DLSU Business & Economics Review 18:2 (2009), pp. 1-30

Exploring the Use of Exchange Market Pressure and RMU Deviation Indicator for Early Warning System (EWS) in the ASEAN+3 Region

Marvin Raymond F. Castell and Lawrence B. Dacuycuy
De La Salle University
castellm@dlsu.edu.ph / dacuycuyl@dlsu.edu.ph

Although macroeconomic and financial surveillance mechanisms have been in place both at the global level and at the Asia regional level, the results of the empirical analysis provide some evidence that a regional monetary unit (RMU) can be used to supplement existing surveillance tools for improved crisis detection and prevention. In particular, this study showed that the RMU may be useful as a tool for macroeconomic consultation.

Keywords: Regional monetary unit, early warning system, crisis management

Increased economic integration among the ASEAN+3 economies starting in the previous decade has highlighted the benefits from more integration in the East Asian region. As a result, efforts to improve and deepen financial and monetary cooperation aimed towards a healthier financial sector and more stable currencies in the region have been proposed. One of the most widely discussed initiatives is monetary integration among the ASEAN+3 economies.

Towards this end, one of the proposed solutions that have gained momentum in recent years is the introduction of a regional monetary unit (RMU). The creation of an RMU will be particularly useful for macroeconomic surveillance and denomination of financial transactions. An RMU for surveillance will facilitate in the monitoring of excessive currency fluctuations. In addition, an RMU can also be employed for private use to diversify assets as in the case of the European Currency Unit (ECU), which has the same functional characteristics of money and can be used for international commercial and financial transactions. These perceived benefits from an RMU have increased interest among policymakers as a possible effective tool for the promotion of regional integration.

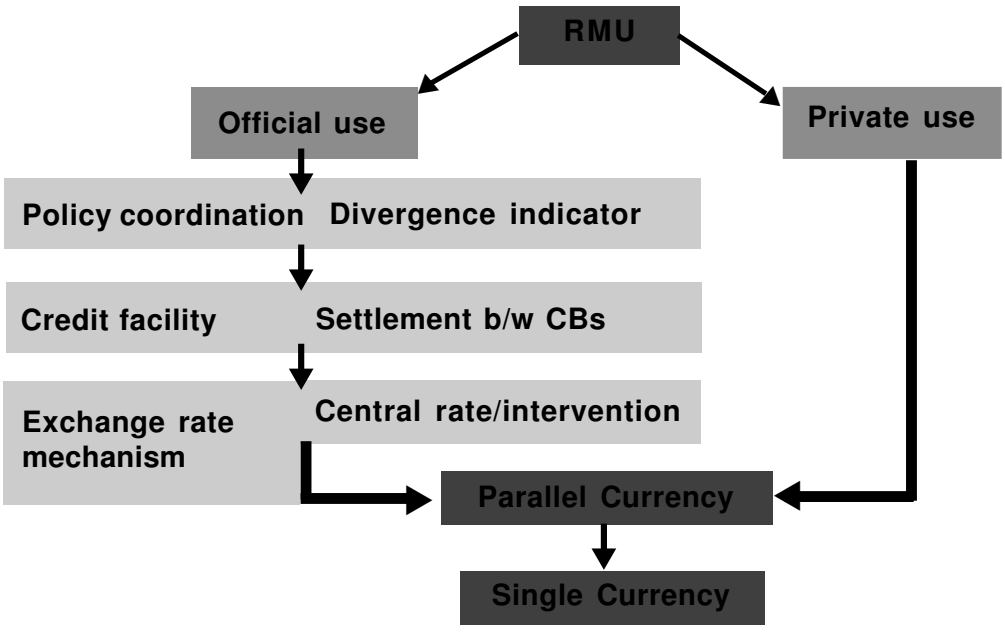
The establishment of an RMU is seen as an intermediate step that could eventually lead to an Asian Monetary Unit (AMU) in the long-run. The RMU could promote the joint objectives of an orderly exchange rate structure, greater regional cooperation, and the ability of currencies in the region to move against other major world currencies (such as the dollar and euro) without experiencing serious intraregional shifts in competitiveness. Also, it can promote diversification among investors and operators whose trade or financial flows are mostly within the region. The diversification can be in the form of working balances denominated in the RMU rather than other international currencies. In addition, an RMU can be used as a unit of account for pricing

and denominating invoices within and around the ASEAN+3 economies. This is particularly beneficial for multinationals that operate mainly within the region. Moreover, firms who will use the RMU as a unit of account and instrument to denominate their invoices can use it as an instrument for settlement, opening accounts, and for seeking financing.

Learning from the experience of the ECU, the establishment of an RMU may likewise offer increased business for the private sector, particularly those in financial institutions through the following: First, the RMU can be used as a hedging instrument for trade. Private exporters or importers in the region may hedge their exposure by using foreign exchange forward transactions of the RMU, reducing transactions costs for regional business firms. Because the RMU will serve as a composite of major currencies, market makers could develop long-term forward exchange rates against a country's local currency rather easily and economically. This may be particularly beneficial to the private sector in countries where long-term forward rates of the home currency are difficult to obtain. Second, the RMU may offer good possibilities for funding at lower rates compared to domestic sources since in the RMU market, it would be possible for issuers of bonds in the ASEAN+3 countries to get long-term funds with less foreign currency risks. In addition, an RMU may also offer better yields and less foreign currency fluctuations and thus would directly benefit the growing number of investors in the region.

In light of the above, there is a need to continue exploring the applicability of RMUs in the region specifically as a surveillance tool. The first part of this study will discuss the framework for monetary integration that can be applied in the ASEAN+3. The second part of this study will focus on the developments and approaches on the use of an Early Warning System (EWS) as surveillance mechanism. The third part of this study will then explore whether exchange market pressure and/or the RMU deviation indicators can be used as an early warning signal of an impending crisis. The last part of the study will provide a discussion of the different hurdles that must be addressed in order to have a successful RMU in the region.

Figure 1 shows the importance of the use of an RMU for official and private use as a pre-requisite



Based on the Moon, Rhee, and Yoon (2006) framework for monetary integration.

Figure 1. *RMU's Role for Monetary Integration*

to achieve monetary integration in the future. There are two broad purposes of creating an RMU in the region. The first is for macroeconomic policy surveillance and the other is for the denomination of financial transactions. The proposed RMU would help provide a benchmark for effective monitoring of exchange rate overvaluation and undervaluation (for official use). On the other hand, RMU can also represent diversified assets that can be used for business transactions as well as private sector financial products (for commercial use).

REVIEW OF RELATED LITERATURE

Macroeconomic and Financial Market Developments on the Use of the Early Warning System (EWS)

The use of the Early Warning System (EWS) model has become popular particularly in detecting a crisis in an economy. There are various types of financial crises discussed in the literature, such as currency crises, banking crises, sovereign debt crises, private sector debt crises, and equity market crises. The focus of this study will be primarily on currency crises. Kaminsky and Reinhart (1999) posit that a currency crisis often coincides with other types of crisis, such as a banking crisis. This is commonly called "twin crises."

The most popular among the various surveillance mechanisms is the Early Warning System (EWS). The EWS is a statistical way of detecting instability in an economy through the use of macroeconomic, financial, and other important information. In other words, surveillance of macroeconomic and financial market developments is utilized as a method of assessing the vulnerability of an economy to certain shocks. Although the EWS does not have perfect forecasting accuracy, it offers a systematic method of predicting a crisis within a specific time horizon. In recent years, the International Monetary Fund (IMF) has included EWS models into its surveillance process (i.e., Developing Country Studies Division model and the Policy Development and Review [PDR] model). Other institutions that use EWS models include the U.S. Federal Reserve, the European Central Bank, and the Bundesbank (Kamin, Schindler, & Samuel, 2001; Bussiere & Fratzscher, 2002).

In the private sector, EWS were also designed for explicit use in advising on foreign currency strategies, in assessing values and risks in emerging market currencies, and in providing economic forecasts to investors. Although the use of EWS models varies from company to company, most firms in the private sector use the EWS model only in instances where a crisis is in the daily headlines. EWS models used in the private sector include Goldman Sachs' GS-Watch, Credit Suisse First Boston's Emerging Markets Risk Indicator, Deutsche Bank's Alarm Clock, Moody's Macro Risk model, and the Morgan Stanley Dean Witter EWS. The Asian Development Bank (ADB) has also adopted an EWS model for ASEAN+3 countries. On the other hand, a number of private institutions have abandoned the use of EWS in their operations. These include Lehman Brothers' Currency Jump Probability model, Citicorp's EWS for balance of payments crisis in Latin America, and JP Morgan's Event Risk Indicator model (Borensztein, Pattillo, & Berg, 2004).

The three most common models used for EWS are: (1) the probit-logit model; (2) the signals approach by Kaminsky, Lizondo, and Reinhart (1998); and, more recently, (3) the Markov switching model.

Probit-logit model. The probit-logit model is based on regression estimates using limited dependent variables. The advantage of this approach is that it summarizes all information into one useful number, which is the probability of a crisis. Also, the approach considers all variables simultaneously and disregards other factors that do not contribute information that is independent from those provided by other variables in the analysis (Kaminsky et al., 1998). Lastly, it is easy to run on standard statistical software and statistical testing.

On the other hand, the model also has several weaknesses. First, it is unable to rank indicators

on the basis of forecasting accuracy since it only provides results in a regression that is either significant or not. Second, measures of statistical significance cannot distinguish between an indicator that is good at predicting a crisis and one that merely sends few false signals. Lastly, the nonlinear nature of the model makes it difficult to assess the marginal contribution of an indicator to the probability of a crisis.

Signals approach. The signals approach was developed by Kaminsky et al. (1998) to serve as basis for the design of an Early Warning System and to address the shortcomings of the probability approach. The signals approach compares the behavior of selected variables during the period preceding a crisis (control group) and identifies variables that have distinct behavior that can be used to assess the likelihood of a crisis. This entails monitoring of economic indicators that tend to systematically behave differently before the occurrence of a crisis.

A crisis, as defined by Kaminsky et al. (1998), is a situation in which an attack on a currency leads to a sharp depreciation of the currency, a large decline in international reserves, or a combination of the two. A crisis also includes both successful and unsuccessful attacks on the currency. The definition is comprehensive enough to include not only currency attacks under fixed exchange rate but also under other exchange rate regimes. Vulnerability to a crisis is signaled when one or more "indicator variables" deviate significantly from its behavior during non-crisis periods. The signals approach identifies the variables that have distinctive behavior that could be used to assess the likelihood of a crisis.

The effectiveness of indicators is based in terms of the matrix presented in Table 1. The most favorable distribution for an early warning system occurs when all signals are in Sections A (i.e., a signal was issued and a crisis eventually takes place) and D (i.e., no signal was transmitted in crisis-free times). However, two possible sources of error are shown in Section C (i.e., a crisis occurs but no signal was sent beforehand) and B (i.e., a signal was transmitted without any crisis occurring).

The advantage of using the signals approach is that it indicates very clearly the variables that are behaving abnormally. This approach provides policymakers with an easier way of detecting a problem in the economy and can provide some indication of how widespread the problem is by noting the number of variables that are deviating from its normal trend. However, the signaling approach also has its disadvantages. First, it does not look at marginal contributions only. This implies that there will be a lot of common information contained in variables that one cannot take into account. Two or more variables that move closely

Table 1
Matrix of Crisis Indicator Effectiveness Using the Signals Approach

Description	Crisis (within 24 months)	No Crisis (within 24 months)
Signal was issued	A (Good Signal)	B (False Signal)
No signal was issued	C (Missed Signal)	D (Good Silence)

Source: Kaminsky et al. (1988).

together will tend to send signals simultaneously. Although they contain the same information, they count as two separate variables with equal weights. Second, it does not lend itself to statistical testing. Thus, it is difficult to assess how well this approach works relative to other approaches or models.

Markov switching model. The Markov switching model with time-varying transition probabilities can be used as an EWS for currency crises. It is said to be appropriate for modeling variables that display sudden and dramatic shifts in behavior, as in the case of a currency crisis. Compared to the two approaches mentioned earlier, the advantage of using the Markov switching approach is that it does not require *a priori* dating of crisis periods and otherwise. In fact, given the data, this information is something that the model estimates. Thus, the problem of arbitrary thresholds used in dating crisis is eliminated. In addition, the model can reveal information about the dynamics of a crisis, not just when they tend to occur, but also how long the crisis is likely to last, and what factors can address the problem. Lastly, since the byproduct of estimating a Markov switching approach is the use of one-step-ahead probability of a crisis occurring, it lends itself naturally for use as an Early Warning System (Abiad, 2002).

Monitoring Economic and Financial Indicators through EWS

Several studies share the idea that it is possible to identify economic and financial indicators as determinants of a financial crisis. The most popular of which is the study by Kaminsky et al. in 1998, which used 15 indicator variables that can be grouped into four major categories namely: (1) current account indicators; (2) capital account indicators; (3) real sector indicators; and (4) financial indicators. The variables were selected based on theoretical considerations and information availability on a monthly basis. The list of variables considered is shown in Appendix A

However, criticisms did not escape the initial study by Kaminsky et al. (1998). These revolved around the exclusion of essential financial and economic indicators in the detection of a crisis. The empirical literature suggests that an effective EWS should consider a broad variety of indicators since a currency crisis often takes place after multiple economic, political, and even social problems have occurred (Edison, 2003; Eichengreen & Arteta, 2000; Berg & Pattillo, 1999; Demirguc-Kunt & Detragiache, 1998, 2000). These indicators are shown in Appendix B.

EMP AND RMU DEVIATION INDICATOR AS A SURVEILLANCE TOOL

EMP as Crisis Indicator

This section will test whether the Exchange Market Pressure (EMP) can be used as a surveillance mechanism for the region. The model is estimated using monthly data from January 2000 to November 2005 for 10 countries, namely: Cambodia, China, Indonesia, Korea, Laos, Malaysia, the Philippines, Singapore, Thailand, and Vietnam. Data was collected from International Financial Statistics of the IMF as well as country data from national sources. Data were processed using the ADB VIEWS standard for EWS model. The dependent variable in the model is the *EMP*, where:

$$EMP = \%\Delta ER - \left(\frac{\sigma_{\Delta ER}}{\sigma_{\Delta FOREX}} \right) \bullet \%\Delta FOREX \quad (1)$$

$\%\ \Delta\ ER$ = percentage change in the exchange rate measured as the value of $ER(t) - ER(t\text{-}1)$ divided by $ER(t-1)$ x 100

$\%\ \Delta\ FOREX$ = $FOREX(t) - FOREX(t\text{-}1)$ divided by $FOREX(t\text{-}1)$ x 100.

σ = sample standard deviations of the percentage changes in FOREX and ER, respectively.

Following the set of indicators used by the IMF, European Union, and the various literatures on Early Warning System, the model will use the most common indicators to predict crises. However, there are dozens of potential variables that could be used to explain the likelihood of a crisis. For instance, Kaminsky et al. (1998) list 103 different indicators. To solve this problem, this study will utilize the IMF *World Economic Outlook* of May 1998 approach to trim down the indicators to three: (1) real exchange rate; (2) credit growth; and (3) M2/Reserves. Following Abiad (2002), the variables were transformed to include the following: (1) deviation of real effective exchange rate from trend (representing the current account indicator); (2) ratio of M2 to foreign exchange reserves (representing capital account indicator); and (3) the ratio of domestic credit to GDP (representing the financial indicator).

Several studies explain that a deviation of the real effective exchange rate from trend may signal an overvalued exchange rate and thus, may lead to a financial crisis. The specification was used since it is in line with the theoretical idea that deviations from an equilibrium real exchange rate translate to pressure for realignment. On the other hand, the ratio of M2 to foreign exchange reserves captures the extent to which the liabilities of the banking system are backed by foreign reserves. In the event of a currency crisis, individuals may rush to convert their domestic currency deposits into foreign currency, so that this ratio captures the ability of the central bank to meet their demands. Lastly, the ratio of domestic credit to GDP indicates that a very high growth of domestic credit may serve as a crude indicator of the fragility of the banking system. This ratio usually rises in the early phase of the banking crisis. It may be that as the crisis unfolds, the central bank may be injecting money to the bank to improve their financial situation.

The deviation indicator will be applied to analyze whether it can be a useful mechanism as a crisis indicator, with the objective of promoting financial and economic stability in the region. Analytically, the deviation indicator proxies currency misalignments, but this time, relative to an average RMU value during the base year. Periods during which deviations are sustained may contain information as to the likelihood of a crisis taking place.

Crisis Dating

To determine the existence of crisis in the sample period, we use the condition:

$$\begin{aligned} Crisis &= 1, if\ EMP > \mu_{EMP} + \sigma_{EMP} \bullet k \\ &= 0, otherwise. \end{aligned} \qquad (2)$$

where $\mu_{EMP} + \sigma_{EMP} \bullet k =$ threshold level; and $k = (1, 1.5, 1.75, 2)$.

The threshold accounts for the central tendency and the spread of the EMP and $\sigma_{EMP} \bullet k$ represents the k – deviation/s from the mean. The lower the value of k, the lower will be the threshold, indicating that the number of crises may increase as we reduce k. Given consecutive crises periods associated with lower values of k, say $t_0 + h$ periods, a crisis period that is identified using a higher value of k at $t_0 + h + 1$ may indicate that the crisis has deteriorated. However, based on statistical construction, the crisis identifier will not register a crisis even when EMP is very close to the threshold. Thus, the crisis identifier will not capture crisis severity as well as duration.

For the first statistical description, changes in exchange rates (including lagged effects), changes in reserves (including lagged effects), and deviation indicators (including lagged effects) were tested to determine crisis episodes. The discussion of the results focuses on threshold levels where $k = 1$ and $k = 2$, respectively.

RESULTS AND DISCUSSION

Deviation Indicator Results

Cambodia. Table 2 summarizes the nine recorded episodes for crisis months for $k = 1$ and three episodes of crisis for $k = 2$ in Cambodia for the sample period.

For both threshold levels, most of the crisis months recorded occurred during the time when changes in reserves decreased significantly in the previous month. The lagged deviation indicator on the other hand was observed to be increasing during the crisis months while the highest EMP during the crisis episode was only 1.690. It may appear that the designation of July 2000 as a crisis episode is counterintuitive as the respective magnitudes of changes in *ER* and reserves are almost the same. However, this can be resolved by examining the relative variation in *ER* and reserves. The former registered only 0.41 while the latter tallied 2.53, indicating that Cambodia during the entire sample period may have extensively used foreign reserves instead of allowing its currency to depreciate. The threshold recorded at $k = 2$ is at 1.03.

China. As shown in the Table 3, China only experienced one crisis episode in November 2004. China is one of the countries that implements a rigid exchange rate system, which implies that most of the variations in the exchange market pressure will be dictated by the movements in foreign reserves. During the said period, the country experienced a significant reduction in reserves while the deviation indicator showed an appreciation in its currency

Table 2
Deviation Indicator Results: Crisis Episodes in Cambodia

Month	$k = 2$	$k = 1$	% Δ *ER*	% Δ Reserves	EMP
2000 M7	1	1	1.526	1.566	1.271
2002 M9	0	1	0.434	-0.612	0.534
2003 M5	0	1	0.812	1.356	0.591
2004 M5	0	1	0.552	-2.965	1.035
2004 M6	1	1	0.200	-9.150	1.690
2005 M5	0	1	0.696	0.958	0.540
2005 M6	0	1	0.790	-1.242	0.992
2005 M7	1	1	1.175	0.801	1.045
2005 M9	0	1	0.777	-0.482	0.855
Thresholds	1.0385129	0.46773416			

Table 3
Deviation Indicator Results: Crisis Episodes in China

Month	$k = 2$	$k = 1$	% Δ *ER*	% Δ Reserves	EMP
2004 M11	1	1	0.000	-4.061	0.453
Thresholds	0.33541105	0.03786672			

Table 4
Deviation Indicator Results: Crisis Episodes in Indonesia

Month	$k = 2$	$k = 1$	% Δ *ER*	% Δ Reserves	EMP
2000 M7	0	1	6.285	0.545	5.428
2000 M10	0	1	4.845	-0.040	4.907
2001 M3	0	1	5.226	-1.332	7.305
2001 M4	1	1	9.856	-1.125	11.625
2001 M9	0	1	5.411	-2.569	9.452
2001 M10	0	1	8.693	-0.399	9.321
2002 M7	0	1	2.677	-1.805	5.515
2002 M10	0	1	2.557	-2.012	5.722
2004 M6	0	1	4.730	-1.248	6.692
2005 M5	0	1	-0.694	-4.605	6.548
Thresholds	9.8285552	4.7413697			

during the said crisis episode. This was also the only period where the EMP was positive in the whole sample period. The threshold was one of the lowest in the sample countries with 0.33 at $k = 2$.

Indonesia. Table 4 summarizes the 10 recorded episodes for crisis months for $k = 1$ and one crisis episode for $k = 2$ in Indonesia for the sample period:

In terms of magnitudes, Indonesia has one of the highest thresholds. For both threshold levels, most of the crisis months recorded occurred during the months when the changes in reserves decreased during the crisis episode month. On

the other hand, almost all crisis episodes occurred during the time when exchange rate increased. The lagged deviation indicator on the other hand was observed to be depreciating during the crisis months. Based on descriptive statistics across countries, Indonesia has the most variable exchange rate movements. It also registered the highest average depreciation during the sample period. Also, among the sample countries, the threshold level for Indonesia was highest at 9.82 for $k = 2$.

Korea. In the case of Korea, 12 crisis episodes were recorded for $k = 1$ and none for $k = 2$ as shown in Table 5.

It can be observed that most of the crisis episodes recorded was concentrated between 2001 and 2002. Results were found to be inconsistent as there were cases where the contemporaneous and lagged reserves decreased while in other crisis episodes, reserves actually increased. Threshold level was recorded at 2.96 at $k = 2$.

Table 5
Deviation Indicator Results: Crisis Episodes in Korea

Month	$k = 2$	$k = 1$	% Δ *ER*	% Δ Reserves	EMP
2000 M12	0	1	5.220	3.695	1.335
2001 M1	0	1	4.580	3.830	0.553
2001 M3	0	1	3.148	1.154	1.935
2001 M9	0	1	0.809	0.174	0.626
2001 M12	0	1	0.752	-0.810	1.604
2002 M1	0	1	1.945	-0.086	2.035
2002 M2	0	1	0.216	-0.934	1.198
2002 M3	0	1	0.217	-1.028	1.297
2002 M9	0	1	1.046	0.390	0.636
2002M10	0	1	2.515	1.174	1.281
2003 M3	0	1	3.751	1.474	2.201
2005 M7	0	1	2.502	1.480	0.946
Thresholds	2.9635387	0.43880708			

Laos. Laos recorded two crisis episodes for $k = 2$ and seven crisis episodes for $k = 1$ (see Table 6). Laos is second only to Vietnam in terms of variability in foreign reserve changes. Except for March 2001, reserves decreased during almost all the crisis episodes while the exchange rate depreciated during the said episodes. The threshold level of 7.79 at $k = 2$ was one of the highest in the sample countries.

Malaysia. In the case of Malaysia, the country experienced crisis episodes at $k = 1$ in six months (see Table 7). Since the exchange rate was relatively fixed, the reserves declined during the crisis episodes. This may simply indicate the active and consistent use of reserves in response in speculative pressures that target the currency's depreciation. Following the theory, this may work but only at the expense of drawing down the country's reserves, which will eventually be exhausted. The threshold level on the other hand for Malaysia recorded the lowest among the sample countries at $k = 2$ at 0.25.

Philippines. The Philippines experienced eight crisis episodes at $k = 1$ and one episode for $k = 2$ (see Table 8). Most of the said crisis episodes happened during the time when the reserves were declining while the currency was depreciating. This may imply the existence of a limited intervention in the exchange market, which point to the possibility that reserves will be reduced to combat speculative pressures only up to a certain extent and then allow the currency to seek its own value. In terms of average depreciation, the Philippines is second only to Indonesia. On a positive note, growth of exchange rate is not as variable as Indonesia's but displays greater variability in terms of its reserves. Threshold on the other hand was in between sample countries with 4.90 at $k = 2$.

Singapore. Singapore experienced 10 crisis episodes for $k = 1$ and one for $k = 2$ (see Table 9). Except for April and October 2001, reserves also declined during the crisis episodes while the currency depreciated. There are also months during

Table 6
Deviation Indicator Results: Crisis Episodes in Laos

Month	$k = 2$	$k = 1$	% Δ *ER*	% Δ Reserves	EMP
2000M9	0	1	0.350	-6.954	4.224
2000M11	1	1	7.574	-2.185	8.797
2001M3	1	1	13.207	0.051	13.178
2001M10	0	1	1.803	-4.478	4.311
2002M1	0	1	0.285	-7.045	4.230
2002M7	0	1	2.824	-8.595	7.637
2002M9	0	1	3.478	-1.022	4.050
Thresholds	7.7926781	3.8532889			

Table 7
Deviation Indicator Results: Crisis Episodes in Malaysia

Month	$k = 2$	$k = 1$	% Δ *ER*	% Δ Reserves	EMP
2000M8	0	1	0.000	-4.289	0.166
2000M9	0	1	0.000	-3.763	0.146
2001M6	0	1	0.000	-3.494	0.136
2001M9	0	1	0.000	-5.508	0.214
2002M2	0	1	0.000	-5.757	0.223
2002M3	0	1	0.000	-2.772	0.108
Threshold	0.2549326	0.09842785			

Table 8
Deviation Indicator Results: Crisis Episodes in the Philippines

Month	$k = 2$	$k = 1$	% Δ *ER*	% Δ Reserves	EMP
2000M7	0	1	3.962	1.923	3.007
2000M10	0	1	5.181	1.018	4.676
2001M1	0	1	2.144	-1.646	2.962
2001M4	1	1	3.549	-2.889	4.984
2001M6	0	1	1.880	-3.665	3.700
2003M6	0	1	1.699	-4.845	4.105
2003M8	0	1	2.377	-1.550	3.147
2005M6	0	1	1.542	-2.054	2.562
Threshold	4.9015556	2.5619129			

which rare combinations of appreciations and reserve declines happened. Threshold level was recorded at a modest 2.73 at $k = 2$.

Thailand. For Thailand, a total of 12 crisis episodes occurred with 10 at $k = 1$ and two at $k = 2$ (see Table 10). For most of the episodes, reserves were relatively increasing while exchange rate was depreciating. For both crisis episodes at $k = 2$, the reduction in reserves occurred and at the same time appreciation of the currency. The Thai case actually shares the characteristics of the Philippines and Singapore at least within the sample period. Threshold level was recorded at 3.63 at $k = 2$.

Vietnam. Vietnam experienced only four crisis episodes at $k = 1$ and one at $k = 2$ (Table 11). The crisis episode at $k = 1$ in October 2001 transpired during the time when the currency during the previous month depreciated with no change in the level of reserves. This was a clear break from the subsequent crisis periods. The remaining crisis episodes were mostly due to the reduction in reserves and the depreciation of the currency. Therefore, what happened was a clear shift in policy intervention. As a matter of fact, the variability of reserve movements is highest for Vietnam relative to the other countries. The threshold level was recorded at 2.80 at $k = 2$.

Exchange Market Pressures and Deviation Indicators

The second statistical description includes the use exchange market pressure (including

Table 9
Deviation Indicator Results: Crisis Episodes in Singapore

Month	$k = 2$	$k = 1$	% Δ *ER*	% Δ Reserves	EMP
2000M1	0	1	0.000	-2.627	1.693
2000M2	0	1	1.796	-0.796	2.309
2000M9	0	1	1.163	-1.095	1.868
2000M10	0	1	0.575	-1.082	1.272
2001M4	0	1	2.260	1.016	1.605
2001M6	0	1	0.552	-1.573	1.566
2001M10	1	1	3.429	0.131	3.344
2002M2	0	1	-0.543	-3.194	1.515
2005M3	0	1	-0.427	-3.367	1.743
2005M6	0	1	1.235	-1.848	2.426
Threshold	2.7390724	1.1903092			

Table 10
Deviation Indicator Results: Crisis Episodes in Thailand

Month	$k = 2$	$k = 1$	% Δ *ER*	% Δ Reserves	EMP
2000M7	0	1	2.919	0.920	2.264
2000M9	0	1	2.444	0.246	2.269
2000M10	0	1	3.182	1.273	2.275
2000M12	0	1	-1.431	-6.313	3.064
2001M3	0	1	2.947	-0.282	3.147
2001M4	1	1	3.579	-0.818	4.161
2002M8	0	1	2.322	0.042	2.292
2004M2	0	1	0.008	-2.876	2.055
2004M5	0	1	2.866	1.315	1.929
2004M6	1	1	0.592	-4.683	3.926
2005M4	0	1	2.405	0.331	2.169
2005M6	0	1	2.740	0.371	2.476
Threshold	3.6300801	1.5918798			

cumulative) and the deviation indicator (including changes and lagged effects) to determine crisis episodes. Though the informational content of EMP and cumulative EMP are the same, the latter provides an indicator for the severity of crisis in that it is concerned with the temporal buildup of EMPs. The discussion of the results focuses on cases involving $k = 1$ and $k = 2$, respectively, for all sample countries.

Cambodia. As expected, the crisis episodes were the same as the first model (i.e., nine episodes for $k = 1$ and three for $k = 2$) (see Table 12). However, it became evident that although EMP increased during the crisis episodes, the cumulative EMP declined during the said periods. This is due to the fact that periods of tranquility outnumber crisis periods. On the other hand, the deviation indicator did not provide consistent result during the crisis episodes. Consider the three crisis months from May to June 2005. EMP has been increasing, indicating that the cumulative market pressure should likewise increase. Note that EMP actually crossed the higher threshold after two months of registering positive for a crisis based on a lower threshold.

China. The crisis episode was also the same as the first model in the case of China (see Table 13). The cumulative EMP also declined during the crisis episode while EMP increased.

Indonesia. In the case of Indonesia, there is one different crisis episode that occurred in July 2005 as compared to the first model where the crisis episode occurred in May 2005 (see Table 14). In most of the crisis episodes identified, the EMP as well as the cumulative EMP increased.

Korea. In the case of Korea, the crisis episodes were consistent with the first model (12 crisis episodes for $k = 1$ and none for $k = 2$) (see Table 15). However, it can be noticed that the cumulative EMP declined considerably while EMP was increasing during the crisis episodes.

Laos. The crisis episodes for Laos were the same as the first model (see Table 16). However, during the crisis episodes, both EMP and cumulative EMP were increasing. Pressures were building up between September 2000 and early months of 2003, which may indicate the failure of past interventions to address the cause of the said buildup.

Malaysia. Malaysia's crisis episodes were the same as the first model (six crisis episodes at $k = 1$ and none for $k = 2$) (see Table 17). The crisis episodes in 2000 and 2001 exhibited a reduction in the cumulative EMP while EMP was increasing. On the other hand, the crisis episodes in 2002 recorded increase in both EMP and cumulative EMP. Based on the data, no appreciable buildup in exchange market pressure can be observed.

Philippines. In the case of the Philippines, the same crisis episodes in the first model occurred in all (except for July 2000) EMP and cumulative EMP increasing during the crisis episodes (see Table 18). Of all the countries contained in the sample, the Philippines' exchange market pressure was indeed very large.

Singapore. Singapore also registered the same crisis episodes as the first model (see Table 19). The crisis episodes the occurred from 2000 to 2002 showed an increasing EMP and cumulative EMP while the 2005 crisis episodes illustrate a reduction in the cumulative EMP.

Thailand. For most part of the crisis episodes in 2000 to 2002, the EMP and cumulative EMP for Thailand were increasing (see Table 20). However the crisis episodes in 2004 and 2005 recorded a decreasing cumulative EMP.

Vietnam. Vietnam also registered the same crisis episodes as the first model (see Table 21). However, during the said crisis episodes, EMP was increasing while cumulative EMP declined.

Table 11
Deviation Indicator Results: Crisis Episodes in Vietnam

Month	$k = 2$	$k = 1$	% Δ *ER*	% Δ Reserves	EMP
2001M10	1	1	6.547	0.000	6.547
2002M2	0	1	0.331	-5.237	1.548
2002M5	0	1	0.191	-5.48	1.464
2002M10	0	1	0.117	-7.186	1.786
Threshold	2.8035582	1.28651			

Table 12
Exchange Market Pressure and Deviation Indicator Results: Crisis Episodes in Cambodia

Month	$k = 2$	$k = 1$	EMP	Cumulative EMP
2000M7	1	1	1.271205	1.163214
2002M9	0	1	0.533961	-4.039756
2003M5	0	1	0.590733	-7.298134
2004M5	0	1	1.034680	-7.049075
2004M6	1	1	1.689996	-5.359079
2005M5	0	1	0.539619	-8.937459
2005M6	0	1	0.991900	-7.945560
2005M7	1	1	1.044591	-6.900968
2005M9	0	1	0.855454	-6.457684

Table 13
Exchange Market Pressure and Deviation Indicator Results: Crisis Episodes in China

Month	$k = 2$	$k = 1$	EMP	Cumulative EMP
2004M11	1	1	0.453052	-11.435760

Table 14
Exchange Market Pressure and Deviation Indicator Results: Crisis Episodes in Indonesia

Month	$k = 2$	$k = 1$	EMP	Cumulative EMP
2000M7	0	1	5.427956	10.059290
2000M10	0	1	4.907273	8.304996
2001M3	0	1	7.304821	9.775780
2001M4	1	1	11.625000	21.400780
2001M9	0	1	9.451832	1.833387
2001M10	0	1	9.321121	11.154510
2002M7	0	1	5.515957	1.386540
2002M10	0	1	5.721833	6.194603
2004M6	0	1	6.692197	-19.821640
2005M7	0	1	6.547807	-24.262500

Table 15
Exchange Market Pressure and Deviation Indicator Results: Crisis Episodes in Korea

Month	$k = 2$	$k = 1$	EMP	Cumulative EMP
2000M12	0	1	1.335430	-31.720550
2001M1	0	1	0.553209	-31.167340
2001M3	0	1	1.935194	-35.965710
2001M9	0	1	0.626291	-45.328880
2001M12	0	1	1.603941	-48.675730
2002M1	0	1	2.035190	-46.640540
2002M2	0	1	1.198350	-45.442190
2002M3	0	1	1.297284	-44.144910
2002M9	0	1	0.636052	-60.499450
2002M10	0	1	1.280510	-59.218940
2003M3	0	1	2.201140	-65.481680
2005M7	0	1	0.945984	-131.699700

Table 16
Exchange Market Pressure and Deviation Indicator Results: Crisis Episodes in Laos

Month	$k = 2$	$k = 1$	EMP	Cumulative EMP
2000M9	0	1	4.243906	7.973393
2000M11	1	1	8.797337	18.318180
2001M3	1	1	13.178260	26.781900
2001M10	0	1	4.310678	12.699950
2002M1	0	1	4.229753	13.477910
2002M7	0	1	7.636611	21.470330
2002M9	0	1	4.050491	25.161640

Table 17
Exchange Market Pressure and Deviation Indicator Results: Crisis Episodes in Malaysia

Month	$k = 2$	$k = 1$	EMP	Cumulative EMP
2000M8	0	1	0.166493	-0.548796
2000M9	0	1	0.146076	-0.402721
2001M6	0	1	0.135620	-0.728665
2001M9	0	1	0.213800	-0.443490
2002M2	0	1	0.223491	0.001510
2002M3	0	1	0.107620	0.109131

Table 18
Exchange Market Pressure and Deviation Indicator Results: Crisis Episodes in the Philippines

Month	$k = 2$	$k = 1$	EMP	Cumulative EMP
2000M7	0	1	3.006907	-2.547459
2000M10	0	1	4.675668	4.588039
2001M1	0	1	2.961669	11.391920
2001M4	1	1	4.983599	6.301037
2001M6	0	1	3.700119	11.393710
2003M6	0	1	4.105025	11.870880
2003M8	0	1	3.146674	15.853080
2005M6	0	1	2.561919	17.575490

Table 19
Exchange Market Pressure and Deviation Indicator Results: Crisis Episodes in Singapore

Month	$k = 2$	$k = 1$	EMP	Cumulative EMP
2000M1	0	1	1.692973	1.692973
2000M2	0	1	2.308920	4.001893
2000M9	0	1	1.868283	3.164008
2000M10	0	1	1.272182	4.436191
2001M4	0	1	1.605230	6.184936
2001M6	0	1	1.565614	6.547353
2001M10	1	1	3.344291	4.952451
2002M2	0	1	1.514828	5.939599
2005M3	0	1	1.742627	-21.184140
2005M6	0	1	2.425556	-19.469590

Table 20
Exchange Market Pressure and Deviation Indicator Results: Crisis Episodes in Thailand

Month	$k = 2$	$k = 1$	EMP	Cumulative EMP
2000M7	0	1	2.263797	-2.508327
2000M9	0	1	2.268766	1.097808
2000M10	0	1	2.275446	3.373254
2000M12	0	1	3.063513	3.382861
2001M3	0	1	3.147472	6.09819
2001M4	1	1	4.161333	10.25952
2002M8	0	1	2.291882	1.285733
2004M2	0	1	2.055489	-16.56849
2004M5	0	1	1.929469	-16.01005
2004M6	1	1	3.926253	-12.08379
2005M4	0	1	2.169415	-24.68701
2005M6	0	1	2.475984	-22.26706

Table 21
Exchange Market Pressure and Deviation Indicator Results: Crisis Episodes in Vietnam

Month	$k = 2$	$k = 1$	EMP	Cumulative EMP
2001M10	1	1	6.547000	-5.046996
2002M2	0	1	1.547511	-2.817917
2002M5	0	1	1.464164	-3.019954
2002M10	0	1	1.786372	-4.130408

Summary of Results

In general, the results of the EMP and deviation indicator showed mixed results in predicting crisis. Based on the results from the 10 countries in the sample, it can be noted that the countries have different degrees of EMP and that the threshold spikes are also different for each country. In many cases, the adjustments were seen either in the exchange rate and/or combination with changes in the international reserves. On the other hand, EMP and thresholds differ for the sample countries with Indonesia having the highest EMP at 11.625 in April 2001 and threshold level of 9.82 at $k = 2$. Meanwhile, Malaysia had the lowest EMP with no crisis episode recorded at $k = 2$. Also, threshold for Malaysia was also lowest for $k = 2$ at 0.25 among all the sample countries.

In a number of instances, it can be observed that the crisis periods were preceded by both rising EMP and cumulative EMP, which suggests that both EMP and cumulative EMP are good predictors of crisis. However, there were also instances when rising EMP and cumulative EMP did not lead to a crisis. In the case of the deviation indicator, there were also instances when the declining deviation indicator did not lead to a crisis. The results show that the various measures, the EMP, the deviation indicator, and the cumulative EMP are at best imperfect when it comes to providing an early warning signal. This may be the case, since the more appropriate method through which we can predict a crisis is provided by the Markov switching model. The measures do not have a probabilistic component, that is, they fail to incorporate the chance that a crisis will actually happen.

Regression Analysis

This study uses two models. The first (Model 1) involves the use of three indicators namely: deviation of real effective exchange rate from trend (representing the current account indicator); ratio of M2 to foreign exchange reserves (representing capital account indicator), and the ratio of domestic credit to GDP (representing the financial indicator). This represents the more traditional approach. The second (Model 2) includes the deviation indicator in the model and tries to determine if it can be used as an early warning indicator for surveillance (see Appendix C). One good criterion for assessing the empirical value of the deviation indicator as an early warning indicator is to be able to observe whether the resultant change in the goodness of fit is significant. It is also of econometric interest to ascertain the form of the deviation indicator that will support a very high explanatory power.

The results for the first model varied from country to country. In the case of Cambodia, the

deviation of real effective exchange rate from the trend is the best crisis indicator while in the case of China and Malaysia, the ratio of M2 to foreign exchange reserves would be the better indicator. For Indonesia, all three indicators have significant explanatory powers to predict a crisis. On the other hand, Korea, Laos, the Philippines, Singapore, Thailand, and Vietnam yielded negative results.

In the second model, the deviation indicator was included to determine its effectiveness as an early warning tool. Results indicate that the deviation indicator is significant for 4 out of the 10 sample countries (i.e., Korea, the Philippines, Singapore, and Thailand). The results are consistent since the said countries use a floating exchange rate system. Thus, it can be said that the use of deviation indicator as surveillance tool can help countries determine if there are weaknesses in the system, particularly if they are currently adopting a flexible exchange rate system.

To check for the lagged effects, the moving average specification of the regressors was used to check the consistency of the results generated in the model. It was also used to economize on the degrees of freedom as noted in Eichengreen, Rose, and Wyplosz (1996). The specifications were divided into four: (1) the moving average of contemporaneous plus one lag; (2) the moving average of contemporaneous plus two lags; (3) the moving average of two lags; and (4) the moving average of four lags. Appendix D shows the summary of the results generated.

In the models that utilized the moving average based regressors, the 12-month percentage change in M2/reserves were significant to both China and Malaysia since during most of the sample period, both countries were using a relatively fixed exchange rate. Understandably, monetary policy will be used to ensure stability. The real exchange rate deviation from the trend also yielded significant results only for China, indicating the significant role of trade. An overvalued currency as shown by an increasing deviation of real effective exchange rate (REER) from its trend implies that for China, the exchange market pressure should decline. This is in contrast to the Cambodia, where an overvalued currency is associated with an increasing exchange market pressure. The 12-month percentage change in credit/GDP did not yield significant results except for Indonesia and Thailand.

For the deviation indicator, the initial regression results were consistent with the moving average as Korea, the Philippines, Singapore, and Thailand yielded significant results. However, the results also support the fact that each of the said countries may require different information set that pertains to the deviation indicator. For instance, the Philippines may scrutinize the first and second lags of the changes in the deviation indicator but may also be interested in the contemporaneous specification. In Singapore's case, the relevant specification for the deviation indicator omits the contemporaneous component.

The econometric results present a case of sample separation with respect to the deviation indicator. On one hand are countries which may not need or require the use of the deviation indicator as an early warning indicator, while on the other are countries where the deviation indicator has informational and inferential values, which may augment the set of early warning indicators that are currently in place. More importantly, the results confirm that countries which use floating exchange rate can benefit from the use of deviation indicator as a surveillance tool, and in the process, achieve financial and economic stability in the region.

Some Remarks

Several weaknesses related to the use of the regression models may easily be pinpointed. First, the models presented did not compute for the probability of a crisis but instead focused only on the relationship between exchange market pressures and a set of crisis predictors. Second, sudden changes in the exchange market pressure were not captured by the regression models. These shifts are evident from the time series characterizations of the cumulative EMP. As Abiad (2002) pointed out, unless the model used is of the Markov switching model variety, the duration of the crisis will not be detected from the data. This may partly explain why in certain countries,

most models fitted were insignificant. Third, since the deviation indicator represents the deviation of the actual currency per RMU from the base year, then it implies that replication studies that stretch the sample from the 1980s to the present will yield different predictions as the base year depends on the period under consideration. Fourth, important qualitative variables (e.g., contagion, political crises, and social crises) that are specific to a given country were not considered. Fifth, the interpretation of the regression equations was done within the context of early warning systems.

Nonetheless, regression analysis is useful in trying to determine the determinants of exchange market pressure. What is now needed is to explore *EMP* thresholds and their relationship to crisis situations.

Hurdles to a Successful RMU in the ASEAN+3 Region

In order for the establishment of the RMU to be successful in the region, several hurdles may need to be addressed:

Deregulation of capital and foreign exchange controls. One major difference between the ECU and the proposed RMU currency basket is that all currencies could be freely traded in the ECU and, thus, actual currency baskets comprised of varying proportions of each member currency could be created. In the case of RMU, a number of the member currencies are restricted. As such, there is a need for ASEAN+3 countries to deregulate their capital and foreign exchange controls to allow convertibility in both the current and capital accounts.

Strengthening political and institutional foundations. In the case of Europe, central exchange rates were established with strict capital control while capital flows in Asia are more vulnerable to large fluctuations in private capital flows due to a more liberalized financial market. Therefore, there is a need to further strengthen political, as well as institutional foundations, to support regional integration. Several studies have indicated that Asia has a relatively short history of economic integration compared with other regions as the ASEAN+3 Summit started only in 1997. The Asian Bond Fund (ABF) as well as the Chiang Mai Initiative (CMI) is still in the early stages of existence (see Watanabe & Ogura, 2006). The ABF was established in 2003 to foster local bond market. The CMI on the other hand was born out of the agreement in 2000 to enhance currency cooperation in the region through currency swap agreement.

Diversity in the level of economic development across countries. This degree of diversity is higher in the ASEAN than among the countries of the EU, which could make it difficult to sustain a monetary union. It was noted that income differentials across countries could pose a constraint only to the extent that they reflect dissimilarities in the production structures across countries. To manage a currency union for a group of countries with a large difference in level of development, it would be important to allow a freer flow of capital and labor across borders. With regard to fiscal policy, a large centralized budget at the union level is needed to make resource transfers across countries. Greater mobility of factors of production will be able to reduce the amount of fiscal transfers needed over the medium to long term. Country-specific fiscal policies can be used to respond to asymmetric shocks across countries within the union.

Weakness in financial sectors in a number of member countries. A weak banking system could also undermine a common currency arrangement. When countries with weak banking and financial sectors and heavy dependence on foreign capital peg their exchange rates to stronger currencies, banking problems could turn into an exchange rate crisis. The 1997 financial crisis exposed the fragility of the banking systems and the financial sectors of many countries in the region. Until now, the remaining agenda of banking reforms is relatively large. Further restructuring of the financial sectors and the banking systems will be

required among the ASEAN countries before they can adopt a common currency. Countries with stronger banking systems can specialize in providing financial services at a regional level, which could lead to greater harmonization in financial sector practices and raise banking and financial sector standards.

Inadequacy of region-level resource pooling mechanisms. Inadequate mechanisms for regional reserve pooling and the absence of regional institutions are also constraints; however, they can be addressed initially through reserve sharing arrangements under the Chiang Mai Initiative. The Chiang Mai Initiative was developed as a regional swap mechanism to promote currency cooperation in the region. In May 2006, it was agreed that the mechanism will be further developed into a multilateral arrangement in the hope of strengthening the resource pooling mechanism of the region. There must be stronger economic cooperation between member countries as well as find ways in achieving prudent macroeconomic policies as well as sound financial markets to maintain credibility and limit excessive capital outflows if and when a financial crisis occurs again.

Lack of political preconditions for monetary cooperation. Another major challenge is that the ASEAN+3 have not developed the political preconditions necessary for a common currency. In Europe, discussions on monetary integration progressed simultaneously with discussions of political integration and creation of a supranational entity with the power to override sovereign national governments. It is understood that if the economic advantages of a regional monetary union are large, countries may have to set aside political differences and form political alliances to reap the economic benefits.

Active support by member countries. Active support in terms of political commitment is needed towards a successful RMU. Member countries must ensure that the RMU will not be perceived as a fixed exchange rate system which can be a source of speculative attacks. Also, a market expectation towards eventual currency unification is an important ingredient for greater promotion of the RMU. This would involve a more active role for the government of member countries in pursuing RMU.

CONCLUSION

The risk of the occurrence of a crisis is always present, especially with the globalization of financial markets. A crisis arises even when countries at first have sound economic and financial fundamentals. There are cases when the risk of a crisis increases due to deterioration of market fundamentals. Therefore, governments must be able to identify weaknesses and imbalances before a crisis occurs.

This study showed that similar to other studies in the past, there is no one common model to detect crisis for all countries. In this study, the EMP and deviation indicators seem to have some promise as surveillance tools. For instance, most crisis periods identified in this study were preceded by both rising EMP and cumulative EMP. However, there were also instances when rising cumulative EMP did not lead to a crisis. On the other hand, the results for the deviation indicator suggest that it could be a useful tool for surveillance particularly for countries that use a floating exchange rate system. In the case of Korea, Singapore, Philippines, and Thailand, the deviation indicator can have informational value in assessing the occurrence of a crisis. However, to fully appreciate the use of EMP and deviation indicators, it must be combined with other economic and financial indicators in detecting a crisis.

This study can be further improved and expanded to include all ASEAN+3 economies. However, due to non-availability of data, not all countries were included in the sample. It was observed that the essential macroeconomic data, such as exchange rates, inflation rates, interest rates, trade data, GDP, and balance of payment accounts, are not consistent across member ASEAN+3 countries. Moreover, several countries,

such as Cambodia, Myanmar, Laos, and Vietnam lag behind its counterparts since they do not have the necessary database available online. Another problem encountered is the accessibility and availability of data in terms of language. Having accessible data at all times is very essential as it lowers the transactions cost of finding data online. The accuracy and timeliness of information is also very essential. This goes to say that information online needs to be maintained and updated frequently.

REFERENCES

Abiad, A. G. (2002). *Early warning systems for currency crises: A Markov switching approach with applications to Southeast Asia*. Unpublished doctoral dissertation, University of Pennsylvania.

Berg, A., & Pattillo, C. (1x999). Predicting currency crises: The indicators approach and an alternative. *Journal of International Money and Finance, 18*(4), 561-586.

Borensztein, E., Pattillo, C. A., & Berg, A. (2004, March). *Assessing early warning systems: How have they worked in practice?* (IMF Working Paper 04/52). Washington, D.C.: International Monetary Fund. Retrieved February 1, 2008, from http://www.imf.org/external/pubs/ft/wp/2004/wp0452.pdf

Bussiere, M., & Fratzscher, M. (2002, May). *Towards a new early warning system of financial crises* (ECB Working Paper 145). Frankfurt am Main: European Central Bank. Retrieved February 1, 2008, from http://papers.ssrn.com/sol3/papers.cfm?abstract_id=357482

Demirguc-Kunt, A., & Detragiache, E. (1998, March). *The determinants of banking crises in developing and developed countries* (IMF Staff Paper 45(1)). Basingstoke: Palgrave Macmillan Ltd. Retrieved February 1, 2008, from http://www.imf.org/external/pubs/ft/staffp/1998/03-98/pdf/demirguc.pdf

Demirguc-Kunt, A., & Detragiache, E. (2000). Monitoring banking sector fragility: A multivariate logit approach. *World Bank Economic Review, 14*(2), 287-307.

Edison, H. J. (2003). Do indicators of financial crises work? An evaluation of an early warning system. *International Journal of Finance & Economics, 8*(1), 11-53.

Eichengreen, B., & Arteta, C. (2000, August). *Banking crises in emerging markets: Presumptions and evidence* (Center for International and Development Economics Research Paper C00-115). Berkeley, CA: University of California at Berkeley. Retrieved February 1, 2008, from http://repositories.cdlib.org/iber/cider/C00-115

Eichengreen, B., Rose, A. K., & Wyplosz, C. (1996, August). *Contagious currency crises* (CEPR Discussion Paper 1453). London: Centre for Economic Policy Research. Retrieved February 1, 2008, from http://www.cepr.org/pubs/dps/DP1453.asp

Kamin, S. B., Schindler, J. W., & Samuel, S. L. (2001, September). *The contribution of domestic and external factors to emerging market devaluation crises: An early warning systems approach* (FRB International Finance Discussion Paper 711). Washington, D.C.: Board of Governors of the Federal Reserve System (U.S.). Retrieved February 1, 2008, from http://www.federalreserve.gov/pubs/ifdp/2001/711/default.htm

Kaminsky, G. L., & Reinhart, C. M. (1999). The twin crises: The causes of banking and balance-of-payments problems. *American Economic Review, 89*(3), 473-500.

Kaminsky, G., Lizondo, S., & Reinhart, C. M. (1998, March). *Leading indicators of currency crises* (IMF Staff Papers, 45(1)). Basingstoke: Palgrave Macmillan Ltd. Retrieved February 1, 2008, from http://www.imf.org/external/pubs/ft/staffp/1998/03-98/pdf/kaminsky.pdf

Moon, W., Rhee Y., & Yoon, D. (2006, October). *Regional currency unit in Asia: Property and perspective* (KIEP Economic Policy Working

Paper 06-03). Seoul: Korean Institute for International Economic Policy. Retrieved February 1, 2008, from http://www.kiep.go.kr/eng/std_data_view.asp? scate =013002 &ssubcate=005&num=131975

Watanabe, S., & Ogura, M. (2006, November). *How far apart are two ACUs from each other? Asian currency unit and Asian currency union* (Bank of Japan Working Paper 06-E-20). Tokyo: Bank of Japan. Retrieved February 1, 2008, from http://www.boj.or.jp/en/type/ronbun/ron/wps/wp06e20.htm

Appendix A
Economic and Financial Indicators of a Financial Crisis

Indicator	Interpretation
Current Account Indicators	
Real exchange rate	An overvalued exchange rate may lead to higher probability of financial crisis.
Export growth	Declining export growth may be caused by an overvalued domestic currency and hence a proxy for currency overvaluation. On the other hand, if export growth slows due to reasons unrelated to the exchange rate, this may cause devaluation pressure. In both cases, declining export growth can be a leading indicator for a sizeable devaluation.
Import growth	Huge import growth could lead to worsening in the current account and have been often related with a currency crisis.
Capital Account Indicators	
Ratio of M2 to foreign exchange reserves	Captures to what extent the liabilities of the banking system are backed by foreign reserves. In the event of a currency crisis, individuals may rush to convert their domestic currency deposits into foreign currency, so that this ratio captures the ability of the central bank to meet their demands.
Growth of foreign exchange reserves	Declining foreign reserves is a reliable indicator that a currency is under devaluation pressure. A drop in reserves is not necessarily followed by devaluation; central bank may be successful in defending a peg, spending large amounts of reserves in the process. On the other hand, most currency collapses are preceded by a period of increased efforts to defend the exchange rate, which are marked by declining foreign reserves. Total values of foreign reserves are also used as indicators of a country's financial difficulty dealing with debt repayment.
Domestic real interest rate	Real interest rate can be considered as proxy of financial liberalization, in which the liberalization process itself tends to lead to high real rates. Also, high real interest rates may increase chances of loan defaults.
Lending and deposit rate spread	An increase of this indicator above some threshold level possibly reflects deterioration in credit risk as banks are unwilling to lend or decline in loan quality.

Real Sector Indicators	
Growth of industrial production	Lower output growth indicates a deceleration. Recessions often precede a financial crisis.
Changes in stock prices	A decline in the growth rate of asset prices may lead to loan defaults. It also signals loss of investor confidence. A burst of asset price bubbles often precede a financial crisis.
Financial Indicators	
M1 and M2 growth	These indicators are measures of liquidity. High growth of these indicators might indicate excess liquidity which may fuel speculative attacks on the currency thus leading to a currency crisis.
M2 money 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.
Ratio of domestic credit to GDP	Very high growth of domestic credit may serve as a crude indicator of the fragility of the banking system. This ratio usually rises in the early phase of the banking crisis. It may be that as the crisis unfolds, the central bank may be injecting money to the bank to improve their financial situation.
Excess real M1 balance	Reflects excess money supply which may put pressure on the exchange rate and lead to currency crisis.
Commercial bank deposits	A decline in the deposit base may increase the chances of domestic bank run and capital flight to occur as crisis unfolds.

Appendix B
Suggested Crisis Indicators

Indicator	Interpretation	Reference
Global Indicators		
G-7 output	Higher foreign output growth should strengthen exports and thus, reduce the probability of a crisis.	Edison (2003); Eichengreen & Arteta (2000)
U.S. output	US recession often precedes a crisis.	Edison (2003)
U.S. interest rate	Rate increases is often associated with capital outflows.	Edison (2003); Eichengreen & Arteta (2000)
Oil prices	High oil prices are associated with recessions.	Edison (2003)
Capital Account Indicators		
Ratio of the current account to GDP	A rise in ratio is generally associated with large external capital inflows that are intermediated by the domestic financial system and could facilitate asset price and credit booms. Increases in current account surplus are expected to indicate a diminished probability to devalue and thus, to lower the probability of a crisis.	Berg & Pattillo (1999)
Real Sector Indicators		
Ratio of fiscal balance to GDP	Higher deficits are expected to raise probability of crisis, since deficits increase vulnerability to shocks and reduce investor confidence.	Demirguc-Kunt & Detragiache (2000); Eichengreen & Arteta (2000)
Ratio of public debt to GDP	Higher indebtedness is expected to raise vulnerability to a reversal in capital inflows, therefore raising the probability of a crisis.	Eichengreen & Arteta (2000)
Inflation rate	Inflation rate is likely to be associated with high nominal interest rates and may be an alternative measure of macroeconomic mismanagement, which affects the economy in general.	Demirguc-Kunt & Detragiache (1998)
GDP per capita	Deterioration of economic activity is expected to increase the probability of a banking crisis.	Demirguc-Kunt & Detragiache (2000); Eichengreen & Arteta (2000)
Financial Indicators		
Ratio of bank reserves to bank assets	Unfavorable macroeconomic shocks are less likely to lead to a crisis in countries where the banking system is liquid.	Demirguc-Kunt & Detragiache (1998)

Appendix C
Summary of Regression Results

Country	Model	Adj-R Squared	12-Month % Change M2/reserves		12-Month % Change Credit/GDP		Deviation from Trend (REER)		Change in Deviation Indicator		Constant	
			Coef.	t-Stat	Coef.	t-Stat	Coef.	t-Stat	Coef.	t-Stat	Coef.	t-Stat
Cambodia	1	0.0668	0.01	1.12	-0.002	-0.42	1.137	2.36			-0.146	-1.92
	2	0.0821	0.01	1.17	-0.001	-0.16	1.137	2.38	0.1	1.45	-0.165	-2.15
China	1	0.3244	0.016	5.36	0.006	1.29	-1.563	-1.2			-0.127	-2.66
	2	0.3266	0.017	5.48	0.005	1.06	-1.974	-1.46	0.01	1.1	-0.115	-2.34
Indonesia	1	0.1018	0.131	2.44	0.151	2.49	20.481	1.95			-0.841	-1.32
	2	0.0965	0.141	2.54	0.149	2.45	19.362	1.83	0.369	0.78	-0.866	-1.36
Korea	1	0.0579	0.071	1.93	0.075	0.95	12.534	1.22			-1.485	-2.01
	2	0.331	0.074	2.38	-0.006	-0.09	6.673	0.76	-1.022	-5.29	-0.904	-1.43
Laos	1	-0.0265	0.043	0.74	0.002	0.08	1.65	0.66			-0.434	-0.65
	2	-0.0412	0.043	0.74	0.002	0.06	1.818	0.71	0.047	0.35	-0.412	-0.61
Malaysia	1	0.0969	0.004	2.6	-0.005	-1.11	1.311	1.29			-0.039	-2.06
	2	0.0831	0.004	2.55	-0.005	-1.09	1.303	1.27	0	0.09	-0.039	-1.99
Philippines	1	-0.0124	0.016	0.55	0.057	0.69	-1.851	-0.25			0.404	0.8
	2	0.398	0.034	1.48	-0.029	-0.45	-1.784	-0.31	-1.033	-6.78	-0.325	-0.8
Singapore	1	-0.0306	0.016	0.72	0	0.02	2.31	0.31			-0.344	-1.75
	2	0.0374	0.014	0.65	-0.002	-0.09	2.056	0.28	-0.571	-2.38	-0.326	-1.72
Thailand	1	0.0265	0.02	0.3	-0.112	-1.2	1.814	0.12			-1.077	-1.34
	2	0.2306	0.084	1.42	-0.016	-0.19	0.785	0.06	-0.881	-4.3	-0.313	-0.43
Vietnam	1	0.0102	0.012	1.16	0	-0.2	5.843	1.47			-0.403	-1.81
	2	-0.0039	0.012	1.12	0	-0.23	5.681	1.4	0.054	0.27	-0.391	-1.72

Appendix D
Summary of Models with Moving Average Regressors

Country	Model	Adj-R Squared	12-Month % Change M2/reserves		12-Month % Change Credit/GDP		Deviation from Trend (REER)		Deviation Indicator		Constant	
			Coef.	t-Stat	Coef.	t-Stat	Coef.	t-Stat	Coef.	t-Stat	Coef.	t-Stat
Cambodia	1	0.0877	0.011	1.24	-0.001	-0.26	1.042	2.2	0.126	1.37	-0.163	-2.03
	2	0.0372	0.014	1.35	-0.001	-0.2	0.619	1.61	0.154	1.33	-0.167	-1.99
	3	0.0856	0	0.01	-0.002	-0.42	2.384	2.67	0.028	0.3	-0.133	-1.66
	4	0.0737	-0.01	-0.8	-0.001	-0.12	3.541	2.71	-0.018	-0.14	-0.12	-1.41
China	1	-0.007	0.017	5.71	0.004	0.99	-2.298	-1.71	0.009	0.82	-0.112	-2.28
	2	0.0851	0.018	5.89	0.003	0.62	-2.618	-2.04	0.015	1.07	-0.093	-1.78
	3	0.0041	0.017	5.5	0.005	1.13	-1.101	-0.77	0.005	0.41	-0.129	-2.56
	4	0.0194	0.019	5.3	0.004	0.8	-1.977	-1.14	0.017	0.85	-0.112	-1.9
Indonesia	1	0.0207	0.082	1.36	0.143	2.03	4.598	0.41	0.332	0.51	-0.651	-0.98
	2	-0.0008	0.011	0.17	0.081	1.08	-7.698	-0.73	-0.304	-0.36	-0.362	-0.53
	3	0.0174	0.061	0.9	0.124	1.78	27.997	2.21	-1.05	-1.64	-0.277	-0.43
	4	-0.0221	0.063	0.71	0.109	1.32	20.581	1.27	-0.723	-0.7	-0.33	-0.47
Korea	1	0.1025	0.07	1.95	0.012	0.15	10.293	0.99	-0.937	-3.32	-1.042	-1.37
	2	0.0382	0.031	0.76	0.076	0.81	-3.928	-0.32	-0.524	-1.17	-1.866	-2.05
	3	-0.0099	0.033	0.83	0.122	1.39	7.862	0.69	0.103	0.34	-2.183	-2.62
	4	-0.0416	-0.005	-0.12	0.236	2.42	1	0.08	0.881	1.97	-3.225	-3.43
Laos	1	0.0361	0.074	1.2	-0.01	-0.38	-0.203	-0.08	-0.169	-0.87	-0.762	-1.08
	2	0.0812	0.09	1.43	-0.012	-0.46	-1.051	-0.47	-0.219	-0.93	-0.926	-1.29
	3	0.053	0.094	1.54	-0.015	-0.6	-0.043	-0.01	-0.225	-1.16	-0.97	-1.38
	4	0.0096	0.125	1.83	-0.019	-0.72	-2.137	-0.32	-0.261	-0.8	-1.16	-1.58
Malaysia	1	0.0454	0.004	2.48	-0.004	-0.97	1.516	1.41	-0.006	-1.08	-0.044	-2.27
	2	0.1405	0.003	1.83	-0.001	-0.15	1.433	1.34	-0.01	-1.6	-0.053	-2.6
	3	0.1897	0.003	1.94	0	-0.04	1.767	1.64	-0.011	-2.2	-0.052	-2.75
	4	0.1312	0.002	1.31	0.004	0.61	1.513	1.23	-0.011	-1.5	-0.052	-2.49
Philippines	1	0.2398	0.038	1.44	-0.029	-0.38	1.417	0.2	-1.068	-4.7	-0.361	-0.77
	2	0.1474	0.025	0.86	0.002	0.02	-2.385	-0.31	-0.967	-3.04	-0.15	-0.29
	3	0.0422	0.005	0.16	0.08	0.9	9.076	1.1	-0.406	-1.52	0.476	0.89
	4	0.0537	-0.038	-1.11	0.181	1.85	9.04	1	0.334	0.93	1.393	2.27
Singapore	1	-0.0319	0.004	0.15	0.008	0.32	5.838	0.7	-0.276	-0.84	-0.355	-1.8
	2	-0.0328	-0.021	-0.74	0.035	1.17	9.797	1.19	0.055	0.13	-0.428	-2.2
	3	0.079	-0.011	-0.47	0.02	0.79	0.219	0.03	0.65	2.05	-0.436	-2.29
	4	0.0596	0.016	0.52	-0.003	-0.09	-3.906	-0.42	1.344	2.49	-0.448	-2.31
Thailand	1	0.1701	0.06	0.9	-0.06	-0.63	3.502	0.23	-0.813	-3.09	-0.665	-0.81
	2	0.1073	-0.022	-0.28	-0.167	-1.53	-9.213	-0.53	-0.503	-1.36	-1.598	-1.7
	3	0.0324	-0.033	-0.47	-0.199	-1.96	3.039	0.19	-0.212	-0.76	-1.81	-2.06
	4	0.0809	-0.113	-1.25	-0.331	-2.62	1.533	0.08	0.336	0.9	-2.857	-2.61
Vietnam	1	-0.0429	0.01	0.89	0	-0.15	2.277	0.81	0.052	0.2	-0.315	-1.4
	2	-0.0374	0.013	1.19	0	0	0.417	0.29	-0.022	-0.07	-0.369	-1.56
	3	0.0028	0.014	1.26	0	0.53	5.504	1.22	-0.179	-0.66	-0.487	-2.04
	4	-0.0399	0.018	1.62	-0.001	-0.75	2.077	0.39	-0.041	-0.11	-0.37	-1.4