 standard deviation threshold instead of 3 standard deviations is used instead. We also look at the results of Gochoco-Bautista and include periods which she identified and are close to the threshold based on Zhang's methodology. The resulting pressure periods are listed in Table 6. Note that these are not all crisis periods.

Table 6
Periods of Speculative Pressure Applying Methodology of Zhang (2001) and Incorporating Results of Gochoco-Bautista

1980	80.4, 80.8, 81.3, 81.12, 82.10, 82.12, 83.06, 83.10, 84.01, 84.06, 84.10, 86.02
1990, 2000	90.01, 90.07, 90.11, 92.09, 95.09, 97.07, 97.09, 97.12, 98.6, 98.11, 99.02, 2000.10

Re-estimated Probit Model

Four equations were estimated. In the first, we constrained the sample to cover the major crises in the Philippines since 1980 and hence only indicators with data from 1980 onwards were considered. In the second, we considered all indicators and hence the sample period starts at the time all data are available. The results of the first two equations are shown in Tables 7 and 8.

Table 7
Probit Results with Sample Constrained to Include 1980 Onwards

Dependent Variable: CRISIS
Method: ML - Binary Probit
Date: 05/28/02 Time: 11:23
Sample(adjusted): 1980:01 2002:04
Included observations: 268 after adjusting endpoints
Convergence achieved after 7 iterations
Covariance matrix computed using second derivatives

Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	-6.846558	2.190534	-3.125520	0.0018
M1(-6)	5.210007	2.136224	2.438887	0.0147
M2M(-6)	0.025305	0.013407	1.887500	0.0591
ELEC(-4)	-0.054234	0.027369	-1.981602	0.0475
SP(-4)	-0.011388	0.005274	-2.159295	0.0308
CONTAGION	2.296141	0.373065	6.154794	0.0000

Mean dependent var	0.089552	S.D. dependent var	0.286073
S.E. of regression	0.228698	Akaike info criterion	0.425933
Sum squared resid	13.70330	Schwarz criterion	0.506328
Log likelihood	-51.07506	Hannan-Quinn criter.	0.458224
Restr. log likelihood	-80.80217	Avg. log likelihood	-0.190579
LR statistic (5 df)	59.45423	McFadden R-squared	0.367900
Probability(LR stat)	1.58E-11	Durbin-Watson Stat	1.85

Obs with Dep=0	244	Total obs	268
Obs with Dep=1	24		

Variable Definitions:

CRISIS	–	dummy variable which equals 1 during a pressure period
M1	–	excess M1 balances
M2M	–	year-on-year growth rate of M2 multiplier
ELEC	–	year-on-year growth in electricity consumption (proxies as output)
SP	–	year-on-year growth in stock prices
CONTAGION	–	dummy variable defined earlier

Table 8
Probit Results with Unconstrained Sample

Dependent Variable: CRISIS
Method: ML - Binary Probit
Date: 05/30/02 Time: 06:59
Sample(adjusted): 1987:09 2001:12
Included observations: 172 after adjusting endpoints
Convergence achieved after 7 iterations
Covariance matrix computed using second derivatives

Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	-2.561647	0.521245	-4.914478	0.0000
STD_FXR(-2)	0.012930	0.007735	1.671579	0.0946
DC(-5)	0.045474	0.024112	1.885994	0.0593
DEFRATIO(-8)	17.48809	8.647058	2.022432	0.0431
M2M(-6)	0.055887	0.025956	2.153109	0.0313
ELEC(-4)	-0.187890	0.075310	-2.494875	0.0126
SP(-4)	-0.011200	0.007359	-1.521819	0.1281
CONTAGION	3.138423	0.709684	4.422284	0.0000

Mean dependent var	0.069767	S.D. dependent var	0.255498
S.E. of regression	0.203162	Akaike info criterion	0.358605
Sum squared resid	6.769056	Schwarz criterion	0.505000
Log likelihood	-22.84004	Hannan-Quinn criter.	0.418001
Restr. log likelihood	-43.52236	Avg. log likelihood	-0.132791
LR statistic (7 df)	41.36464	McFadden R-squared	0.475211
Probability(LR stat)	6.89E-07	Durbin-Watson Stat	1.89

Obs with Dep=0	160	Total obs	172
Obs with Dep=1	12		

Variable Definitions:

CRISIS	–	dummy variable which equals 1 during a pressure period
STD_FXR	–	ratio of short-term foreign debt to foreign exchange reserves
DC	–	year-on-year growth of domestic credit in real terms
DEFRATIO	–	year-on-year change of national government deficit as a ratio to electricity sales
M2M	–	year-on-year growth rate of M2 multiplier
ELEC	–	year-on-year growth in electricity consumption (proxies as output)
SP	–	year-on-year growth in stock prices
CONTAGION	–	dummy variable defined earlier

The results show a more useful lag structure than that of Gochoco-Bautista. For example, a sharp increase in the M2 multiplier signals possible pressure on the exchange rate six months hence. This gives ample time for policy makers to react and even gives allowance for lags in the release of data. Another major difference is that we eschewed using variables that were used in identifying pressure periods, e.g. growth in international reserves and interest rate differentials.

The variables that are significant in both equations are the M2 multiplier, monthly electricity consumption, the stock price index, and the contagion variable. The number of lags are also the same. The only indicator which has a complete data set for the entire sample but did not turn up significant in Table 7 but did so in Table 8 is domestic credit.

The other two equations have the same specification but include the weighted average of exchange rate changes of competing countries. The results are reported in Tables 9 and 10.

Table 9
Probit Results with Sample Constrained to Include 1980 Onwards
Including Exchange Rate of Competing Countries

Dependent Variable: CRISIS
Method: ML - Binary Probit
Date: 05/28/02 Time: 11:28
Sample(adjusted): 1980:01 2002:04
Included observations: 268 after adjusting endpoints
Convergence achieved after 7 iterations
Covariance matrix computed using second derivatives

Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	-6.527663	2.245272	-2.907293	0.0036
M1(-6)	4.855289	2.190937	2.216079	0.0267
M2M(-6)	0.025158	0.013780	1.825631	0.0679
ELEC(-4)	-0.066148	0.028841	-2.293504	0.0218
SP(-4)	-0.010875	0.005367	-2.026237	0.0427
CONTAGION	2.402869	0.380879	6.308742	0.0000
WTDER(-6)	0.057330	0.025198	2.275167	0.0229

Mean dependent var	0.089552	S.D. dependent var	0.286073
S.E. of regression	0.226423	Akaike info criterion	0.415825
Sum squared resid	13.38079	Schwarz criterion	0.509620
Log likelihood	-48.72061	Hannan-Quinn criter.	0.453498
Restr. log likelihood	-80.80217	Avg. log likelihood	-0.181793
LR statistic (6 df)	64.16313	McFadden R-squared	0.397038
Probability(LR stat)	6.39E-12	Durbin-Watson Stat	1.80

Obs with Dep=0	244	Total obs	268
Obs with Dep=1	24		

Variable Definitions:

CRISIS	–	dummy variable which equals 1 during a pressure period
M1	–	excess M1 balances
M2M	–	year-on-year growth rate of M2 multiplier
ELEC	–	year-on-year growth in electricity consumption (proxies as output)
SP	–	year-on-year growth in stock prices
CONTAGION	–	dummy variable defined earlier
WTDER	–	weighted average of month-on-month changes in the nominal exchange rates of Indonesia, Malaysia and Thailand

The results are basically the same as those reported in Tables 7 and 8. However, the variable STD_FXR becomes insignificant in Table 10. One reason is that the correlation between STD_FXR and WTDER is relatively high—the correlation coefficient of the two variables at the indicated lag structure is 0.19—in the relevant sample period.

The variable WTDER is significant with a six month lag, indicating that exchange rate movements of competing countries influence the peso. It should be noted that the CONTAGION variable was retained in the specification of the last two equations. The latter is defined by actual currency crises while changes in WTDER, even sharp movements, need not necessarily lead to a crisis in the relevant countries. However, currency crises are almost always accompanied by large changes in the nominal exchange rate. But since CONTAGION includes countries aside from Indonesia, Malaysia and Thailand, there is no duplication between this variable and WTDER.

Table 10
Probit Results with Unconstrained Sample
Including Exchange Rate of Competing Countries

Dependent Variable: CRISIS
Method: ML - Binary Probit
Date: 05/28/02 Time: 11:39
Sample(adjusted): 1987:09 2001:12
Included observations: 172 after adjusting endpoints
Convergence achieved after 8 iterations
Covariance matrix computed using second derivatives

Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	-2.878252	0.642027	-4.483067	0.0000
STD_FXR(-2)	0.011359	0.009940	1.142777	0.2531
DC(-5)	0.056671	0.027191	2.084161	0.0371
DEFRATIO(-8)	18.49533	9.386452	1.970428	0.0488
M2M(-6)	0.063926	0.028839	2.216611	0.0266
ELEC(-4)	-0.231133	0.086760	-2.664058	0.0077
SP(-4)	-0.010650	0.007646	-1.392845	0.1637
CONTAGION	3.471384	0.806460	4.304473	0.0000
WTDER(-6)	0.071745	0.038965	1.841242	0.0656

Mean dependent var	0.069767	S.D. dependent var	0.255498
S.E. of regression	0.198784	Akaike info criterion	0.352509
Sum squared resid	6.440960	Schwarz criterion	0.517204
Log likelihood	-21.31578	Hannan-Quinn criter.	0.419330
Restr. log likelihood	-43.52236	Avg. log likelihood	-0.123929
LR statistic (8 df)	44.41316	McFadden R-squared	0.510234
Probability(LR stat)	4.75E-07	Durbin-Watson Stat	1.96

Obs with Dep=0	160	Total obs	172
Obs with Dep=1	12		

Variable Definitions:

CRISIS	–	dummy variable which equals 1 during a pressure period
STD_FXR	–	ratio of short-term foreign debt to foreign exchange reserves
DC	–	year-on-year growth of domestic credit in real terms
DEFRATIO	–	year-on-year change of national government deficit as a ratio to electricity sales
M2M	–	year-on-year growth rate of M2 multiplier
ELEC	–	year-on-year growth in electricity consumption (proxies as output)
SP	–	year-on-year growth in stock prices
CONTAGION	–	dummy variable defined earlier
WTDER	–	weighted average of month-on-month changes in the nominal exchange rates of Indonesia, Malaysia and Thailand

The next step is to determine which of the significant variables were flashing prior to the relevant crises. This is achieved with the help of the signals approach. A by-product of this analysis would be a comparison of the results of the two approaches.

The Kaminsky-Reinhart Signals Approach

Tables 11a, 11b and 11c (at the end of the paper) show the behavior of the indicators used in our study for three periods 1981-83, 1987-1990 and 1995-1997. The definitions of the variables are shown in Table 11d. Meanwhile, Table 12 identifies the indicators which were most active and the number of months wherein their values crossed the threshold during the 36 month window identified.

Table 11a
Transformed Indicators for the Philippines, 1970-1996 (in-sample), 1997-2001 (out-of-sample) Period 1981.01-1983.12

	RER	X	M	RIRD	FXR	M2M	M2/ RES	DC	M1	RIR	L/D	ELEC	DEF/ ELEC	SP	STD/ FXR	TD/ FXR	CONT	IBD	S	S-adj	K	K-adj
Threshold	1.0569	-11.9152	41.2131	8.9279	-38.7843	14.4382	74.6609	24.3759	1.0781	12.4083	11.9961	0.0657	0.0342	-21.2849	12.2871	15.9101		97.9758				
noise/signal ratio	0.22	0.51	0.87	1.00	0.50	0.59	0.51	0.68	0.57	0.77	1.00	0.57	1.00	0.46	1.00	1.00	1.00	1.00				
1981 JAN	0	0	0	1	0	1	0	0	0	0	n/a	0	n/a	1	n/a	n/a	0	n/a	3	4.15	4.87	7.82
1981 FEB	0	0	0	1	0	1	0	0	0	0	n/a	0	n/a	1	n/a	n/a	1	n/a	4	5.54	5.87	9.43
1981 MAR	0	0	0	0	0	1	0	0	0	0	n/a	0	n/a	1	n/a	n/a	0	n/a	2	2.77	3.87	6.21
1981 APR	0	0	0	0	0	0	0	0	0	0	n/a	0	n/a	0	n/a	n/a	0	n/a	0	0.00	0.00	0.00
1981 MAY	0	0	0	0	0	0	0	0	0	0	n/a	0	n/a	0	n/a	n/a	0	n/a	0	0.00	0.00	0.00
1981 JUN	0	0	0	1	0	0	0	0	0	0	n/a	0	n/a	0	n/a	n/a	0	n/a	1	1.38	1.00	1.61
1981 JUL	0	0	0	0	0	0	0	0	0	0	n/a	0	n/a	0	n/a	n/a	1	n/a	1	1.38	1.00	1.61
1981 AUG	0	0	0	0	0	0	0	0	0	0	n/a	0	n/a	0	n/a	n/a	0	n/a	0	0.00	0.00	0.00
1981 SEP	0	1	0	0	0	0	0	0	0	0	n/a	0	n/a	0	n/a	n/a	0	n/a	1	1.38	1.96	3.15
1981 OCT	0	0	0	0	0	0	0	0	0	0	n/a	0	n/a	0	n/a	n/a	0	n/a	0	0.00	0.00	0.00
1981 NOV	0	1	0	0	0	0	0	0	0	0	n/a	0	n/a	0	n/a	n/a	0	n/a	1	1.38	1.96	3.15
1981 DEC	0	0	0	0	0	0	0	0	1	0	n/a	0	n/a	0	n/a	n/a	0	n/a	1	1.38	1.75	2.82
1982 JAN	0	1	0	0	1	0	1	0	0	0	n/a	0	n/a	1	n/a	n/a	0	n/a	4	5.54	8.10	13.00
1982 FEB	0	1	0	0	1	0	1	0	0	0	n/a	0	n/a	0	n/a	n/a	1	n/a	4	5.54	6.92	11.12
1982 MAR	0	1	0	0	0	0	0	0	0	0	n/a	0	n/a	1	n/a	n/a	0	n/a	2	2.77	4.13	6.64
1982 APR	0	0	0	0	1	0	1	0	0	0	n/a	0	n/a	1	n/a	n/a	0	n/a	3	4.15	6.13	9.85
1982 MAY	0	0	0	0	1	0	1	0	0	0	n/a	0	n/a	0	n/a	n/a	0	n/a	2	2.77	3.96	6.36
1982 JUN	0	1	0	0	0	0	0	0	0	0	n/a	0	n/a	0	n/a	n/a	0	n/a	1	1.38	1.96	3.15
1982 JUL	1	0	0	0	0	1	0	0	0	0	n/a	0	n/a	0	n/a	n/a	0	n/a	2	2.77	6.24	10.02
1982 AUG	1	1	0	0	1	1	1	0	0	0	n/a	0	n/a	0	n/a	n/a	1	n/a	6	8.31	13.16	21.14
1982 SEP	1	1	0	0	0	1	0	0	0	0	n/a	0	n/a	0	n/a	n/a	0	n/a	3	4.15	8.20	13.17
1982 OCT	1	0	0	0	1	1	1	0	0	0	n/a	0	n/a	0	n/a	n/a	0	n/a	4	5.54	10.20	16.38
1982 NOV	0	0	0	0	1	1	1	0	0	0	n/a	0	n/a	0	n/a	n/a	0	n/a	3	4.15	5.66	9.08
1982 DEC	0	0	0	0	1	1	1	0	0	0	n/a	0	n/a	0	n/a	n/a	1	n/a	4	5.54	6.66	10.69
1983 JAN	0	0	0	0	1	1	1	0	0	0	n/a	0	n/a	0	n/a	n/a	0	n/a	3	4.15	5.66	9.08
1983 FEB	0	1	0	0	1	0	1	0	0	0	n/a	0	n/a	0	n/a	n/a	1	n/a	4	5.54	6.92	11.12
1983 MAR	0	0	0	0	1	0	1	0	0	0	n/a	0	n/a	0	n/a	n/a	0	n/a	2	2.77	3.96	6.36
1983 APR	0	0	0	0	1	0	1	0	0	0	n/a	0	n/a	0	n/a	n/a	1	n/a	3	4.15	4.96	7.97
1983 MAY	0	0	0	0	1	0	1	0	0	0	n/a	0	n/a	0	n/a	n/a	0	n/a	2	2.77	3.96	6.36
1983 JUN	0	0	0	0	1	1	1	0	0	0	n/a	0	n/a	0	n/a	n/a	0	n/a	3	4.15	5.66	9.08
1983 JUL	0	0	0	0	1	0	1	0	0	0	n/a	0	n/a	0	n/a	n/a	0	n/a	2	2.77	3.96	6.36
1983 AUG	0	0	0	0	1	0	1	0	0	0	n/a	0	n/a	0	n/a	n/a	0	n/a	2	2.77	3.96	6.36
1983 SEP	0	0	0	0	1	0	1	0	0	0	n/a	0	n/a	0	n/a	n/a	0	n/a	2	2.77	3.96	6.36
1983 OCT	0	0	0	0	1	0	1	0	1	0	n/a	0	n/a	0	n/a	n/a	0	n/a	3	4.15	5.72	9.18
1983 NOV	0	0	0	0	1	0	0	0	1	0	n/a	0	n/a	0	n/a	n/a	0	n/a	2	2.77	3.75	6.03
1983 DEC	0	0	0	1	0	0	0	0	1	0	n/a	0	n/a	0	n/a	n/a	0	n/a	2	2.77	2.75	4.42

Table 11b

Transformed Indicators for the Philippines, 1970-1996 (in-sample), 1997-2001 (out-of-sample) Period 1987.01-1989.12

	RER	X	M	RIRD	FXR	M2M	M2/RES	DC	M1	RIR	L/D	ELEC	DEF/ ELEC	SP	STD/ FXR	TD/FXR	CONT	IBD	S	S-adj	K	K-adj
Threshold	1.0569	-11.9152	41.2131	8.9279	-38.7843	14.4382	74.6609	24.3759	1.0781	12.4083	11.9961	0.0657	0.0342	-21.2849	12.2871	15.9101		97.9758				
noise/signal ratio	0.22	0.51	0.87	1.00	0.50	0.59	0.51	0.68	0.57	0.77	1.00	0.57	1.00	0.46	1.00	1.00	1.00	1.00				
1987 JAN	0	0	0	0	0	0	0	0	0	1	n/a	0	0	0	0	0	0	0	1	1.06	1.30	1.40
1987 FEB	0	0	0	0	0	0	0	0	0	0	n/a	0	0	0	0	0	0	0	0	0.00	0.00	0.00
1987 MAR	0	0	0	0	0	0	0	0	0	1	n/a	0	0	0	0	0	0	0	1	1.06	1.30	1.40
1987 APR	0	0	0	0	0	0	0	0	0	0	n/a	0	0	0	0	0	0	0	0	0.00	0.00	0.00
1987 MAY	0	0	0	0	0	0	0	0	0	0	n/a	0	1	0	0	0	0	0	1	1.06	1.00	1.08
1987 JUN	0	0	0	0	0	0	0	0	0	0	n/a	0	0	0	0	0	0	0	0	0.00	0.00	0.00
1987 JUL	0	0	1	0	0	0	0	0	0	0	n/a	0	0	0	0	0	0	0	1	1.06	1.15	1.24
1987 AUG	0	0	1	0	0	0	0	0	0	0	n/a	0	0	0	0	0	0	0	1	1.06	1.15	1.24
1987 SEP	0	0	1	0	0	0	0	0	0	0	n/a	0	0	0	0	0	0	0	1	1.06	1.15	1.24
1987 OCT	0	0	0	0	0	0	0	0	0	0	n/a	0	0	0	0	1	0	0	1	1.06	1.00	1.08
1987 NOV	0	0	0	0	0	0	0	0	0	0	n/a	0	0	0	0	1	0	0	1	1.06	1.00	1.08
1987 DEC	0	0	1	0	1	0	1	0	1	0	0	0	0	0	1	1	0	0	6	6.00	8.86	8.86
1988 JAN	0	0	0	0	1	0	1	0	1	0	0	0	0	0	1	1	0	0	5	5.00	7.72	7.72
1988 FEB	0	0	0	0	1	0	1	0	0	0	0	0	0	0	1	1	0	0	4	4.00	5.96	5.96
1988 MAR	0	0	0	0	1	0	1	0	1	0	0	0	0	0	1	1	0	0	5	5.00	7.72	7.72
1988 APR	0	0	0	0	1	0	1	0	0	0	0	0	0	0	1	1	0	0	4	4.00	5.96	5.96
1988 MAY	0	0	0	0	1	0	1	0	0	0	0	0	0	0	1	1	0	1	5	5.00	6.96	6.96
1988 JUN	0	0	0	0	1	0	1	0	0	0	0	0	1	0	1	1	0	1	6	6.00	7.96	7.96
1988 JUL	0	0	0	0	1	0	1	0	0	0	0	0	0	1	1	1	0	1	6	6.00	9.13	9.13
1988 AUG	0	0	0	0	1	0	1	0	0	0	0	0	0	0	1	1	0	0	4	4.00	5.96	5.96
1988 SEP	0	0	0	0	1	0	1	0	0	0	0	0	0	0	1	1	0	0	4	4.00	5.96	5.96
1988 OCT	0	0	0	0	1	0	1	0	0	0	0	0	0	0	1	1	0	1	5	5.00	6.96	6.96
1988 NOV	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	1	0	0	3	3.00	3.75	3.75
1988 DEC	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	1	3	3.00	3.75	3.75
1989 JAN	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00
1989 FEB	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1.00	1.00	1.00
1989 MAR	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	2	2.00	2.90	2.90
1989 APR	0	0	1	0	0	0	1	0	0	0	0	0	0	0	1	1	1	0	5	5.00	6.11	6.11
1989 MAY	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	2	2.00	2.00	2.00
1989 JUN	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	2	2.00	2.00	2.00
1989 JUL	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	1.00	1.00	1.00
1989 AUG	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00
1989 SEP	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00
1989 OCT	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00
1989 NOV	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	2	2.00	5.55	5.55
1989 DEC	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	2	2.00	6.30	6.30

Table 11c
Transformed Indicators for the Philippines, 1970-1996 (in-sample), 1997-2001 (out-of-sample) Period 1995.01-1997.12

	RER	X	M	RIRD	FXR	M2M	M2/ RES	DC	M1	RIR	L/D	ELEC	DEF/ ELEC	SP	STD/ FXR	TD/ FXR	CONT	IBD	S	S-adj	K	K-adj
threshold	1.0569	-11.9152	41.2131	8.9279	-38.7843	14.4382	74.6609	24.3759	1.0781	12.4083	11.9961	0.0657	0.0342	-21.2849	12.2871	15.9101		97.9758				
noise/signal ratio	0.22	0.51	0.87	1.00	0.50	0.59	0.51	0.68	0.57	0.77	1.00	0.57	1.00	0.46	1.00	1.00	1.00	1.00				
1995 JAN	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	2	2.00	3.17	3.17
1995 FEB	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	2	2.00	3.17	3.17
1995 MAR	0	0	0	0	0	1	0	1	0	0	0	0	1	0	0	0	0	0	3	3.00	4.17	4.17
1995 APR	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	1	3	3.00	4.17	4.17
1995 MAY	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	2	2.00	3.17	3.17
1995 JUN	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	1	3	3.00	4.17	4.17
1995 JUL	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	1	3	3.00	4.17	4.17
1995 AUG	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	1.00	1.47	1.47
1995 SEP	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	1.00	1.47	1.47
1995 OCT	0	0	0	0	0	1	0	1	0	0	0	0	0	1	0	0	0	0	3	3.00	5.34	5.34
1995 NOV	0	0	0	0	0	1	0	1	0	0	0	0	1	1	0	0	0	0	4	4.00	6.34	6.34
1995 DEC	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	2	2.00	3.22	3.22
1996 JAN	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	2	2.00	3.17	3.17
1996 FEB	0	0	1	0	0	0	0	1	0	0	1	0	1	0	0	0	0	0	4	4.00	4.62	4.62
1996 MAR	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	2	2.00	2.47	2.47
1996 APR	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	2	2.00	2.47	2.47
1996 MAY	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	2	2.00	2.47	2.47
1996 JUN	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	2	2.00	2.47	2.47
1996 JUL	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	2	2.00	2.47	2.47
1996 AUG	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	2	2.00	2.47	2.47
1996 SEP	0	0	0	0	0	0	0	1	0	0	1	0	0	1	0	0	0	0	3	3.00	4.64	4.64
1996 OCT	0	0	0	0	0	0	0	1	0	0	1	0	0	1	0	0	0	0	3	3.00	4.64	4.64
1996 NOV	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	2	2.00	2.47	2.47
1996 DEC	1	0	0	0	0	0	0	1	1	0	1	0	0	0	0	0	0	0	4	4.00	8.77	8.77
1997 JAN	1	0	0	0	0	0	0	1	0	0	1	0	0	1	0	0	0	0	4	4.00	9.19	9.19
1997 FEB	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	2	2.00	6.02	6.02
1997 MAR	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	2	2.00	6.02	6.02
1997 APR	1	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	3	3.00	8.19	8.19
1997 MAY	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	2	2.00	6.72	6.72
1997 JUN	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	2	2.00	6.72	6.72
1997 JUL	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	1	1	0	4	4.00	4.69	4.69
1997 AUG	0	0	0	0	0	0	0	1	0	1	0	0	0	0	1	1	1	0	5	5.00	5.77	5.77
1997 SEP	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	1	3	3.00	3.47	3.47
1997 OCT	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	1	1	1	5	5.00	5.30	5.30
1997 NOV	0	0	0	0	0	0	0	0	0	1	0	0	0	1	1	1	0	0	4	4.00	5.47	5.47
1997 DEC	0	0	0	0	0	0	0	0	1	1	0	0	0	1	1	1	0	0	5	5.00	7.23	7.23

Table 11d
Definitions of Indicators Used in Updated Kaminsky-Reinhart Signals Approach
(See tables 11a-11c)

RER	–	measure of currency overvaluation
X	–	year-on-year growth rate of exports in nominal dollar terms
M	–	year-on-year growth rate of imports in nominal dollar terms
RIRD	–	real interest rate differential, foreign less domestic interest rate
FXR	–	year-on-year growth rate of foreign exchange reserves
M2M	–	year-on-year growth rate of M2 multiplier
M2/RES	–	year-on-year growth rate of ratio of M2 to foreign exchange reserves
DC	–	year-on-year growth rate of outstanding domestic credit in real terms
M1	–	excess demand for real M1 balances
RIR	–	real interest rate
L/D	–	year-on-year growth rate of loans-to-deposits ratio
ELEC	–	year-on-year growth rate of electricity consumption (proxies as output)
DEF/ELEC	–	year-on-year change of ratio of national government deficit to electricity consumption
SP	–	year-on-year growth rate of stock prices
STD/FXR	–	year-on-year growth rate of the ratio of short-term external debt to foreign exchange reserves
TD/FXR	–	year-on-year growth rate of the ratio of total external debt to foreign exchange reserves
CONT	–	measure of contagion
IBD	–	year-on-year growth of interbank loans in real terms
S	–	Kaminsky-Reinhart S index
S-adj	–	S index adjusted for a factor related to number of available indicators in the Particular month (factor = total number of possible indicators/number of available indicators)
K	–	Kaminsky-Reinhart K index
K –adj	–	K index adjusted for a factor (factor = sum of noise-signal ratio of all possible Indicators/sum of noise-signal ratio of available indicators)

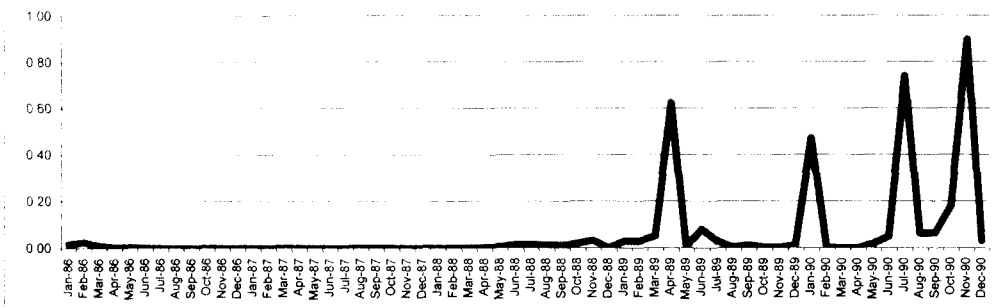
Table 12
Most Active Indicators in Time Period Indicated
(Number in parentheses indicates number of times indicator crossed threshold)

1981-83	FXR (20), M2/RES (18), M2M (11), CONTAGION (7), RER (4), SP (3)
1987-89	TD/FXR (17), STD/FXR (16), M2/RES (12), FXR (11), IBD (6)
1995-97	DC (30), L/D (12), M2M (11), SP (10), RER (7), IBD (5), CONTAGION (4)
2000-2001	SP (15), ELEC (10), X (8)

Generally the results are similar to those obtained by Yap (2001). There was more activity in terms of number of signals flashing in the 1983 crisis compared to the 1997 crisis. The maximum number of signals flashing simultaneously was only 4 in the 1997 crisis compared to 6 in the 1983 crisis and this has not even been adjusted for the number of available indicators. A more valid comparison is 4 in 1997 and 8.3 in 1983 (Table 11a). The earlier crisis conforms to a first generation BOP crisis wherein the depletion of reserves was consistently beyond its critical value. However, based on the probit results, what triggered the crisis would have been the high money multiplier and contagion. In the case of the 1997 crisis, excessive credit, a fall in stock prices and contagion triggered the crisis. The variables that are significant in the probit estimates are generally prominent in the crisis episodes, except for the deficit ratio and electricity consumption.

What is interesting, however, is the period of marked stress between November 1987 and October 1988 which did not culminate in any major crisis. Figure 1 shows that the estimated probability of a crisis—using the results of the equation in Table 9—was generally low between 1987 and 1989 except for the month April 1989. What would set apart this period from those wherein a major crisis occurred is the number of times the contagion variable deviated from zero. Between 1987 and 1989, only once did a country relevant to the Philippines experience a crisis and this occurred in April 1989.

Figure 1 Estimated Probability of Crisis, 1986.01-1990.12



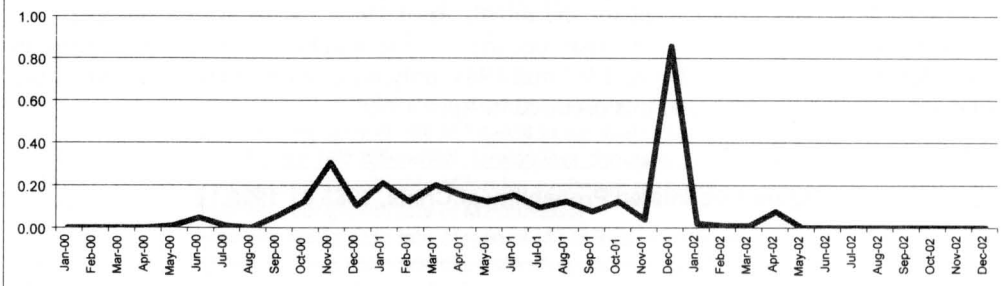
These findings conform to earlier analysis of the causes of the 1997 crisis, which emphasized the role of contagion (Yap 2001). Foreign borrowing and high domestic credit made the economies vulnerable but not necessarily weak. What transformed the vulnerability to a weakness was contagion from the Thai crisis. The latter was triggered by a standard first generation sequence of events—an unsustainable current account deficit which led to a sharp depreciation of the baht. The sharp adjustment in the exchange rate transformed the vulnerability of the Thai banking system into an economic weakness. This led to the downward spiral in the Thai economy, subsequently dragging its neighbors into the quagmire.

VIII. EXISTING IMBALANCES AND SUSTAINABLE ECONOMIC GROWTH

The two empirical approaches can be used to assess the short- and medium-term prospects of the Philippine economy. Estimates of the probability of a crisis up to 2002.4 using the equation in Table 9 show a relatively small value indicating no major stress in the economy (Figure 2). The exception is December 2001 where a spike occurs because of the crisis in Argentina. However, contagion did not become relevant because foreign investors had already factored in the repercussions of the Argentine economic crisis since it had been imminent for an extended period of time.

Another reason for a more optimistic outlook is that the indicators that have consistently crossed their threshold between 2000.1 and the present have been exports—which is related to the cyclical downturn in the global electronics market—and stock prices, reflecting the higher risk aversion of foreign portfolio investors (Table 12). The downward trend in these two factors is expected to be reversed in 2002. Even the deficit ratio, which has received a lot of attention lately, has not reached its critical level.

Figure 2 Estimated Probability of Crisis, 2000.01-2002.12



A financial indicator that has not been included in the empirical tests but has been a source of great concern lately is the ratio of nonperforming loans of commercial banks. From a level of 12 percent in January 1999, the NPL ratio has reached 18.4 percent in February 2002. While this remains lower than that of economies harder hit by the 1997 crisis, the rising trend should be a signal of increasing corporate and financial distress. One solution being considered is an asset managed company to be operated by a private group, with the participation of commercial banks.

What should be more critical to policy makers are persistent structural problems that constrain the rate of economic growth. As seen from the probit estimates, the proxy of economic growth significantly affects the probability of a crisis. We turn now to crucial factors that have affected medium-term economic growth.

One is infrastructure, which is considered by some analysts as the weakest link in the chain of Philippine economic development. Table 13 shows some indicators related to power generation for selected countries in East Asia. The Philippines has the highest transmission and distribution losses in percentage terms and this is one reason why it has the second highest average rate, next only to Japan. The table also shows the number of telephone lines per 1,000 people.

Table 13
Indicators Related to Power Generation and Communications

	Percentage Transmission and Distribution Losses, 1994	Average Rates (in peso per KWh), 1997	Telephone Mainlines (per 1,000 people), 1999
Singapore	3.39	3.0076	482
Korea	5.26	2.7435	438
Japan	5.98	5.6451	568
Malaysia	8.88	3.1177	203
Thailand	9.65	1.6505	86
Indonesia	12.47	1.6505	29
Philippines	19.00	3.360	39

Sources: Medium Term Development Plan 1998-2004 for data on power generation; UNDP 2001 Human Development Report for data on telephone mainlines.

The Philippines also compares poorly in terms of paved road ratio, which is the length of paved roads divided by the total length of roads (Table 14). However, in terms of road density the Philippines ranks higher than its Southeast Asian neighbors.

Table 14
Road Densities and Paved Road Ratios, 1997

	Road Density Km/square km	Paved Road Ratio
Philippines	0.63	0.20
Indonesia	0.19	0.47
Malaysia	0.20	0.74
Thailand	0.42	0.82
Viet Nam	0.46	0.35

Source: Medium Term Development Plan 1998-2004.

These infrastructure indicators indicate that the Philippines still has lot of catching up to do when compared to its East Asian neighbors.

Another critical factor where the Philippines is lagging is human resource development. Table 15 reports the indices of human development derived from the 2001 UNDP report. This includes the life expectancy at birth, population growth rate, the education index and the overall human development index. The Philippines fares well in terms of the education index but this is rather deceptive given the mediocre quality of her tertiary schools. The overall human development index is on a lower end of the spectrum in this sample and one reason is the relatively high population growth rate. As of the last census in 2000, the population growth rate in the Philippines was 2.36 percent, very close to the average value in the previous 25 years.

Table 15
Human Development Indicators, 1999

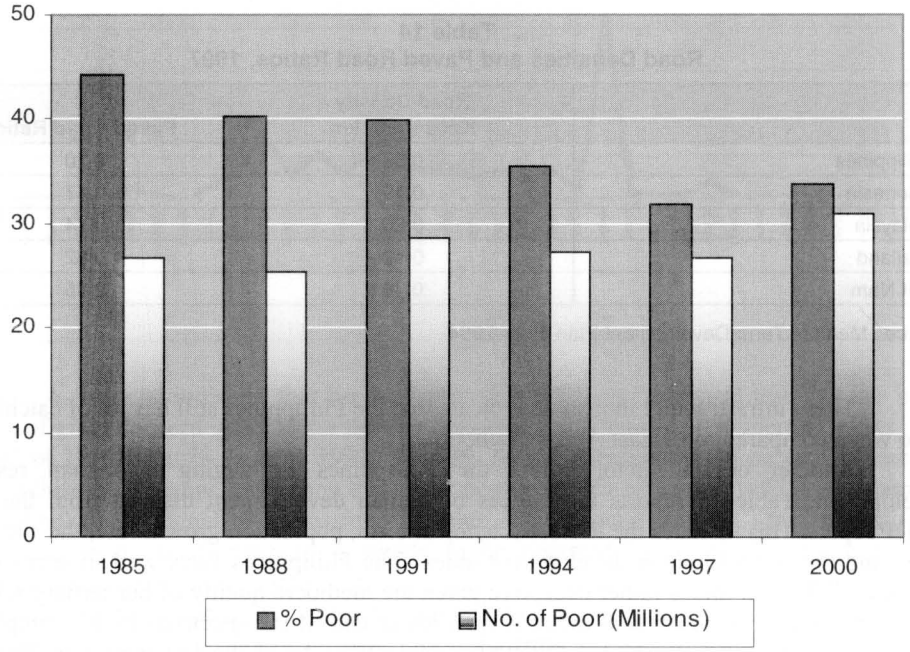
	Life Expectancy at Birth	Population Growth Rate (1975-1999)	Education Index	Human Development Index
Singapore	77.4	2.3	0.87	0.876
Korea	74.7	1.1	0.95	0.875
Japan	80.8	0.5	0.93	0.928
Malaysia	72.2	2.4	0.80	0.774
Thailand	69.9	1.7	0.84	0.757
Indonesia	65.8	1.8	0.79	0.677
Philippines	69.0	2.4	0.91	0.749

Source: UNDP 2001 Human Development Report.

An outcome of inferior infrastructure development, a relatively poor record in human resource development, and erratic economic growth in the past three decades is a worrisome poverty situation. Based on official data, the rate of poverty incidence increased between 1997 and 2000 while the number of poor has actually increased between 1985 and 2000 (Figure 3)[4]. This is one indicator that reflects the inadequacy and perhaps even the failure of economic policy in the past three decades.

[4] Figure 3 was obtained from Dr. Arsenio Balisacan of the University of the Philippines School of Economics. The basic data are derived from the Family Income and Expenditure Surveys of the Philippines, 1985-2000.

Figure 3
Poverty in the Philippines



REFERENCES

Berg, A., E. Borensztein, G. M. Milesi-Ferretti, and C. Pattillo. 1999. "Anticipating Balance of Payments: The Role of Early Warning Systems." IMF Occasional Paper 186.

Calvo, G. 1987. "Balance-of-Payments Crises in a Cash-in-Advance Economy." *Journal of Money, Credit and Banking*, 19 (February).

Frankel, J., and A. Rose. 1996. "Currency Crashes in Emerging Markets: An Empirical Test." *Journal of International Economics*, 41.

Gochoco-Bautista, M. S. 2000. "Periods of Currency Pressure: Stylized Facts and Leading Indciators." *Journal of Macroeconomics*, 22, 1 (Winter).

Goldstein, M. 1998. "Commentary: The Causes and Propagation of Financial Instability, Lessons for Policymakers." Manuscript.

Goldstein, M., G. Kaminsky, and C. Reinhart. 2000. *Assessing Financial Vulnerability: An Early Warning System for Emerging Markets*. Washington, D.C.: Institute for International Economics.

Harding, D. 1998. "Tools for surveillance of the East Asian economies." Paper presented at the Workshop on Monitoring Financial Systems in Selected East Asian Economies. Shangri-la Hotel, Makati City, 25 June.

International Monetary Fund. 2000. "Macroprudential Indicators of Financial System Soundness." IMF Occasional Paper No. 192, April.

Kaminsky, G., and C.M. Reinhart. 1996. "The Twin Crises: the Causes of Banking and Balance-of-Payments Problems." International Finance Discussion Paper No. 544. Washington, D.C.: Board of Governors of the Federal Reserve System (March).

_____. 2000. "On Crises, Contagion, and Confusion." *Journal of International Economics* 51.

Kaminsky, G., S. Lizondo, and C.M. Reinhart. 1998. Leading Indicators of Currency Crises. *IMF Staff Papers* 45, 1 (March).

Kim, S. H., M. A. Rose, and M.G. Plummer. 1999. "Understanding the Asian Contagion: An International Business Cycle Perspective." Manuscript (December).

Krugman, P. 1979. "A Model of Balance-of-Payments Crises." *Journal of Money, Credit and Banking*, 11 (August).

_____. 2001. "Crises: The Next Generation?" (March). http://econ.tau.ac.il/research/sapir/Krugman.pdf.

Obstfeld, M. 1986. "Rational and Self-Fulfilling Balance of Payments Crises." *American Economic Review*, 76 (March).

_____. 1996. "Models of Currency Crises with Self-fulfilling Features." *European Economic Review* 40 (April).

Rojas-Suarez, L. 2001. "Rating Banks in Emerging Markets: What Credit Rating Agencies Should Learn from Financial Indicators." A paper presented during the 5th Brainstorming Workshop of the Asian Policy Forum at the ADB Institute, Tokyo, Japan, on 13 April 2001.

Yap, J. T. 1999. The East Asian Financial Crisis: Causes, Impact and Policy Lessons. Paper presented at the World Bank-sponsored Global Development Network Conference in Bonn, Germany, 6-8 December 1999.

_____. 2001. "Developing an Early Warning System to Help Understand and Monitor Economic Crises." In M. B. Lamberte (ed.), *Economic Crisis...Once More*. Makati: Philippine Institute for Development Studies.

Yoshitomi, M., and K. Ohno. 1999. "Capital-Account Crisis and Credit Contraction." ADB Institute Working Paper 2 (May).

Zhang, Z. 2001. "Speculative Attacks in the Asian Crisis." IMF Working Paper 89-01 (November).

Indicators and Analysis of Vulnerability to Economic Crisis: Korea

Won-Am Park[*]

1. INTRODUCTION

Korea has witnessed the remarkably high growth since it launched the export-oriented growth strategy in the early 1960s. It recorded the annual average growth of almost 8% until it encountered the financial crisis in 1997. Not only Korea but also other East Asian economies showed the rapid growth, often called the "East Asian Miracle." The miracle, however, turned into crisis.

There is a famous rule of Herbert Stein that things that cannot continue don't. The natural question is whether Korea or East Asia had crisis because its fundamentals were not sustainable. Immediately after the crisis, the numerous studies drew the conclusion that East Asian crises were caused by the structural weaknesses. In the case of Korea, many have argued that it suffered from crisis due to lax financial supervision and regulation for financial institutions and a significant mismatch in the sources and uses of funds, although it maintained the relatively sound macro-fundamentals.[1] This is called the first generation model. There were of course dissenting views that investors' panic triggered a sudden reversal of capital inflows.[2] The swift recovery of Asian economies after the crisis-stricken bust strengthened the second generation model that tilted toward financial panic or self-fulfilling expectations. For example, in explaining Asian crises Krugman (1999) switches to self-fulfilling expectations associated with the contagion effect from his position that holds for structural factors such as moral hazard (Krugman, 1998).[3]

Rather than distinguishing market fundamentals from self-fulfilling expectations, this paper concentrates on the vulnerability of the Korean economy from the perspective that economic vulnerability or financial fragility that are the building blocks for the second generation model can be explained by the development of market fundamentals (Kaminsky, 1998). It tries to ascertain whether one can predict the Korean crisis by looking at a list of indicators and thereby avoid another crisis. Section 2 introduces the indicator model for Korea. Section 3 shows the within sample and out-of-sample forecast performance of the indicator model for Korea and compares them with those of the probit model. Section 4 assesses the current vulnerabilities of Korea based upon the indicator model. The concluding remarks are provided in Section 5.

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1 Refer to Krugman (1998), Kaminsky (1998), and Park and Choi (1998).

2 Refer to Radelet and Sachs (1998, 1999), Lee and Lee (1998), and Krugman (1999).

3 Krugman (1999) upholds the third generation model of the open economy Bernake-Gertler model.

2. THE INDICATOR MODEL FOR KOREA

Kaminsky, Lizondo, and Reinhart (1997) propose the indicator approach as an early warning system to predict crisis. The model is composed of identification of crisis and monitoring of a number of indicators based on the theoretical background and predictability of the crisis. The indicators indicate economic vulnerability that might originate from dynamic interplay between market fundamentals and expectations.

A. Identification of Crisis

The crisis occurs via the various channels. Korean economic crisis hinged on the collapse of *Hanbo* and other conglomerates in the early 1997 and the contageous transmission of the Thai crisis through the financial markets since August 1997. Immediately after the Baht crisis, such structural weaknesses as lax financial supervision and regulations for financial institutions and the significant mismatch in the sources and uses of funds triggered investors' panic and the consequent sudden reversal of capital inflows, despite Korea was sound in macro-fundamentals compared to other Asian neighbors.

Many countries have experienced crises of various types over the decades. Most empirical studies on crises use multi-country data to gather as many episodes as possible and modify the model to consider country characteristics. Since the patterns of the crises have differed significantly across countries and through time, the identification of crisis is very hard. If the lax financial supervision and regulations, the significant mismatch in the sources and uses of funds, and sudden reversal of capital inflows played the great role in triggering crisis, models of crisis should also adapt to changing patterns and identify the crisis by the vulnerability of the financial sector.

In this paper we use only Korean data at a loss of generality. As studies on crisis using cross-country data already attest the usefulness of the early warning model, we cannot add much to them if we use cross-country data. Since Korean data occupy only a small portion of total cross-country data set, we cannot say that cross-country study results also hold for Korea. For these reasons and on the presumption that Korea's experience of crisis is very unique, we use only Korean data and check whether Korean crisis can be predicted by a model.

Although the financial vulnerability played the important role in triggering crisis, it emerged with the increasing pressure for won's depreciation in foreign exchange market. In this paper Korean crisis is identified as the extremely strong exchange market pressure for won's depreciation. In other words, we define Korean crisis as largely the currency crisis and utilize exchange market pressure as the quantitative measure for the severity of the crisis. A currency crisis is defined to occur when the exchange market pressure (EMP) that is the weighted average of won depreciation (e), percent point changes of interest rate (i), and percent changes in foreign reserves from the year earlier (R) is very high. The weights are the inverse of the standard deviation of each variable so that variability of each variable is controlled.

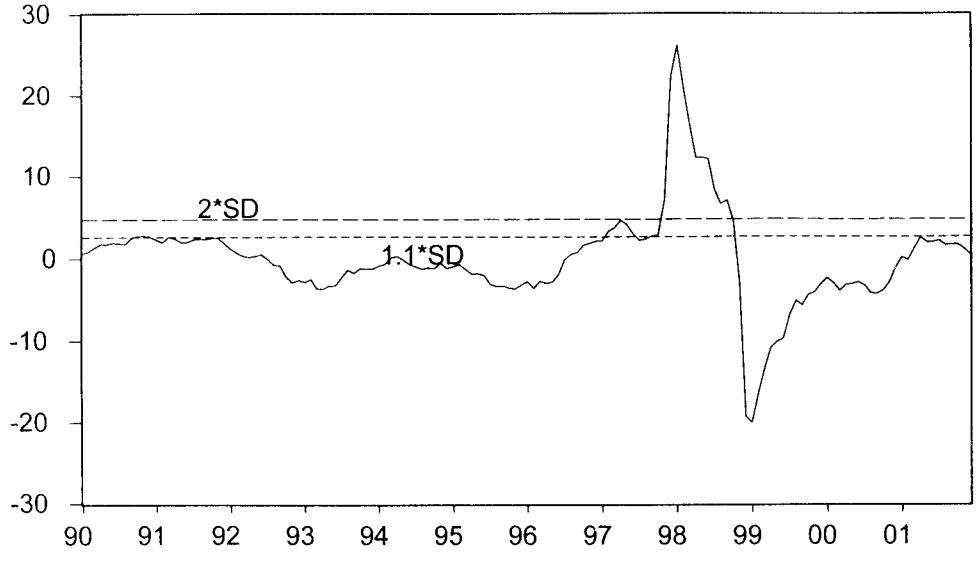
$$EMP = \frac{1}{\sigma_e} \times \Delta e + \frac{1}{\sigma_i} \times \Delta i - \frac{1}{\sigma_R} \times \Delta R \qquad (1)$$

The exchange market pressure as defined in equation (1) is called the Eichengreen-Rose-Wyplosz crisis index. The sample period is Jan. 1990-Nov. 1997. The period of

Dec. 1997-Dec. 2001 is reserved for out-of-sample forecasts.[4] The standard deviation of each variable during the sample period is used to generate the crisis index out-of-sample.[5]

Figure 1 exhibits the movements in the exchange market pressure, which began to increase after 1996 and culminated on January 1998 after a brief respite in the middle of 1997. Afterwards it declined very rapidly until January 1999 when it turned upward again. If the crisis is defined to occur when the deviation of exchange market pressure from the mean exceeds 1.1 times standard deviation of exchange market pressure, then the crisis months are Oct.-Dec. 1990, Feb.-June 1997, and Nov. 1997 during the sample period. The exchange market pressure was not high during the crisis months of Oct.-Dec. 1990 and Feb.-June 1997 compared with that in Nov. 1997 when Korea actually had crisis. If we want to identify November 1997 as the only crisis month, we need to apply the 2 times standard deviation. The two different levels of threshold for crisis are applied to show the sensitivity of analysis to different threshold.[6]

Figure 1
Exchange Market Pressure and Crisis



B. Signal and Crisis

A brief explanation of the signals analysis is already provided in the systhesis report. The ability of forecasting crisis is measured by the ratio of noise-to-signal which can be interpreted as the ratio of Type II error over one minus Type I error, or

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[4] Out-of-sample predictability of the crisis model is important since the model is built after the crisis within the sample that includes crisis period.

[5] By using the sample-period standard deviation, the variability of each variable weighted by the inverse of standard deviation will not be the same out-of-sample. Despite this caveat, we use sample standard deviation to assess the out-of-sample predictability of the early warning model.

[6] Kaminsky, Lizondo, and Reinhart (1997) apply the 3 standard deviation. Even at this very high threshold, November 1997 is only identified as the crisis month.

$$\frac{Noise}{Signal} = \frac{Type\ II\ error}{1 - Type\ I\ error} = \frac{B/(B+D)}{A/(A+C)} \quad \text{.....(2)}$$

where A, B, C, D are defined in Table 1 below

Table 1
Signal and Crisis

	Crisis within a window	No crisis within a window
Signal Issued	A	B
No signal Issued	C	D

C. Indicators

Table 2 lists 22 indicators that are often chosen in other studies such as Kaminsky, Lizondo, Reinhart (1997) and references therein. Most of the indicators except for interest differential, capital account /GDP, current account/GDP, and budget deficit/GDP are taken as growth from the year earlier, considering the unit root of each series. Most data are obtained from the Bank of Korea database, except for real effective exchange rates that are obtained from JP Morgan.

The optimal threshold for each indicator is chosen between the upper 25% and upper 10% distribution to minimize noise-to-signal ratio during the sample period of Jan.1990-Nov.1997. The threshold for crisis is set to 1.1 standard deviation of exchange market pressure over its mean and the window is set to 12 months.[7] To highlight financial fragility of Korean economy, such indicators as dishonored bill ratio, stock price, foreign exchange reserves, external debt/foreign reserves, domestic credit/GDP, M2 multiplier, M2/foreign reserves, foreign debt/total debt are listed. Since the noise-to-signal ratio of the random signal is one, however, we exclude from the composite index industrial production, service price/manufacturing price, and foreign debt/total debt of the monetary institutions whose noise/signal ratio is larger than one. It is notable that such indicators as terms of trade, stock price index, exports, domestic credit/GDP, and M2 multiplier predict the crisis quite accurately.

Table 2-1 shows the performance of indicators with threshold for crisis tightened to 2 times standard deviation of exchange market pressure. The November 1997 is only identified as a crisis month under the tightened threshold, but the crisis period is Dec. 1996 – Nov. 1997 when the 12 months window is applied. As the threshold for crisis is tightened to 2 times standard deviation, the periods of Jan. – Dec. 1990 and March – Nov. 1996 are excluded from the crisis period. Hereafter we call 1.1 times standard deviation of exchange market pressure that includes the year of 1990 in the crisis period 'low threshold' and 2 times standard deviation that excludes Jan. – Dec. 1990 and March – Nov. 1996 from the crisis period 'high threshold.'

[7] Many studies adopted the 24 months window, but we chose 12 months window considering the sample size.

Table 2
Performance of Indicators (Crisis Threshold: 1.1 times standard deviation)

	A/(A+C)	B/(B+D)	Noise/signal ratio [B/(B+D)]/ [A/(A+C)]	Threshold Interval (*x*)	A/(A+B)
Terms of trade	45.5	0.0	0.00	4*	100.0
Industrial production**	21.2	25.8	1.22	1*	30.4
Inventory Index/ Shipment Index	45.5	12.9	0.28	1	65.2
Stock price**	36.4	8.1	0.22	7*	70.6
Dishonored bill ratio	12.1	9.7	0.80	12	40.0
Service price/ Manufacturing price	6.1	25.6	4.26	1	11.1
Capacity Util. Ratio in Manufacturing	12.1	9.7	0.80	15*	40.0
Foreign Exch. Res.**	42.4	14.5	0.34	2*	60.9
Capital account/GDP	18.2	6.5	0.35	15	60.0
Interest differential**	24.2	21.0	0.86	2	38.1
Current account/GDP	21.2	6.5	0.30	14*	63.6
REER**	18.2	12.9	0.71	7	42.9
Exports**	33.3	6.5	0.19	10*	73.3
Depreciation of Asian Competitors	24.2	3.2	0.13	14	80.0
External debt/For. Res.	39.4	14.5	0.37	2	57.1
Budget deficit/GDP	18.2	14.5	0.80	8	40.0
Domes. Credit/GDP**	51.5	0.0	0.00	5	100.0
M2 multiplier	57.6	0.0	0.00	2	100.0
M2/For. Res.	36.4	16.1	0.44	1	54.5
For.Debt/Total Debt of Monetary Inst.	21.2	25.8	1.22	1	30.4
For. Debt/For. Res. of Fin. Inst.	33.3	16.1	0.48	3	52.4
S&P credit rating	6.1	0.0	0.00	1	100.0

Notes: 1) * indicates the minus of the corresponding variable. Growth from the year earlier except for the interest differential (% point change) and capital account/GDP, current account/GDP, budget deficit/GDP (all the level).

2) A to D represents the cell in Table 1.

3) Threshold interval represents the corresponding interval between the upper 25% and upper 10% that minimizes noise/signal ratio.

4) ** indicates the indicator listed in Kaminsky, Lizondo, and Reinhart (1997).

Table 2-1
Performance of Indicators (Crisis Threshold: 2 times standard deviation)

	A/(A+C)	B/(B+D)	Noise/signal ratio [B/(B+D)]/ [A/(A+C)]	Threshold Interval (x)	A/(A+B)
Terms of trade	33.3	13.3	0.40	4 *	26.7
Industrial production**	33.3	15.7	0.47	10 *	23.5
Inventory Index/ Shipment Index	16.7	13.3	0.80	10	15.4
Stock price**	58.3	8.4	0.14	10 *	50.0
Dishonored bill ratio	33.3	7.2	0.22	12	40.0
Service price/ Manufacturing price	83.3	1.2	0.01	13	90.9
Capacity Util. Ratio in Manufacturing	25.0	8.4	0.34	15 *	30.0
Foreign Exch. Res.**	50.0	6.0	0.12	9 *	54.5
Capital account/GDP	33.3	10.8	0.33	12	30.8
Interest differential**	0.0				0.0
Current account/GDP	41.7	19.3	0.46	1 *	23.8
REER**	75.0	1.2	0.02	14	30.0
Exports**	33.3	6.5	0.19	10 *	73.3
Depreciation of Asian Competitors	25.0	8.4	0.34	14	30.0
External debt/For. Res.	91.7	13.3	0.14	2	50.0
Budget deficit/GDP	16.7	9.6	0.58	14	20.0
Domes. Credit/GDP**	75.0	1.2	0.02	14	90.0
M2 multiplier	100.0	0.0	0.00	12	100.0
M2/For. Res	25.0	8.4	0.34	14	30.0
For.Debt/Total Debt Of Monetary Inst.	41.7	21.7	0.52	1	21.7
For. Debt/For. Res. of Fin. Inst.	91.7	12.0	0.13	3	52.4
S&P credit rating	16.7	0.0	0.00	1	100.0

Notes: 1) * indicates the minus of the corresponding variable. Growth from the year earlier except for the interest differential (% point change) and capital account/GDP, current account/GDP, budget deficit/GDP (all the level).

2) A to D represents the cell in Table 1.

3) Threshold interval represents the corresponding interval between the upper 25% and upper 10% that minimizes noise/signal ratio.

4) ** indicates the indicator listed in Kaminsky, Lizondo, and Reinhart (1997).

The industrial production is the only indicator excluded because of very large noise-to-signal ratio under high threshold. However, the indicators of service price relative to manufacturing price and real effective exchange rate of the Korean won are included as they are measured as the per cent deviation from the trend.[8] such indicators as terms of trade, stock price index, exports, domestic credit/GDP, and M2 multiplier predict the crisis quite accurately.

D. Contagion

Contagion emerged as the recent feature of the crisis since the Mexican crisis. In Asian crisis three years later, the plunge of the Thai baht early in July 1997 quickly spread through the neighboring countries, notably to Indonesia and Malaysia. It also severely affected Hong Kong dollar and stock market and even Korean won. With investors nervous about emerging markets in general and Asia in particular, it is not surprising that Thai crisis reached Korea within 6 months. During six months, almost 100 billion dollars were withdrawn from the Asian region. In addition to the traditional trade links among Asian countries, increased international financial linkages helped transmit shocks from one country to another. In particular, Japanese banks began to cut credit lines and withdraw their money from the crisis-prone economy including Korea.

Masson (1998) categorized contagion effects into the monsoonal, spillover, and pure contagion effect. Among the three effects, the monsoonal and the spillover effects are related to market fundamentals rather than self-fulfilling expectations. For instance, the common shocks of the Japanese slowdown and marked depreciation of the yen can deteriorate market fundamentals through trade and financial linkage. Inter-regional trade continues to grow and Japanese influence in this region increased after 1985. Masson (1998) studied the contagion effect during the Mexican crisis and the recent Asian crisis but found that the multiple equilibria conditions for the pure contagion effect do not hold in Korea and Malaysia which had a relatively low external debt/GDP ratio, suggesting the possibility of spillovers.

Baig and Goldfajn (1998) also found the increasing correlations among stock price, exchange rates, and interest rates during the Asian crisis, but this could be due to the monsoonal effect rather than the pure contagion effect. Similarly, Kaminsky and Reinhart (1999) argue that contagion in Asia is fundamentals-based and the dynamic interplay between expectations and market fundamentals should be developed into third generation model.

We include currency depreciation of Asian neighbors as an indicator that captures the contagious effect from the Baht. It measures average depreciation of real effective exchange rates of seven countries such as Thailand, Malaysia, Indonesia, Philippines, Hong Kong, Taiwan, and Singapore. Certainly, rapid depreciation of currencies of Asian neighbors spilled over to Korea through trade or financial channels.

E. Composite Index

Now the composite indicator can be constructed by summing up the number of signals from all indicators. With low crisis threshold, the number of signals was highest in January-February, 1997, when 12 indicators out of 19 ones actually used signaled. No signal was found in May-June, 1995. Rather than simply adding up the number of signals from all indicators, Kaminsky (1998) suggests using the inverse of noise-to-signal ratio as weights to incorporate more information in constructing composite index. Following her advice, we use

[8] The relative price variables of terms of trade, service price/manufacturing price, and real effective exchange rate of the Korean won are transformed into two forms: per cent change from the year earlier and per cent deviation from the trend. The trend is calculated using the Hodrick-Prescott filter. Then the the noise-to-signal ratio determines the appropriate transformation of relative price variables.

the noise-to-signal ratio as weights, but one minus noise-to-signal ratio instead of the inverse of noise-to-signal ratio is used because the noise-to-signal ratios of some indicators are zero.

$$I_t = \sum_{j=1}^{n} (1 - \omega^j)\, s_t^j \qquad (3)$$

where I_t ; the composite index, ω^j ; noise-to-signal ratio, and s_t^j ; signal dummy (1 if signaled, 0 if not signaled).

Figure 2 shows the fluctuations of the composite index as defined in equation (2), when 19 leading indicators and their noise-to-signal ratios less than 1 in Table 2 are used. The composite index peaked in January 1997 and then declined to zero in July 1997 when it turned around to rise again. The composite index moves closely with the exchange market pressure. If the composite index stayed at a high level in the first half of 1997, it would be easier to predict the crisis. The rapid decline of the composite index after the peak in the beginning of the crisis year along with the same movement of exchange market pressure made the government optimistic for the future, but the sudden reversal in the second half of 1997 perplexed the government. With benefit of hindsight, we can see that the composite index warned early for the crisis, as it peaked in January 1997.

Figure 2
The Composite Index (low threshold)

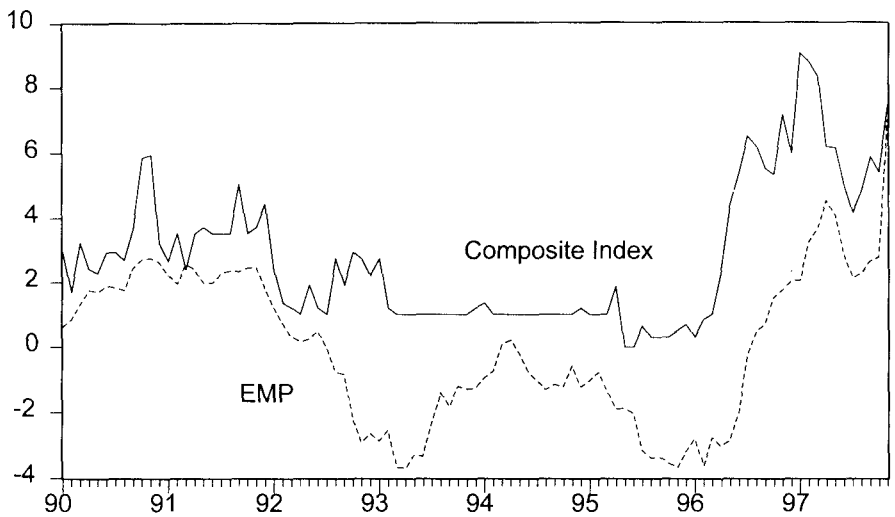
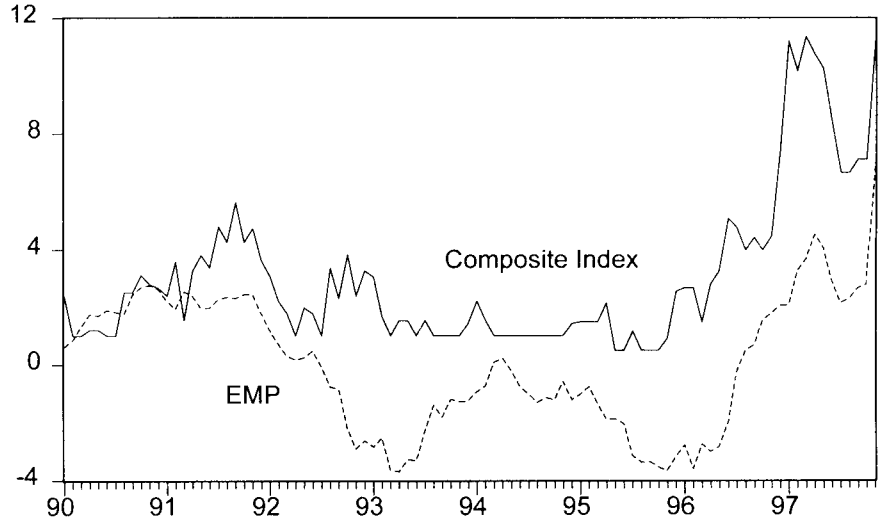


Figure 2-1 shows the fluctuations of the composite index under high threshold, when 21 leading indicators and their noise-to-signal ratios less than 1 in Table 2-1 are used. As the crisis period is confined to Dec. 1996 – Nov. 1997, the signal is concentrated to increase the composite index in this period. Again, we can see that the composite index warned early for the crisis, as it peaked in the very beginning of 1997.

Figure 2-1
The Composite Index (high threshold)



F. Probability of Crisis

The conditional probability of crisis can be defined as the relative frequency of the occurrence of crisis within a window of h months when the composite index lies in a certain interval.[9]

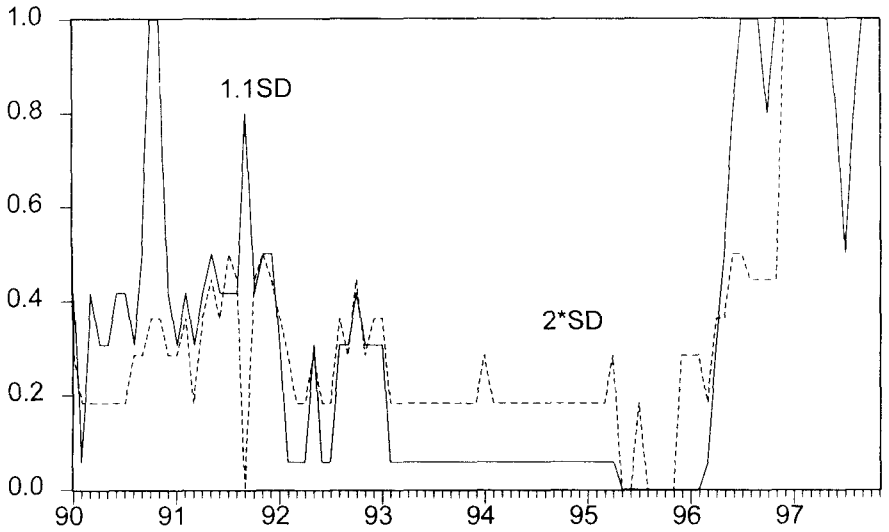
$$P(C_{t,\,t+h} \mid I_i < I_t < I_j) = \frac{\textit{months with } I_i < I_t < I_j \textit{ and a crisis within h months}}{\textit{Months with } I_i < I_t < I_j} \quad (4)$$

where P denotes probability of the occurrence of a crisis within h months($C_{t,\,t+h}$) in the composite index interval [I_i, I_j] and h is set to 12.

Figure 3 shows the conditional probability of crisis as defined in equation (3) under the low and high crisis threshold, respectively. The conditional probability of crisis was estimated high in the crisis period, and actually reached one. It was estimated to be one after December 1996, when the crisis threshold was tightened.

[9] The composite index is divided into 10 intervals: 0-1, equally divided 8 intervals between 1 and 8, and an interval larger than 8.

Figure 3
Conditional Probability of Crisis



3. FORECASTING ABILITY

There are two ways to calculate the predictive ability of the indicator model on the basis of conditional probability. One is to calculate the probability score, following Diebold and Rudebusch (1989). The probability score measures closeness of predictive probability to actual observation of crisis that is represented by the zero-one dummy variable. Kaminsky (1998) introduces the quadratic probability score, log probability score, and global squared bias to evaluate the forecasting ability of the composite indicators. The other is to use a certain level of the conditional probability as the cutoff probability for the signal, following Berg and Pattillo (1998). After defining the signal, we can rely on various measures such as noise-to-signal ratio to evaluate forecasting ability. The cutoff probability is often used in the probit model to check its predictability, but Berg and Pattilo (1998) use it in the indicator model to compare the predictability of two models. We follow the second approach to maintain consistency in the criteria of choosing the appropriate indicators and evaluating predictability of the model.

A. Within and Out-of-Sample Predictability

Table 3 shows the within-sample predictability of the composite index for Korea's currency crisis. The conditional probabilities of 0.25, 0.5, and 0.75 are chosen as the cutoff probability. As cutoff probability rises, type I error increases but type II error decreases. The noise-to-signal ratio as defined in equation (2) will not be sensitive to the cutoff probability, since it is an increasing function of both errors. As mentioned in the above, however, it has the drawback that it is more influenced by type II error than type I error. Therefore other criteria of goodness-of-fit such as percent of observations correctly called, (A+D)/(A+B+C+D), and percent of signals incorrectly called, B/(A+B), are also applied. The noise-to-signal ratio and percent of signals incorrectly called in within-sample forecasts are very low, while percent of observations correctly called is very high. The forecasting ability improves as we tighten the threshold for crisis.

Table 3
Within Sample Predictability of the Indicator Model (90.1-97.11)

	Low threshold	High threshold
Cutoff Probability 0.5		
(A+D)/(A+B+C+D)	0.84	1.00
A/(A+C)	0.58	1.00
D/(B+D)	0.98	1.00
B/(A+B)	0.05	0.00
[B/(B+D)]/[A/(A+C)]	0.03	0.00
Cutoff Probability 0.25		
(A+D)/(A+B+C+D)	0.82	1.00
A/(A+C)	0.82	1.00
D/(B+D)	0.82	1.00
B/(A+B)	0.29	0.00
[B/(B+D)]/[A/(A+C)]	0.22	0.00
Cutoff Probability 0.75		
(A+D)/(A+B+C+D)	0.81	1.00
A/(A+C)	0.45	1.00
D/(B+D)	1.00	1.00
B/(A+B)	0.00	0.00
[B/(B+D)]/[A/(A+C)]	0.00	0.00

Note: 1) A to D represents the cell in Table 1.

One of the concerns is whether the indicator model built using data before the crisis can be used as an early warning model for the possible crisis in the future. To be more concrete, one can raise the question that thresholds for crisis and indicators that are set using pre-crisis data can be applied to forecast the future crisis. The out-of-sample forecasts are made over the period of Dec. 1997-Sep.2000. The period of Oct. 2000-Dec. 2001 is excluded since the Bank of Korea does not publish its series of central government budget deficit on a monthly basis after Oct. 2000.

Table 4 shows out-of-sample forecasting performance of the indicator model. The out-of-sample performance turned out to be as good as the within-sample performance. This implies that the indicator approach is very useful as an early warning model of the currency crisis. It also strongly suggests that economic indicators in the real and financial market predicted the crisis.

Table 4
Out-of-Sample Predictability of the Indicator Model (97.12-00.9)

	Low threshold	High threshold
Cutoff Probability 0.5		
(A+D)/(A+B+C+D)	0.94	0.94
A/(A+C)	0.91	0.80
D/(B+D)	0.96	1.00
B/(A+B)	0.09	0.00
[B/(B+D)]/[A/(A+C)]	0.04	0.00
Cutoff Probability 0.25		
(A+D)/(A+B+C+D)	0.79	0.94
A/(A+C)	1.00	0.80
D/(B+D)	0.70	1.00
B/(A+B)	0.39	0.00
[B/(B+D)]/[A/(A+C)]	0.30	0.00
Cutoff Probability 0.75		
(A+D)/(A+B+C+D)	0.97	0.94
A/(A+C)	0.91	0.80
D/(B+D)	1.00	1.00
B/(A+B)	0.00	0.00
[B/(B+D)]/[A/(A+C)]	0.00	0.00

Note: 1) A to D represents the cell in Table 1.

B. Comparison with Probit Model

While the indicator model is non-parametric, the probit model is parametric so that it can test the statistical significance of individual indicators, taking into account correlations among different indicators. The exchange market pressure (y_t*) is a function of explanatory variables (x_t) and assumed to be normally distributed. It is set to one if the maximum value of exchange market pressure (y_t*) within the forthcoming h months is not less than the threshold value (θ) and zero, otherwise. The threshold value for crisis is the same as in the indicator model, i.e., 1.1 times standard deviation added to the mean of exchange market pressure.[10]

$$\begin{aligned} y_t^* &= \alpha + \beta x_t + u_t \\ y_t &= 1, \quad if \quad y_t^* \geq \theta \\ y_t &= 0, \quad otherwise \end{aligned} \tag{5}$$

where y_t^* denotes the maximum of exchange market pressure within h months.

[10] The results of applying threshold of 2 times standard deviation are not described for brevity.

This approach is called the probit analysis. The coefficients are estimated using the maximum likelihood estimation method. The probit model is typically used for panel studies but it is now used for the time series analysis. Since it assumes the linear relationship between the exchange market pressure and the indicators, it is so close to the first generation model of crisis as to consider indicators as market fundamentals. It has both advantages and disadvantages in comparison with the indicator model. It is advantageous that we can test the statistical significance of each indicator by assuming the normal distribution of exchange market pressure and estimated exchange market pressure can serve as the composite index in the indicator model. The disadvantage is that the assumption of normal distribution could be a restriction.

It is noted that dummy variable for crisis is defined in the framework of forecast horizon. We could incorporate the lag structure between the dependent dummy and explanatory variables in the estimation. However, it seems almost impossible to identify the appropriate lag structure just depending upon the statistical significance of each lagged variable because the dynamic interaction between the market fundamentals and expectations is so complicated. Therefore we don't estimate the lag structure between explanatory variables and the occurrence of crisis, but estimate how much explanatory variables exert the influence on exchange market pressure within a specified window.[11]

Table 5 shows the estimation results. Among 22 indicators, only three variables of exports, stock price, and domestic credit/GDP are significant with probit specification.[12] This is not peculiar to Korea. In the probit model built by Developing Country Studies Division of IMF to use as an early warning system, only five indicators among the total 18 turned out to be significant (Berg et al. 1999). The variable of external debt/foreign reserves was not significant, contrary to expectations.[13] The depreciation of Asian neighbors, the contagion variable, also turned out to be insignificant.

Table 5
Estimation of Probit Model

Constant	Export	Stock Price	Domestic Credit/GDP	McFadden R2
-0.856*	-0.067*	-0.037*	192**	0.54
(-2.312)	(-2.481)	(-2.333)	(3.096)	

Notes: 1) z statistic is in parentheses.

2) * denotes significant at 5%. ** denotes significant at 1%.

Figure 4 shows the probability of crisis from the probit model in equation (4). In the probit model, the probability of crisis is also estimated to be high in the crisis period and reaches one in some months. The probit model that has only three explanatory variables seems to forecast the crisis as much as the indicator model.

[11] The same methodology has been adopted in Berg and Pattillo (1998).

[12] The variable of real appreciation is also significant, but omitted because its inclusion worsens out-of-sample predictability.

[13] If the short-term foreign debt instead of total foreign debt is used, it could be significant. The short-term foreign debt data are not available from 1990. The BIS reports Korea's short-term foreign debt since 1990, but semi-annually.

Figure 4
Probability of Crisis from the Probit Model

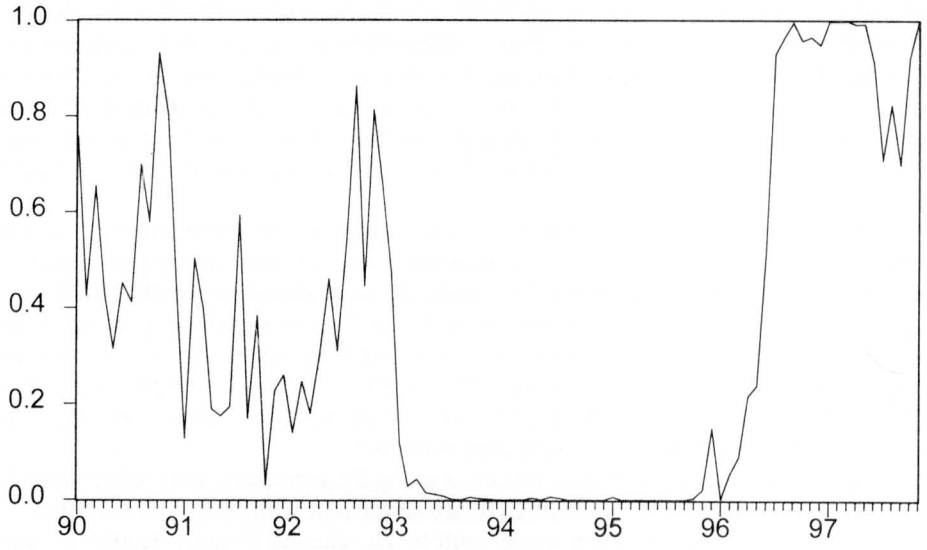


Table 6
Within-Sample and Out-of-Sample Predictability of the Probit

	Within Sample 90.1-97.11	Out of Sample 97.12-00.9
Cutoff Probability 0.5		
(A+D)/(A+B+C+D)	0.84	0.84
A/(A+C)	0.73	1.00
D/(B+D)	0.90	0.71
B/(A+B)	0.20	0.27
[B/(B+D)]/[A/(A+C)]	0.14	0.29
Cutoff Probability 0.25		
(A+D)/(A+B+C+D)	0.82	0.84
A/(A+C)	0.91	1.00
D/(B+D)	0.77	0.71
B/(A+B)	0.32	0.27
[B/(B+D)]/[A/(A+C)]	0.25	0.29
Cutoff Probability 0.75		
(A+D)/(A+B+C+D)	0.82	0.84
A/(A+C)	0.55	1.00
D/(B+D)	0.97	0.71
B/(A+B)	0.10	0.27
[B/(B+D)]/[A/(A+C)]	0.05	0.29

Note: 1) A to D represents the cell in Table 1.

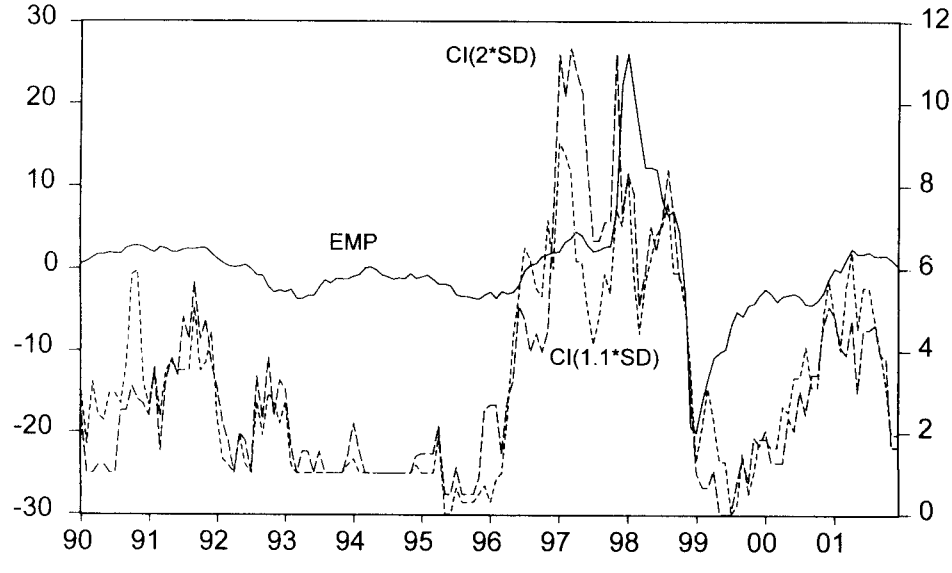
To compare the forecasting ability of the probit model with the indicator model, we calculate the noise-to-signal ratio and other criteria for goodness-of-fit on the same cutoff probability for signal. Table 6 shows the within-sample and out-of-sample predictability of the probit model. It turned out that the probit model predicts as good as the indicator model within sample, but it predicts a little worse than the indicator model out of sample. For instance, at the cutoff probability of 0.5, the noise-to-signal ratio of out-of-sample forecast from the probit model is 0.29, much higher than that from the indicator model (0.04). Judging from predictive power, we can say that indicator model is more useful as an early warning model for predicting Korean crisis.

4. CURRENT VULNERABILITY

As shown in Figure 1, the exchange market pressure varied in a wide margin before and after the crisis. Recently it began to rise rapidly in the beginning of the last year up to April after the respite in 2000 and then declined slowly toward the end of the year. Figure 5 shows the movements of the composite index along with those of the exchange market pressure.[14] It is interesting to see that the composite index built using the pre-crisis information on the choice of indicators and their noise-to-signal ratios performed very well to show the vulnerability of the Korean economy. The movement of the composite index matches very well with that of the crisis index of the exchange market pressure.

Just looking at the level of the exchange market pressure, one can say that Korea is not safe from the volatile movements of foreign capitals since exchange market pressure stayed at a high despite the decreasing trend last year. However, the composite index that represents economic vulnerability declined rapidly last year. Reflecting Korea's efforts to prevent another crisis under uncertain environment of world economy.

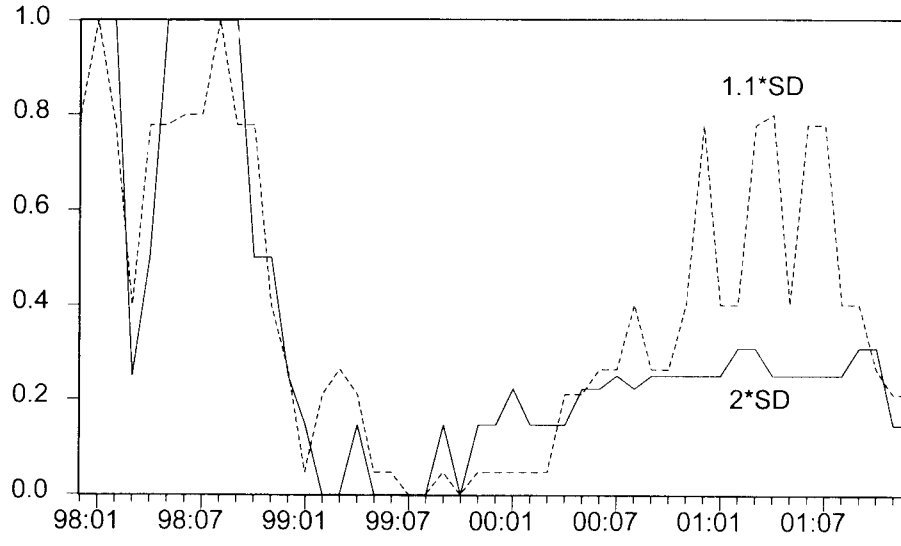
Figure 5
Current Vulnerability: Exchange Market Pressure and Composite Index



[14] The budget deficit was extended after Sep. 2000 with the consolidated central government statistics published by Ministry of Finance and Economy. There remains inconsistency problem in budget deficit data.

Figure 6 shows the conditional probability of crisis that was calculated from the composite index. The probability of crisis reached 0.8 in early 2001 under low threshold. The high probability of crisis is expected since the exchange market pressure came close to the crisis threshold, as shown in Figure 1. But the probability of crisis declines to be a little above 0.2 under high threshold. The striking divergence of crisis probability is attributable to the fact that crisis index comes close to one of the two crisis thresholds and should be interpreted that Korean economy was somewhat critical in early 2001. However, the crisis probability was lowered to below 0.2 in the end of 2001 on both accounts of crisis threshold.

Figure 6
Current Vulnerability: Conditional Probability of Crisis



5. CONCLUDING REMARKS

macroeconomy and even more difficult to forecast stock price, since self-fulfilling expectations so often trigger economic crisis. Despite the well-known difficulty in predicting crisis, there have been many efforts to design an early warning system after the Mexican crisis of December 1994 and increasingly so after the Asian crisis in 1997.

This paper benefits greatly from the pioneering work on the early warning system. It built the most popular models, i.e., the indicator model and probit model and compared within-sample and out-of-sample performance of two models. It was found that the non-parametric indicator model performed better than the probit model particularly regarding out-of-sample forecasting, despite its structural weaknesses.

This paper showed that the leading indicators and composite index along with the calculated conditional probability are very useful to represent economic vulnerability in Korea, even after the crisis. However, there is still so much room for further improvement that much effort should be devoted to improve the early warning model.

REFERENCES

Baig, T., and I. Goldfajn. 1998. "Financial Market Contagion in the Asian Crisis." IMF Working Paper 98/155.

Berg, A., and C. Pattillo. 1998. "Are Currency Crises Predictable? A Test." IMF Working Paper 98/154.

Berg, A., E. Borensztein, G. M. Milesi-Ferretti, and C. Pattillo. 1999. "Anticipating Balance of Payments Crises: The Rise of Early Warning Systems." IMF Occasional Paper 186.

Jeanne, O. 1997. "Are Currency Crises Self-fulfilling?" *Journal of International Economics* 43, 263-286.

Kaminsky, G. 1998. "Currency and Banking Crises: The Early Warnings of Distress." International Finance Discussion Papers No. 629, Board of Governors of the Federal Reserve System, October.

Kaminsky, G., and C.M. Reinhart. 1996. "The Twin Crisis: The Causes of Banking and Balance-of-Payments Crisis." International Finance Discussion Paper No. 544. Board of Governors of the Federal Reserve, March (also published in American Economic Review, June 1999).

Kaminsky, G., S. Lizondo, and Carmen M. Reinhart. 1997. "Leading Indicators of Currency Crises." IMF working paper 97/79.

Krugman, Paul. 1979. "A Model of Balance-of-payments Crises." *Journal of Money, Credit, and Banking* 11, 311-325.

_____. 1998. "What Happened to Asia?" web home page.

_____. 1999. "Balance Sheets, the Transfer Problem, and Financial Crises." web home page.

Masson, Paul. 1998. "Contagion: Monsoonal Effects, Spillovers, and Jumps between Multiple Equilibria." IMF Working Paper 98/142.

Obstfeld, M. 1994. "The Logic of Currency Crises." NBER Working Paper #4640, February.

Park, Won-Am, and Gongpil Choi. 1998. "Predicting Korean Crisis: A Signal Approach." *Econometric Review*, Korean Econometric Society, (in Korean).

Radelet, S., and J. Sachs. 1999. "What Have We Learned, So far, From the Asian Financial Crisis." (manuscript)

Sachs, J., A. Tornell, and A. Velasco. 1996. "Financial Crises in Emerging Markets: the Lessons from 1995." *Brookings Papers on Economic Activity* 1, 1996b, 147-198.

How Far is China Away from a Financial Crisis

He Fan[*]

INTRODUCTION

In the last several years, policy makers and scholars in China became more and more concerned about the potential instability and risk of its financial system. During the 1997 Asian Financial Crisis, China was lucky to avert a currency crisis and sustain relatively strong growth. This was largely attributable to its capital controls as well as a healthy and stable macroeconomic situation. But this does not mean that China can be immune from future financial crisis. Doubts have been cast on the effectiveness of China's capital controls. A more disturbing fact is that China's bank situation was no better than those crisis-hit countries. The Chinese financial system, like those of the crisis-hit countries, were heavily relied on banking intermediation, and when the crisis happened, the estimated ratio of non performing loans (NPLs) in China was 24-26 percent, which was higher than that in Korea and Malaysia. There are widespread signs indicate that China's banks are so fragile that they are not sustainable even in a closed economy, let alone when China opens up its capital markets.

In 2001, China entered into the WTO. This is a milestone on China's long march to liberalize its economy. A membership in the WTO makes China's opening up policy more credible to the world. But this also put China's banking sector into a more dangerous situation because banks have to face up the fierce competition with foreign banks. Now foreign banks as well as foreign insurance companies and other financial institutions are already launching on this "hot land". Within 5 years, foreign banks will be able to do RMB business with foreign and Chinese enterprises. There is not sufficient time left for China to restructure its banking sector. The opening up of China's financial sector also makes many measures to control capital movement inept and invalid. With the benefit of the capital controls declines and its cost soars, Chinese authority will be forced to loose or even abandon capital controls. Without the capital controls as a shelter, and with the exposure of the banking sector to the blizzard they never experienced, will China suffer from a financial crisis?

This paper provides a preliminary analysis of the financial fragility in China and how we can tackle with this issue. Special focus will be on the NPLs in banking sectors. Our discussion is organized as follow: Section 1 is an empirical analysis of the Chinese financial structure. The results clearly shows that the banking sector still plays a dominant role in Chinese financial system. The monopoly position of the four big largest state-owned banks even consolidated after the Asian financial crisis. Section 2 explains the evolution of China's banking system from the perspective of political economy. We argued that the "iron triangle" of the government budget, the state-owned enterprises and the state-owned banks determined the structure and performance of the Chinese financial system in the transitional period. Section 3 deals with the issue of the NPLs. It provides an estimate of the size and pattern of the NPLs and also discusses the causes of the NPLs. Section 4 discuss how susceptible is China to a financial crisis. We are cautiously optimistic about China's ability to avoid a

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financial crisis in recent years. The likelihood of bank runs or a collapse of the banking system is minimal under the current situation.

1. The Chinese Financial Structure: An Empirical Analysis

From the 1980s, a large body of literature emerged exploring the relationship between financial deepening and economic growth. It is not our task in this paper to give a thorough examination of these studies. In the context of our research, the implication of these studies can be summarized as follow: (1) financial sector matters. A well functioning financial infrastructure can encourage investment and improve the performance of economic growth, while a fragile financial system will aggravate crisis and hamper investor confidence. (2) Financial structure matters. Different groups in the financial system play different role and imply different risk. Some crises first burst out as the currency crisis and then transfer to the banking crisis, some directly stem from banking crisis. To study financial fragility, first we need to identity the most likely channel through which the financial crisis may burst out, and then we can provide specific diagnoses and treatments.

Table 1 shows the change of the relative share of different kinds of financial assets in the financial system. From this table it is quite clear that the monsters in the Chinese financial system are still banks. In late 1990s, the total deposits and loans accounted to more than 85 percent of the total financial asset in China. Total credit mounted to 140 percent of GDP. The security markets, while developed very fast, are still shallow. The market value of A shares and B shares in Shenzhen and Shanghai stock exchange market all together, only accounted to 25 percent of GDP. The bond market is even less undeveloped.

Table 1
Financial Asset Structure in China (%)

	1978	1988	1992	1996	1998
Cash	6.95	8.89	7.74	5.94	5.45
Deposit	30.40	33.50	38	43.10	40.64
Firm bond	0	0.79	1.72	3.05	0.25
Gov bonds	0	2.85	2.77	3.12	6.27
Stock	0	0.15	0.34	0.25	0.70
Loans	62.2	53.5	49.1	44	45.09

Source: Almanac of China's Finance and Banking 2001.

King and Levine (1993) developed a set of indicators to study the degree of financial development. We also use two of these indicators to depict the evolution of the Chinese financial structure. The definitions of these two indicators are:

BANK = deposit money bank domestic assets / deposit money bank domestic assets + central bank domestic assets

PRIVACY = credit issued to private enterprises / GDP

The BANK indicator describes the relative importance of commercial banks in the financial system, and the PRIVACY indicator can serve as a proxy of the quality of the bank loans, because it is widely accepted that private investment is more productive than that of the public investment. Table 2 shows a mixed picture. On one hand, the BANK ratio increased steadily, which means the bank sector is becoming more and more important, on the other hand, less than 20 percent of the loans were extended to the non state-owned sector. The implication of this is that the bank sector is still manipulated by the government despite the separation of the central bank and the commercial banks.

Table 2
Deposit Money Bank Assets and Credit Issued to Private Enterprises

Year	(1)	(2)	(3)	(1)/(1)+(2)	(3)/GDP
1978	n.a.	1,890.4	49.8	n.a.	1.4
1985	3,935.1	2,611.9	760.7	60.1	8.9
1988	7,731.4	4,270.1	2,322.6	64.4	11.3
1992	16,567.9	8,756.3	3,447.7	65.4	12.9
1995	49,903.5	5,465.7	5,465.7	78.2	9.5
1998	89,337.2	17,707.4	13,470.0	83.5	16.4

Notes: (1) deposit money bank domestic assets;
(2) central bank domestic assets;
(3) credit issued to private enterprises.

Source: Almanac of China's Finance and Banking 2001.

From the above discussion we can draw the conclusion that the banking sector still plays the most important role in the Chinese financial system. Next we will analysis the structure within the banking sector. Current banks/financial institutions in China are falling into the following categories:

- Four state-owned banks;
- Three policy banks;
- Share ownership commercial banks;
- Urban co-operative banks;
- International trust and investment corporations.

The four biggest state-owned banks including Industrial and Commercial Bank of China, Agricultural Bank of China, Construction Bank of China, and Bank of China. These four banks used to be called specialized banks. Before 1993, the central bank still controlled the credit plan, and these four banks were just tools to implement the credit plan in different fields. Since the late 1980s, a dozen or so of share ownership commercial banks emerged. In 1995, the first urban co-operative bank was established in Shenzhen and by the end of 2000, the number of urban co-operative banks sum up to 92. Branches and affiliations of foreign banks in China increased gradually and by the end of 1999, the total assets of foreign banks reached US$ 31.7 billion, which accounted to 2 percent of the total financial assets in China. After 1996, with the permission of foreign banks to do RMB business, the number of foreign banks in China mushroomed. The question we want to ask is: has the emergency of commercial banks and foreign banks shaken the big four's monopoly position?

Since the four state-owned banks dwarfed other banks in China, We can conveniently use the CR4 index to examine the degree of market concentration in the banking sector. CR4 depicted the share of the four largest firms in the industry. The indicators we examine include asset, deposit and loan.

Table 3
Market Share of the Big Four (%)

	1995	1996	1997	1998	1999
total asset	69.08	66.13	61.99	63.77	64.32
total deposit	61.04	61.43	62.17	63.09	63.73
total loan	61.19	59.28	59.83	61.96	61.30

Source: Almanac of China's Finance and Banking.

From the above figure we can see that the big four still have the lion's share in China's banking sector. Although after 1995, their share in the total asset and total loan shrunk, from 1997 these shares increased again because of the atmosphere of risk aversion after the Asian financial crisis.

2. THE EVOLUTION OF THE CHINESE FINANCIAL SYSTEM

From the very beginning of the establishment of the People's Republic of China, the government ambitiously set the goal to achieve heavy industrialization. Under the background of the cold war, heavy industrialization will help China to strengthen its defense power and make her feel more secure. In a capital scared economy like China, however, this development strategy implies government intervention to channel domestic capitals from more productive sectors like light industry to less productive heavy industrial sector (Lin et al. 1994). The government distributed capital to the state-owned enterprises directly so there is no need for financial intermediates. The only bank in the planned economy, People's Bank of China (PBC), was just a cashier of the Ministry of Finance (MOF). The government filled input into the state-owned enterprises and took away all the output, so the financial accounts automatically balanced. The revenue of the government almost solely relied on the profits of state-owned enterprises (SOE).

This seemingly well-designed system was not sustainable. The distortion of the factor allocation mechanism finally paid its price. The capital-output ratio increased sharply in the late 1970s, which means the government has to inject more and more money to the state-owned sector in order to sustain the previous growth rate. Gradually the growth rate declined and so did people's living standard. For a long period of time the nominal wage was frozen so the real wage level actually declined. Thus the source for government revenue shrunk and the discontentment of the people accumulated. Without reform, a fiscal crisis as well as legitimacy crisis will came in no time (He 1998).

The reform started from the late 1970s and adopted a gradualist approach. More autonomy was given to enterprises, individuals and local governments to improve their incentives. Redistribution of the national income tilted to individuals rather than the government. As a result, the share of government revenue in GDP dropped sharply from 31.2 percent to 22.4 percent in 1985 and 10.8 percent in 1996.

As its fiscal capacity declined, the government begun to shift the burden of raising funds to support SOEs to state-owned banks. Government intervention of economic activities was still pervasive, although less obvious. In 1984, PBC transferred its commercial banking function to the newly founded four specialized banks and assume the role of central bank. The monobank system now evolved into a two-tier system. The reform of "loan for grant" started from 1983. From then on SOEs turned to the state-owned banks for their funding. The debt ratio of SOEs increased substantially and in the 1990s this ratio was still above 80 percent.

Fiscal weakness and lack of modern social safety network made government has to count on SOEs to protect employment and provide social welfares. This approach scarified economic efficiency but could avoid social turmoil associated with "shock therapy". SOEs were more like communities than profit maximizing units. Most SOEs have their own kindergartens, schools, and hospitals. The heavy social burden greatly hurt the competitiveness of the SOEs and eroded their profitability, which in turn resulted in the accumulation of NPL in China's banking sector. Government interventions also make it more difficult to evaluate the performance of the banks. The bank managers can easily shift their responsibility of bad loans to government since it is difficult or even impossible to distinguish the commercial losses and the intervention-induced losses.

At the first stage of China's reform, the triangle relationship between the government budget, SOEs and state-owned banks seemed very stable. Because of the high economic

growth and the Pareto improvement nature of the reform, disposable income of household increased dramatically. Most of their money went to the state-owned banks because people did not have other alternatives to invest. More than 60 percent of the individual financial assets are in the form of bank deposits. The state-owned banks successfully collected money from households, and then the government can conveniently utilize sate-owned banks to transfer private savings to SOEs.

Local government reinforced the "iron triangle" between the government budget, SOEs, and state-owned banks. Not like other planned economies, most of Chinese enterprises are of small and medium size and local governments own most of the SOEs. Local governments have even stronger incentive to protect local enterprises. For a long time, the branches of the state-owned banks are in parallel with the administration hierarchy. State-owned banks set their branches and affiliates in every province, every city. Because they were so closely related to local politics, branch managers often found themselves in a very difficult situation if they wanted to cut the loans to ailing SOEs. These branch managers faced with asymmetric incentive: if they agreed to gave loans to the SOEs but it turned out to be bad loans, they can use government intervention as escape goat; if they extend loans at the will of the local officers, they can improve the relationship with the local government and get rents. Thus it not surprise to see that branch managers always have an impulsion to maximize their lending and then forced the central bank to issue more money to finance their lending losses. This resulted in the inflation pressure and to a large extend decided the boom-burst cycle in the socialist economic system.

Soft budget constrain facing by SOEs and the moral hazard problem resulting from government intervention makes a large proportion of loans extended to SOEs unrecoverable. Yet the funding keeps flowing into the state-owned sector. On the other hand, the vigorous and competitive non state-owned economy already accounted for 75 percent of total output and more than 50 percent of employment in urban areas, but they cannot get sufficient financial support from the state-owned banks.

In 1993, the central bank launched a set of reforms to revamp the system. The central bank stopped the traditional way of credit plan. It started to control the banks' credit allocation through market instruments like interest rate and open market operation. Three policy banks were established to take over the policy loans used to be assigned to the four commercial banks. The PBC and four big were reorganized to reduce the local government intervention. Trans-provincial supervision was introduced. A comprehensive legal and regulatory framework for the operation of the financial system was established.

From the third quarter of 1997, deflation pressure and a slowdown of the growth have harassed the Chinese economy. Coincidentally, after the Asian financial crisis, the central authority realized the seriousness of financial fragility and decided to reduce the NPL ratio. Several bank managers were dismissed because of bad loans. Given the personally severe consequences from an increase in the ratio of NPLs, the typical bank manager has to think twice before increase credit to his traditional SOE clients. Does this mean that now the bank loans are on sound commercial basis? It is hard to say. Because the state banks are also reluctant to lend to new clients that are non-state enterprises, partly because the latter's non-standard accounting makes risk assessments difficult. More importantly, a banker knows that while a NPL to an SOE is financially undesirable, a NPL to a private enterprise is more than that, it is also politically undesirable. The outcome presently is that the loans that state banks are most willing to make are infrastructure loans guaranteed by the central government.

We sketched the complexity and the interconnectedness of reforms in SOEs, and in financial and fiscal areas. From the above discussion we can see that the banks' problem is actually the problem of the ailing SOEs, and SOEs' problem is actually the problem of an ill-functioning public finance system. Fiscal weakness is Chinese economy's Achilles Heel. How to solve the problem? The answer lies partly in strengthening fiscal revenue and domestic

capital markets and partly in developing as quickly as possible a modern and social security system.

3. NPL IN CHINA'S BANKING SECTOR

The exact amount of NPL in China's banking sector is still a conundrum for almost everyone. The officially released estimates changed from time to time. Because of the inaccuracy of bank accounting, it's quite possible that the government itself does not know the answer. Another problem is that China adopted a unique asset classification system and thus made its statistics not internationally comparable. Prior to 1999, Chinese banks used an asset classification system based on actual loan performance that divided NPLs into three types: 'overdue', 'doubtful' and 'bad'. This approach tended to underestimate NPL as it did not include highly risky loans that were still paying interests and were not yet overdue. The international five-tier classification method ("mention", "pass", "special mention", "substandard") was only introduced in 1999.

In 1998, it was widely reported that the average ratio of NPL in the four big is proximately 25 percent, which was higher than that of the crisis-hit economies in Asia. In 1999, four state-funded asset management companies (AMCs) were established to handle the NPLs of the state-owned banks. These companies totally bought 1.47 trillion RMB NPLs at the book value from the big four. At that year, the total loan of these four banks was 5.66 trillion RMB. Taken into consideration the fact that the AMC did not transfer all the NPLs from the banks, the NPLs ratio of the big four must be higher than 25 percent. The situation of policy banks, share ownership banks, urban credit cooperatives, rural cooperatives and trust and investment corporations was nothing better. The NPL ratio of Agricultural Development Bank was more than 27 percent in 1997 and this figure was still growing. National Development Bank transferred 100 billion RMB bad loans to AMC in 1999, which was about 15 percent of its total credit (Liu, 2002). A survey conducted by People's Bank of China Shanghai Branch showed that, the NPL ratios of the share ownership banks, urban commercial banks, urban credit cooperatives, rural cooperatives were respectively 11.71 percent, 21.2 percent, 21.24 percent, 23.86 percent. This area has one of the most dynamic economies in China, so the banks are in a relatively better situation than those of other areas. Therefore these figures can only underestimate the seriousness of the problem in the whole country.

Table 4
Estimated Proportions of NPLs and Estimated Costs of Clean Up

Study	Period	Estimate
***NPL* (as percentage of outstanding loans)**		
Li (1998)	End of 1996	24.4%
	Mid-1997	29.2%
Fan (1999)	1997	26.1%
	1998	28.3%
Yuan (2000)		20-29%
J.P. Morgan	1998	>36%
***Clean up costs* (as percentage of GDP)**		
Moody	1999	18.8%
Dornbusch and Givazzi (1999)	1999	25.0%

Another way to estimate the NPL ratio is to look at individual bank's financial report. Among the four big state-owned banks, Bank of China (BOC) was the first to release its financial report based on the new system. According to BOC, the NPL ratio at the end of 2001 stood at 27.51 percent, down 1.3 percent from 28.8 percent at the end of the previous year. The improvement of the NPL ratio was mainly due to the NPL purchasing scheme. But as table shows, at the end of 1999, the NPL ratio under the old classification was 14.9 percent, but it would have been 39.3 percent under the new system. The scale of the gap due to the change in classification system is quite surprising. Since BOC is generally perceived as financially sound among the big four, we guess the NPL ratio of the big four will be somewhere around 30 percent.

Table 5
NPL Ratio of BOC (%)

	2001	2000	1999	1999*	1998*	1997*
Normal	56.36	51.9	43.7	85.1	89.7	90.0
Special mention	16.13	19.3	17.0			
NPL	27.51	28.8	39.3	14.9	10.3	10.0
Substandard	6.87	10.0	13.7			
Doubtful	14.79	14.6	19.7			
Loss	5.85	4.2	5.9			
Total	100	100	100	100	100	100

Note: * the old asset classification.

Source: Annual report 2001, BOC; Ikeya (2001).

This estimation can be supported by a February 2001 speech by Dai Xianglong, Governor of PBC. In this speech he declared the target of the government was to reduce the NPL ratio of the big four to 20 percent by 2004. The NPL ratio reduction is set at 2 percent to 4 percent annually. Counting back, the averaged NPL ratio at the end of 2000 would be 31 percent. On March 24, 2002, Governor Dai made a speech at the "China Development Summit Forum", announcing that in 2001, the NPL ratio of the big four was 25.37 percent, which indicated the total NPL amounted to RMB 2,289.8 billion.

Combining pieces of information from different sources together, we estimate the NPL ratio in China is around 30 percent. Of the NPLs, the recoverable rate is less than 30 percent. A look at the deteriorating quality of SOEs, a very bad credit culture and a cripple law system would suggest an even more pessimistic guess. Based on the above estimation, we can estimate the likely macroeconomic cost of a bank restructuring. At the end of 2001, the total loans in China's banking sector was RMB 11,283 billion, suppose the NPL ratio is 30 percent, and recoverable rate is 30 percent, the cost for bank reconstruction is around RMB 2,369 billion, which is roughly 25 percent of the GDP. Because the existing bank capital is not up to the Basel standard, this estimation needs to be raised. A working assumption therefore is a total clean up cost of 30 percent of GDP.

In an Asian Development Bank report, the NPL ratio (both including and excluding the assets transferred to AMCs) of Asian economies were estimated (see Table 6).

A closer examination shows that the northeast region and the south coastal region have the highest NPL ratio. The NPL ratio is high in the former region because it was traditionally the heavy industry base and most of its firms are large SOEs in steel, coal, and coal mining industries. The NPL ratio is high in the latter because it wittiness the real estate bubble in the early 1990s. In Hainan province, a southern island and China's largest special economic zone, the NPLs ratio was as high as 62 percent in 1997.

Table 6
NPL Ratio in Asian Economies (%)

	NPL	NPL (including the assets transferred to AMCs)
China	26.6	37.0
Indonesia	18.0	55.2
Korea	4.1	19.2
Malaysia	10.3	16.6
Philippines	17.0	NA
Thailand	12.6	25.1

Source: Asian Recovery Report, September 2001, ADB.

The main causes of NPL are: (1) Economic bubble in early 1990s. It was estimated that during 1980s, the NPL ratio in China's banking sector was only 10-15 percent (Liu 2002). After 1992, however, the Chinese economy became overheated and banks mobilized a large amount of money to speculate on stock market and real estates. From the third quarter of 1993, the government adjusted its macroeconomic policy in order to let the economy cool down. The bubble burst and left 200 billion RMB NPL. From 1992 to 1997, NPL in China's banking sector increased by 4 times. (2) Soft-budget constrain. Loans of the state-owned banks were heavily biased to SOEs and these loans had a high ratio of default. Even in the 1990s, the policy loan still mounted to 1/3 of the total lending of the state-owned banks. This also makes it difficult to performance of bank managers because they can use as escape goat. (3) Poor management and supervision. All big four are overstaffed and thus hurt their profitability. In 1999, the profits per employee of these four banks are 1.5 thousand dollars on average, while the simple averages of the profits per employee of the four largest banks in USA, UK, Germany and Japan are 83.27, 60.19, 167.97, and 35.54 thousand dollars respectively. The governance of Chinese banks is characterized by strong government intervention and weak regulation and supervision. Bank regulation is a very specialized business. It requires a thorough understanding of the banking activities. Such personnel are still in great shortage in China.

The high NPL ratio imposed both macroeconomic and microeconomic cost. Since a well functioning bank sector is the prerequisite for the effectiveness of monetary policy, the high NPL ratio causes impotence of monetary policy. Chinese government tried to use expansionary monetary policy to simulate economy but failed. Because of high burden of NPLs, banks were prudent to new loans especially to ailing SOES. Despite several more reductions in interest rates, money growth (at least until the middle of 1998) has continued to drop in line with the decline in GDP growth.

The NPLs have also imposed efficiency loss on the economy. With NPLs accounting for a third of total bank loans, bank loans accounting for about a fifth of fixed investments, and fixed investments at about 35 percent of GDP, this means that about 2.3 percent of GDP has been wasted annually in the last decade. Moreover, since most of the bank loans are extended to SOEs with little going to the more efficient non-state sector, the performing loans are not in investments with the highest rates of return. In short, the productive capacity of the economy could be higher than what it is (Woo 2000).

After the Asian financial crisis, the government took a set of reforms to tackle with the problem: (1) Recapitulation. In 1998 the government sold bonds worth RMB 270 billion (around US$32.5 billion) to raise funds to re-capitalize the country's four major state banks. This enabled those banks to report an average equity to assets ratio of 4.7 percent by the end of 1999. Now the government plans to issue further bonds for bank recapitalization. The authorities have targeted the end of 2002 for three of the four banks to reach the current international standard 8 percent capital adequacy ratio, with the remaining bank expected to

achieve this by the end of 2003. (2) Loan provision. Before 1987, there was no requirement for loan loss provision. Since 1992, 0.5 percent of the total bank loans are required to be placed aside for loan loss provision, and to this 0.1 percent has been added each year. The final objective is to reach 1 percent of the total loans, which is close to the international standards of 1.25 percent; (3) Debt-equity swap. Banks replace NPLs with special bonds issued by AMCs. In return for this, AMCs substitute for the banks to control shares in the enterprises and will restructure the enterprises so as to make them profitable. Up to now, RMB 1.6 trillion NPLs have been swapped. (4) Write-off. Since 1995, 190 billion RMB in bad loans has been written off.

Despite worthwhile progress, China's inadequate framework for recovery of bad debts will hinder the solution of the NPL problem. Moreover, the government's struggle to reduce the number of investment and trust companies, which have been plagued with insolvencies, points up the difficulties for Beijing in getting the provinces' cooperation with central government reform policies. Accordingly, progress in addressing the banking system's problems is unlikely to be as fast as it would like.

The long-term answer to the NPL problem goes beyond punishing bank managers who experienced increases in the NPL ratio, the long-term answer lies in changing both the supply-side and the demand-side of the credit market. Many changes are required on both sides of the credit market, and the most fundamental changes include the transformation of the state banks and the SOEs into shareholding corporations to make profit-maximization their primary objective, the establishment of a modern legal framework to promote transparency and reduce transaction costs, and the creation of a prudential regulatory body to reduce excessive risk-taking by banks.

4. How Susceptible Is China to a Financial Crisis

For many outside observers, China's financial system is one of the worst in the world or maybe the worst. Many predict that Chinese economy will collapse due to banking crisis. According to N. Lardy, "the most serious threat to macroeconomic stability in China is the possibility of a domestic banking crisis...the central precondition for a crisis, a largely insolvent banking system, already exists." (Lardy 1998).

N. Lardy (1998) provided a scenario of financial crisis for China as follows: Either an economic growth slowdown or a currency depreciation would lead households to withdraw their savings from banks and the insolvency problem of China's banks could become a liquidity problem. The central bank serves the role of lender of last resort and supplied funds to banks, which results in high inflation and fiscal crisis.

However, Lady's scenario is not very convincing. Despite the serious problem of the banking sectors, the macro performance of Chinese economy is so far so good (Yu 2001). The Asian financial crisis is typified by: (1) a collapse of the exchange rate because of heavy capital outflow, and (2) a collapse of the domestic financial system causing a shortage of working capital that, in turn, caused output to collapse. Because Chinese economy is quite different with other Asian economies, these two events are unlikely to happen under China's current situation.

Quite contrary to the internal factor weakness, China's external financial position is quite sound: (1) the RMB, the Chinese currency, is still not fully convertible, so the direct speculation of RMB could be ruled out. International speculators can't buy RMB with US dollar unless they have documents proving these purchase are related to real economic transactions. (2) China has a strong balance of payment, large foreign exchange reserves, which can also bolster investors' confidence for the RMB; (3) Most of foreign capitals in China are FDI, which is not easily to withdraw in a short period of time. China also has relatively modest foreign debts with a sound maturity structure; (4) Unlike that of Korea,

China's firms and banks do not rely heavily on short-term foreign currency borrowings and so are not vulnerable to a withdrawal of foreign bank lending.

Household deposits increased steadily and to a large extent made for the liquidity loss of the banks. China recorded an average increase of household deposits of 30 percent per year, almost twice the average income growth of 15.7 percent. New deposits have supplied huge liquidity into the fragile banking system. An alarming sign is that from 1996, the growth rate of deposits declined and in 1997, for the first time the growth rate of deposits lagged behind the growth rate of lending. After 1998, due to interest rate cut, the growth rate of deposit further declined. Taken into consideration that: (1) other financial tools offer more diversified investment opportunities and soak more and more of people's saving; (2) during the 1990s, the growth rate of income slowed down, the heyday of fast growth of individual saving is gone. But it's quite likely that the trend of increase of deposits will continue. One reason is that Chinese people still have limited choice for placing their funds, another reason is that their saving propensity will continue to be strong under the deflationary economy.

The most important reason why people are confident about their deposits in state-owned banks is the implicit government guarantee. The government has repeatedly pledged to honor all deposits in the state banks. This pledge is credible because the government is in a position to make good its promise. Because the government acts as the guarantor of the state-owned banks, the disposition of NPL will likely to be transformed as fiscal burden. Can the government have sufficient fiscal capacity to tackle with this problem?

Table 7
Fiscal Deficit in China (billion RMB)

	Fiscal revenue	Fiscal spending	Fiscal deficit
1985	200.482	200.425	0.057
1986	212.201	220.491	-8.290
1987	219.935	226.218	-6.283
1988	235.724	249.121	-13.397
1989	266.490	282.378	-15.888
1990	293.710	308.359	-14.649
1991	314.948	338.662	-23.714
1992	348.337	374.220	-25.883
1993	434.895	464.230	-29.335
1994	521.810	579.262	-57.452
1995	624.220	682.372	-58.152
1996	740.799	793.755	-52.956
1997	865.141	923.356	-58.215
1998	987.595	1,379.818	-92.223
1999	1,144.408	1,318.767	-174.359

Source: China Statistics Yearbook, 2000.

From the above table we can see that in the last two decades, China's fiscal deficit has increased dramatically. However, for the time being, China is still regarded as a low debt burden country, with a debt to GDP ratio of 25 percent, of which about 10 percent is domestic debt and 15 percent is external debt. This ratio is significantly lower than the internationally acceptable level for sustainability of 60 percent (Fan 1999). The government can easily borrow to cover the NPLs. If we assume an NPL ratio of 30 percent, the borrowing would raise the public debt/GDP ratio to just 40 percent. Alternatively, the central bank could just issue currency to provide liquidity when bank run happens. This expansion of high power

money cannot be easily translated into a loss of foreign reserves because capital controls are in place.

Hu (2000) analysis the fiscal burden of the cost of bank reconstruction in a dynamic framework. Table 6 shows his calculation. According to his estimation, in the most likely situation, the NPL ratio is not higher than 40 percent, with a recoverable ratio of 30 percent, then the debt/GDP ratio will climb to 45 percent and then drop gradually; under the worst situation, the NPL ratio is 50 percent and the recoverable ratio is 15 percent, then the debt/GDP ratio will shoot to 57.4 percent and then decline; under the most desirable situation, the NPL ratio is 30 percent and the recoverable rate is 50 percent, then the debt/GDP ratio will arrive at a peak value of 39 percent and then decrease. This policy simulation clearly shows that the cost of bank reconstruction will not lead to fiscal crisis and Chinese government should play a more active role in dealing with the NPL problem.

Table 8
Cost of Bank Reconstruction and Debt/GDP Ratio

	1999	2000	2001	2002	2003	2004	2005	2006
The most likely situation								
Bank reconstruction cost RMB bn	225	225	225	225	225	225	225	225
Debt/GDP ratio	34.2	39.7	43.2	45.0	44.4	42.7	40.9	39.0
The worst situation								
Bank reconstruction cost RMB bn	357	357	357	357	357	357	357	357
Debt/GDP ratio	37.6	44.9	50.4	54.6	56.4	57.0	57.3	57.4
The best situation								
Bank reconstruction cost RMB bn	107	107	107	107	107	107	107	107
Debt/GDP ratio	31.4	35.7	38.1	39.1	37.5	34.9	32.3	29.9

Source: Hu (2000).

Quite recently, some signs even show that the NPL ratio may decline: (1) The credit structure of banks changed in recent years. Consumer credit increases dramatically. By the end of 1999, consumer credit accounted to 1.5 percent of the total loan. All kinds of consumer loans like residential mortgage loan, car loan, and foreign currency loan for studying abroad have been launched. In 5 years, consumer credit will approach to 10-15 percent of the total loans. As the banks' willingness to lend depends more and more on profit incentives, the government has sought to create new safe lending opportunities to the banks like the housing reforms. (2) With the decrease of the stock of total loans, the ratio of NPL will decline. From a dynamic perspective, the stock of NPL is not a serious problem since the government has all kind of measures to solve this problem. The most important problem is to stop the trend of further increase of new NPL. This is depended on the growth rate, the reform of SOEs and public finance system, and the improvement of inner management and outside supervision of the banks.

CONCLUSION

At this early stage we can't pretend to know the future, but China appears to be taking sensible steps towards establishing a sounder banking system. The main downside risk for China is that domestic political pressure prevents the government from implementing fundamental reforms and continuing to intervene with banks and other financial institutions, thereby building up greater problems.

REFERENCES

Dornbusch, R., and Givazzi, F. 1999. "Heading off China's financial crisis," Unpublished paper, Department of Economics, Massachusetts Institute of Technology, Cambridge, M.A.

He, Fan. 1998. *A Constitution for Market Economy: Institutional reform of China's Fiscal System.* Beijing: China Today Press.

Hu, Fred. 2000. "China's Banking Reform: A Long March." *International Economic Review* (Guoji jingji pinglun), July-August, pp. 5-12.

Lardy, Nicholas R. 1998. *China's Unfinished Economic Revolution.* Washington D.C.: Brookings Institution and Institute for International Economics.

Li, Xinxin. 1998. "Looking at China's Potential Financial Risks from the East Asian Financial Crisis: Analyses of the Assets Operation of the State-owned Commercial Banks." *Reform*, 3(March 1998): 31-39 and 86.

Lin Yifu, Fang Cai, and Zhou Li. 1994. *The China Miracle: Development Strategy and Economic Reform.* Shanghai Sanlian Publishing House.

Xie, P. 1992. "An Analysis of China's Financial Assets." *Economic Research Journal* [*Jingji Yanjiu*], 11(November 1992).

Yi, G. 1996. "An Analysis of China's Financial Assets Structure and Its Policy Implications." Zhongguo Jinrong Zichan Fenxi Jiqi Zhengce Hanyi'], Working Paper Series, No. 1996004, November 1996, China Center for Economic Research, Beijing.

Yu Yongding. 2001. "Lessons from Asian Financial Crisis." Working Paper Series No. 1. Research Center for International Finance, Chinese Academy of Social Sciences.

Yuan, Gangming. 1999. "Bad Debts of China's State Owned Enterprises." Paper presented at the 11th Annual Conference of the Association for Chinese Economic Studies, July 15-16, 1999.

An Assessment of the Risks Associated with Vietnam's Balance of Payments

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I. INTRODUCTION

Opening the economy and liberalizing the balance of payments (BOP) is recognized as an essential policy measure for developing countries and transitional economies to promote economic growth and development. The financial and currency crises in the 1980s and 1990s showed that this process, if not properly implemented, could also involve the risks:

- The "debt servicing" cost increases as the size of debt and/or interest rates rise. Due to the accumulation of debt for financing persistently large current account (CA) deficits (and capital flight), a country could become heavily indebted and run into a debt crisis.
- It is difficult to have an effective monetary policy, while attempting to maintain the pegged exchange rates and to manage the risks of cross-border capital movements (Leung 1996).
- A potential crisis triggers from poor management of capital flows, especially short- term flows. This can generate an adverse impact on the balance sheets of financial institutions and firms due to serious maturity and currency mismatch, which can result in a credit contraction and a collapse of domestic demand (APF 2000 and Yoshitomi and Shirai 2000).

There have been also a number of theories and the generations of crisis models attempted to characterize the natures of the BOP crises. Though being different in terms of "fundamentals" strengths, CA deficit and its financing, and degree of capital account (KA) opening and its compositions, the BOP crises share some common causes such as the inefficient over-investments, inconsistency of macroeconomic policies and the weaknesses of corporate and financial sectors.

The market-oriented reforms with the turning point in 1989 dramatically changed the face of Vietnam's economy. There is no doubt that the process of trade and BOP

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liberalization — a key element of the reform process, has made a significant contribution to Vietnam's rapid economic growth and other remarkable achievements during the 1990s.

However, there were some concerns about the high CA deficit and the structure of its financing during 1990s. In the future, according to the Socio-economic Development Strategy 2001-2010, Vietnam will have to depend rather heavily on foreign savings to achieve high economic growth and therefore, the question of whether the CA deficit and the external debt would threaten the country's external position needs to be investigated. Moreover, although Vietnam has imposed many controls over capital account, it suffered from mini-banking crisis in 1996-97, which was associated with the opening of deferred L/Cs and the guarantees by domestic commercial banks. As a transitional economy striving for international integration and in context of a high degree of dollarization, Vietnam has faced with many difficulties in implementing consistent macroeconomic policies. The case of dollarization intensification in 1999-2001 is an example. Also, as a result of the crisis in 1997, attention has been focused on factors that have led to the crisis in other countries and examining the situation in Vietnam to make sure that Vietnam will not follow the same mistakes.

This study attempts to examine the possible risks associated with the BOP, focusing on three interrelated issues: (i) CA deficit and external debt sustainability; (ii) macroeconomic policy consistency in dealing with capital flows and dollarization; and (iii) problem of double mismatch. The study employs both qualitative and quantitative assessments. The quantitative techniques are based on, for example, the dynamic debt model developed by Jaime de Pine, the interest rate parity condition and the so-called "impossible trilemma", which states the impossible coexistence of exchange rate stability, free movement of international capital, and monetary autonomy. The analytical framework of the relationship between balance sheet and flows of funds is applied for analyzing the problem of double mismatch.

The first issue was substantially examined in our research on CA and external debt sustainability in Vietnam (see Vo et al. 2001a). This study can be regarded as an extension of our previous research. The problem of macroeconomic policy consistency in Vietnam was only touched in some studies such as ADB (1999) and Vo et al. (2001b). To our knowledge, this is the first time when the problem of double mismatch is examined for Vietnam, though this issue has been in focus of several international studies[1]. A more rigorous study of both issues of macro-policy consistency and double mismatch in Vietnam, therefore, is interesting and necessary.

The remainder of the study is organized as follows. Section II describes briefly the financial reforms, the exchange rate arrangement and the major measures of capital controls in Vietnam as a background for the analysis in the next sections. Section III gives the overall picture of the CA financing and capital inflows during the 1990s. The preliminary analysis of the possible risks associated with the BOP and dollarization is also provided. In Section IV, based on Jaime De Pine's dynamic debt model, the CA deficit and debt sustainability in Vietnam in the 1990s, and in the period 2001-2010 is assessed quantitatively. Section V first analyzes the problems of macroeconomic policy consistency and the effectiveness of monetary policy. Then the section shows how the macro-policy inconsistency can have a significant contribution to the intensification of dollarization during 1999-2001. Section VI, examines both the problems of currency mismatch and maturity mismatch for banks and firms in recent years. The section also considers the financial mini-crisis in 1996-97 as an example for the danger of macro-policy inconsistency and problem of double mismatch in linkage with investment inefficiency. The final section, Section VII concludes with a summary of the main findings and some policy implications.

[1] See, for example, Eichengreen and Hausmann (1999), Yoshitomi and Shirai (2000), and Tan et al. (2001).

II. FINANCIAL REFORMS, EXCHANGE RATE ARRANGEMENT AND CAPITAL CONTROLS IN VIETNAM

II.1. An Overview of Economic and Financial Reforms

Prior to the 1980s, Vietnam followed closely the model of a centrally planned economy (CPE). During 1980-88, Vietnam's economy can be characterized as a modified-planned economy. Some microreforms were undertaken but without any significant changes in macroeconomic management, especially in the triangular relationship involving the state budget – the central bank – the state-owned enterprise (SOE) sector. Since March 1989 Vietnam's economy has been shifted to a market-oriented economy, striving for industrialization and international integration. The government has already instituted many of the specific reforms in pricing policy, the external sector, fiscal policy, the SOE sector, the private sector, the financial sector and the labour market, which have been necessary to effect this change. The 1990s marked a turning point in Vietnam's economic development. However, the reform process in general has been slowing down since 1996, especially after Asian crisis and the structural weaknesses of the economy have been recognized. The years of 2000 and 2001 witnessed the new commitments to reform continuation and some progresses were made, especially in the development of private sector and trade liberalization[2]. However, the reforms of the SOE sector, banking system and public administration was slower than expected and this limited the effectiveness and efficiency of other reforms.

In 1988, the functions of a central bank and commercial banks within the State Bank of Vietnam (SBV) as a mono-bank were separated. But only in 1990 did the laws on banking (the 'Decree on the State Bank of Vietnam' and the 'Decree on Banks, Credit Cooperative and Finance Companies') authorize the SBV to assume traditional central bank functions such as the conduct of monetary policy and the supervision of the financial system. Sectoral restrictions on the specialized banking activities and barriers to entry for new domestic and foreign banks were abolished. At present, in addition to the six state-owned commercial banks (SOCBs), there have been in operation a number of joint-stock banks, credit cooperatives/funds, joint-venture banks and foreign banks (Table 1).

However, the current financial system is still characterized as an oligopolistic market structure, the lending of the SOCBs, especially credits to SOEs, remains subject to official intervention. The banking sector is also structural fragile with its high non-performing loans (NPLs), inadequate capital base, and weak regulations and supervision Banks' balance sheets have steadily deteriorated since 1994. In 1997-1998, the NPLs were more than 12% of total loans. By the end of 2000, this figure reduced to 10% (about USD 1 billion). But this assessment appears to be underestimated. The non-performing debts could reach 30% of total loans if the estimates used international accounting standards (Martin and Pham 2001). The weaknesses of the banking system have been largely linked with the inefficiency of the SOE sector. At the end of 1999, the total SOE debt, including inter-enterprise debt, was officially estimated at about 48% of GDP, a large proportion of which is owned to banks and is non-performing. During 2001-04, the costs of restructuring the banking system and the SOE sector and associated social spending are estimated at about 12% GDP (IMF 2001).

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[2] Over 2000-2001, thanks to the realization of the new Enterprise Law enacted since 2000, about 35,000 new private enterprises were established under the new Enterprise Law (This figure is higher than the total number of private enterprises established during 1991-99). With the government's announcement of a Five-year (2001-05) Import - Export Regime, the trade policy became more transparent and it provided a more stable trade environment; some quantitative restrictions was eliminated ahead of schedule under the Poverty Reduction and Growth Facility Program. The process of integration was accelerated as the changes in tariff lines were consistent with the commitments under AFTA and both Vietnam and US approved the BTA. A more favourable climate for FDI was created.

Table 1
Financial Structure and Banking System's Concentration

	1994	1996	2001
Structure of financial system (number)			
SOCBs	4	4	6
Joint-stock banks	46	52	45
Joint venture banks	3	4	4
Foreign banks	9	23	26
Financial companies	2	2	2
Insurance companies	2	3	18
Credits funds and credit cooperatives	219	907	Na
Concentration of banking system (% of total)			
Total deposits	*100*	*100*	*100*
SOCBs	88	76	74
Joint-stock banks	8	10	9
Joint venture banks	2	3	5
Foreign banks	2	11	12
Total loans	*100*	*100*	*100*
SOCBs	85	74	60
Joint-stock banks	11	14	12
Joint venture banks	2	5	10
Foreign banks	2	7	18

Sources: Saito (1997) and data provided by the SBV.

Vietnam is not yet a financially deepened country, although the ratio of M2 to GDP rises from 28 percent at year-end 1997 to 51% at the 2000 (IMF 2001). This ratio is far below the 90 percent in Thailand and 120 percent in China. Vietnam is also still a under-developed capital market. It began issuing T-bonds and T-bills in 1992 in order to cover the budget deficits. Following the first auction of domestic treasury bills in June 1995, a limited market in securities has developed between banks. The first treasury bond issue on the international market was launched in 1996. Stock exchange market was established in July 2000 and there are now only 17 listed companies.

II.2. Monetary Policy and Monetary Instruments

Since 1992, the SBV has been pursuing a more prudent monetary policy with long-term goals including stabilizing the currency, controlling inflation and supporting the government economic development strategy (Table 2). The volume of annual M2 – the immediate target of monetary policy, has been predetermined and it has been set based on the last year's magnitude of broad money ($M2_{t-1}$), the planned growth rate of the economy (g^p), and the anticipated inflation rate (Π^e): $M2_t = M2_{t-1} \times (1 + g^p + \Pi^e)$. In recent years, the target of money supply has also consisted of the changes in the key items (net foreign assets, net domestic assets) of the balance-sheets of the SBV and the whole banking system.

The SBV has also paid more attention on the development and the use of monetary instruments. In order to curb the high inflation rates, bank-by-bank *credit ceilings* had been introduced since 1993 and have been actively used during 1994-1996 to constraint credit and monetary aggregate growth. At first, the ceilings were imposed only on the SOCBs but later on two thirds of the whole banking sector. Initially, the credit ceilings appeared to tighten the growth of the credit effectively (IMF 1996). However, the effectiveness of the instrument was weakened in the subsequent years since the actual credit growth often far exceeded the

planned ones, partly due to the lack of punishment regulations for those commercial banks violating the ceilings. This instrument was ceased in mid 1998 due to the contractual demand for credits.

Table 2
The Strategy of the State Bank of Vietnam

Tools of the SBV	Operating targets	Intermediary targets	Goals
- Reserve requirement - Interest rate management - Refinancing facilities - Credit ceilings - Issuance of T-bills and T-bonds - Open market operation	- Reserve money	- Monetary aggregate: M2	- Currency and foreign exchange market stability - Economic growth - Price stability

Source: Nguyen Thu Ha (2000).

Regarding *interest rate policy*, after a long time being negative because of high inflation rates (and hyperinflation in some short period), real interest rates has became positive since March 1989 when the SBV raised the savings rates substantially. However, the positive real interest rates was short-lived when high inflation rates came back in 1991-92 and incomplete implementation of the positive interest rate policy existed. Positive changes in the interest rate policy was observed in October 1993 when the SBV began to apply *ceiling on lending interest rates* (Decision No. 184/QD-NH1). Control on the ceiling on lending interest rates in foreign currencies also implemented. In 1998 the spread between deposit and lending interest rates of 0.35 percent per month was eliminated. Three categories of ceilings on lending rates were in place: short-term, long and medium-term loans and loans provided to the Credit Funds' members. By June 1999, three types of ceilings were replaced by only one type of ceilings on lending rate of 1.15 percent per month (further lowered in October 1999 to 0.85 percent monthly), which was applied for all credit institutions. In August 2000, ceiling on interest rates was replaced by the basic monthly rate of 0.75 percent in VND (Decision No. 241& 243/2000/QD-NHNN). The interest rates then can be adjusted within a trading band of 0.3 percent for short-term loans and 0.5 percent for medium- and long-term loans (The SBV set a basic rate based on the lending interest rates that nine selected commercial banks apply to their "best" clients). The interest rate has been liberalized since 1 June 2002 (Decision 546/2002/QD-NHNN dated 30 May 2002).

It is worth noting that, in the early of 1991 the SBV for the first time permitted foreign currency deposits in the banking system (Decision 08-NH/QD dated 14 January 1991). The interest rate ceiling on lending in foreign currency had been fixed for long time. In August 2000, together with the change in the management of VND interest rates, the SBV allowed credit institutions to determine the foreign currency lending rates by the Singapore Inter-bank market rates (SIBOR) with the fluctuation band of 1-2.5 percent per year. Since July 2001, the foreign currency interest rate has been liberalized.

Reserve requirement was introduced since mid 1992 but it has continued to be an under-utilized monetary policy instrument. During 1995-98, the required reserve ratio (RRR) had not been adjusted. In 1999 the SBV started to reduce the RRR to stimulate credit, reduce operational costs, and improve the profitability of credit institutions. In the past, "the calculation of required reserves was cumbersome" (World Bank 1995). At present, RRR is calculated based on the average deposit balance with the SBV during the implementation period. The use of the RRR for foreign currency deposits become more active by the end of 2000 and in 2001 in order to restrict credit institutions to deposit foreign currency abroad (Table 3).

Table 3
Reserve Requirement Ratio, 1994-2001 (%)

Type of Deposit	Mar.94	Nov.94	Oct.95	1996	1997	1998	Jul.99	2000-01
- VND deposits and savings								
Demand Deposit	13	13	10	10	10	10	5	3
Time Deposit	13	13	10	10	10	10	5	3
3-Month Savings	7	8	10	10	10	10	5	3
6-Month Savings	7	8	10	10	10	10	5	3
- Securities	*7*	*8*	*10*	*10*	*10*	*10*	*5*	*3*
Foreign currency	*Up to Oct 2000: 5; Nov 2000: 8; Dec 2000: 12; May 2001: 15; Dec 2001: 10*							

Sources: SBV (various issues) and CIEM (2001 and 2002).

In Vietnam, the *refinancing facilities* have been introduced since 1994, applying for all credit institutions. Refinancing facilities have been introduced in the forms of collateralized refinancing facilities and policy lending. The former requires collateral papers for the lending while the latter finances selected activities such as temporary provision of food, assistance activities post natural disasters etc. In addition, the SBV has also provided a very short-term facility to meet the liquidity needs of the commercial banks. The fact that the refinancing rates are lower than the maximum lending rates which are stipulated for banks, results in the banks' little incentive to manage their short-term liquidity. Thus, this rate should be a penal one only.

Table 4
Refinancing Interest Rate, 1994-2000 (in percentage)

	Oct. 94	Apr. 95	May 97	Jun. 97	Jan. 98	Feb. 99	Oct. 99	2000-01
Refinancing rate	(a)	(b)	1.1	0.9	1.1	1.0	0.7	0.5-0.4

Note: (a) and (b) are measured as the percentage of the lending interest rates applied by commercial banks in their loan contracts, with a = 95% and b =100%.

Sources: *Vietnam Banking Review*, No. 16, Oct.1999 and CIEM (2001 and 2002).

The T-bills/bonds are the key price-based instruments for *open market operation* (OMO) in Vietnam. They are auctioned off to allow a greater role of the market forces in determining the rate and size of the issuance. Objectives of the T-bill/bond issuance are to finance the deficit, to signal the target interest rate, and to pave the way for a securities market. However, the transactions in the secondary market are still very limited. In addition, the value of these papers are very small, both in terms of absolute value and in percent of GDP (IMF 2000). The official OMO was only introduced in mid-2000 and it is still recognized as a rudimentary tool.

In general, during the 1990s the reforms of key monetary instruments have been slow, with frequent abuse of direct administrative instruments which are now irrelevant and of little effect, while indirect instruments formulating and implementing monetary policies remain rudimentary (Nguyen Tan Dung 1999). Moreover, the SBV is still defined as a body of the government and is assigned tasks by the government (Article 1 of the SBV Decree and Section II of the Law). Even though progress has been made in improving the effectiveness of monetary instruments since 2000, a number of challenges remain. First, the existing practice of implicit subsidies to the SOEs through loans at concessional interest rates crowds out credit to the private sector. Second, the use of market-based indirect methods for managing money supply is hampered by the lack of a well-developed capital market. Third, dollarization

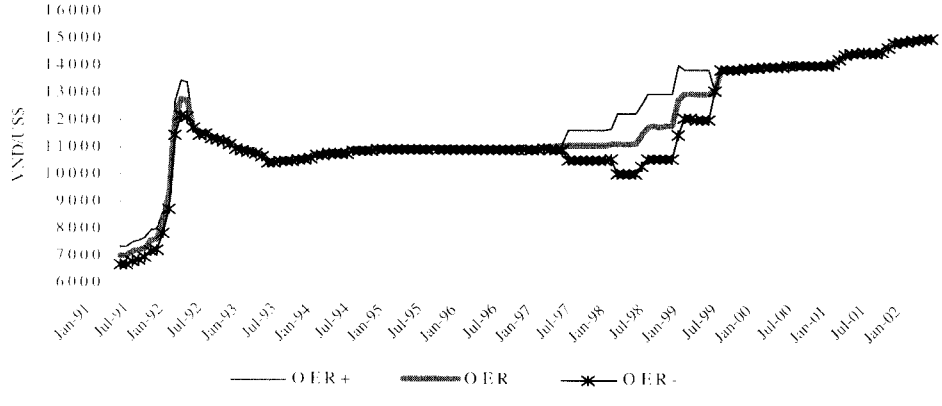
phenomenon reduces the SBV's margin for maneuver. It is also a potential source of instability in the banking system.

II.3. Exchange Rate Arrangement, Foreign Exchange and Capital Control

In March 1989, the *official exchange rate* (OER) was unified with the parallel market rate. Up to February 1999, the SBV set and announced levels of the OER and the exchange rate band within which commercial banks were allowed to trade foreign exchange (SBV Decree Law 1990). During 1990-91, the OER was often set at levels that were below those prevailing in the parallel market. To overcome this problem, an official foreign exchange market was established in 1991 comprised of two foreign exchange transaction floors, one in Ho Chi Minh City (in August) and one in Hanoi (in November). Based on the auctioned rates at these two floors, the OER was set and announced by the SBV. To reduce the amplitude of exchange rate fluctuations, however, the band was significantly reduced from 5% to 0.5%. In the following years, a surge in capital inflows, mainly through foreign direct investment (FDI), to a certain extent lessened pressure on the scarcity of foreign exchange. An inter-bank foreign exchange market was established in September 1994. The SBV, while still playing a dominant role in the market as the "seller and buyer" of last resort, continued setting and announcing the OER based on rates in the inter-bank market. During 1993-96, the parallel market premium was less than 1%, and both the OER and the parallel exchange rate (ER) remained stable, but at levels that were believed to overvalue the VND.

In order to increase the possibility of ER fluctuation, the ER band was adjusted, from 0.5% first to 1% in November 1996, to 5% in February 1997 and then to 10% in October 1997; it was again narrowed to 7% in August 1998. Moreover, after the Asian financial crisis in 1997, two devaluations took place, in February 1998 and in 7 August 1998, following soaring rates in the parallel market resulting in a total VND devaluation of 16.3%. In an attempt to improve the ER arrangement, in February 1999, a new principle for setting the ER was introduced. Effective the following day, in lieu of the OER, an average inter-bank rate of exchange between VND and USD would be determined by the SBV but the ER band within which credit and financial institutions could trade was narrowed to 0.1% (Figure 1). In July 2002, the ER band was relaxed to 0.25%.

Figure 1
Official Exchange Rates (VND/USD) and Exchange Rate Bands



Source: Based on the SBV's data.

For Vietnam, the ER regime is often classified as a managed-floating one and since 1997, the SBVN "took flexible and prompt measures to adjust exchange rate in order to achieve the set objectives without causing any great shock to the economy" (SBV 1998). Actually, as the study on ER management in developing Asia carried out by Ohno (1999) points out, "the VND has been effectively pegged to the dollar with several discrete realignments in 1997-1998" (=Adjustable peg system).

Controls over foreign exchange have been heavily exercised by the SBV to curb pressure on the exchange rate. After the Asian crisis, economic entities have been required to deposit all foreign exchange in one onshore account. Furthermore, requiring foreign exchange surrender requirements of 80 percent of available balances strengthened the controls. In late 1999, this restriction has been eased to 50 percent and further reduced to 40 percent in April 2001 and to 30 percent in May 2002.

Although foreign exchange restrictions have been eased, there still exist a number of restrictions on payment for CA transactions (under Article VIII of the IMF). They are, for example, the requirement for foreign exchange balancing, the tax on profit remittances, and other administrative measures limiting the foreign exchange available for imports of certain goods, depending on the foreign exchange situation. In November 2000, the foreign exchange balancing requirement for foreign-invested enterprises was abandoned. But these enterprises became subject to the foreign exchange surrender requirement.

Vietnam has not yet liberalized its capital account (KA) and *the controls over capital flows* are still substantial:

- *Foreign direct investment* (FDI). The inward FDI is quite liberal while outward direct investment is heavily regulated because it needs special allowance of the State Bank.[3]

- *Portfolio investment.* As mentioned before, the stock exchange market in Vietnam has been operated since mid 2000. The market, however, now has only few "goods" with the list of 17 companies and eight bond, including six government bonds and two bonds issued by a SOCB. The participation in the market by non-residents is very limited.[4]

- *External Borrowing.* Before August 1998, the external borrowings by both organizations and individuals should receive approval from the SBV. If receiving approval, the borrower must report periodically to the SBV the expenditures in foreign currency from funds deposited abroad. After August 1998, the SBV has relaxed some conditions for foreign borrowings made by enterprises. Short-term borrowings can take place without registration with the State Bank, but the State Bank still imposes external borrowing ceilings and short-term loan ceilings.

It is worth to have some remarks on the regulations on KA transactions in Vietnam. *First,* capital controls have been used for a wide variety of purposes, which may be unrelated

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[3] It is reported by the Ministry of Planning and Investment that up to June 2001, only about USD 30 millions was invested abroad.

[4] According to Decision No 139/1999/QD-TTg and Decision No 145/1999/QD-TTg which regulate the foreign participation,

(i) Nonresidents are allowed to own up to 20 percent of total outstanding shares of an issuing unit in which a single foreign organization could hold up to 7 percent and a single foreign individual 3 percent;

(ii) Nonresidents are allowed to hold up to 40 percent of total outstanding bonds of an issuing unit in which a single foreign organization could hold up to 10 percent and a single foreign individual 5 percent;

(iii) The maximum share of foreign partner in a joint-venture securities company is 30 percent (foreign-wholly owned securities are not allowed);

(iv) Foreign portfolio investors can not sell shares within one year from the date of purchase.

to and not necessary for dealing with risks of short-term capital movements. Controls have been used not only to restrict "non-essential imports", improve balance of payments, and prevent capital outflows, but also to subsidy favored "important SOEs" and protect domestic market from competition. For example: only some companies, especially those investing in "essential import substitutes" and some other important project can have foreign currency convertibility permits.[5] *Second,* Vietnam's quantity-based capital controls seem to be much more distortionary and costly than price-based capital control instruments[6] and they have been increasingly difficult to enforce in a highly integrated world. *Third*, the regulations on capital flows have suffered from a lack of transparency, consistency and predictability. This has affected not only volatile short- term capital, but also, and much more significantly, longer-term inflows.

III. Capital Inflows, External Debt and Problem of Dollarization

III.1. Current Account Balance and Capital Flows

In Vietnam, the BOP has been recorded according to the IMF's *Balance of Payments Manual* (IMF 1993). The CA consists of the balance on international trade in goods and services, net factor income and net transfers from abroad. The KA records all transactions on FDI, and external borrowings (short-, medium-, and long-term loans). The overall balance is financed by the change in net foreign assets of the banking system. Some exceptional financing items such as debt relief, use of Fund credit and arrears accumulation are also included as financing items. The errors and omissions of Vietnam's BOP are usually relatively high.[7]

Vietnam's external transactions have undergone a dramatic change since the launch of the market-oriented reforms in 1989. The CA deficit fell rapidly between 1989 and 1992, because the traditional sources of financing from the former Soviet Union dried up. After 1993, Vietnam found financing sources from other countries, and as a consequence, the CA deficit widened year by year until 1996, when it reached a peak of 9.9% of GDP (Table 5). The CA deficit narrowed in 1997-1998, and became a surplus in 1999. One reason was the Government's effort to control imports. In addition, the regional crisis (and the structural weaknesses of Vietnam's economy) had a negative impact on FDI inflows; both the number of new projects and the disbursements of the existing licensed projects decreased sharply after 1998. Therefore, FDI-related imported equipment and machinery decreased. In 1999, the recovery of the regional economies led to an increase in demand for Vietnam's exports. In 1999, with a low growth rate of imports, the trade and CA balances moved into surplus for the first time. In 2000, imports increased rapidly and as a result the surplus of trade and CA balances narrowed. A decrease in CA surplus continued to be observed in 2001. Note that the trend of the CA and the (merchandise) trade balance were similar, but the CA deficit was never close to the trade deficit (Table 5) because of the substantial changes in non-factor services, net factor income and transfers from abroad.

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5 Only since August 2000, all foreign-invested companies have been allowed to buy foreign exchange from commercial banks for their current transaction demand.

6 Generally, there are two kinds of price-based capital controls: Explicit tax as tax on the repatriation of profit on portfolio investment and implicit tax in the form of unremunerated reserve requirement.

7 Usually these errors and omissions correspond to unrecorded short term capital movements, for example, leads and lags in trade finance.

Table 5
Trade and Current Account Balances, 1991-2001

	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Trade balance (USD million)	-63	-60	-1,177	-1,190	-2,345	-3,143	-1,315	-981	1,080	628	373
- % of GDP	-0.76	-0.61	-8.94	-7.30	-11.24	-12.82	-4.69	-3.52	3.81	2.08	1.14
Merch. export growth	*17.97*	*21.20*	*20.61*	*35.81*	*28.22*	*41.15*	*24.64*	*2.41*	*23.22*	*23.99*	*6.88*
Merch. import growth	*18.79*	*20.43*	*64.18*	*26.00*	*43.84*	*38.94*	*-0.19*	*-1.09*	*1.10*	*30.78*	*9.06*
CA balance (USD mill.)	-123	-8	-1,395	-1,197	-1,876	-2,431	-1,664	-1,070	1,285	892	512
- % of GDP	-1.49	-0.08	-10.60	-7.34	-8.99	-9.92	-5.93	-3.84	4.53	2.96	1.56

Source: From Appendix 1.

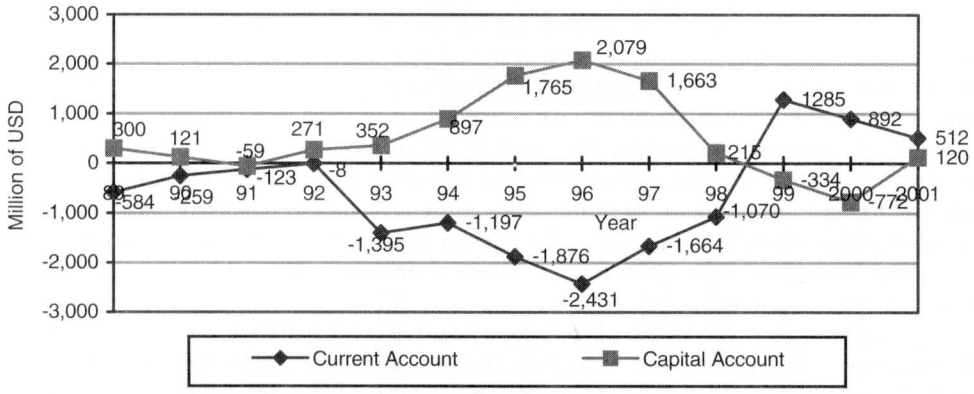
Although the net non-factor services have become highly negative since 1996 and the net factor income have been negative,[8] the net transfers, especially private transfers, have always been highly positive and hence, they have played an important role to balance CA. Private transfers were mainly remittances by Vietnamese overseas. Following the removal of tax on remittances since 1995, average annual private transfers have jumped from USD94 million during 1990-94 to nearly USD990 million during 1995-2001. In October 1999, the Prime Minister issued Decision No 170/1999/QD-TTg, which aimed to encourage remittances by Vietnamese overseas. As a result, in 2000 and 2001, private transfers reached USD 1,340 million.

During 1989-91 there was a fall in capital inflows as a result of the collapse of the CMEA – a major financing source for Vietnam before 1989. Since 1992, the KA surplus has increased dramatically and reached a peak of more than USD2 billion in 1996, which corresponded to the highest level of the CA deficit. After 1997, there was a decline in the KA, to USD 215 million in 1998, together with an increase in FDI loan repayments, and in the payments to service the foreign debt. The KA moved into deficit during 1999-2000 and again to a small surplus in 2001 (Figure 2). Such a shift was caused mainly by the sharp fall in FDI disbursements owing to the Asian crisis, and the deterioration of the investment environment in Vietnam.

Since 1989, Vietnam has enjoyed access to various types of foreign capital inflows to finance the CA deficit. During 1989-98, net FDI inflows covered nearly 80 percent of the CA deficit (Table 6). This coverage was much higher than that in other ASEAN countries. For example, in 1996 FDI covered only 34 percent of the CA deficit in Malaysia, 10 percent in the case of Thailand, and 68 percent in the case of Indonesia (IMF 1996). Since the net short-term and longer-term loans in general did not contribute to financing the CA deficit, the overall balance was in deficit and therefore, several measures such as the arrears accumulation, debt relief (especially in 1993), and the use of Fund credit were undertaken. Financing the CA deficit by arrears accumulation eroded the creditworthiness of Vietnam in international capital markets. During 1999-2001, in contrast, the CA was in surplus, while the KA was in smaller deficit/small surplus. As a result, the overall balance was also in surplus and gross official reserves increased from USD1.77 billion, or 6.8 weeks of imports in 1998 to USD3.03 billion, or 8.2 weeks of imports in 2000 (IMF 2001). The KA position during 1999-2001 was largely explained by a sharp fall in net FDI (and also in gross FDI), and a considerable increase in net repayment of short-term loans.

[8] The revenue from non-factor services are related to tourism, mail service, transportation, insurance, and similar services. The item "net factor income" should cover both labor compensation (such as wages, salaries and bonus) and investment income (like interest and profit) (IMF 1993). However, in Vietnam's BOP published by the SBV as well as by the World Bank and the IMF, this item includes only investment income, due to the lack of data on labor income.

Figure 2
Current Account and Capital Account, 1989-2001



Source: Appendix 1.

Table 6
Current Account Balance and Sources of Finance, 1989-2001

	1989-98		1999-2001	
	Yearly average (USD mill.)	Percent of CA balance	Yearly average (USD mill.)	Percent of CA balance
CA balance	-1,061.0	*100.0*	896.3	*100.0*
Net FDI	840.9	*79.3*	156.3	*17.6*
Medium & long-term loans (net)	-3.1	*0.3*	657.0	*73.3*
Short-term capital (net)	-77.4	*7.3*	-682.0	*-76.1*

Source: The calculation is based on Appendix 1.

III.2. Overall Assessment of the Risks Associated with Capital Inflows

Together with a consideration of the level of capital inflows, it is important to look at their composition since the same size of capital inflows may have different costs and involve different risks. In Vietnam, capital inflows can be in the form of foreign direct investment, commercial loans, and official flows.[9] The possible risks associated with capital flows can also be seen by looking at the changes in external debt and the phenomenon of dollarization.

- *Foreign direct investment*

It is often argued that FDI is a desirable form of capital flow to the host country, as it may bring in additional resources such as technological know-how and management expertise. Since the Foreign Investment Law was introduced in 1987, the FDI inflow into Vietnam has increased substantially and the foreign-invested enterprises have become an integrated part of Vietnam's economy. However, a more thorough evaluation needs to examine the possible costs of FDI or its link with external debt and CA.

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[9] The portfolio investment has been negligible because of the underdevelopment of the financial market, unsecured convertibility of VND, and regulations on foreign participation in stock market (According to Decision No 139/1999/QD-TTg, foreign organizations and individuals shall be entitled to a maximum of 20% holding of an issuer's total outstanding shares, of which a foreign organization shall only hold a maximum of 7% and a foreign individual shall only hold a maximum of 3% of the issuer's total outstanding shares of investment units.

According to the Foreign Investment Law, the total investment of a project includes at least 30 percent of authorized capital that is contributed by both sides. The Vietnamese contribution is usually in the form of land use rights. In fact, most of the licensed projects have minimum authorized capital. The rest is borrowings (from domestic and foreign creditors) and almost all joint ventures have had to obtain financial resources from their parent companies and other foreign creditors. As a result, FDI inflows in Vietnam have involved a substantial foreign loan component, the share of which has been larger than that of equity contributed by foreign investors since 1994 (see Appendix 1). Shishido (1996) argued that a substantial foreign loan component in FDI may allow investors to repatriate earnings even in the case of low profitability. Moreover, the interest rates on FDI loans are at market rates so they are high compared with ODA interest rates. Sometimes, interest rate can be up to 10 percent and even 12 percent per year.

In general, FDI is considered to make a positive contribution to the economic growth of the receiving country. In terms of welfare analysis, as the social rate of return on the FDI exceeds the payments to foreigners to service the FDI, it is favourable for the country. In the context of BOP, however, there is concern about the possible negative impact of FDI on the CA balance. An argument here is that while the initial impact of FDI inflow on BOP is often positive, the medium term impact may be negative as the joint ventures increase imports of capital and intermediate goods and services, and they begin to repatriate their profit. Vietnam appears to be witnessing such a scenario in the past few years. As indicated in Table 7, with a low share in the total exports and a higher share in the total imports, the trade deficit created by the FDI sector accounted for around 30 percent of the total trade deficit of the economy, except in 1999 and 2000.

Table 7
Exports and Imports of FDI Sector, 1994-2000 (USD mill.)

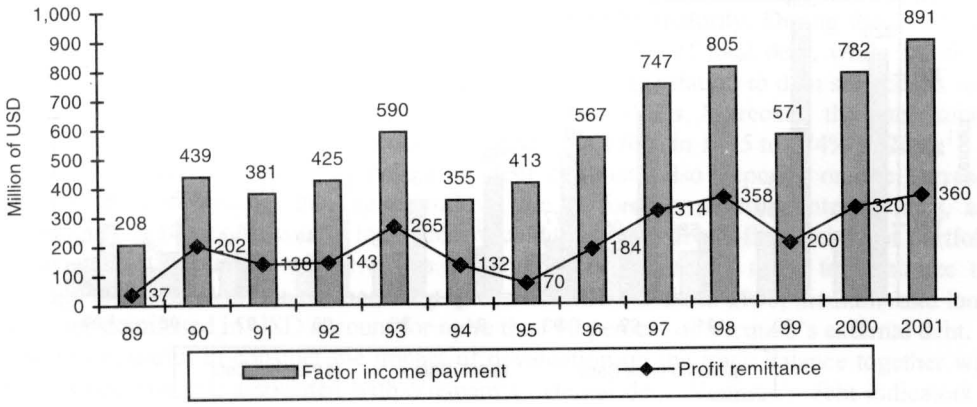
	1994	1995	1996	1997	1998	1999	2000
Total exports *(f.o.b.)*	4,054	5,449	7,255	8,759	9,365	11,540	14,308
- FDI sector's exports	161	440	786	1,498	1,983	2,590	3,307
Total imports *(c.i.f.)*	5,826	8,155	11,143	11,151	11,494	11,633	15,200
-FDI sector's imports	600	1,468	2,043	2,902	2,668	3,382	4,352
Trade balance	-1,772	-2,706	-3,888	-2,392	-2,129	-93	-892
-FDI sector's balance	-439	-1,028	-1,257	-1404	-685	-792	-1,045

Sources: GSO and Custom Office.

Moreover, attracting huge amounts of foreign capital without its efficient utilization will create pressures on the BOP and the capacity for paying the external debt. The FDI in Vietnam has been channeled to high cost, capital and import-intensive industries. More than half of cumulative FDI went to sectors that had an effective rate of protection in excess of 90 percent (CIE 1999). In contrast with China, light manufacturing and manufactured exports received a much lower share of FDI in Vietnam (World Bank 2000). Moreover, most FDI projects are joint ventures with SOEs. However, the SOE sector is not efficient. Although the SOEs have enjoyed easier access to credit and received preferences in fiscal treatment, trade protection and land use rights, only 40 percent of the SOEs are reportedly profitable. The unprofitable SOEs are very vulnerable since they have high leverage ratios and short term debt-to-total assets ratios. At the end of 1999, the total SOE debt (including inter-enterprise debt) was officially estimated at about 48 percent of GDP, a large proportion of which is owed to banks and is non-performing (IMF 2001).

Also, the remittance of foreign investors' profit to their home countries had risen (Figure 3). In addition, payments of technical fees, copyrights, payment royalties and interest payments of the FDI loans has also increased.

Figure 3
Size of Profit Remittance in Total Factor Income Payments, 1989-2001



Source: Data provided by the SBV.

- *Foreign borrowings and external debt*

In the past few years, medium and long-term loans (including a large part of ODA) from foreign countries have played an important role in financing the CA deficit, together with FDI, but the scheduled amortization has increased gradually because of debt accumulation in the previous years. Regarding short-term loans, their net position was negative during 1991-92 and positive during 1993-96 (due to the import expansion in the form of Letter of Credit (L/C) with differed payments) and then it became highly negative during 1997-2000. In 2001, it returned positive due to the ease of short-term loan ceilings.

While looking at the *flow* figures of external borrowing, it is worthwhile to examine the *stock* of debt. The same stock of debt would impose different burdens and involve different risks depending on the composition of debt by maturity, type of loan, currency domination and different interest rates.

Vietnam's external debt in the 1990s consisted of two distinct components: the Transferable Roubles (TR) debt owed to members of the CMEA (about TR11 billion mainly due to the Soviet Union) and the convertible currency debt. In terms of original data, there is no difference between data published by the World Bank, the IMF and Vietnam. However, there is a big difference among these three sources of data because of the different exchange rates between USD and TR used for converting the TR debt into USD. As a result, *the debt burden in the 1990s* could be assessed differently.

According to the World Bank database, Vietnam's outstanding debt reached around USD27 billion in 1998 and USD26 billion in 1999. Although the debt-to-GNP and the debt-to-export ratios declined considerably, both they were very high (Figure 4 and Figure 5) compared to the "critical values" proposed by the World Bank.[10] Thus, up to the year of 2000,

[10] According to the World Bank, a country is regarded as severely indebted if total debt to GNP exceeds 50% *or* if total debt to exports exceeds 275% (Export here includes both goods and services).

Vietnam was still regarded by the World Bank as a severely indebted economy (if Vietnam had not reached any debt rescheduling agreement with Russia, it would have had the most severe debt problem of any low income country).

Figure 4
Debt-to-GNP Ratio, 1989-99

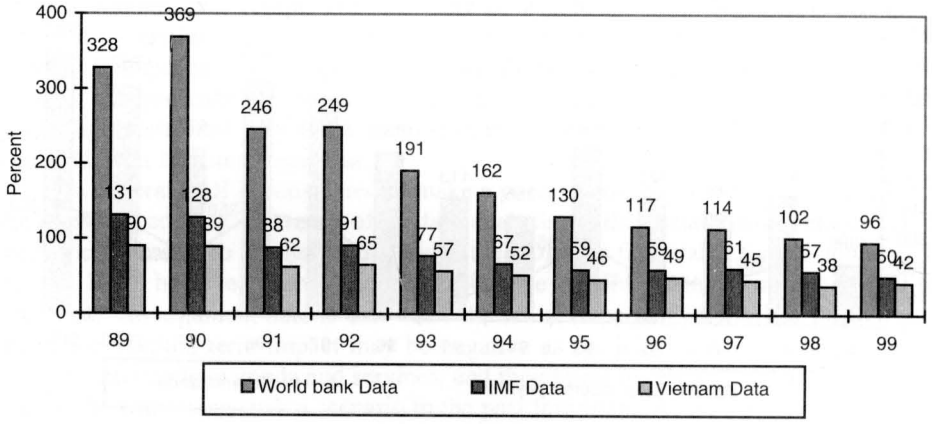
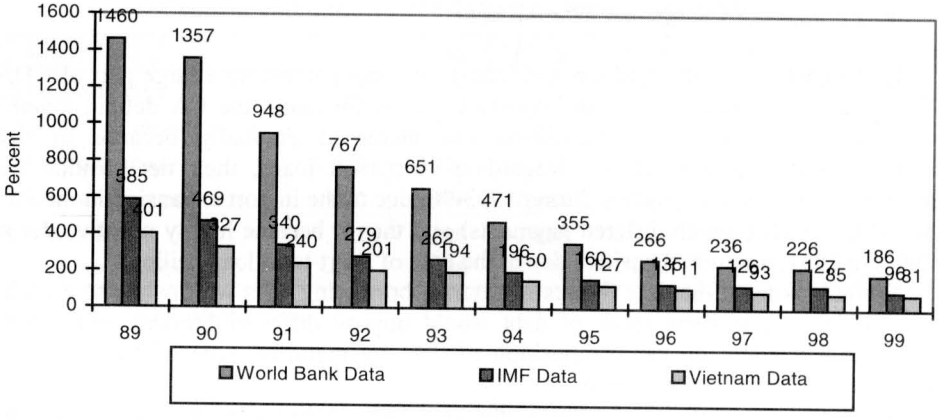


Figure 5
Debt-to-Export Ratio, 1989-99



Source: Vo et al. (2001a) (see also Appendix 2).

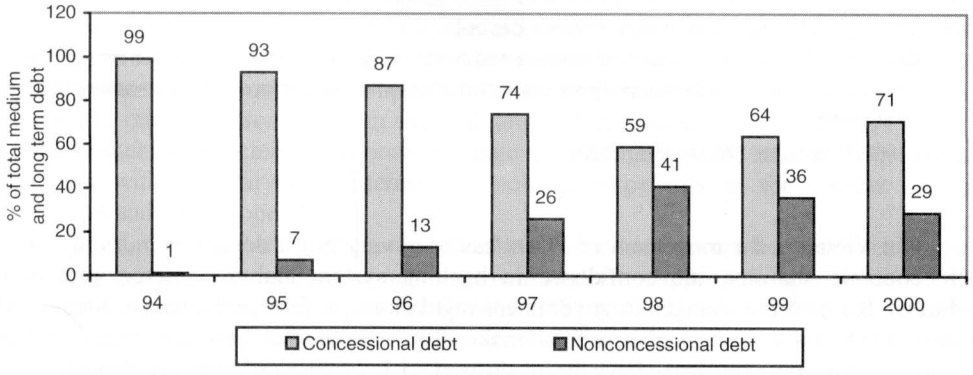
According to other sources, Vietnam's debt situation in the 1990s was not as serious as described by the World Bank. The reason is that different exchange rates between USD and TR were used to convert non-convertible debt to USD. The World Bank used the exchange rate of TR0.56 against USD1 while the IMF used the exchange rate of TR2.4 against USD1. Following the bilateral agreements with some former socialist creditors, in 1990s Vietnam tried also to get a favorable exchange rate of TR5.5 per USD1 in the negotiations of restructuring the debt with Russia. According to the IMF data, during 1989-99, Vietnam was still in indebtedness but the situation was much less severe than in the case of using the World Bank database. However, according to the Vietnam database, Vietnam has

been out of severe indebtedness since 1995 (see Figure 4 and Figure 5). It is worth noting that in September 2000 the rescheduling agreement with Russia was concluded, with the agreement that the remaining debt would amount to about USD1.7 billion, and would be repaid over 23 years at an interest rate of 5 percent (IMF 2001). Therefore, Vietnam's total external debt could be converted unambiguously to USD since the end of 2000, and it is estimated at USD12.5 billion (40.9% of GNP and 73.6% of total exports).

As presented in the World Debt Tables (World Bank, *various issues*), the total debt stock of Vietnam has had a favourable debt composition by maturity. During the 1990s, the long-term debt accounted for the largest part (about 80-90%) of total debt, while the short-term debt and the use of Fund credit amounted to 10-20%. In relation to debt service, its ratio to export was around 11-13% during the second half of 1990s. Moreover, the international reserve coverage of short-term debt stock increased from 176% in 1995 to 574% in 2000.[11]

However, the degree of risk from debt contracts also depends on the currency denomination and whether the capital inflows are at fixed or floating interest rates, and concessional or non-concessional loans. Many countries have diversified their debt portfolio by increasing the number of currencies in which they borrow in order to minimize the exchange rate risk. With the rescheduling agreement with Russia in 2000, medium- and long-term loans dominated in USD account for more than 90 percent of Vietnam's external debt. It is, therefore, useful to consider the impact of devaluation on the trade balance together with the exchange rate risk associated with Vietnam's external debt. Vietnam's debt indicators in the World Debt Table 1999 also show that during 1994-1999, the share of concessional loans in the total debt was very high, at around 70-80 percent. However, its share had decreased since 1994 as the share of commercial loans had increased (Figure 6). If the TR debt is excluded from the total, the share of non-concessional debt had increased rapidly. This means that the external borrowing of Vietnam has become more expensive over time.

Figure 6
Concessional and Non-concessional Debt, 1994-2000



Sources: Data for medium and long-term loans during 1994-96 are according to IMF (1997); data for medium and long-term loans during 1997-2000 and short-term loans are provided by the MOF and SBV.

Moreover, while the interest rates of ODA remain at a low level (about 2-3% per year), the non-concessional loans are at high rates (an average of 7% per year). Out of non-concessional loans, the floating interest rate loans accounted for 57 percent and the remainder was at fixed interest rates. The floating rate is usually LIBOR or SIBOR plus 1.5-2.5 percent.

[11] Estimates by data in IMF (2002).

This implies that Vietnam's external debt has become more vulnerable to the volatility in international interest rates. Interest rate variability should thus be taken into careful consideration for external debt management of Vietnam in the future.

♦ *Dollarization problem*

Dollarization is a phenomenon when residents of a country hold foreign currencies (often US dollars) as a store of value and a medium of exchange. Vietnam is often recognized as a highly dollarized economy. However, there has been no reliable data on foreign currency in circulation in Vietnam, although the amount involved in believed to be substantial. For example, Nguyen (2002) suggested that only during 1996-2001 approximately USD 2.5 billions in cash were pumped additionally into circulation outside the banking system. The estimate is based on the fact that during this period, the net private transfers were amounted to over USD 6 billions, whereas the foreign currency deposits of households with the banking system increased by nearly USD 3.5 billions. In order to have an "acceptable", though may not be comprehensive, analysis of dollarization, the ratio of foreign currency deposits (FCDs) to broad money (M2) is often used as a rough proxy for degree of dollarization.

Measured as the ratio of FCDs to M2, dollarization in Vietnam first fell sharply from its peak of 41% in 1991 following macroeconomic stabilization and stabilized in the range of 20-23% in the mid-1990s. This ratio started to increase in 1997 and dollarization was intensified during 1999-2001 (Table 8).

Table 8
Ratios of FCDs to M2 (Unit: VND)

	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
As % of M2	41.1	30.2	22.9	19.8	21.0	20.3	22.9	23.5	27.3	31.5	31.7
Annual % of Change*	127.0	-1.7	-9.8	10.6	16.1	19.0	42.0	28.8	54.5	60.5	25.9

Notes: * Annual % of change in foreign currency deposits.
Data for 1996-1998 comprise four state-owned commercial banks and 24 nonstate-owned banks.
Data from 1999 onwards comprise six state-owned commercial banks and 83 non-state credit institutes.

Sources: IMF (1996), IMF (2001), IMF(2002).

In Vietnam, the movement of FCDs has been very much dependent not only on the macroeconomic stability, the confidence in banking system and the interest rate parity conditions, but also the changes in government regulations on foreign exchange. Since 1988, business firms have been authorised to make free use of their foreign currency bank deposits.[12] Domestic residents have been allowed to hold foreign currency deposits since January 1991 (Decision 08-NH/QD dated 14 January 1991). Since February 1995, under Decision No 48-QD/NH7 of the State Bank's Governor, the overseas Vietnamese's remittances can be kept in foreign currency bank accounts or in the form of foreign currency

[12] Business firms are not allowed to make foreign currency deposits with overseas banks except a limited number of economic entities such as posts and telecommunication providers, insurers, airlines. However, the amount of foreign currencies that such enterprises deposited with foreign banks is insignificant in strict compliance with foreign exchange regulation whereby such enterprises have to remit to Vietnam when their account balances exceed a certain amount as authorised by the SBV. Data released by the International Settlement Banks (BIS) also suggested that the amount of foreign currencies deposited with overseas banks by Vietnamese organisations or individuals was inconsiderable and stable during 1999-2000, increasing from USD 24 million in 1999 to USD 130 million at the end of 2000 (Nguyen 2002).

savings and can be withdrawn in foreign currencies or exchanged into VND. In 1996, the tax on overseas Vietnamese' remittances was abolished. Especially, in 1999, the Government promulgated Decision No.170/1999/QD-TTg dated 19th August to encourage and create favourable conditions for overseas Vietnamese to remit their money to Vietnam. Subject to this Decision, beneficiaries are no longer required to pay personal income tax on the amount of foreign currency remittances. They may also, at their choice receive remittance in VND or in foreign currencies, or sell it to credit institutions or exchange bureau or deposit it in personal foreign currency accounts opened with an authorised credit institution.

Dollarization can have some benefits such as it can be a safety instrument for savings in environment of high inflation and it can enhance the opportunities for re-intermediation and financial deepening. However, there is a substantial risk with high dollarization. Dollarization narrows the basis of inflation tax, thus reducing seigniorage revenues for the central bank. Since dollarization is similar to very *mobile short-run capital flow "within-the-economy"*, the effectiveness of monetary policy is very limited and the macroeconomic policy consistency is hardly kept over time. As a result of inappropriate macroeconomic environment, the problem of "currency mismatch" becomes more serious and the risks associated with exchange and credit arise. The most important challenge of dollarization then concerns bank's safety and prudential supervision.

In sum, this more or less "traditional" analysis of different aspects of capital inflows to Vietnam in the 1990s has shown that the CA deficit was financed mostly by medium- and long-term loans. Moreover, the external debt indicators such as total debt to GNP, total debt to exports of goods and (non-factor) services, and debt service ratio in recent years are regarded as manageable. All these mean that Vietnam's external debt vulnerability is considered relatively low, especially in the context of its limited access to international capital markets. However, some problems have appeared and deserve policy-makers' attention.

First, since the FDI has involved substantial loans at commercial terms, the debt creating finance has accounted for the larger part of capital inflows and this tends to raise the cost of financing the CA deficit;

Second, as the share of non-concessional debt has increased, and the floating interest rate loans accounted for more than half of the total non-concessional debt, the external debt has become more vulnerable to the interest rate variability in international financial markets. It is also necessary to consider the impact of devaluation on the trade balance together with the exchange rate risk associated with external debt. This, of course, makes it more difficult for policymakers to implement a rational exchange rate arrangement in terms of flexibility and consistency with monetary and interest rate policies (especially in the context of high dollarization and a more open KA);

Third, the inefficiency of capital utilization is another concern because it can have a significantly negative impact on economic growth and the capacity to service debt. The underlying sources of risk here are the inefficient SOEs and FDI, the fragile banking sector, and trade barriers in favour of import-substituting industries.[13]

Fourth, since dollarization can be seen as *mobile short-run capital flows "within-the-economy"*, it reduces the effectiveness of monetary policy and the capability for managing consistently macroeconomic policies. Dollarization adds also vulnerabilities to banking and corporate sectors arising from currency mismatch and from exchange and credit risks. Under the policy/external shocks, it could be similar to the foreign exchange liquidity problem in having too much short-term external debt compared to reserves and the panic could happen if there would be a perception that the supply of foreign currencies may not be forthcoming.

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[13] IMF (2001) believed, however, that both SOEs and state-owned commercial banks (SOCBs) were more vulnerable to a sharp rise in interest rates than a sharp fall in the exchange rate, given the preponderance of domestic currency debt.

In the next three sections, the problems of CA deficit and external debt sustainability, macroeconomic policy consistency, and double mismatch will be examined in more detail.

IV. Current Account Deficit and External Debt Sustainability in Vietnam[14]

IV.1. Analytical Approaches and Jaime De Pine's Dynamic Debt Model

Our attempt here is to answer the question: whether Vietnam's CA deficit and external debt was sustainable in the 1990s and how it could be for the period of 2001-10.

There are two alternative approaches to evaluate the CA deficit sustainability. The first approach relies on a set of macroeconomic, financial, and external indicators that involve risks of external crisis. This approach raises, however, two problems: how to "rank" these indicators, and how to translate them into an overall measure of CA deficit sustainability. The second approach relies on the solvency condition. The sustainability of the CA deficit is ensured if the path of the trade/CA balance is consistent with intertemporal solvency. For an economy to be solvent, the ratio of debt-to-GDP or debt-to-export cannot grow without limits. This suggests that an indebted country must keep the ratio of debt-to-GDP constant to ensure its solvency. In this context, the sustainability of the CA deficit is ensured if (net) foreign debt is sustainable.

However, defining the sustainability of the CA deficit by measuring the debt-to-export or debt-to-GDP ratio has some shortcomings. First, although it provides a long-run condition for stability of the ratio of external debt-to-GDP ratio, it does not define whether that ratio is appropriate or "optimal". Second, if a country with a low level of debt wants to accelerate economic growth, it should not aim at keeping debt-to-GDP or debt-to-export constant. It is not necessary that a country with a high debt-to-export or a high debt-to-GDP ratio make its debt unsustainable. Many countries, which have had high debt-to-GDP ratio, have been able to pay back the debt while some countries, which have had low debt-to-GDP ratios, have not. Moreover, some economists argue that external crisis can occur because of stock imbalance and capital market factors like interest rates.

These shortcomings call for a more comprehensive analysis of the CA deficit sustainability not only by the solvency condition, but also by the risks involved in the KA. The latter was somehow considered in Section III. We are now going to examine the CA deficit (and external debt) sustainability is based on the solvency condition using *Jaime De Pine's dynamic debt model* (De Pines 1989).

The fundamentals of debt dynamics in Jaime De Pine's model are shown to be determined by four ratios: interest rate to export growth rate, import growth rate to export growth rate, the initial debt-to-export and the import-to-export ratios. It is stated that "if the debt-to-export ratio grows without limit, this signals that both the debt and the balance of payments deficits, which give rise to it, are unsustainable. Conversely, if the debt-to-export ratio is on a downward trend, the debt will be sustainable and the debtor country solvent; that is the debtor will be able to repay its debt". The model emphasizes also "the excess import restraint" that is synonymous with "overadjustment" in the sense that it is the difference between the actual and warranted imports, where the warranted import is the maximum amount of imports that still allows the debt-to-export ratio to decline. The concept of overadjustment can be used to ask how rapidly imports can grow while keeping the debtor solvent and its CA deficit sustainable. It measures the amount of extra credit (or extra CA deficit) that a debtor country could service to finance additional imports.

[14] This section follows the study by Vo et al. (2001a).

Starting from the BOP identity: $D_t = D_{t-1} + CA_t$ ..... (1)

Where D is the USD value of net foreign debt, CA is the CA (in USD), and t is time. Adding net interest payments to and subtracting them from Equation (1) yields:

$$D_t = D_{t-1} - i_t D_{t-1} + CA_t + i_t D_{t-1} = (1+i_t) D_{t-1} + CA_t - i_t D_{t-1} = (1+i_t) D_{t-1} + M_t - X_t \quad \text{..... (2)}$$

Where i is the interest rate on external debt

Dividing both side of Equation (2) by $X_t = (1+gx_t)X_{t-1}$, where gx_t is the export growth rate, yields:

$$\frac{D_t}{X_t} = \frac{(1+i_t)}{(1+gx_t)} \bullet \frac{D_{t-1}}{X_{t-1}} + \frac{(1+gm_t)}{(1+gx_t)} \bullet \frac{M_{t-1}}{X_{t-1}} - 1 \quad \text{..... (3)}$$

Where gm_t is the import growth rate

Denote $d_t = \frac{D_t}{X_t}$, $a = \frac{(1+i_t)}{(1+gx_t)}$, $b = \frac{(1+gm_t)}{(1+gx_t)}$, and $V_{t-1} = \frac{M_{t-1}}{X_{t-1}}$ (the debt-to-export ratio, the interest rate to export growth ratio, the import growth to export growth ratio, and the import-to-export ratio or non-interest CA, respectively. Then Equation (3) can be rewritten as follows:

$$d_t = a.d_{t-1} + b.v_{t-1} - 1 \quad \text{..... (4)}$$

By definition, $v_t = b.v_{t-1}$ ..... (5)

Assume that both a and b are positive and constant. Equation (5) and Equation (6) represent a system of difference equations, which can be solved:

$$d_t = a^t.d_0 + b.v_0 . \frac{(b^t - a^t)}{(b - a)} - \frac{(1 - a^t)}{(1 - a)} \quad \text{..... (6)}$$

According to Equation (6), the debt-to-export ratio, d_t, is determined by two parameters: the interest rate-to-export growth ratio, a, and the import growth-to-export growth ratio, b. Two initial predetermined variables are d_o and v_o. The parameters a and b determine the future evolution of the debt-to-export ratio. The path of the debt-to-export ratio through time can show the ability to service debt.

It can be proved that[15] if a<1 and b<1, the export growth rate is higher than both the interest rate and the import growth rate, i.e. the debt-to-export ratios have a decreasing trend. In contrast, if a>1 and b>1, the debt-to-export ratio will be explosive. If the legacy from past adjustments efforts represented by v_o (the initial import-to-export ratio or non-interest CA) is less than one, the debt-to-export ratio may keep decreasing for a certain period. However, if the import growth rate and interest rate are higher than the export growth rate, the debt-to-export ratio will exhibit a rising trend, and the non-interest CA balance will eventually turn into an ever increasing deficit, thereby erasing the initial adjustment efforts, v_o, which can only exert a continuing influence into the future when the import growth matches the export

[15] The detailed proof is given in Vo et al. (2001a).

growth (b=1). For this to happen, the initial import-to-export ratio must obey the following inequality

$$v_o \leq 1 - d_o(a-1) \quad \text{.....(7)}$$

The importance of this inequality is that it specifies the knife-edge value of the import-to-export ratio that ensures a declining debt-to-export trend while allowing imports at the same rate of export growth. Based on this inequality, the critical v_o can be calculated and the warranted import can be found.[16]

If a>1 and b<1, the outcome is ambiguous because both explosive and opposite forces are operative. While export revenue tends to drive the debt-to-export ratio down, interest payments tend to drive it up. If import growth is sufficiently restricted relative to export growth, the debt-to-export ratio can be placed on a declining trend even if the interest rate exceeds the export growth rate, and the initial import-to-export ratio is greater than one. This will happen if the following inequality holds:

$$b < az/(z-v_o) \text{ where } z = d_o + 1/(1-a) \quad \text{.....(8)}$$

Inequality (8) specifies the knife-edge value of parameter b that will ensure CA sustainability. If a<1 and b>1, the debt-to-export ratio has an increasing trend and the economy has an unsustainable CA deficit and debt. The reason is that with the higher import growth rate compared with the export growth rate, the non-interest CA balance is growing into an ever increasing deficit.

IV.2. Analysis Using Jaime De Pine's Model

- *Vietnam's CA deficit and debt sustainability during 1990s*

As mentioned before, the debt burden in the 1990s could be assessed differently, dependent on the exchange rate used between TR and USD. The first question, therefore, is to choose a database of debt, which seems to be more relevant in analyzing the CA deficit and debt sustainability? *From the point of view of policy making during 1989-99*, the IMF data seems to be most relevant. First, the exchange rate of TR 0.56 against USD1 used by the World Bank was the rate used by the CMEA members only for barter trade and hence, was not realistic. Moreover, although the exchange rate agreed between Vietnam and some CMEA countries as mentioned above was around TR5.5-6 against USD1, the outstanding debt of Vietnam to these countries was very small. Therefore, up to the year of 2000, it was not certain that Russia would accept this exchange rate.

During 1990-1999, the annual average growth rate of exports was 27.4% and the annual average growth of imports was 24.8%. This implies that the ratio of the one-plus-import growth rate to one-plus-export growth rate (parameter *b)* was less than 1. The World Bank (*various issues*) shows that the average interest rate was in the range of 2-5.7% per year in the relevant period. Even when the interest rate was at the maximum rate (5.7%), it was still well below the average export growth rate. On average, the interest rate was 3.02% per year. Correspondingly, the ratio of one-plus-interest rate to one-plus-export growth rate (parameter *a)* is 0.79. Since 1994, commercial loans have increased substantially and their interest rates were at 7-8% per year. According to the SBV, some loans were contracted at

[16] It should be stressed that "warranted imports" is defined as the maximum amount of imports, which are possible without entailing a steady increase in the debt-to-export ratio (or in other words, which preserves the sustainability of the CA deficit). This amount of imports is not necessarily economically "optimal" in any well-defined sense.

10-11% per year. Therefore, it is sensible to calculate a at the maximum rate during this period. At an interest rate of 5.7%, a is 0.81. When both a and b are smaller than 1, the interest payment component and the non-interest CA balance are both growing less rapidly than exports. With b smaller than 1 (and even with b = 1) the steady state debt sustainability is maintained. Therefore, the cases of $b=1$ and a = 0.79 or 0.81 will be used to simulate the debt-to-export ratios in the period of 1989-99.

The year 1989 is chosen as the base year. With the total import value at USD1,670 million and total export value at USD1,320 million, the initial import-to-export ratio, v_0, is equal to 1.27. According to IMF data, the total debt was USD7,719 million in 1989. Then, the initial debt-to-export ratio, d_0, is equal to 5.85 (Appendix 2). The simulations of the trend of debt-to-export ratios derived from equation (6) given earlier, are indicated in Table 9. Accordingly, as even the import growth rate was equal to the export growth rate (b is equal to 1), Vietnam's debt-to-export ratio during 1989-99 has a downward trend, even with the maximum interest rate of 5.7%. In this period, the export growth rate was very high compared with the interest rate, which leads to a low parameter a. As a result, the debt-to-export ratios declined rapidly, from 5.01 in 1990 to 1.96 in 1999 (the IMF case with b =1 and a = 0.81). Thus, the CA deficit and the external debt of Vietnam were sustainable during 1989-99.

Table 9
Debt-to-Export Ratios, 1989-1999
(Given 1989 initial value according to IMF data: d_o = 5.85 and v_o=1.27)

		1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
b	*A*										
1.00	0.79	4.89	4.13	3.54	3.06	2.69	2.40	2.16	1.98	1.83	1.72
1.00	0.81	5.01	4.33	3.77	3.33	2.97	2.67	2.43	2.24	2.09	1.96

Sources: The calculation is based on Equation (6) and Appendix 2.

The debt-to-export ratios mentioned in Table 9 are simulated using the average export and import growth rates (so parameters a and b are held constant) and the values of d_o and v_o of the base year in Jaime De Pine's model. However, the values of d_o and v_o of each year are different. As noted previously, the model emphasizes also the import restraint based on the assessment of Inequality (7). Based on values of d_0, v_0, imports, and exports of each year, the overadjustment in each year during 1990-99 could be estimated. Firstly, the critical import-to-export ratio, v, is derived from Inequality (7), given in an earlier section. The critical ratio v means the initial non-interest CA deficit at which the debt-to-export ratio starts to have a declining trend. By multiplying v by the export value, the warranted imports can be calculated. Then, the excess import cut shows the levels of imports, which could have been allowed in each year, while still avoiding a rise in d (see Appendix 2).

The import restraint or overadjustment can be derived from the warranted imports and actual imports as presented in Table 10. The actual imports were under the warranted imports during 1989-1994, and nearly matched each other in 1995. In 1996, the actual import was higher than the warranted import. The high trade and CA deficit level in 1996 was considered as "dangerous" by the Vietnamese Government, and since 1997, the Government has undertaken measures to narrow the CA deficit by imposing import restrictions. The use of non-tariff barriers was also intensified during 1997-99. As a result, the actual imports during 1997-99 fell below the warranted imports again. In the context of the high trade and CA deficit in 1996 and the Asian crisis, the efforts undertaken by the Vietnamese Government were necessary to ensure macroeconomic stability. On the other hand, the sharp fall in imports had a negative impact on domestic production and economic growth.

Table 10
Import Restraint or Overadjustment, 1990-1999 (USD mill.)

a	1990	1991	1992	1993	1994	1995	*1996*	1997	1998	1999
0.79	1,664	1,895	2,575	968	1,026	257	***-356***	1,151	1,672	3,362
0.81	1,501	1,726	2,397	771	816	25	***-627***	857	1,368	3,093

Source: Appendix 2.

Table 10 shows that Vietnam has experienced a great deal of overadjustment. Except in the years 1995 and 1996, import has been substantially restrained in comparison with the level it could have expanded to without threatening debt sustainability. With the average interest rate of 5.7% per year on external debt (a = 0.81), in 1996, imports should have been restricted by USD 627 million (with an average interest rate of 3.02% per year, imports in 1996 should be restricted by USD 356 million). Thus, it is reasonable to say that Vietnam's CA deficit reached an "alarming level" in 1996 (Kokko 1997). However, the import restriction measures implemented since 1997 seem to be an over-response and more than what was required. The imports could have expanded by more than USD 800 million in 1997, USD1.3 billion in 1998 and USD3 billion in 1999. This assessment is consistent with the criticism of the World Bank that the CA deficit has declined more than necessary during that period.

- *Vietnam's CA deficit and debt sustainability in the period 2001-2010*

Using Jaime De Pine's dynamic debt model, this section will project the future external debt path and show to what extent imports could be expanded to accelerate economic growth while still maintaining the CA deficit sustainability. The following scenario is chosen for the projection.

The export and import growth rates are based on the targets set in the Socio-Economic Development Strategy 2001-2010. According to this strategy, over 2001-2010, Vietnam's GDP will be doubled (average economic growth rate is about 7.2% per year). The average export and import growth rates are expected to be 15% and 13.5% per year respectively.[17] For Vietnam, the CA includes a substantial amount of transfers, and hence the transfers need to be included in the non-interest CA as a source of foreign exchange revenue like export revenue. Transfers during 2001-2010 are projected to grow annually by USD100 million. As a result of including transfers in the total revenue of exports, the average export growth rate is 13% (the average import growth rate remains the same at 13.5%. Parameter b in Jaime De Pine's model, therefore, is about 1.00.

Since 1995, commercial loans increased, and on average accounted for 28% of the total external debt (the ODA accounted for 72% of the total external debt). The same interest rate for ODA applied in the 1990s will be used for estimating the interest rate on future ODA. For commercial loans, the interest rate is projected to be about 8 percent per year. Then, the weighted interest rate on Vietnam's future external debt is equal to 4 percent. With the export growth rate at 13% and the interest rate at 4%, parameter a will be 0.92.

For projecting the future external debt path, the calculation of the values of v_0 and d_0 will be based on the external debt and trade data for the year 2000 as the base year. Note again that since 2000, there have been no divergent measures of external debt, as witnessed in the past. In 2000, with total foreign debt at USD12.511 billion and total export value at

[17] The nature of the projection is not the growth rate of trade, but the "gap" measured in percentage points between growth rates of exports and imports.

USD18.209 billion,[18] d_0 is equal to 0.687; given the total import value of USD16.990 billion, v_0 can be also calculated and it is equal to 0.933.

All information in this scenario gives the debt-to-export ratio path over 2001-2010 that shows that Vietnam's CA deficit and the external debt will be sustainable, since the debt-to-export ratio has a declining trend (the case b=1 in Table 11).

However, it is prudent to use some alternative parameters b > 1 to project the future external debt path. The argument here is that as Vietnam is still in shortage of capital, and its domestic production depends largely on imported goods (as mentioned earlier), import growth could be higher than export growth in the coming years to support domestic production. According to the IMF (2001), for example, during 2001-2005, export and import values are projected to grow considerably, at rates of 10.8 and 12.2 percent per year, respectively (i.e. b = 1.013). Table 11 summarizes the projection of Vietnam's debt-to-export ratios during 2001-2010 for the cases of b = 1.01, 1,02, 1.03, 1.04, and 1.05 (meaning that, the import growth rates would be 14.13, 15.26, 16.39, 17.52, and 18.65% respectively if the export growth rate is 13%).

Table 11
Debt-to-Export Ratios, 2000-2010
(Given 2000-initial values d_o=0.687 and v_o=0.933)

b	a	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
1.00	0.92	*0.57*	*0.45*	*0.35*	*0.25*	*0.17*	*0.09*	*0.01*	*(0.05)*	*(0.12)*	*(0.17)*
1.01	0.92	*0.57*	*0.48*	*0.40*	*0.34*	*0.30*	*0.26*	*0.24*	*0.23*	*0.23*	*0.25*
1.02	0.92	*0.58*	*0.51*	*0.46*	*0.43*	*0.43*	*0.44*	0.48	0.53	0.61	0.70
1.03	0.92	*0.59*	*0.54*	*0.51*	*0.52*	0.56	0.63	0.73	0.85	1.00	1.17
1.04	0.92	*0.60*	*0.56*	0.57	0.61	0.70	0.82	0.99	1.18	1.42	1.69
1.05	0.92	*0.61*	*0.59*	0.62	0.71	0.84	1.03	1.26	1.53	1.86	2.23

Note: Figures in brackets are negative. The negative debt-to-export ratio means that the country is regarded as not a debtor but a creditor.

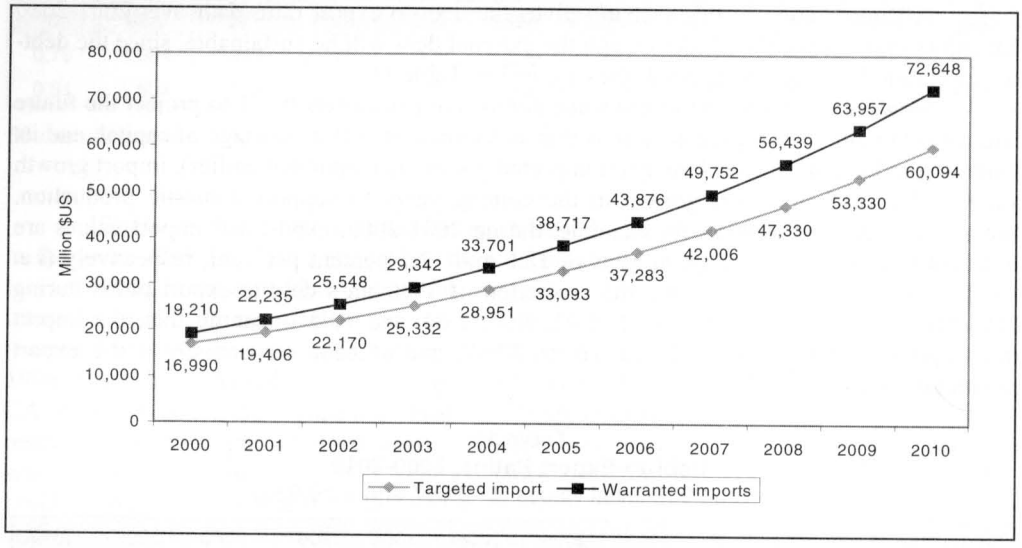
Sources: The calculation is based on Equation (7) and Appendix 2.

By taking into account transfers, the import growth rate could exceed the export growth rate by more than 1 percentage point without any risk of an unsustainable external debt (the case b=1.01). Imports can even grow faster than exports by about 2-3 percentage points (the cases of b = 1.02 and 1.03) at least during the first half of the decade; only thereafter Vietnam needs to be careful in managing the relationship between export and import growth rates. The problem of keeping the CA deficit and external debt sustainable really occurs when the (average) import growth rate exceeds the export growth rate by more than 4 percentage points. In all cases, the debt-to-export ratios are lower than the critical value of indebtedness, so Vietnam would not face the problem of serious indebtedness.

This projection so far focuses only on the average export and import growth rates (parameters a and b are held constant) over the projection period. Using the same technique given earlier, the level of warranted imports and hence, the annual value of imports in excess to the targets set in the Socio-Economic Development Strategy 2001-2010 can be estimated. Figure 7 shows that with a high growth rate of export, the level of imports can be expanded much more than the strategy target.

[18] This may be different from actual figure in 2000.

Figure 7
Warranted and Targeted Imports, 2001-2010



Source: Appendix 2.

Of course, the estimates of the import over-adjustment levels *in the future* cannot be seen as precise, but as illustrative estimates, since they are very much dependent on the assumption of trade growth rates. Some believe that the target of 15% per year for the average export growth rate in Vietnam during the period 2001-10 is too high. A key point in the analysis here is the relative extent to which the import growth rate can exceed the export growth rate while ensuring the sustainability of the CA deficit and external debt sustainability. In that sense, Vietnam seems to be somewhat overcautious in setting the target of import growth rates during 2001-2010. The possible expansion of imports can make a positive contribution to economic growth. More importantly, it can be a good condition for accelerating the process of trade liberalization. The underlying philosophy is that export success is seldom the ultimate objective of any development policy; instead, the motive for promoting exports is to create more efficient import capacity. In fact, the much discussed positive correlation between export success and economic growth may hide a causal connection between import capacity and economic growth (Kokko 2001).

V. Macroeconomic Policy Consistency in Vietnam

V.1. Concept and Analytical Framework

The *objective* of this section is to study the problem of macroeconomic policy consistency. In particular, we attempt to answer the question: Have ER and monetary policies, including interest rate policy, in Vietnam been consistent during 1990s? The risks and costs of this kind of policy inconsistency are ineffectiveness of monetary policy and mismanagement of cross-border capital movements. For Vietnam, the intensification of dollarization during the period of 1999-2001 is examined as a case study.

The concept of consistency between monetary and exchange rate policies is approached as, according to Johnston and Otker-Robe (1999), the relationship between ERs and interest rates at a point in time and the sustainability of these policy mix over time.

The consistency at a point in time can be best demonstrated by the conditions of the covered and uncovered interest rate parities.[19] These two parities indicate the interdependent relationship between domestic interest rate and ER at a point in time, when investors consider the different returns on various financial assets to maximize the return on his portfolio. Under high capital mobility context, the investor assesses the returns among domestic and foreign financial assets. Thus, broadly he has to take into account the rates of return on the assets and estimate the expected depreciation of the currency denominated in the concerned foreign assets. Of course, if returns on the various assets are changing, there will be incentives to shift investments between currencies. Otherwise, there is no changes in the investors' portfolio, reflecting the consistency between monetary and ER policy at a point in time.

The policy consistency over time determines the sustainability of the chosen policy mix. At the initial point of time, policy-makers have to decide what is the best action to take over a certain time period. Maybe some actions will have to be taken during the concerned period. The policy-makers can decide on the 'right' set of policies by minimizing the expected social loss, using a given model of the economy and the available instruments. The right policy may involve a sequence of actions to be carried out today and at future dates. When the future date comes, however, it may be better to pursue a different course of action instead of the initially decided. Thus, an economic policy is *'time inconsistent'* when a future policy decision that shapes part of an optimal plan formed at some initial date is no longer optimal when considered at some later date.

In practice, the policy consistency over time requires the authorities to have either a *very strong commitment* to a pegged ER or pursue a flexible ER. Otherwise, for example, under the peg regime, private agents can attack the peg if they find that the peg has become inconsistent with the prevailing economic and market conditions. In an open economy, however, the efforts to maintain the macroeconomic policy consistency are constrained by the well-known "impossible trinity" or "impossible trilemma", which states the impossible coexistence of exchange rate stability, free movement of international capital, and monetary autonomy. If a country attempts to achieve ER stability and monetary independence, it needs to introduce capital controls. If a country attempts to have full financial integration and monetary independence, it needs to adopt the floating ER regime. If a country attempts to achieve ER stability and full financial integration, the very rigid fixed ER such as the currency board system or a currency union should be considered (see, for example, Yoshitomi and Shirai 2000)

Note that since dollarization can be regarded as short-run capital flows within-the-economy, the interest rate parity conditions can also be applied for the choice by the people between holding domestic currencies and foreign (say, USD) currencies. Dollarization may also undermine the effectiveness of monetary policy, especially in the context of peg exchange rate regime.

Policy-makers can have several economic policies to response to capital flows such as sterilization, revaluation of the nominal exchange rate and greater exchange rate flexibility, liberalization of capital outflows and controls on capital inflows (e.g. Tobin tax). Other policy measures such as fiscal austerity, trade liberalization, and prudential measures can also be implemented.

Sterilization is most universal measure aimed at maintaining the autonomy of monetary policy. Sterilization refers to operations undertaken by the central bank in order to *neutralize* the effects that its intervention in foreign exchange markets has on the monetary base (monetary supply, if it assumed that the money multiplier is quite stable). Under a

[19] The covered equation is: $i_{t,k} = i^*_{t,k} + f_d$; where, $i_{t,k}$ and $i^*_{t,k}$ are rates of return on domestic and foreign assets of the same maturity and otherwise identical, except that they are denominated in different currencies, and f_d is the forward discount on the domestic currency for that maturity. The uncovered interest parity holds if the covered interest parity holds, and investors are assumed to be risk neutral, expectations are formed rationally, and the expected future depreciation of the home currency ($\Delta s^e_{t,t+k}$) equals the forward discount: $i_{t,k} = i^*_{t,k} + \Delta s^e_{t,t+k}$.

fixed/pegged ER regime, sterilization operations are linked to whether the BOP is in surplus or deficit. Both indirect (open market operations and reserve requirements) and more direct (the shift of government deposits from commercial banks to the central bank and direct lending controls) instruments are used to sterilize net capital inflows. Therefore, to capture the impact of the sterilization operations through these various instruments, a broad measure such as changes in net domestic assets of the whole banking system is usually adopted.

Sterilization is often costly and risky. For example, the sterilized intervention can further raise domestic interest rate, inducing further unintended capital inflows and causing significant quasi-fiscal costs.

V.2. Empirical Study and Main Findings

This section undertakes the empirical study on macroeconomic policy consistency in Vietnam during 1990s. Two tests, the test of uncovered interest parity condition and the test of effectiveness of sterilization are conducted.

- *Test of uncovered interest parity (UIP) condition*

The uncovered interest parity condition can be written as

$$i_{t,k} = i^*_{t,k} + \Delta s^e_{t,t+k} \quad (9)$$

with $i_{t,k}$ denoting domestic interest rate, $i^*_{t,k}$ – international interest rate, and $\Delta s^e_{t,t+k} = [(e^e_{t+k} - e^e_t) / e^e_t]$ – expected depreciation over period t, t+k.

To test this condition, the usual test is the parameterization of condition (9) as

$$\Delta s^e_{t,t+k} = \alpha + \beta(i_{t,k} - i^*_{t,k}) + \varepsilon_t \quad (10)$$

The null hypothesis of UIP is $\beta = 1$. In this specification, a possible exchange risk premium is subsumed into the constant and into the error term to the extent that is time-varying. The expected depreciation is not directly observable but may be proxied by the forward rate, survey expectations or the actual.

Following the work of Brouwer (1999), the actual depreciation is decomposed into an expected depreciation (formed on the basis of all available information Ω_t) and a forecast error term (ϖ_t) which has a zero expected mean.

$$\Delta s_{t,t+k} \equiv \Delta s^e_{t,t+k} + \varpi_t \quad (11)$$

Where $\Delta s^e_{t,t+k} = E_t[\Delta s_{t,t+k} \mid \Omega_t]$ and $E[\varpi_t \mid \Omega_t]$. Substituting into (11) we receive

$$\Delta s_{t,t+k} = \alpha + \beta(i_{t,k} - i^*_{t,k}) + \omega_t \quad (12)$$

Where ω is a composite error term, $\omega_t = \varpi_t + \varepsilon_t$. From (9) and (11), the uncovered interest differential (UID) is defined as:

$$UID_{t,k} = i^*_{t,k} - i_{t,k} + \Delta s_{t,t+k} \quad (13)$$

If the uncovered interest parity condition holds, the uncovered interest differential is expected to be equal to zero.

In short, we run equations (10) (the null hypothesis of uncovered interest parity is $\beta=1$ and equation (13) (if the uncovered interest parity condition holds, the uncovered interest differential is expected to be equal to zero).

The magnitude of the coefficient β of the equation (10) and the uncovered interest differential of the equation (13) indicate the degree of the financial integration of the economy

with the world market. In a deep financial integration condition, domestic interest rate and ER become increasingly interdependent due to these conditions, requiring a consistency between monetary (particularly interest rate policy) and ER policies. In the case of Vietnam, although capital controls have been extensive, there have been still existing the short-term and volatile capital flows (such as capital flows "within-the-economy", trade financing through LC during 1996-97, dollar fund deposited at offshore banks during 1999-2001, and other disguised capital flows). Testing the UIP helps to assessing degree of the difficulty of maintaining consistency of the interest rate and ER policy mix in Vietnam.

Three-month time-series are used for estimations. The test will run for the period from October 1993 to December 2000. The starting point of October 1993 is chosen since this is the point when interest rates were still regulated but more liberalized. For simplicity, ED (EDIB) stands for $\Delta s^{e}_{t,t+k}$ using the actual parallel market ER (the actual interbank market ER). IVN denotes domestic three-month deposit interest rates, which is a proxy for $i_{t,k}$, while IW denotes the three-month interbank offer US dollar interest rate in the Singapore market on the last Friday of the month, which is a proxy for $i^*_{t,k}$.[20] IUSL stands for Vietnam's local three-month dollar interest rate. ID stands for $i_{t,k} - i^*_{t,k}$ = IVN – IW, while IDUSL = IVN - IUSL ; IDUSW = IUSL – IW and UID = ED (EDIB)– ID.[21]

The results of the estimations are as follows:

ED	**=**	**0.2172**	**–**	**0.1796 ID**	**and**	**EDIB =**	**0.2057 – 0.1506 ID**
p-value		(0.0026)		(0.1464)			(0.0001) (0.0856)

For both regressions, the Wald test indicates that the coefficients of the explanatory variable ID significantly differs from 1, which means the policy mix inconsistency.

Running regression (10) with IDUSL – the spread between domestic dong and local dollar interest rate, it is found that the coefficients of both the intercept and the independent variable are statistically insignificant. Thus UIP condition does not hold in this approach either. Furthermore, it reinforces the conclusion that capital controls are extensive and local USD interest rates are far from converging to the world rates in the sample period.

Regarding the estimation results of equation (13), during the sample period, mean UID is equal to –0.233 with standard deviation of 0.7 (EDIB for $\Delta s_{t,t+k}$).[22] Theoretically, UID is negative and significant because of persistent expectation errors, currency or country risk or impediments to capital inflows into the country (Brouwer 1999). In the case of Vietnam, it might suggest that the explanations do not lie in persistent expectation errors but lie in capital controls and risk premium.

Furthermore, it is interesting to examine the co-integration between domestic interest rates and international interest rates to assess the possibility of a long-run relationship between these two variables. Running the Johansen co-integration test of two variables IVN and IW, it is found that there is evidence of co-integration between domestic and foreign interest rates. However, there is little evidence of co-integration between domestic USD interest rate and foreign USD interest rates. Thus, the domestic dollar-denominated rate is likely to be more isolated from the world interest rate than the domestic interest rates (Note that during 1999-2000 the dollar rate had followed closely the world level. However, the small weight of the short period 1999-2000 cannot reverse this overall conclusion for the entire sample period 1993-2000).

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[20] *Source:* Monetary Authority of Singapore, http://www.mas.gov.

[21] The detail of the estimations and regressions can be provided by request. Note that running the ADF test, it is observed that all time series variables are stationary at 5% significant level.

[22] The result is similar for ED=$\Delta s_{t,t+k}$.

♦ *Test of sterilization effectiveness*

As mentioned earlier, the changes in net domestic assets of the whole banking system is adopted to capture the impact of the sterilization operations through various instruments. In the estimations, therefore, the coefficient on the net domestic assets is interpreted as the offset coefficient, which is expected to lie in the range [-1,0]. When the estimated "offset" coefficient is statistically insignificant or relatively small in absolute terms, this would imply that, during the sample period, despite pegged ER and increasing capital flows, the central bank was able to maintain a relatively independent monetary policy. In the case of the estimated 'offset' coefficient being statistically significant and relatively large in absolute terms, the central bank was facing difficult trade-off between maintaining pegged ER and pursuing independent monetary policy.

Applying the portfolio balance approach of ER determination, Vo et al. (2001b), estimated the following equation:

$$NFA = f(NDA, CAB, \text{real GDP}, \text{domestic inflation}, \text{world i}, DLER^{(e)}) \quad \ldots\ldots\ldots\ldots (14)$$

Where NFA is net foreign assets, NDA is net domestic assets, CAB is current account balance, GDP is gross domestic products, *i* is world interest rate, $DLER^{(e)}$ is expected depreciation rate. The choice of NFA, instead of capital inflows, seems to be more appropriate in the context of Vietnam's high degree of dollarization and since the errors in the BOP are quite high.

Using 2SLS method, equation (14) was run for the data sample of 1993:Q3 – 1999:Q2. The acceptable regressions indicate that the "offset" coefficients are significant at about 5% levels and relatively large in absolute terms (from –0.61 to –0.79). Moreover, they are not significantly different from –1.

In this study, applying the monetary approach to the BOP,[23] we run the following equation:

$$NFAR = \beta_0 + \beta_1 \Delta \log P + \beta_2 \Delta \log Y + \beta_3 \Delta i + \beta_4 NDAR + u_t$$

Where NFAR and NDAR stand for the ratios [NFA/(NFA+NDA)]Δlog NFA and [NDA/(NFA+NDA)]Δlog NDA, with NFA and NDA are denoted net foreign assets and net domestic assets, respectively; Y, i and P are denoted for real income, the interest rate, and prices, respectively. β_1 is expected to equal unity, β_2 and β_3 to take values similar to those estimated in conventional money demand equations (that are 1 and –0.01 respectively) and β_4 to equal to –1.

Data sample used for estimation covers 1991:Q1 - 2000:Q4 and all variables are stationary at 5% level. The OLS estimation result is as follows:

NFAR =	0.0145 +	0.6762Δ log P +	0.1130Δ log Y –	0.0497Δi –	0.5531NDAR
p-value:	(0.004)	(0.003)	(0.056)	(0.397)	(0.003)

The coefficient of NDAR is significantly different from –1.

The estimation may indicate that Vietnam is far from a financially deepened economy (e.g. insignificance of the coefficient of Δi can be explained by the fact that in general, during the sample period the interest rates were heavily regulated by the SBV).

The regressions, though they are derived from the different approaches applied, imply that the SBV has been facing a lot of difficulties in pursuing independent monetary policy while maintaining a pegged exchange rate even in an environment of highly regulated

[23] See the estimated equation derived from the monetary approach to the BOP in Appendix 3. The detail of the regression can be provided by request.

banking system and capital control. This would become more difficult with the process of financial deregulation (as shown in Table 12, which presents the estimated offset coefficients for other Asian countries).

Table 12
Offset Coefficient for Selected Asian Countries

	Fry (1960-91)	Frankel & Okongwu (1977:Q3-1991:Q4	Leung (1984:Q4-1995:Q4)	Vo et al. (2001b) (1993:Q3-1999:Q2)	Our estimate (1991:Q2-2000:Q4)
Thailand	0.18	na	-0.68***	na	na
Indonesia	-0.30**	na	-0.40*	na	na
Korea	-0.48**	-0.16***	-0.74***	na	na
Philippines	0.46	-0.64***	na	na	na
Malaysia	-1.30	na	na	na	na
Vietnam	na	na	na	(-0.79; -0.61)**	-0.55***

Note: *, **, and *** indicate the significance at 10%, 5%, and 1% level.

Sources: Leung (1996); Vo et al. (2001b) and our estimates.

V.3. Case Study: Intensification of Dollarization during 1999-2001

♦ *Macroeconomic environment*

Since 1997 there has been a deep concern with the question of sustainable economic growth and development. The East Asian crisis not only has undermined Vietnam's exports due to the overvaluation of VND and the shrunk external markets, but also has exposed evidently the structural weaknesses of Vietnam's economy. As a result of the slow-down of economic growth, since 1999 the government has undertaken the demand-stimulus policy by expanding the public investment (mainly through the SOEs to offset a decrease in FDI) and easing monetary policy. The SBV loosened the monetary policy through lowering the lending ceiling rates five times, the refinancing rate four times and the discount rate three times during 1999 and the first half of 2000 (before the introduction of the basic interest rate mechanism; see Section II.2). Despite of this fall, for the first five months of the year 2000 the growth rate of mobilized funds was at 13 percent while credit grew at only 2.5 percent in Hanoi and 18.1 percent and 5.9 percent in Ho Chi Minh city, respectively.[24] The credit was almost exclusively in VND lending and mostly from the SOCBs. Given the low demand for credit, this rapid growth of fund mobilization could have weakened the banks' asset quality.

During 1999 the spread between domestic VND-denominated interest rates and local USD deposit interest rates began widening because of the continuously lowered domestic interest rates. This gap was more significant in 2000 when FED raised the prime rate to remarkable levels.[25] Regarding ER, the nominal depreciation was moderate, being less 4% per year during 1999-2001 (Remember that the new ER system was introduced in February 1999 with the band of 0.1 percent).

[24] *Investment Review* No. 39/2000.

[25] FED raised the prime rate to as high as 6 percent annually in March and to 6.5 percent per year in May.

◆ *Intensification of dollarization*

Following the approach of the UIP, it is very important to compare the rates, which are equal to local interest rates minus (expected) depreciation rates, with the international interest rates or local USD interest rates, for assessing the currency portfolio choices. We can observe that during 1992-96 these rates were *much higher* than the local USD interest rates and even the international interest rates. Given the capital controls and expectation of ER stability as a goal of government policy, the public had shifted the preferred portfolio in favor of the VND. During 1997 – 2001 the situation was reversed. These rates were negative during 1997-98 and became positive during 1999-2001 but still somewhat lower than local USD interest rates (Table 13). Obviously, in the context of high depreciation expectation, the USD returned to be more attractive than the VND.

Table 13
Savings Interest Rate of USD and VND, 1992-2001 (% per year)

Year	VND depreciation rate	VND savings interest rate	Return on VND in terms of USD	USD savings interest rate	Different rates
	(1)	(2)	(3)=(2)-(1)	(4)	(5)=(3)-(4)
1992	-8.13	34.1	42.23	4.05	38.18
1993	2.62	20.4	17.78	3.2	14.58
1994	1.92	16.8	14.88	3.5	11.38
1995	-0.33	16.8	17.13	4.5	12.63
1996	0.33	9.6	9.27	4.8	4.47
1997	11.57	9.6	-1.97	5	-6.97
1998	12.70	9.6	-3.10	5	-8.10
1999	0.89	5.25	4.36	4.7	-0.34
2000	3.54	4.45	0.91	4.43	-3.52
2001	3.90	5.95	2.05	3	-0.95

Note: The end of period ER is used to calculate the depreciation rate.

Source: Adapted from Nguyen (2002).

As a result, the holding in favour of USD was intensified. In fact, as shown in Section III.2, the ratio of USD deposits over M2 stabilized in the range of 20-23% in the mid 1990s, but increased significantly since 1998 and reached 27.3% in 1999, 31.5% in 2000, and 31.7% in 2001. The annual growth rate of dollar deposits also jumped from about 29% in 1997 to 74% in 1999 and 55% in 2000. This growth rate was lower in 2001, but still high as of more than 40% (Table 14).

The behaviour of banking sector had a considerable contribution to deepening dollarization in the economy during 1999-2001. This is because the banks attempted to attract foreign-currency deposits for the deposits abroad to earn the differential spread. Generally, there have been three ways to use the USD mobilized funds: (i) lending in US dollar; (ii) selling dollar for the VND; and (iii) depositing dollars at offshore banks. In the case of Vietnam during 2000-2001, the major motive for banks is to earn the spread between local USD rate and foreign USD rate on the fund deposited at offshore banks.[26] The net short-term

[26] *First*, the option of using the dollar-denominated deposits to lend was very constrained with high expectation of depreciation of VND. *Second*, the rigid management of the interest rate policy by the SBV also constrained lending activities. Before August 2000, the ceiling rate mechanism on lending in foreign currencies caused many difficulties in lending to risky projects. Since August 2000, the more market-determined lending interest rate mechanism has been introduced; the lending rates have been based on the SIBOR rates. But the very narrow fluctuation band of 1 percent per year for short-term and 2.5 percent per year for medium and long-term maturity has revealed the seemingly unchanged rigidness of the new policy. Many banks' lending activities in dollar have still squeezed.

capital flow rose remarkably from USD -644 millions in 1998 to USD -1,036 millions and USD -1,700 millions in 1999 and 2000, respectively. Interestingly, the increases in the negative short-term net capital flow between 1999 and 2000 compared with 1998, respectively are approximately equal to the increase in dollar deposits in the banking system between the same period 1998-1999 and 1998-2000 (IMF 2000).

Table 14
Deposits in VND and Foreign Currencies, 1996-2001
(VND deposits in VND trillions; foreign currency deposits in USD millions; end of period)

						2001		
	1996	1997	1998	1999	2000	Mar	Jun	Aug.
VND Ds	28.9	37.8	51.4	75.3	100	106	108	111
FC Ds	1,180	1,521	1,795	3,126	4,854	5,351	5,677	5,981
(Annual %-change)								
VND Ds	28.5	30.8	36	24.4	33.2	24.8	18.2	18.3
FC Ds	17.5	28.9	13.9	74.2	55.3	50.0	49.6	44.4

Note: Data for 1996-1998 comprise four state-owned commercial banks and 24 non-SOCBs; data from 1999 onwards comprise six SOCBs and 83 non-state credit institutes.

Source: SBV.

Other underlying factors intensified dollarization in recent years were the changes in government regulations on foreign exchange such as the measures to encourage and create favourable conditions for overseas Vietnamese to remit their foreign currencies to Vietnam (Section III.2). During 1999-2001, the policy response was not flexible and proactive for dealing with dollarization and the massive USD deposit abroad. The adjustment of the RRR on foreign currency deposits was late. In addition, lowering domestic interest rates was unlikely to increase sound loans since the underlying cause of falling demand for credit lied in the structural weaknesses of the economy and the lack of profitable investment opportunities. The new exchange rate system introduced in February 1999 did not yet give a greater role to market forces in determining ER. The mechanism of foreign exchange management has also created "troubles". For example, during the year of 2000 the Ministry of Finance sold just a small part of the USD earned from exporting crude oil to commercial banks and the SBV. As a result, the supply of dollars was artificially scare while the demand for the USD (for import of petroleum products) was increasing.[27]

Our analysis has, thus, shown that a major determinants of dollarization intensification during 1999-2001 was inconsistency of interest rate and ER policy mix in favour of holding the USD. This encouraged the commercial banks to make "speculation" on the currency games rather than on the productive investments. The changes in foreign exchange regulations and the more or less passive policy responses were also the causes of the intensification of dollarization during 1999-2001.

[27] A major export revenue-earning commodity is crude oil, while petroleum products account for a major part of import expenditures. The former reflects supply of USD (kept by the Treasury) and the latter reflects demand for USD.

VI. Problem of Double Mismatch in Vietnam

VI.1. Double Mismatch: Problems and Effects

Problem of double mismatch in Asian crisis-hit countries has been in the focus of a number of international studies. However, the question of how serious the problem of double mismatch has been in Vietnam, was never touched, not say, examined rigorously. The objective of Section VI is to give an answer to this question and to find the causes of the problem of double mismatch in Vietnam recently.

Double mismatch in balance sheet of an institution (e.g. banks or firms) is the situation in which a maturity mismatch (short-term sources of funds are used in longer term) coupled with a currency mismatch (differences in currency compositions of this institution's liabilities and assets). Maturity mismatch is inherent in bank's balance sheet. The currency mismatch is often a serious problem in developing countries because of high demand for attracting foreign capital and issuing foreign currency-denominated debts for domestic investment as well as lack of the instruments to hedge the exchange rate risks.

It is difficult for a country to have macroeconomic policy consistency in the context of serious double mismatch. The currency and maturity mismatches create a dilemma for exchange-rate policy. If on the one hand, the government seeks to defend the currency by increasing interest rates and draining liquidity from the financial system, banks faced with the increased cost of funding will be forced to contract their portfolios by calling their loans. If borrowers are unable to repay immediately due to maturity mismatch, a banking crisis can result. The prevalent view now is that pegged exchange rates and open international capital movements are an accident waiting to happen in emerging countries, whose banks suffering serious double mismatch in balance sheets (Eichengreen & Hausmann 1999).

If on the other hand, the authorities let go off the peg and permit the exchange rate to float, banks and corporate will be hammered by currency mismatch, with contractionary macroeconomic effects. As the exchange rate starts to fall, moreover, firms fearful of further depreciation will scramble to purchase foreign exchange to cover their exposures. This will cause the domestic currency to depreciate further. The depreciation of the domestic currency leads to a deterioration in firms and banks' balance sheets because much of their debt is denominated in foreign currency, thus, raising the burden of indebtedness and lowering banks and firms' net worth. The central bank would be reluctant to let the exchange rate move too much, let the dollar liabilities in the financial system precipitate widespread bankruptcies. To limit the movement of their currencies, it should raise interest rates and as a result, interest rates will be volatile, even more than in fixed-rate economies. The danger is reinforced by a disorder of financial liberalization and capital account opening.

In this case, a sudden and massive capital flows could led to crisis, which can be described in the following scheme:

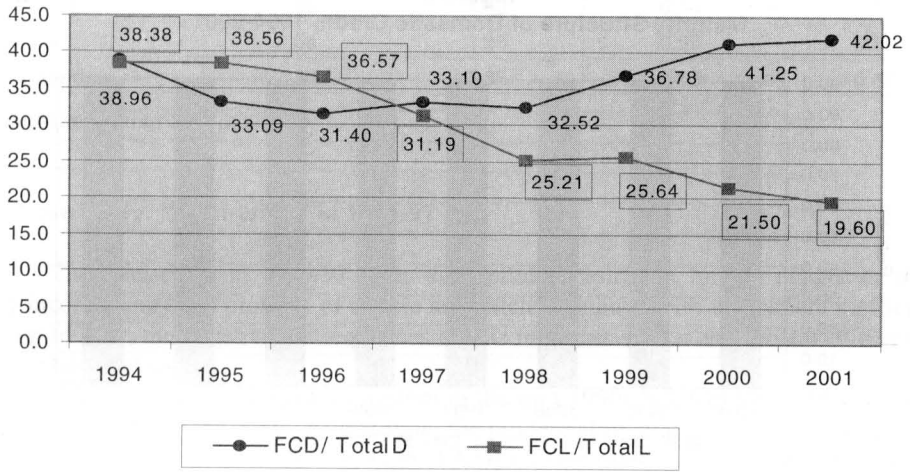
Capital inflows, especially short-term inflows $\Rightarrow$ banks' foreign currency – denominated liabilities $\Rightarrow$ long-term investment in real estate and (inefficient) manufacturing $\Rightarrow$ further deteriorated double mismatch $\Rightarrow$ the balance sheets of local financial institutions and enterprises are extremely vulnerable to external shocks, including currency devaluation, a refusal of rollover by foreign investors and shortage of international reserves $\Rightarrow$ they may be seriously damaged and as a result, the currency crisis and banking crisis reinforce each other (Yoshitomi and Shirai 2000; see also Appendix 4).

VI.2. Problem of Double Mismatch in Vietnam

♦ *Problem of currency mismatch*

The currency mismatch has been widening *recently* in the banks' balance sheets due to a sharp increase in the foreign currency deposits and a decrease in foreign currency loans measured as the shares in total deposits and total loans respectively (Figure 8).

Figure 8
Ratios of Foreign Currency Deposit and Loans in Total, 1994-2001



Note: Data for 1994-98 comprise 4 SOCBs and 24 non-state owned banks. Data from 1999 onwards comprise 6 SOCBs and 83 non-state credit institutions.

Source: IMF (2001 and 2002).

Regarding to the firms' balance sheets, firms have suffered the currency mismatch, although its seriousness seems to be reduced. The share of foreign currencies in total bank loans was high in the mid-1990s (35-40%); it decreased during 1996-98 and become stable at around 21% during 1999-2001.

But given the weaknesses of the banking system associated with the inefficiency of the SOE sector and the high level of NPLs (Section II.1), and the high degree of dollarization, the economy is still vulnerable to the problem of currency mismatch. This could be reinforced by the fact that most firms borrowed in foreign currencies only have had income in local currency obtained by selling goods imported in the domestic market (World Bank 1998). Moreover, of the short-term foreign currency debts, the financing for export, which has generated hard currencies, has accounted for only small part (Table 15).

Table 15
Short-term Foreign Currency Debts, 1991-97, million USD

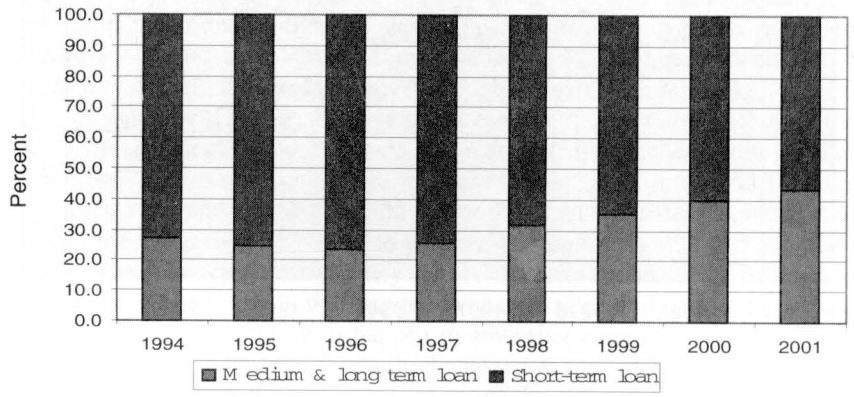
	1991	1992	1993	1994	1995	1996	1997
Short-term debt	1,932	2,585	2,469	2,663	3,272	3,754	2,388
Of which export credit	*431*	*506*	*475*	*515*	*553*	*866*	*984*

Source: Calculated from World Development Finance, 1999.

♦ *Problem of maturity mismatch*

Vietnam is a developing country, capital market still under-developed and hence, the lack of long-term capital is apparent. In fact, investment has been largely based on the bank deposits, which are mostly with the terms less than one year. Moreover, medium and long-term loans have showed upward trend since the promulgation of Decision No. 367/QD-NH1 dated 25 December 1995, allowing commercial banks to use a larger proportion of short-term deposits for expanding medium and long-term loans. The share of medium and long-term loans in total credit increased from 22% in 1995 to about 40% in 2000 and 2001 (Figure 9).

Figure 9
Maturity Structure of Domestic Credit, 1994-2001



Source: SBV.

The severe maturity mismatch of the banking system was still passed to domestic firms since the medium and long-term loans could not meet the demand. As a result, domestic firms have often been forced to use short-term loans for longer-term investment, causing maturity mismatch in firms' balance sheets. This made also the corporate sector vulnerable to the slowdown in cash flow or business cycle or other shocks. In turn, it has also imposed a debt burden on the banking sector.

In comparison with the Asian crisis-hit economies, the leverage ratio of Vietnamese firms was the lowest, but the share of short-term debt in total debt was the highest (Table 16). This could mean that, Vietnamese firms suffered from a serious maturity mismatch and they become vulnerable to shocks. The vulnerability of firms and banks with large amount of short-term debts was also reflected in the overdue debt ratio. In 1997, in the total overdue debts, the short-term debts occupied 51.8 percent, meanwhile only 6.5 percent were the long-term debts. In addition, the maturity structure of overdue loans is extremely unfavorable, with well over half of overdue by more than 180 days. In such a context, the duration of banks' assets was shortened and hence, the maturity mismatch was widened.

In short, recently double mismatch of both banking system and domestic firms has been quite serious. Moreover, the problem has been reinforced by each to other. The major factors, which are often listed as the main causes of problem of double mismatch, can be observed in Vietnam. The first is inappropriate macro-economic environment such as inconsistency of interest rate and exchange rate policy mix and high degree of dollarization. The second is the weaknesses of banking system (lack of transparency and good accounting and auditing system, weakness of enforcement of loan contracts, banks' lending relies too heavily upon collateral, weaknesses in risk management). The third is the under-development

of financial market, especially (corporate) bond market, and the lack of efficient derivative markets. The fourth is the heavy intervention of government with implicit/explicit government guarantees. The fifth is the inefficiency of corporate sector, especially the SOE sector.

Table 16
Selected Indicators of Corporate Financing
(Vietnam in 1997 and selected Asian economies in 1996)

	Debt to Equity Ratio		Ratio of ST Debt to Total Debt	
	Mean	Median	Mean	Median
Vietnam	1.40	1.76	0.80	0.81
Indonesia	1.88	1.83	0.54	0.57
Korea	3.55	3.25	0.57	0.59
Thailand	2.36	1.85	0.63	0.67

Source: Adapted from Tran (2000) .

VI.3. Case Study: "Mini-crisis" in 1996-97

The mini-crisis in 1996-97 is an appropriate illustration for the danger of macro-policy inconsistency and problem of double mismatch in linkage with investment inefficiency. Even up to now, the negative consequences of this mini-crisis such as problem of bad debts, have not been yet solved.

The situation of the banking system in the mid 1990s helps to understand the role it had played in causing the crisis. At that time, the prudential regulations in the banking system were nearly ignored. In 1996 the very high (VND) interest rates caused a substantial increase in banking deposits, while credits were hardly expanded due to the high lending rates and the tight regulations on credit ceilings. Reserves in commercial banks raised substantially and many banks had excessive reserves; even some banks refused to receive more deposits. This situation created "incentives" for banks to evade the government controls. The Letter of credits (LC) was one important channel for the evasion since up to that time the LC was excluded from credit ceilings. The LC was seen as an off-balance activity of banks, generating vagueness in the balance sheet of the banks. Moreover, the weak capability of bank staff resulted in the bank's provision of the LC guarantees to many unqualified firms.

Firms also attempted to evade regulations on limits of foreign-currency borrowings (Only importers and other import-related activities can obtain loans in foreign currencies). Although Vietnam has imposed certain restrictions on CA and KA, the flows of funds from abroad through deferred payments on the LC had been outside those restrictions. Domestic enterprises were allowed to have their trade credit guaranteed by commercial banks through deferred LC. In fact, this was equivalent to enterprises borrowing short-term foreign currency loans from abroad through domestic commercial banks. Moreover, in an environment of very high VND interest rate and limited foreign currency loans, but with stability and rigidity of exchange rates as an implicit government guarantee against foreign exchange risk, there was, of course, a strong incentive for domestic firms to borrow from abroad. Thus both commercial banks and firms had incentives to lend and borrow though LC.

As a result, domestic firms (both SOE and private enterprises) borrowed a large amount of short-term USD loans. The stock of the LC was estimated to accumulate at USD 1.5 billions by early 1997 (World Bank 1997). Net flows on short-term debt increased significantly, from about USD 120 million in 1993 and 1994 to USD 311 million in 1995 and USD 224 million in 1996. It has become thereafter a largely negative in 1997 (Appendix 2).

The consequences were severe. *First*, it widened the CA deficit. In 1996 the trade deficit was more than USD 3.1 billions or 12.8% GDP and CA deficit (9.2% of GDP) was at

"alarming level" (see Section III). *Second,* a large part of this short-term borrowing was channeled into speculative real estate market, resulting in a market boom. But the market turned into bust later, in early 1997, when those firms could not pay back the debt. *Third,* it weakened the banking system and the financial sector as a whole. Around 40% of the LC (equivalent to 3 percent of GDP) guaranteed by commercial banks became bad debts (Leung and Le Danh Doanh 1999).

As a result, the SOCBs, especially the state-owned Vietcombank, and some other joint-stock commercial banks defaulted on these guaranteed short-term debts (IMF 1998). Defaults by the Vietcombank to honor some small LC caused concern about the level of foreign exchange reserves and about Vietnam's commitment to international financial arrangements. The SBV had to use the foreign reserves to bail out these commercial banks. This was estimated that the stock of foreign reserves fell by 5 week of imports equivalently. Vietnam's sovereign credit rating was lowered from Ba3 to C.

Moreover, the evasion of banks weakened the effectiveness of monetary policy because the direct control mechanism was eroded, distorting monetary aggregates. In addition, it generates upward pressure on the exchange rate. Due to a sharp increase in demand for foreign exchange by the end of 1996 and early 1997, the SBV broadened the band between selling and buying rate of foreign exchange from 1 percent to 5 percent in February 1997. In addition, in mid 1997, the SBV set strict limit on the amount of deferred LC and tightened the controls over commercial banks' LC guaranteeing. To import goods on the restricted goods list a deposit equivalent to 80 percent of each LC was required instead of 0-30 percent level previously (McCarty 1999). As a result, during the second half of 1998, the value of late LC payments fell from around US$ 350 millions to some US$200 millions at the end of 1998 (IMF 1999).

VII. CONCLUSIONS

The objective of this study is to examine the possible risks associated with the BOP in Vietnam, focusing on three interrelated issues: (i) the CA deficit and external debt sustainability; (ii) the macroeconomic policy consistency in dealing with capital flows and dollarization; and (iii) the problem of double mismatch in the context of financial liberalization and BOP liberalization.

The examination of the first issue is based on the solvency condition using Jaime De Pine's dynamic debt model in conjunction with the analysis of the external risks affecting the KA. It was found that during 1990s, the CA deficit and the external debt of Vietnam were sustainable. In 1996 Vietnam's CA deficit did reach an "alarming level" in the sense that the warranted imports were much lower than actual imports. Except in the years 1995 and 1996, however, import was substantially restrained in comparison with the level it could have reached. The import restriction measures implemented since 1997 seemed to be an over reaction and more than what was necessary.

For the period of 2001-2010, the (average annual) import growth rate can be allowed to be 1 percentage point higher than the export growth rate without any risk of external debt unsustainability. In fact, imports can even grow faster than exports by about 2-3 percentage points during the first half of the decade. Thus Vietnam seemed to be *overcautious* in setting the target of import growth rate lower than that of export growth rate during 2001-2010.

However, some problems have appeared and deserve policy-makers' attention. First, debt-creating finance has accounted for the larger part of capital inflows (including FDI), and this tends to raise the cost of financing the CA deficit. Second, the external debt has become more vulnerable to the interest rate variability in international financial markets since the share of non-concessional debt and the floating interest rate loans have increased. Third, the decline in efficiency of capital utilization (due to inefficient SOEs, the fragile banking sector,

and several trade barriers in favour of import-substituting industries) could have a significantly negative impact on economic growth and the capacity to service the foreign debt. Fourth, dollarization not only reduces the effectiveness of monetary policy and the capability for managing consistently macroeconomic policies, but also adds vulnerabilities to banking and corporate sectors arising from currency mismatch and from exchange and credit risks.

The interest rate parity conditions and the well-known "impossible trinity" are foundations for studying the second issue. The econometric tests show that the UIP condition does not hold, meaning inconsistency of the interest rate and ER policy mix, and that even though there have been diverse measures to control capital flows, the SBV nevertheless had difficulty in pursuing an independent monetary policy under the pegged ER regime. In general Vietnam is far from fully financial integration. However, during the 1990s, the domestic USD interest rate is likely to be more isolated from the world interest rate than the VND interest rate.

The macroeconomic policy inconsistency in favour of holding the USD was a major underlying determinant of the dollarization intensification during 1999-2001. This encouraged the commercial banks to make "speculation" on the currency games rather than on the productive investments. The changes in foreign exchange regulations and the rather passive policy responses were also the cause, which can not be ignored either. In recent years, the international reserve coverage of official short-term debt stock increased. However, the intensification of dollarization has added more vulnerability to banking and corporate sectors arising from currency mismatch and from exchange and credit risks. Under the certain policy/external shocks, dollarization is similar to the foreign exchange liquidity problem in having too much short-term external debt compared to reserves and the panic could happen if there would be a perception that the supply of foreign currencies may not be forthcoming.

The analysis of the third issue covers problems of both currency and maturity mismatches. It was found that symptoms of mismatches have been in evident in Vietnam recently. Currency mismatch has been widening for banks, with more USD deposits than loans. Firms also have had currency mismatch with a rather high proportion of borrowings (though declining) while most of income has been in local currency. Maturity mismatch has also been present, given the inherent feature of banking system and the under-developed capital market. As a result, domestic firms have had to rely mainly on short-term borrowings.

The major factors causing the problem of double mismatch can be listed. They are: (i) the inconsistency of macro-policy mix and high degree of dollarization; (ii) the weaknesses of banking system; (iii) the under-development of financial market; (iv) the intervention of government with implicit/explicit guarantees; and (v) the inefficiency of the SOE sector.

The mini-crisis in 1996-97 is a very appropriate illustration for the danger of macro-policy inconsistency and problem of double mismatch in linkage with investment inefficiency.

From the analysis and the findings, some policy recommendations can be made. The first and foremost is the direction for BOP liberalization. The motive for promoting exports is to create more efficient import capacity while ensuring CA deficit and external debt sustainability. As mentioned earlier, Vietnam seemed to be *overcautious* in setting the target of import and export growth rates during 2001-2010. A possible further expansion of imports could make a positive contribution to economic growth and more importantly, it could facilitate the acceleration of trade liberalization and international integration. At the same time, as the cost of financing the CA deficit and the risks associated with KA tend to rise, managing the CA deficit and external debt requires the government to monitor closely the process of KA opening in an orderly, well-sequenced way. The well-known argument of prerequisite conditions for successful KA opening is to ensure macroeconomic stability and to strengthen the efficiency of the banking system.

These conditions seem to be not enough in the context of high degree of dollarization as in the case of Vietnam. It is now important to have a rational exchange rate arrangement in

terms of moving to a more flexible regime[28] and being consistent with monetary and interest rate policies. The liberalization of both foreign currency and local currency interest rates by the SBV recently is a positive and proactive move towards market and international integration. But this also means that the economy is more vulnerable to the shocks (e.g. when the domestic economic activities slow down and international interest rate increases/the USD is appreciated) given the weaknesses of banking and corporate sectors.

Enhancing soundness and efficiency of the banking system should be now as a first priority. In particular, this requires a careful monitor of FDI- related loans, short-term/non-concessional debt, and the movement of foreign currency deposits/loans. For the SBV, the improvement of effectiveness of indirect monetary instruments and the strengthening of the prudential supervision is very essential. Of course, in the case of Vietnam, the banking system can not be effective and efficient without other structural reforms, especially the reform of the SOE sector.

In longer term, it is also important for Vietnam to foster the development of capital market, especially corporate bond market.

Our study can not avoid certain limitations. The comprehensive interrelationship between BOP, external debt, dollarization phenomenon, consistency of macroeconomic policies, and problem of double mismatch, is not yet understand well from both points of views of theories and practical experiences. For example, our analysis has shown the complexity of a "vicious circle" among three issues: macro-policy inconsistency, dollarization, and double mismatch problem.

The quantitative assessments are still based on certain inaccuracies of Vietnam's BOP statistics. In general, Vietnam's economic, financial, and BOP statistics do not conform with international standards (IMF 2001), although there have been considerable improvements with respect to their collection, processing and dissemination. Unclear benchmark for quantitative assessments and the lack of micro-data for a deep analysis of the double mismatch problem is another shortcoming in our study.

[28] Once again remember that in July 2002, the ER band was relaxed to 0.25%.

Appendix 1 Balance of Payments of Vietnam, 1989-2000

	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Current account balance	**-587**	**-259**	**-123**	**-8**	**-1,395**	**-1,197**	**-1,876**	**-2,431**	**-1,664**	**-1,070**	**1,285**	**892**	**512**
(Excluding official transfer)			-188	-72	-1,589	-1,329	-2,029	-2,581	-1,839	-1,242	1,154	756	374
Trade balance	-350	-41	-63	-60	-1,177	-1,190	-2,345	-3,143	-1,315	-981	1,080	628	373
Export, fob	1,320	1,731	2,042	2,475	2,985	4,054	5,198	7,337	9,145	9,365	11,540	14,308	15,292
Import, fob	1,670	1,772	2,105	2,535	4,162	5,244	7,543	10,480	10,460	10,346	10,460	13,680	14,919
Non-factor service (net)	-38	55	179	311	78	19	159	-61	-623	-539	-547	-615	-586
Receipts		55	450	724	772	1,283	2,074	2,709	2,530	2,604	2,493	2,695	2,824
Payments	38		271	413	694	1,264	1,915	2,770	3,153	3,143	3,040	3,310	3,409
Investment income (net)	-208	-411	-339	-382	-560	-328	-317	-427	-611	-672	-429	-597	-753
Receipts		28	42	43	30	27	96	140	136	133	142	185	138
Payments	208	439	381	425	590	355	413	567	747	805	571	782	891
Transfers (net)	9	138	100	123	264	302	627	1,200	885	1,122	1,181	1,476	1,478
Private transfers	9	138	35	59	70	170	474	1,050	710	950	1,050	1,340	1,340
Official transfers			65	64	194	132	153	150	175	172	131	136	138
Capital account	**300**	**121**	**-59**	**271**	**352**	**897**	**1,765**	**2,079**	**1,663**	**215**	**-334**	**-772**	**120**
Gross foreign direct investment	100	120	220	260	832	1,048	1,780	1,812	2,074	800	700	800	1,000
Equity				222	594	454	791	891	1,002	240	301	320	600
Loan disbursements				38	238	594	989	921	1,072	560	399	480	400
(FDI loan repayments)				(0)	(0)	(0)	(36)	(55)	(174)	(372)	(603)	(601)	(827)
Medium & long-term loans (net)	413	-47	-191	52	-597	-275	-290	98	375	431	605	729	637
Disbursements	763	233	65	487	54	272	443	772	1,007	1,121	1,036	1,411	1,100
Scheduled amortization	350	280	256	435	651	547	733	674	632	690	431	682	463
Short-term capital (net)	-213	48	-88	-41	117	124	311	224	-612	-644	-1,036	-1,700	690
Errors and omissions	*67*	*-4*	*132*	*-198*	*-13*	*-109*	*-89*	*54*	*-3*	*328*	*-183*	129	*-123*
Overall balance	**-220**	**-142**	**-50**	**65**	**-1,056**	**-409**	**-200**	**-298**	**-4**	**-527**	**768**	**249**	**509**
Financing	220	142	50	-65	1,056	409	200	298	4	527	-768	-249	-509
Change in net inter. Reserve	-105	-156	-282	-261	438	-117	-347	-293	-319	-15	-1,316	-249	-509
Use of Fund credit (net)		3	-6		-39	175	92	178	-54	-78			-509
Other net inter. Reserves	-105	-159	-276	-261	477	-292	-439	-471	-265	63			-572
Arrears	291	298	332	196	-265	526	547	591	323	129	548	-9,024	0
Debt relief	34				883					413		9,024	0
Export/GDP (%)	20.2	21.2	24.7	25.0	22.7	24.9	24.9	29.9	32.6	33.6	40.7	47.5	46.7
Import/GDP (%)	25.6	21.7	25.5	25.6	31.6	32.2	36.2	42.8	37.3	37.2	36.9	45.4	45.5
Trade balance/GDP (%)	-5.36	-0.50	-0.76	-0.61	-8.94	-7.30	-11.24	-12.82	-4.69	-3.52	3.81	2.08	1.14
CA balance/GDP (%)	-8.98	-3.17	-1.49	-0.08	-10.60	-7.34	-8.99	-9.92	-5.93	-3.84	4.53	2.96	1.56

Sources: SBV, IMF and authors' own estimates.

Appendix 2 Database 1989-1999

	GNP (1)	Export of goods and services (EXGS) (2)	Growth rate of EXGS (3)	Export of goods (EXG) (4)	Growth rate of EXG (5)	Import of goods and services (IMGS) (6)	Growth rate of IMGS (7)	Import of goods (IMG) (8)	Growth rate of IMG (9)	Total debt (TD) by W.B (10)	Total debt (TD) by IMF (11)	Total debt (TD) by VN (12)
1989	5,883	1,320	0.8	1,320	0.8	1,670	0.182	1,670	0.182	19,275	7,719	5,293
1990	6,360	1,731	0.311	1,731	0.311	1,772	0.061	1,772	0.061	23,492	8,119	5,655
1991	9,613	2,492	0.440	2,042	0.180	2,376	0.341	2,105	0.188	23,616	8,463	5,987
1992	9,867	3,199	0.284	2,475	0.212	2,948	0.241	2,535	0.204	24,533	8,932	6,421
1993	12,834	3,757	0.174	2,985	0.206	4,856	0.647	4,162	0.642	24,458	9,839	7,272
1994	15,509	5,337	0.421	4,054	0.358	6,508	0.340	5,244	0.260	25,115	10,464	8,022
1995	19,864	7,272	0.363	5,198	0.282	9,458	0.453	7,543	0.438	25,813	11,651	9,214
1996	22,899	10,046	0.381	7,337	0.412	13,250	0.401	10,480	0.389	26,764	13,525	11,123
1997	24,193	11,675	0.162	9,145	0.246	13,613	0.027	10,460	-0.002	27,541	14,738	10,840
1998	26,500	11,969	0.025	9,365	0.024	13,489	-0.009	10,346	-0.011	27,025	15,152	10,161
1999	27,088	14,033	0.172	11,540	0.232	13,500	0.001	10,460	0.011	26,046	13,470	11,334

Source: Vo et al. (2001a).

	TD/GNP (WB)	TD/GNP (IMF)	TD/GNP (SBV)	V_o	*Do* (WB)	*Do* (IMF)	*Do* (VN)	*i*	*a*	*b*
1989	3.28	1.31	0.90	1.27	14.60	5.85	4.01	0.050	0.58	0.66
1990	3.69	1.28	0.89	1.02	13.57	4.69	3.27	0.057	0.81	0.81
1991	2.46	0.88	0.62	0.95	9.48	3.40	2.40	0.030	0.72	0.93
1992	2.49	0.91	0.65	0.92	7.67	2.79	2.01	0.017	0.79	0.97
1993	1.91	0.77	0.57	1.29	6.51	2.62	1.94	0.020	0.87	1.40
1994	1.62	0.67	0.52	1.22	4.71	1.96	1.50	0.027	0.72	0.94
1995	1.30	0.59	0.46	1.30	3.55	1.60	1.27	0.032	0.76	1.07
1996	1.17	0.59	0.49	1.32	2.66	1.35	1.11	0.025	0.74	1.01
1997	1.14	0.61	0.45	1.17	2.36	1.26	0.93	0.032	0.89	0.88
1998	1.02	0.57	0.38	1.13	2.26	1.27	0.85	0.032	1.01	0.97
1999	0.96	0.50	0.42	0.96	1.86	0.96	0.81	0.040	0.89	0.85

Source: Vo et al. (2001a).

Warranted Imports and Excess Import Cut 1989-1999

	a	Critical import-to-export ratio (v)	Warranted imports (v*Xo) (USD mill)	Excess import cut (v*Xo-Mo) (USD mill.)
1989	0.79	2.23	2,942	1,272
(do=5.85; vo=1.27; Mo=1,670; Xo=1,320)	0.81	2.11	2,787	1,117
1990	0.79	1.98	3,436	1,664
(do=4.69; vo=1.02; Mo=1,772; Xo=1,731)	0.81	1.89	3,273	1,501
1991	0.79	1.71	4,271	1,895
(do=3.40; vo=0.95; Mo=2376; Xo=2,492)	0.81	1.65	4,102	1,726
1992	0.79	1.59	5,073	2,575
(do=2.79; vo=0.92; Mo=2,948; Xo=3,199)	0.81	1.53	4,895	2,397
1993	0.79	1.55	5,824	968
(do=2.62; vo=1.29; Mo=4856; Xo=3,757)	0.81	1.50	5,627	771
1994	0.79	1.41	7,534	1,026
(do=1.96; vo=1.22; Mo=6508; Xo=5,337)	0.81	1.37	7,324	816
1995	0.79	1.34	9,715	257
(do=1.60; vo=1.30; Mo=9458; Xo=7,272)	0.81	1.30	9,483	25
1996	0.79	1.28	12,894	(356)
(do=1.35; vo=1.32; Mo=13250; Xo=10,046)	0.81	1.26	12,623	(627)
1997	0.79	1.26	14,764	1,151
(do=1.26; vo=1.17; Mo=13,613; Xo=11,675)	0.81	1.24	14,470	857
1998	0.79	1.27	15,161	1,672
(do=1.27; vo=1.13; Mo=13,489; Xo=11,969)	0.81	1.24	14,857	1,368
1999	0.79	1.20	16,862	3,362
(do=0.96; vo=0.96; Mo=13,500; Xo=14,033)	0.81	1.18	16,593	3,093

Source: Vo et al. (2001a).

Database 2000-2010

	Export of goods, services and transfers	Import of goods and services	Total external debt	The import-to-export ratio (v_0)	The debt-to-export ratio (d_0)
2000	18,209	16,990	**12,511**	0.93	0.69
2001	20,983	19,406	15,648	0.92	0.75
2002	24,154	22,170	17,425	0.92	0.72
2003	27,811	25,332	19,141	0.91	0.69
2004	32,031	28,951	20,869	0.90	0.65
2005	36,905	33,093	22,643	0.90	0.61
2006	41,946	37,283	24,126	0.89	0.58
2007	47,687	42,006	25,811	0.88	0.54
2008	54,227	47,330	27,647	0.87	0.51
2009	61,679	53,330	28,476	0.86	0.46
2010	70,173	60,094	30,939	0.86	0.44

Note: The calculation of exports is based on the targets of exports and imports in the Socio-Economic Development Strategy 2001-10. (Export of goods grows at 16% in 2001-2005 and at 14% in 2006-2010; import of goods grows at 15% in 2001-2005 and grows at 13% in 2006-2010; and export of services grows at 15% and import of services grows at 11% in 2001-2010). The transfers are projected by the authors.

Vietnam's Measured Overadjustment, 2001-2010
(Scenario: Non-interest CA including transfers with a=0.92)

	Total export (Xo) (USD million)	Total import (Mo) (USD million)	do	Critical import-to-export ratio(v)	Warranted imports (v*Xo) (USD million)	Excess import cut (v*Xo-M0) (USD million)
2000	18,209	16,990	0.69	1.05	19,210	2,220
2001	20,983	19,406	0.75	1.06	22,235	2,829
2002	24,154	22,170	0.72	1.06	25,548	3,378
2003	27,811	25,332	0.69	1.06	29,342	4,009
2004	32,031	28,951	0.65	1.05	33,701	4,750
2005	36,905	33,093	0.61	1.05	38,717	5,624
2006	41,946	37,283	0.58	1.05	43,876	6,593
2007	47,687	42,006	0.54	1.04	49,752	7,745
2008	54,227	47,330	0.51	1.04	56,439	9,109
2009	61,679	53,330	0.46	1.04	63,957	10,627
2010	70,173	60,094	0.44	1.04	72,648	12,554

Source: Vo et al. (2001a).

Appendix 3 The Monetary Approach to the BOP and Estimation of Offset Coefficient

This part follows closely the study by Hallwood and MacDonald (1986). The reduced form equation is derived from the following equations:

$$L = P^k Y^{\alpha y} i^{\alpha i} \quad \text{.....(I)}$$

$$M^s = NFA + NDA \quad \text{.....(II)}$$

$$M^s = L \quad \text{.....(III)}$$

$$P^k Y^{\alpha y} i^{\alpha i} = NFA + NDA \quad \text{.....(IV)}$$

Where equation (I) is a Cagan-style money demand equation which implies that the demand for money balances depends on real income (Y), the interest rate (i), and is homogenous of degree one in prices (P). Equation (II) is the money supply identity with NFA and NDA standing for foreign reserve and domestic credit of the whole banking system, respectively. Equation (III) and (IV) represent conditions of equilibrium in money markets where demand is equal to supply.

In these equations, Y, P, i, and d are assumed all exogenous. The exogeneity of Y is justified on the Monetary Approach to the BOP grounds of long-run employment; i and P are assumed exogenous on the grounds that the economy is small in world goods and financial markets; and d are assumed exogenous.

Taking logarithmic changes of the money market equilibrium condition we receive $\Delta \log P + \alpha_y \Delta \log Y + \alpha_i \Delta i = [NFA/(NFA + NDA)]\Delta \log NFA + [NDA/(NFA + NDA)]\Delta \log NDA$

By denoting $[NFA/(NFA+NDA)]\Delta \log NFA$ as NFAR and $[NDA/(NFA+NDA)]\Delta \log NDA$ as NDAR, we can obtain

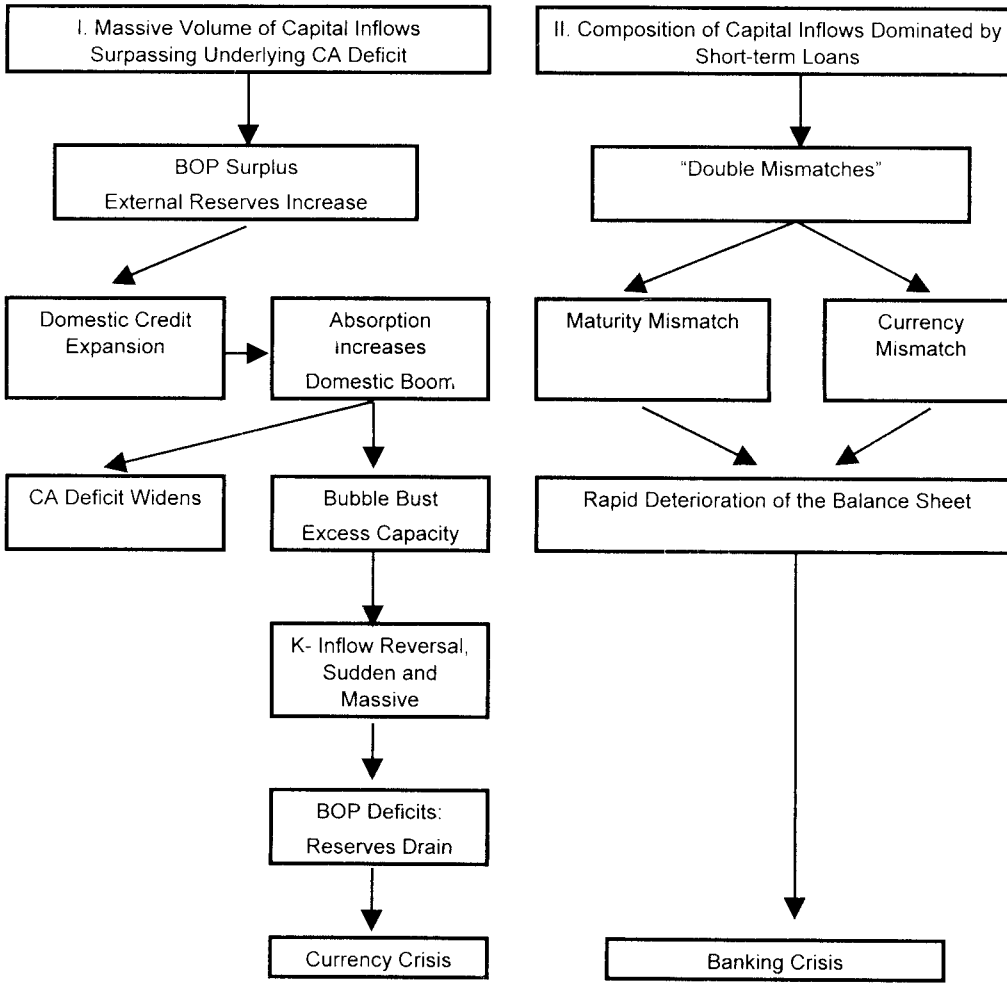
$$NFAR = \Delta \log P + \alpha_y \Delta \log Y + \alpha_i \Delta i - NDAR \qquad (V)$$

Equation (V) can be written in a form that is suitable for econometric investigation:

$$NFAR = \beta_0 + \beta_1 \Delta \log P + \beta_2 \Delta \log Y + \beta_3 \Delta i + \beta_4 NDAR + u_t \qquad (VI)$$

Where β_1 is expected to equal unity, β_2 and β_3 to take values similar to those estimated in conventional money demand equations (that are 1 and –0.01 respectively) and β_4 to equal to -1.

Appendix 4 KA Crisis and Credit Contraction: Causality Linkages Two Major Components of the Crisis



Source: Yoshitomi and Shirai (2000).

REFERENCES

1. Asian Policy Forum (APF). 2000. *Policy Recommendations for Preventing Another Capital Account Crisis.* Tokyo: ADBI. May.

2. _____. 2001. *Designing New and Balanced Financial Market Structures in Post – Crisis Asia.* Tokyo: ADBI. October.

3. Brouwer, G. 1999. *Financial Integration in East Asia.* Cambridge University Press.

4. Centre for International Economics (CIE). 1999. *Non-tariff Barriers in Vietnam: A Framework for Developing a Phase out Strategy.* Report prepared for the World Bank. Canberra & Sydney.

5. De Pines, Jaime. 1989. "Debt Sustainability and Overadjustment." *World Development.* Vol 17, No. 1.

6. Dornbusch, R., I. Goldfajn, and R.O. Valdes. 1995. "Currency Crises and Collapses." *Brookings Papers on Economic Activity* 2.

7. Eichengreen, B., and R. Hausmann. 1999. "Exchange Rates and Financial Fragility." *NBER Working Paper* No 7418.

8. Hallwood, P., and R. MacDonal. 1986. *International Money: Theory, Evidence, and Institutions.* UK: Basil Blackwell.

9. International Monetary Fund (IMF). 1993. *Balance of Payments Manual.* Washington D.C.: IMF.

10. International Monetary Fund (IMF). 1996. 1997, 1999, 2000 and 2002. "Vietnam: Selected Issues and Statistical Appendix." *IMF Staff Country Report* No. 96/30, 99/55-56, 00/53, and 02/5.

11. _____. 2001. "Vietnam: Request for a Three-year Arrangement Under the Poverty Reduction and Growth Facility." *IMF Staff Country Report* no. 01/59.

12. Johnston, B.R., and Otker-Robe. 1999. "A Modernized Approach to Managing the Risks in Cross-Border Capital Movements." *IMF Policy Discussion Papers*, PDP/99/6.

13. Kokko, A. 2001. "Globalization and Internationalization: Opportunities and Challenges for Indochina." Paper presented at the Workshop on Economic Cooperation of the Indochina Countries in the Context of International and Regional Integration, Hanoi, 11-12 July.

14. Leung, S. 1996. "Capital Flows, Monetary Policy and Exchange Rates in the Asian Region." Paper presented at the EDAP workshop, ANU, Canberra, 3-4 December.

15. Leung, S., and Le Dang Doanh. 1999. "Vietnam." In Garnaut, R., and R.H. McLeod (eds.), *East Asian in Crisis: From Being a Miracle to Needing One?*. London: Routledge.

16. Martin, and Pham Minh Duc. 2001. Problems of Banking System in Vietnam. Hanoi (mimeo).

17. McCarty, A. 1999. "Vietnam's Integration with ASEAN: Survey of Non-tariff Measures Affecting Trade." Volume 1 (Main Report). UNDP Project, Promoting Vietnam's Integration with ASEAN-VIE 95/015, January.

18. Nguyen Tan Dung. 1999. "The Struggle for Monetary Strength." *Vietnam Economic Times*, December.

19. Nguyen Thi Hong. 2002. "An Evaluation of the degree of dollarization of households, business firms, and banks in Vietnam." Hanoi, June (mimeo).

20. Nguyen Thu Ha. 2000. "Money Supply Control by the State Bank." *Vietnam- Japan Joint Research's Paper,* Hanoi, December.

21. Ohno, K. 1999. "Exchange Rate Management in Developing Asia." *ADBI Working paper* No 1, January.

22. Saito, H. 1997. "The Current Status of Financial Sector in Vietnam." Background Paper prepared for the Vietnamese-Japanese joint studies and presented at the Hanoi Workshop, June.

23. Shishido, H. 1996. "Current Account Sustainability in Vietnam." In *Vietnam: Selected issues.* Country Report No 96/146, Washington D.C.: IMF. December

24. SBV (State Bank of Vietnam) (Various issues). *Annual Report.* Hanoi.

25. Tan, Khee-Giap, T. Karigane, and M. Yoshitomi. 2001. "Avoiding Double Mismatches and Withstanding Regional Financial Crises: The Singapore Experience." *ADBI Research Paper* No 30, December.

26. Tran Duc Thinh. 2000. Strenthening Vietnam's Banking System: Lessons from the Asian Financial Crisis, 1997-98. MA Thesis, Vietnamese-Duch Master Program in Development Economics, Hanoi.

27. Vichyanond, P. 2000. *Financial Reforms in Thailand.* Bangkok: Thailand Development Research Institute. February.

28. Vo Tri Thanh (principal researcher). 2000. "Economic Growth and the Macro-Constraints: An Analysis of Vietnam's Economy using Three-gap Model." Research Project of the MPI, Hanoi, August (in Vietnamese).

29. Vo Tri Thanh, Dinh Hien Minh, Do Thu Huong and Nguyen Thi Hong. 2001a. "The Sustainability of the Current Account Deficit and External Debt in Vietnam." *EADN Working Papers* No 10, ISEAS, December.

30. Vo Tri Thanh, Dinh Hien Minh, Do Xuan Truong, Hoang Van Thanh, and Pham Chi Quang. 2001b. *Exchange Rate in Vietnam: Arrangement, Information Content and Policy Option.* CIEM, Hanoi, February.

31. World Bank. 1995. *Vietnam: An Agenda for Financial Sector Development.* The WB, Country Department I, East Asia and Pacific Region, March.

32. _____. 1997. *Vietnam: Deepening Reform for Growth.* An Economic Report, Report No 17031 - VN, October.

33. _____. 1998. *Vietnam: Rising to the Challenge.* A report to the Vietnam's Donors, December.

34. _____. 2000. *Vietnam 2010: Entering the 21st Century — Pillars of Development.* Joint Report of World Bank, ADB and UNDP, Consultative Group Meeting for Vietnam, December.

35. World Bank (various issues). *World Debt Tables*. Washington D.C.: The World Bank.

36. Yoshitomi, M., and S. Shirai. 2000. "Technical Background Paper for Policy Recommendations for Preventing Another Capital Account Crisis." ADBI, July.

37. Yoshitomi, M., and S. Shirai. 2001. "Designing a Financial Market Structure in Post-Crisis Asia – How to Develop Corporate Bond Markets." *ADBI Working Paper No 15,* March.

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EADN Regional Project on Indicators and Analyses of Vulnerabilities to Economic Crises

The papers in this volume are the results of an East Asian Development Network (EADN) regional research project on "Indicators and Analyses of Vulnerabilities to Economic Crises" coordinated by the Thailand De velopment Research Institute (TDRI). The aim of the project is to learn from the recent economic crisis that severely affected most economies in the region, and develop indicators that could be used to forewarn of future crises.

Studies were carried out for six countries; China, Indonesia, Philippines, South Korea, Thailand and Vietnam, together with a synthesis report. Four of the six countries were strongly affected by the 1997 crisis; Indonesia, the Philippines (mainly through contagion), South Korea and Thailand. For these countries, similar methodologies (signaling and probability approaches) were applied, and the studies also used the results to make assessments of the risks of crises under recent conditions. China and Vietnam did not go through a similar crisis to the other countries, so using similar methodologies to the other countries would not make much sense. The country authors therefore focused on specific issues that may create future vulnerabilities and risks to the economy. China focused on the problem of non-performing loans in the banking system, which is very high due to problem loans to state-owned enterprises. Vietnam focused on the problem of capital account sustainability. The studies for these two countries also attempted to assess the extent of the future risks for their economies and also identified necessary policy responses.

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