Toward Greater Financial Stability in the Asian Region: Measures for Possible Use of Regional Monetary Units for Surveillance and Transaction

Final Draft

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By

Hwee Kwan Chow, Peter N. Kriz, Roberto S. Mariano*
and Augustine H. H. Tan

School of Economics
Singapore Management University

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* Corresponding Author
Roberto S. Mariano
Dean, School of Economics
Singapore Management University
90 Stamford Road, Singapore 178903
Telephone: 65-6828-0888
Fax: 65-6828-0877
E-mail: rsmariano@smu.edu.sg

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EXECUTIVE SUMMARY

Part I

We investigate the usefulness of the AMU and its associated divergence indicators as proposed by Ogawa and Shimizu (REITI website) through counter-factual experiments. The assessment is made in terms of the AMU indicators' responses to shocks and the ease with which they can be used to identify policy requirements for fostering greater intra-regional exchange rate stability. We summarize the simulation results and their policy implications according to 3 broad issues pertaining to basket weight structure, reference points and anchor currencies.

1. ***Asymmetry in the Basket Weights***. The divergence indicators will not accurately reflect the fluctuations of currencies with large basket weights since the movements of their divergence indicators are muted by sizable shifts in the currency basket. Asymmetric baskets are useful for smaller countries only if they would like their currencies to track the currencies of larger countries. This calls for less asymmetry in the basket weight structure. Otherwise, a relatively narrow monitoring band should be applied to currencies with large basket weights.

2. ***Reference Points***. Should the ASEAN+3 countries decide to adopt a RMU as its reference currency, care should be taken that the basket is not dominated by currencies that are misaligned. Otherwise, the regional currencies will end up shadowing misaligned currencies. One possibility is for the ASEAN+3 countries to work towards an agreement on the exchange rate levels of the regional currencies that could reasonably serve as benchmark rates. Alternatively, we could draw on the work done by the CGER group at the IMF for their estimates of equilibrium exchange rates of the regional currencies and use those as the target exchange rates in place of benchmark rates computed from a base period.

3. ***Anchor Currencies***. To determine the appropriate policy adjustments in response to excessive divergences signaled by the AMU based divergence indicators, certain constituent currency (or group of currencies) will have to be assigned the responsibility of anchoring the system. There should either be an agreement amongst the ASEAN+3 countries about the appropriate external value of the currency basket or an agreement that the external value of the basket will be market determined. In the first instance, anchor countries must manage the value of their currencies, while in the second case they must focus monetary policy on internal price stability. In either case, they should act passively vis-à-vis other currencies in the basket as regards intra regional exchange rates. Under the EMS, the deutsche mark became the anchor currency with the external value of the ECU tied down by German monetary policy.

Part II

In this part, we assess the performance of AMU real divergence indicators relative to the REER deviations from trend in predicting crisis in an early warning system. This is carried out by incorporating the AMU variable in the ADB methodology that employs the Kaminsky-Reinhart signaling approach. With the assistance of ADB's OREI department, we apply the VIEWS software and obtain mixed results on the relative predictive ability of the AMU and REER variables. In particular, the AMU variable slightly outperformed the REER variable for the pre-2000 sample period but the reverse is true for the post-2000 sample period. Further, the two composite indexes (that comprise either the AMU or the REER variable but not both) had similar performances. We highlight that the use of the real divergence indicators does not incorporate information on the external value of the currency which are relevant to factors that give rise to crises.

Part I

RMU and Divergence Indicators as Surveillance Tools[1]

In the previous ASEAN+3 project on “Toward Greater Financial Stability in the Asian Region: Exploring Steps to Create Regional Monetary Units” (hereafter termed the previous project), various research groups discussed the merits for economic and financial stability of introducing a Regional Monetary Unit (RMU) as a basket of Asian currencies (see *inter alia* Chow, et al. 2007). Drawing on the experience with the European Currency Unit (ECU) in the European Monetary System (EMS), some have suggested that the RMU could provide a framework for specifying exchange rate objectives as part of a formal effort to coordinate exchange rate policies in East Asia. See, for example, Wyplosz (2004); Wilson (2004); and Kawai (2006). However, as pointed out by Chow, et al. (2006) and Wanatabe and Ogura (2006) amongst others, there are doubts on whether the region is ready to formally co-ordinate exchange rate policies.

Give these concerns, a natural question that arises is whether a regional currency basket could still play a role in the official ASEAN+3 surveillance of intra-regional exchange rates in order to achieve intra-regional exchange rate stability. In particular, would deviation indicators which measure the extent to which individual ASEAN+3 currencies diverge from the RMU basket be helpful as additional tools for the East Asian monetary authorities to monitor exchange rates divergences? After all, similar exchange rate divergence indicators were constructed based on the ECU. What difficulties, if any, were faced when using these indicators for monitoring intra-regional exchange rate movements and what role did these indicators play in the EMS?

Broadly speaking, there are three issues that must be addressed regarding the use of a regional monetary unit and the associated divergence indicators in exchange rate surveillance. First is the identification of a desirable basket weight structure for the RMU that raises its signaling power. Second is the selection of the base period or reference point when

[1] The contents of this part of the report is partially drawn from Adams and Chow (2007)

constructing the divergence indicators, for the meaningful interpretation of exchange rate deviations. Third is the clarification of the roles played by the constituent currencies in the currency basket for determining appropriate policy adjustments.

I.1 Basket Weight Structure

A RMU can be defined as a basket of specific quantities of different Asian currencies. As noted in the previous project, basket compositions must be specific to the role played by the RMU. For a RMU promoted as a market instrument, a narrow basket consisting of convertible currencies only is required. In comparison, a basket based on a wider grouping is more suited for a RMU used in exchange rate surveillance. In this study, we focus on a currency basket comprising the currencies of the ASEAN+3 countries. Like the ECU, the RMU can be a fixed quantity basket with periodic changes in the quantities of currencies to avoid the basket becoming dominated by strong currencies. Following the approach taken in the EMS, we use the term “weights” to refer to the share of the currencies evaluated at a given set of exchange rates. In the previous project, a number of studies explored different weighting schemes for the currency basket. Invariably, higher weight is assigned to the plus three countries of Japan, Korea and China with their combined weight ranging from 60% to over 70%.

In particular, we examine the weight structure of a currency basket proposed by Ogawa and Shimizu of which a second version is available on the following RIETI website (http://www.rieti.go.jp/users/amu/en/index.html). The authors proposed a RMU (which they name the AMU) that follows the construction of the ECU. Accordingly, the AMU is a weighted average of the thirteen ASEAN+3 currencies. The weight of each component currencies in the AMU is computed based on the relative size of the country over the years 2002 to 2004, as measured by average trade volume and GDP measured at PPP (see Table 1). We note the asymmetry of weights between the ASEAN countries and plus three countries of China, Japan and Korea. The three non-ASEAN countries dominate the basket, being assigned a total weight that exceeds 70%.

Table 1. Quantities of Component Currencies in the AMU

	Trade volume % (a)	GDP measured at PPP % (b)	Weights %[b] (c)	Benchmark exchange rate (d)	Quantities (c)/(d)
Brunei	0.37	0.37	0.37	0.589114	0.0063
Cambodia	0.20	0.22	0.21	0.000270	7.8590
China	23.40	50.35	36.88	0.125109	2.9476
Indonesia	4.40	5.38	4.89	0.000113	434.2310
Japan	26.40	26.38	26.39	0.009065	29.1145
South Korea	13.05	6.94	10.00	0.000859	116.3365
Laos	0.08	0.08	0.08	0.000136	5.9528
Malaysia	8.39	1.74	5.06	0.272534	0.1858
Myanmar	0.36	0.08	0.22	0.159215	0.0137
Philippines	2.98	2.61	2.79	0.021903	1.2760
Singapore	11.88	0.82	6.35	0.589160	0.1078
Thailand	6.51	3.49	5.00	0.024543	2.0366
Vietnam	1.98	1.53	1.76	0.000072	245.4844

Notes:
Source: Table 2 of Ogawa and Shimizu with only slight modifications.
[b] Average of (a) and (b).

The external value of the AMU can be tracked in terms of a basket of external currencies. Following Ogawa and Shimizu (2005), we express the external value of the AMU in terms of the weighted average of the US dollar and the euro with weights 65% and 35% respectively (hereafter, termed the duro). The value of AMU in terms of the duro, S(duro/AMU), is given by the sum over all thirteen currencies, the product of the quantity of each currency Q(J) and its duro value S(duro/J), i.e.

$$S(duro/AMU) = \sum_{j=1}^{13} Q(J)S(duro/J) \qquad (1)$$

As shown in Table 1, the quantity of currency J is computed as a ratio of its weight in the AMU and its benchmark exchange rate. The latter is the average exchange rate of currency J against the duro during benchmark period 2000-2001. While it is not clear that the exchange rates are in equilibrium during this period, the benchmark period is chosen by the closeness of the trade balance of the ASEAN+3 grouping to zero.

Based on the AMU, we can derive a set of divergence indicators to measure exchange rate divergences. At the outset, we make a distinction between extra regional exchange rate divergence and intra regional exchange rate divergence. The former considers deviations of the currency basket vis-à-vis currencies outside the currency basket while the latter considers deviations of constituent currencies from the currency basket. To measure extra regional exchange rate divergence, we first need to specify a reference rate for the AMU. Following Ogawa and Shimizu (2005), we use the time period 2000 to 2001 as the benchmark period where equilibrium is assumed to be held. The reference rate $S_0(duro/AMU)$ is thus specified as the average exchange rate of the AMU against the duro during this period.

Changes in the value of the AMU in terms of the duro can then be monitored relative to the reference rate as follows:

$$\left[S_T(duro/AMU) - S_0(duro/AMU)\right]/S_0(duro/AMU) \quad (2)$$

where the subscript 0 refers to the reference point while T is the period for which the divergence is calculated. Following Adams and Chow (2007), we approximate the proportionate change by the logarithmic first differences so that the extra regional divergence is given by:

$$\ln S_T(duro/AMU) - \ln S_0(duro/AMU) \qquad (3)$$

The logarithmic approximation does not substantially change the conclusions that would be reached with raw numbers and were also used to approximate proportional exchange rate changes in the EMS.

In comparison, the intra regional exchange rate divergence indictors gauge the extent to which constituent currencies deviate from the currency basket. Thus, we specify the reference rate for each component currency K, $S_0(AMU/J)$ as the average exchange rate of currency J against the AMU during the same benchmark period 2000 to 2001. As in the case of the EMS, the divergence indicator for constituent currency J is constructed as the ratio of the currency's proportionate movement in terms of the currency basket:

$$\left[S_T(AMU/J) - S_0(AMU/J)\right]/S_0(AMU/J) \qquad (4)$$

where the subscript 0 refers to the reference point while T is the period for which the divergence is calculated. The corresponding logarithmic approximation for intra regional divergence is:

$$\ln S_T(AMU/J) - \ln S_0(AMU/J) \qquad (5)$$

Effect of Asymmetric Weights on Signaling

No doubt, the weighting scheme for the RMU will have important implications for the behavior of the basket and the derived divergence indicators. Politically considerations may lead smaller ASEAN countries with near zero weights to exit the RMU and operate independently outside of the RMU. Sweden and Denmark followed such a course with notable success. At the same time, weighting schemes must be specific to the purpose assigned to the RMU. If the RMU is to be promoted as a market instrument, then as was suggested in Chow et al (2007), the basket weights must adhere strictly to market principles. Distorting these weights for political or other reasons will undermine the hedging properties of the RMU, and reduce its attractiveness as a regional instrument. However, if the RMU is used for surveillance purposes, then political weighting schemes within reason might prove prudent to advance regionalism.

This study investigates how the asymmetry of weights between the ten ASEAN countries and the plus three countries affects the usefulness of the AMU as a surveillance tool. We show through counterfactual experiments that the high asymmetry observed in the AMU places a greater adjustment burden on the currencies with smaller weights. In addition, we also demonstrate that greater symmetry in the weighting structure would raise the signaling power of the RMU and its divergence indicators.

In each counter-factual experiment, we consider the responses of the AMU and its associated divergence indicators to a number of "shocks" by examining their behavior relative to the baseline, i.e. "shock minus control". The baseline refers to the original movements of the AMU and the divergence indicators computed from the actual fluctuations of the exchange rate series as they have occurred in practice. For simplicity, we introduce shocks in each scenario as step jumps over the last half year in the sample, i.e. from

November 2006 to April 2007, of the affected exchange rate series. For instance, a 10% depreciation of the Japanese yen against the duro is represented by a downward shift by 10% in the levels of the yen-duro exchange rate from November 2006 to April 2007. The AMU and the associated divergence indicators are then re-computed using the "shocked" series.

To gauge the reaction to a shock, we compute for the AMU and each divergence indicators the percentage change between the last time point (April 2007) and the time point just before the shock was introduced (October 2006), i.e.

$$\left[\ln(duro/AMU)_{2007m4} - \ln(duro/AMU)_{2006m10}\right]\times 100\% \qquad (6)$$

$$\left[\ln(AMU/K)_{2007m4} - \ln(AMU/K)_{2006m10}\right]\times 100\% \qquad (7)$$

The difference between these values and those similarly calculated for the baseline (where there is an absence of shocks) gives the percentage point deviations from baseline, which serve as measures of the responses of the AMU and the divergence indicators to the shocks.

To investigate whether asymmetrical weights in the currency basket affect the clear transmission of signals for surveillance, we consider the following two Scenarios. In Scenario I, we assume that only the yuan which has the largest weight of 37% in the AMU depreciates by 20% against all other currencies while in Scenario II, we assume that only the peso which has a small weight of 3% in the AMU depreciates by 20% against all other currencies. Table 2 below show the percentage point deviations from baseline for these two scenarios.

We can see from the table that in each case the shock to a single currency is clearly identified by the divergence indicators. This is because we have hypothetically limited the shock to a single currency in order to demonstrate the effects of weighting scheme on the divergence indicators. In practice, there will more likely be multiple shocks to different currencies and the signals from the divergence indicators will be less clear. Nevertheless, in the case of the single errant currency, the shock to the peso in Scenario II is better captured by the divergence indicators compared to the shock to the yuan in Scenario I. We also observe from Table II that the external value of the AMU shifted by a far greater amount in Scenario I than in Scenario II. Reflecting the higher weight of the yuan in the AMU, the shock to the yuan causes the entire currency basket to shift by a larger extent compared to a similar shock to the peso. This in turn causes all the divergence indicators in Scenario I to moved by a greater amount than those in Scenario II. As a result, the shock to the yuan is somewhat muted and does not stand out as clearly in the divergence indicators in comparison to the peso shock.

Table 2. AMU and Deviation Indicators Under Scenarios I & II
(Percentage Point Deviations From Baseline)

Basket Type	Asymmetric Basket	
	Scenario I	*Scenario II*
AMU	-7.38	-0.56
Divergence Indicators		
Brunei	7.38	0.56
Cambodia	7.37	0.56
China	-12.63	0.56
Indonesia	7.37	0.56
Japan	7.38	0.56
Korea	7.38	0.56
Laos	7.37	0.56
Malaysia	7.38	0.56
Myanmar	7.38	0.56
Philippines	7.38	-19.44
Singapore	7.38	0.56
Thailand	7.38	0.56
Vietnam	7.37	0.56

Notes:
Scenario I: 20% depreciation of Chinese Yuan
Scenario I: 20% depreciation of Philippines Peso

Plots of the divergence indicators corresponding to Scenarios I and II are found in Figures 1 and 2 respectively. It is clear from the behavior of the divergence indicator of the peso in Figure II that the peso has been subjected to depreciation shock. By contrast, the divergence indicator of the yuan which has been subjected a similar shock does not reveal any meaningful divergence. Hence, the clarity of the signals emitted by the divergence indicators is affected by the asymmetrical weighting in the basket.

Figure 1. Divergence Indicators of AMU for Scenario I (10% depreciation of yuan)

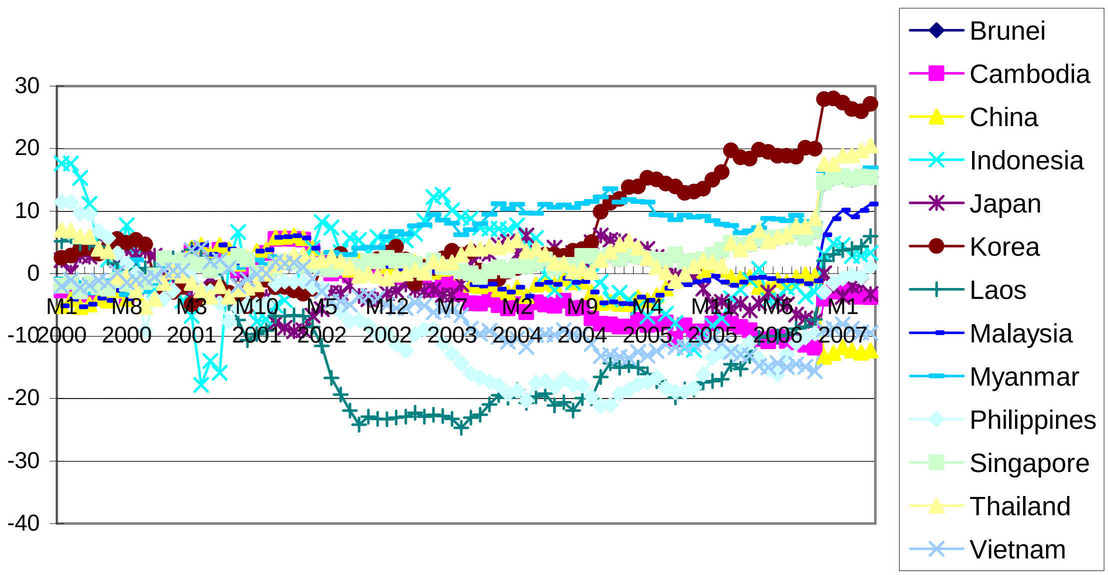
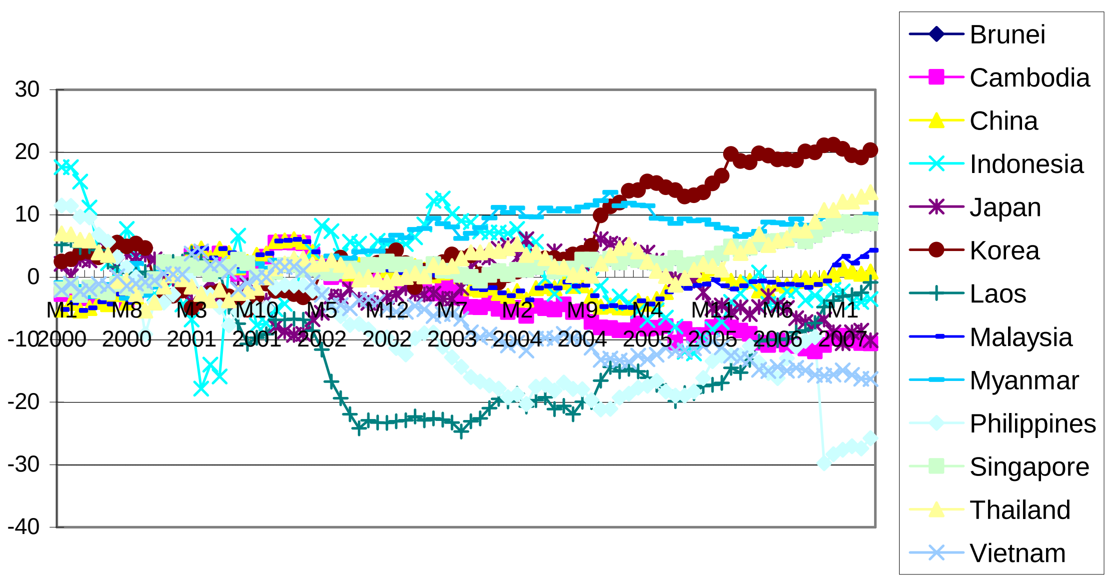


Figure 2. Divergence Indicators of AMU for Scenario II (10% depreciation of peso)



Symmetric Basket Emits Clearer Signals

In order to overcome the effect of asymmetrical weights, we now consider a symmetric currency basket where all constituent currencies are assigned equal weight. Like the AMU, this RMU comprises the thirteen ASEAN+3 currencies except that it is not dominated by any single currency. To illustrate that the divergence indicators derived from such a RMU transmit clearer signals for surveillance, we repeat Scenarios I and II using a symmetric currency basket. Table 3 below reports the percentage point deviations from baseline for the symmetric basket as well as its associated divergence indicators.

Table 3. Symmetric Basket and its Deviation Indicators Under Scenarios I & II
(Percentage Point Deviations From Baseline)

Basket Type	Symmetric Basket	
	Scenario I	*Scenario II*
RMU	-0.02	-0.02
Divergence Indicators		
Brunei	0.02	0.02
Cambodia	0.02	0.02
China	-19.98	0.02
Indonesia	0.02	0.02
Japan	0.02	0.02
Korea	0.02	0.02
Laos	0.02	0.02
Malaysia	0.02	0.02
Myanmar	0.02	0.02
Philippines	0.02	-19.98
Singapore	0.02	0.02
Thailand	0.02	0.02
Vietnam	0.02	0.02

Notes:
Scenario I: 20% depreciation of Chinese Yuan
Scenario II: 20% depreciation of Philippines Peso

It is evident from Table 3 above that a 20% depreciation of either the yuan or the peso shifts the symmetric basket to the same extent. Consequently, all the divergence indicators across the two cases move by the same amount and the shock is equally well captured by the divergence indicators in either case. Figures 3 and 4 below gives us the plots of the divergence indicators associated with the symmetric basket under Scenarios I and II the respectively. In each case, the divergence indicator of the depreciated currency—yuan for Figure I and peso for Figure II—reveals discernable deviation. We conclude that the divergence indicators derived from a symmetric basket, as opposed to those from a asymmetric basket, are better for assessing exchange rate divergences.

Figure 3. Divergence Indicators of Symmetric Basket for Scenario I

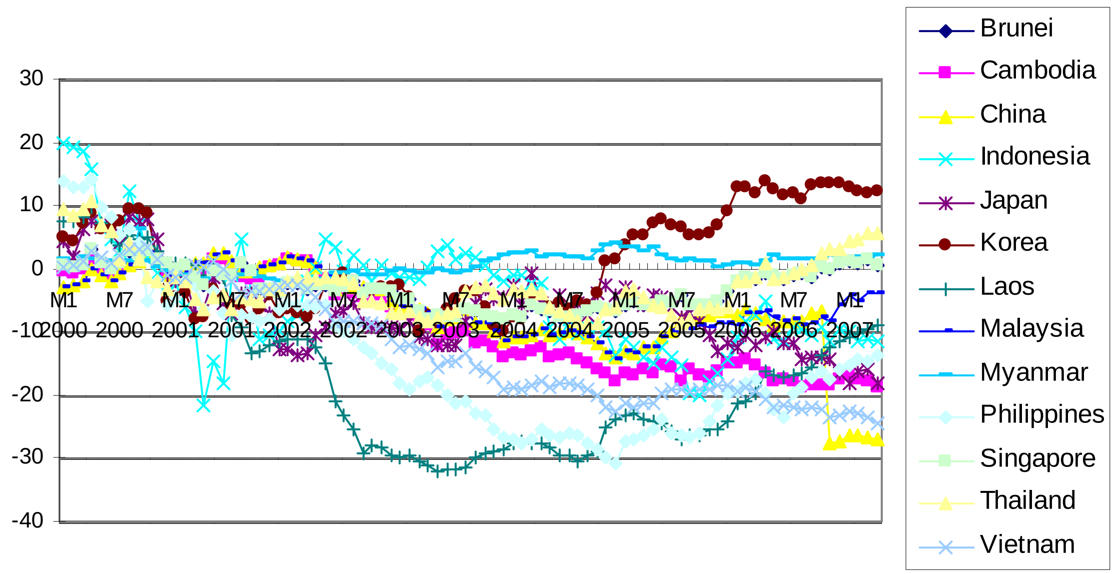
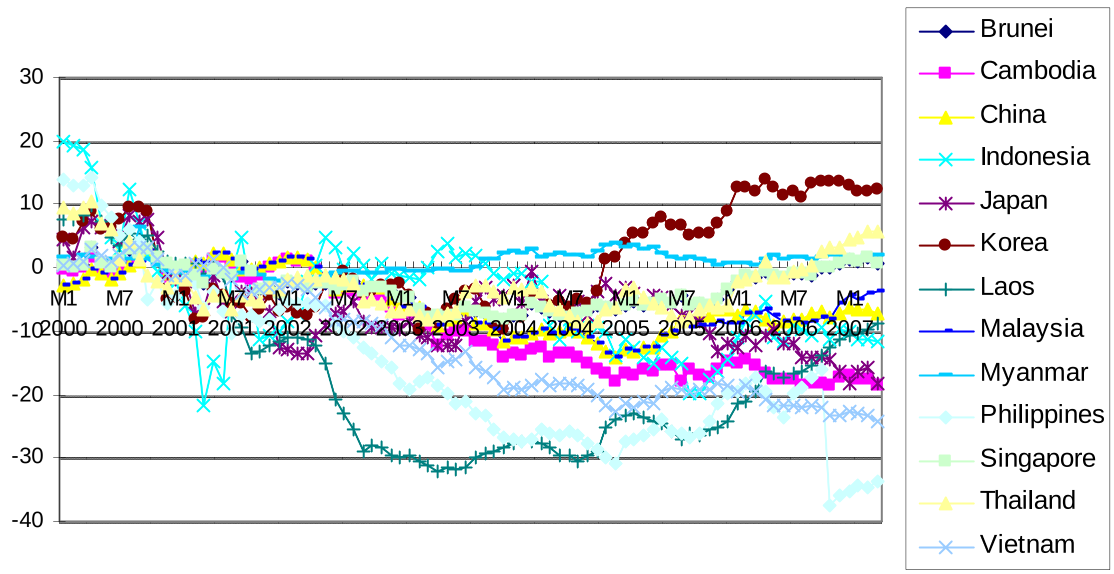


Figure 4. Divergence Indicators of Symmetric Basket for Scenario II



Policy Implications

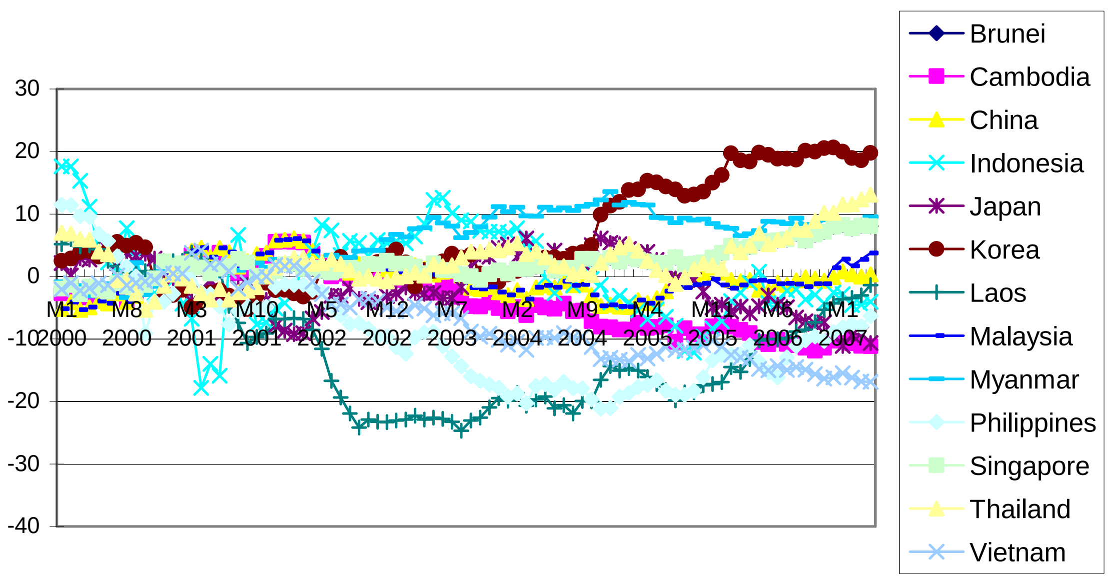
If there is agreement that the smaller countries would like their currencies to track the currencies of the larger countries, then the divergence indicators derived from the AMU may still prove to be useful for exchange rate surveillance of the smaller countries. This is because the AMU assigns currency weights according to the relative size of the countries. As illustrated by the counter factual experiments above, movements in the large currencies will shift the currency basket which in turn moves all the divergence indicators by non-trivial amounts, thereby signaling the need for adjustments even for the small currencies. In addition, the asymmetric treatment of the currencies in the basket result in more attention being paid to the smaller currencies during surveillance since their deviations from the AMU leads to larger movements in their divergence indicators.

However, we should bear in mind that the divergence indicators will not accurately reflect the fluctuations of large currencies, since the movements of their divergence indicators are muted by shifts in the basket. Besides, it is unclear that less attention should be paid to these larger and thus, more important currencies during exchange rate surveillance. Indeed, there is no obvious criterion for determining an optimal set of weights when the currency basket is used for surveillance purposes. In this case, we should choose the weights according to the ease with which we can interpret the associated divergence indicators and identify policy requirements for fostering greater intra-exchange rate stability. If basket based divergence indicators are to be adopted for exchange rate monitoring, then those derived from a symmetric currency basket—whereby all constituent currencies are given equal weight—should be used. As shown above, the uniform treatment of all currencies yields divergence indicators that emit clearer signals of exchange rate deviations. Otherwise, if an asymmetric basket is used, then a relatively narrow monitoring band should be applied to component currencies with large basket weights.

I.2 Reference Points

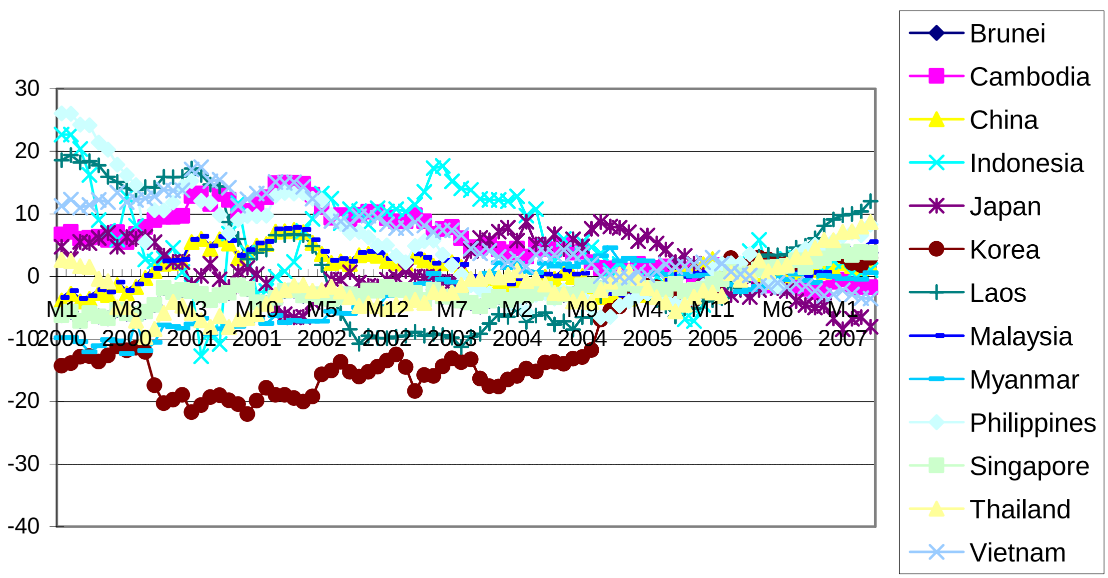
As discussed in the previous section, extra regional and intra regional exchange rate divergences can be defined with reference to benchmark rates (see equations (2) and (4)). Unlike the exchange rate mechanism in the EMS, however, there is no formal agreement amongst the ASEAN+3 countries on reference values for assessing intra-regional exchange rate divergence. In the case of the AMU, the benchmark rate for each component currency is specified as its average exchange rates in terms the AMU in some base period where equilibrium is assumed to be held. Specifically, the base period is chosen to be 2000 to 2001 as the trade balance of the ASEAN+3 countries with Japan, with the rest of the world and within the grouping are relatively small during this period (see Ogawa and Shumizu, 2005). However, it is not clear that the exchange rates are in equilibrium during this period. Indeed, there will always be some degree of arbitrariness on the choice of base period. Figure 5 below is a plot of the divergence indicators derived from the AMU using this base period.

Figure 5. Divergence Indicators of AMU with 2000/01 as Base Period



Obviously, the choice of the base period that is used for computing the reference values will have significant implication on the interpretation of the divergence indicators, particularly with regard to identifying currencies with excessive divergence. To illustrate, we now arbitrarily set the base period as 2005 to 2006 and select the average exchange rates during this period as the benchmark rates. Figure 6 below is a plot of the divergence indicators corresponding to this new base period. When comparing Figures 5 and 6, we observe that the sign and sizes of the divergence indicators are indeed sensitive to the choice of the base period. For instance, in Figure 5 the Korean won will be identified as too strong relative to the AMU but in Figure 6 it will be deemed as tracking the currency basket in recent periods. Such differences in the interpretation of the divergence indicators in turn have important implications on the appropriate policy requirements for fostering greater intra-regional exchange rate stability.

Figure 6. Divergence Indicators of AMU with 2005/06 as Base Period



Equilibrium Exchange Rates as Benchmark

When we use a base period to compute the benchmark rates, we are effectively looking backwards in time to obtain reference values for assessing intra-regional exchange rate divergence. Alternatively, the reference values can be based on independently determined estimates of long term equilibrium exchange rates. To the extent that the AMU based divergence indicators are used to identify currencies with excessive divergences, the component currencies are guided towards the benchmark rates. Thus, it is reasonable to use some measure of long term equilibrium rates for the constituent currencies rather than its past values as the targeted exchange rates.

Nevertheless, it is well recognized that there are various ways to compute the equilibrium exchange rates (see MacDonald, 2000 for an overview). The three main approaches are: purchasing power parity (PPP) whereby the equilibrium exchange rate leads to PPP; behavioral effective exchange rate (BEER) which gives an index level that the market exchange rate is expected to revert to beyond the short term; and fundamental effective exchange rate (FEER) that uses a macroeconomic balance concept of equilibrium. There are methodological issues associated with each of these approaches resulting in imprecise estimates of the equilibrium exchange rate. Indeed, the different methods of computation typically yield a wide range of estimates of misalignment. For instance, in the case of China the estimates of the undervaluation of the Chinese yuan range from zero to nearly 50 percent (see Dunaway and Li, 2005).

We would obviously not want to defend the method that we employ nor the estimates that are produced, as our focus is not to develop the best measure of equilibrium exchange rates for the regional currencies. Rather, our purpose is to illustrate how a set of target exchange rates can serve as benchmark rates for the computation of divergence indicators. As demonstrated below, the use of target exchange rates as reference values has a great visual impact on the appearance of the divergence indicators, with significant implications on which currencies will be identified as tracking the basket closely vis-à-vis those that are deviating significantly from the basket.

In this study, we employ the enhanced PPP approach to obtain an approximate measure of the equilibrium exchange rate for the constituent currencies. Reflecting the Balassa-Samuelson effect—which predicts that the real exchange rate should appreciate as countries grow richer—we regress the real exchange rate of a country against its output. Such a regression is known as the Penn regression and the fitted value provides a quick measure of the equilibrium real exchange rate. By running a cross-country regression, the implicit assumption is that PPP will apply over the long run, spanning the period over which the developed countries have become rich and others that have not. Undervaluation or overvaluation is then indicated by the extent which a country's exchange rate diverges from the estimated regression line.

Following the approach taken in Frankel (2006), we run a cross-sectional regression on 181 countries based on year 2003 data which are available from Penn World Tables v6.2[2]. (We did not choose a more recent year due to missing data for some of the ASEAN+3 countries.) This gives us the following fitted regression line

$$q = -4.10 + 0.37y \qquad (8)$$

where q represents the real exchange rate measured by the log of a country's price level relative to the U.S.; and y is log of the country's per capita GDP in PPP terms. Both coefficients are highly significant and the fit is relatively high with R^2=41%. For each ASEAN+3 country, we first obtain the predicted value from this regression and then take the difference between the predicted and the actual real exchange rate, as measured by the log of the country's price level relative to the U.S.. These values are found in Table 4 below; they are indicative of the extent of overvaluation or undervaluation of the currency in year 2003 in logarithmic terms.

[2] Source: Alan Heston, Robert Summers and Bettina Aten, Penn World Table Version 6.2, Center for International Comparisons of Production, Income and Prices at the University of Pennsylvania, September 2006. Unfortunately, data for Myanmar is not available.

Table 4. Tentative Disequilibrium Estimates Suggested by Penn Regression (in logarithmic terms)

COUNTRY	2003
Brunei	-0.414
Cambodia	0.191
China	-0.481
Indonesia	-0.542
Japan	0.642
Korea, Republic of	0.128
Laos	-0.090
Malaysia	-0.466
Philippines	-0.415
Singapore	0.017
Thailand	-0.436
Vietnam	-0.521

We emphasize that these estimates of misalignment are subject to wide margins of error and are only very tentative approximations. In particular, we highlight an important limitation of the enhanced PPP approach: when the price level of a country is measured below its actual level, an undervaluation will be imputed for its currency. Notwithstanding the arbitrary numbers, we use them to adjust the average duro value of each ASEAN+3 currency in year 2003. For simplicity, we use the disequilibrium estimates as approximate measures of misalignment of the currencies in terms of the duro value. The adjusted values replace the base period's exchange rates as benchmark rates and we derive the divergence indicators based on the new reference values. A plot of these divergence indicators is depicted in Figure 7.

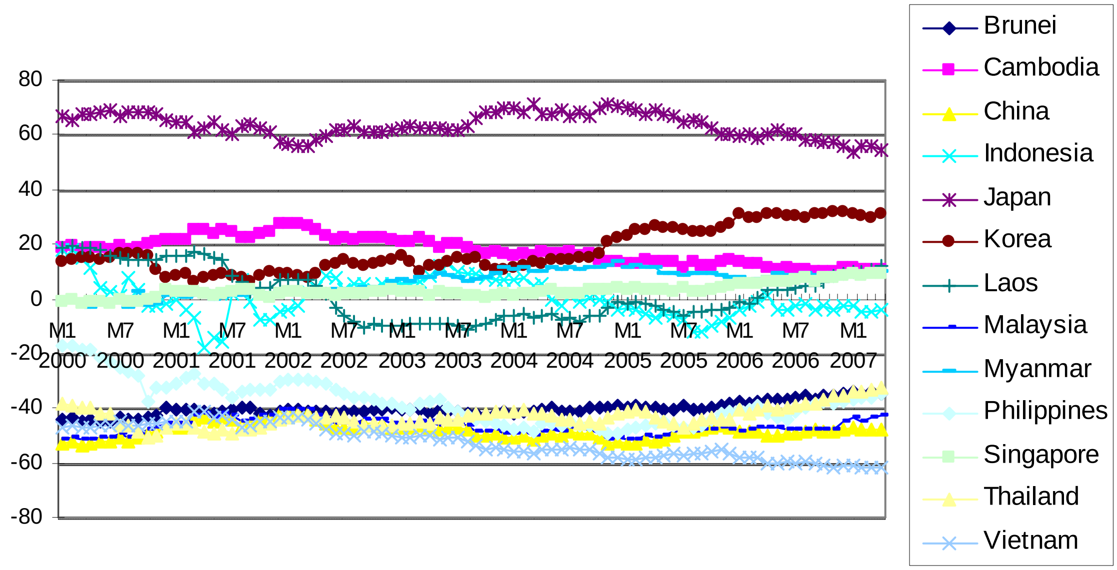


Figure 7. Divergence Indicators of AMU Using Tentative Estimates

In contrast to the previous plots of divergence indicators that use base periods as reference points (see Figures 5 and 6), Figure 7 reveals that the divergence indicators take on very different appearances when target exchange rates are used as benchmark rates. A comparison between the plots reveals that the latter give a better sense of misalignment of the respective currencies.

Policy Implications

Benchmark rates should be selected to ensure meaningful interpretation of exchange rate behavior. Should the ASEAN+3 countries decide to adopt a RMU as its reference currency, consideration has to been given as to whether that the currency basket is dominated by component currencies that are misaligned. Otherwise, the regional currencies may end up shadowing misaligned currencies. One way to prevent this from happening is to specify the benchmark rates for deriving the divergence indicators as target exchange rates instead of the exchange rates at some base period. Of course, this requires the countries in the ASEAN+3 grouping to work towards an agreement on the exchange rate levels of the regional currencies that could reasonably serve as benchmark rates. Another possibility is to draw on the work by the CGER group at the IMF for their estimates of equilibrium exchange rates of the regional currencies and use those as the target exchange rates.

In the exchange rate mechanism of the EMS, there are formally agreed bilateral exchange rate parities among intra regional currencies and these provide natural benchmarks for assessing divergence. In fact, the maximum allowable movements in currencies vis-à-vis the ECU were based on maximum allowable movements in bilateral rates relative to bilateral central rates in the EMS. During the surveillance exercise, divergence thresholds were set at seventy-five percent of the maximum allowable fluctuation in terms of the ECU as a means of signaling when policy action was needed. In this way, the ECU based divergence indicators were seen, in principle, as providing a reference point for considering the policy requirements for fostering exchange rate convergence.

However, there are some technical difficulties with the use of the basket based divergence indicators for monitoring intra regional exchange rate movements (Adams and Chow, 2007). Apart from asymmetry of weights which we discussed earlier, another key problem is offsetting effects. This refers to the divergence indicators not always signaling large changes in the bilateral exchange rates of currencies included in the basket. Since the divergence indicator is a weighted average of one currency's movement against all other currencies in the basket and there can be offsetting effects when one currency is strong against some currencies in the basket and weak against others. This implied that a currency might not trigger the divergence indicator even when the bilateral rate was moving by more than the permissible range of plus or minus 2 ¼ percent range in the narrow band or the plus or minus 6 percent range in the wide band.

In addition, the EMS also has difficulties related to the fact that not all currencies in the ECU were in the exchange rate mechanism at all times. Further, intra marginal intervention within the exchange rate band reduced the signaling role of the divergence indicator. All the above difficulties became evident early on when the ECU based divergence indicators were used in the EMS and as a result, substantially reduced the role played by these indicators in the EMS.

I.3 Anchor Currencies

In general, it is not sufficient to focus only on intra-regional exchange rate movements when interpreting exchange rate behavior. It is necessary to take into account movements in the basket vis-à-vis external currencies during exchange rate surveillance. This is because any dispersion of intra-regional exchange rates can be consistent with a potentially infinite number of configurations of extra-regional exchange rates. In other words, different movements in the external value of the component currencies can give rise to identical movements in the intra regional divergence indicators. Following Adams and Chow (2007), we illustrate this with counterfactual experiments.

Consider the following two Scenarios involving three sub-groups of constituent currencies. In Scenario III, assume that Group 1 comprising the Korea won, the Singapore dollar and the Thai Baht appreciates against the duro by 10%; Group 2 comprising the Chinese yuan and the Malaysian Ringgit remains unchanged in terms of the duro; while Group 3 comprising the rest of the APT currencies depreciates against the duro by 10%. As a comparison, Scenario IV has the duro value of the currencies of Group 1 remaining unchanged; currencies in Group 2 depreciating by 10% against the duro; and currencies in Group 3 depreciating by 20% against the duro. Table 5 below shows the percentage point deviations from baseline for the two scenarios, while the plots of the divergence indicators for Scenario III and IV are found in Figures 8 and 9 respectively.

Table 5. AMU and Deviation Indicators Under Scenarios III & IV
(Percentage Point Deviations From Baseline)

Basket Type	Asymmetric Basket	
	Scenario III	*Scenario IV*
AMU	-0.77	-5.77
Basket Deviation Indicators		
Brunei	-4.23	-4.23
Cambodia	-4.23	-4.23
China	0.77	0.77
Indonesia	-4.23	-4.23
Japan	-4.23	-4.23
Korea	5.77	5.77
Laos	-4.23	-4.23
Malaysia	0.77	0.77
Myanmar	-4.23	-4.23
Philippines	-4.23	-4.23
Singapore	5.77	5.77
Thailand	5.77	5.77
Vietnam	-4.23	-4.23

Figure 8. Divergence Indicators of AMU for Scenario III

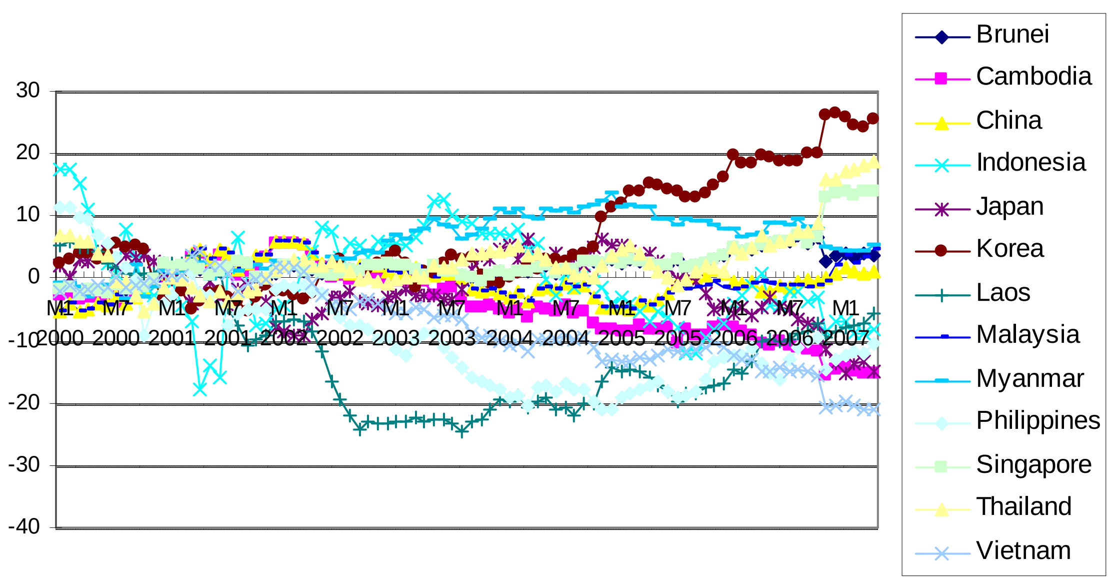
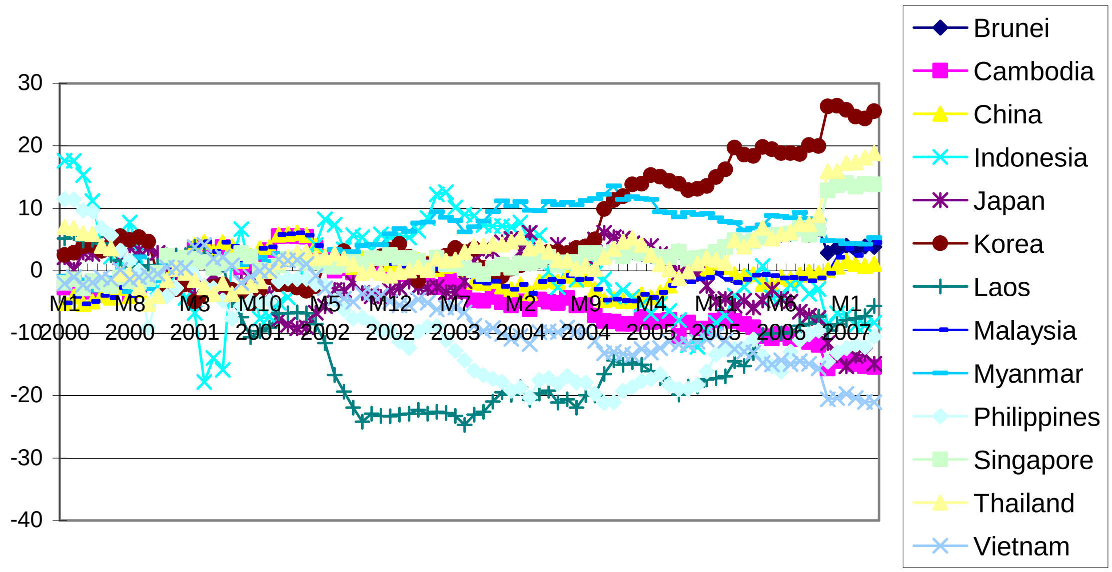


Figure 9. Divergence Indicators of AMU for Scenario IV



We observe from Table 5 that the currency basket behaved rather differently in the two scenarios, with the external value of the AMU depreciating more in Scenario IV than in Scenario III. However, the different movements in the component currencies between the two scenarios are not reflected in the percentage point deviations of the divergence indicators, in fact these turn out to be identical across Scenarios III and IV. The plots in Figures 8 and 9 confirm that the divergence indicators behave in the same way despite differences in the movements of the external value of the constituent currencies in the two scenarios. This shows that the divergence indicators, while capturing the deviation of the regional currencies from the basket, do not accurately reflect information about extra-regional exchange rate movements. The movements of the regional currencies vis-à-vis external currencies can be monitored by tracking the external value of the AMU. Hence, the use of divergence indicators for exchange rate surveillance requires the direct monitoring of the changes in the value of the AMU in terms of external currencies as well.

Under the EMS, it was not necessary to track the value of the ECU in terms of external currencies as the system de facto became based on the deutsche mark with the external value of the ECU tied down by German monetary policy. In practice, the EMS system quickly evolved into a de facto deutsche mark zone in which currencies shadowed the deutsche mark instead of the ECU (Gros and Thygesen, 1998). With all currencies in the system tracking the deutsche mark and the deutsche mark floating against external currencies such as the U.S. dollar and the Japanese yen but anchored by the Bundesbank, both the internal and external value of the ECU currency basket were tied down in the EMS. Hence, the EMS did not include explicit targets for the ECU vis-à-vis external currencies, so that monitoring of the external value of the basket was not central to that system's exchange rate mechanism.

Policy Implications

Unlike the EMS, there is currently no agreement or understanding amongst the ASEAN+3 countries on which currency or subgroup of currencies should play the role of an anchor currency (as did the German mark). This leads to difficulties on discussing how policy should react to excessive divergences in exchange rates. For instance, in a situation in which the Japanese yen appreciates sharply vis-à-vis the Chinese yuan, it is necessary to decide whether the yen is too strong or the yuan is too weak in order to reach an agreement on policy response. In order to identify the appropriate policy response for fostering intra regional exchange rate stability, it is thus necessary to take into account the movements of the regional currencies vis-à-vis external currencies.

Amongst the members of the ASEAN+3 grouping, there should either be an agreement about the appropriate external value of the currency basket or an agreement that the external value of the basket will be market determined. In the first instance where the external value of the currency basket is managed, there must be agreement that one or more participating countries manage their currencies relative to external currencies and not intervene vis-à-vis other currencies in the basket. Alternatively, in the floating external exchange rate case, there must be an understanding that one or more of the countries in the currency basket arrangement must focus monetary policy on internal price stability and act passively vis-à-vis other countries in the basket as regards intra regional exchange rates.

In other words, to determine the appropriate policy adjustments in response to excessive divergences signaled by the AMU based divergence indicators, certain constituent currency (or group of currencies) will have to be assigned the responsibility of anchoring the system as was the case in the EMS. Alternatively, the currency basket needs to be expanded to include external currencies such as the US dollar and the euro.

I.4 Data Requirements

To facilitate the creation of an effective RMU, good quality statistics are needed. In particular, a coherent body of statistical information across participating countries is required for the computation of weights used in the construction of the RMU. As mentioned in Section I.1, the currency weights are determined by variables such as GDP evaluated at PPP-based exchange rates (alternatively, nominal US dollar-based GDP computed at market exchange rates can be used to capture the size of the economies), imports and exports. Only data at annual frequency are required for these variables. As for the computation of the RMU itself, official exchange rates of the participating countries are used. Further, the real value of the RMU would require the CPI of the participating countries. Country statistics on the exchange rates and CPI are needed at monthly frequency.

The accessibility and availability of relevant online data of sufficiently high frequency could be limited in some countries due to lack of technology and capital or language barriers. In this study, we focus on the new ASEAN countries namely, Cambodia, Laos, Myanmar, and Vietnam. We survey the official databases of the new ASEAN countries as well as international/regional databases such as IMF’s *International Financial Statistics* and ADB’s *Asian Regional Integration Centre* to identify data gaps with regard to statistical information required for the computation of the RMU. Table 6 below lists the time span for which data on the relevant variables are available as well as the data source.

Table 6. Data Sources of New ASEAN Members for Construction of RMU

	Brunei	Cambodia	Laos	Myanmar	Vietnam
Annual frequency					
GDP(PPP)	1999-2004(without 2002) General Statistics Office of Vietnam http://www.gso.gov.vn/default_en.aspx?tabid=475&idmid=3&ItemID=6375	1999-2004(without 2002) General Statistics Office of Vietnam http://www.gso.gov.vn/default_en.aspx?tabid=475&idmid=3&ItemID=6375	1999-2004 General Statistics Office of Vietnam http://www.gso.gov.vn/default_en.aspx?tabid=475&idmid=3&ItemID=6375	1999-2004(without 2000,2002 &2003) General Statistics Office of Vietnam http://www.gso.gov.vn/default_en.aspx?tabid=475&idmid=3&ItemID=6375	1999-2004 General Statistics Office of Vietnam http://www.gso.gov.vn/default_en.aspx?tabid=475&idmid=3&ItemID=6375
GDP	2001-2005 General Statistics Office of Vietnam http://www.gso.gov.vn/default_en.aspx?tabid=475&idmid=3&ItemID=6374 2003-2005 Brunei Economic and Finance Publications http://www.bruneiresources.com/pdf/economic_key_indicator_2005.pdf	1993-2005 National Institute of Statistics of Cambodia http://www.stats.nis.gov.kh/PERIODIC/NA/Table.htm 1995-2004 General Statistics Office of Vietnam http://www.gso.gov.vn/default_en.aspx?tabid=475&idmid=3&ItemID=6373	1990-2004 General Statistics Office of Vietnam http://www.gso.gov.vn/default_en.aspx?tabid=475&idmid=3&ItemID=6370	1990-2003 General Statistics Office of Vietnam http://www.gso.gov.vn/default_en.aspx?tabid=475&idmid=3&ItemID=6368	1990-2006 General Statistics Office of Vietnam http://www.gso.gov.vn/default_en.aspx?tabid=468&idmid=3 1986-2005 Bloomberg

Exports &Imports (Regional)	1980-2003 DOTS	1980-2003 DOTS	1980-2003 DOTS	1980-2003 DOTS	1980-2003 DOTS
Monthly frequency					
EX(official)	Jun 1993-Sep 2007 ARIC(ADB) http://aric.adb.org/indicators/External_Sector/E_BRU_M_External_Sector.htm	May 1997-Sep 2007(missing value) ARIC(ADB) http://aric.adb.org/indicators/External_Sector/E_CAM_M_External_Sector.htm	Jun 1993- Sep 2007 ARIC(ADB) http://aric.adb.org/indicators/External_Sector/E_LAO_M_External_Sector.ht	Aug 1994 -Sep 2007 ARIC(ADB) http://aric.adb.org/indicators/External_Sector/E_MYA_M_External_Sector.htm	Jun 1993 - Sep 2007 ARIC(ADB) http://aric.adb.org/indicators/External_Sector/E_VIE_M_External_Sector.htm
CPI	Jan 1984 - Dec 2005 IFS (with missing values Jan 1987-Dec 1988, Jan 1990-Dec 1992, May 1998-Dec 1999)	Oct 1994 - Jul 2007 IFS Jan 2001-Sep 2007 National Institute of Statistics of Cambodia http://www.stats.nis.gov.kh/PERIODIC/CPI/CPI.HTM	Dec 1987-Dec 1991 May 1993-Sep 2007 IFS	Jan 1970- Dec 2006 IFS Jun 2005-Mar 2007 Ministry of National Planning and Economic Development http://www.csostat.gov.mm/S16MA02.asp	Jan 1995 - May 2007 IFS Jan 1995-Dec 2006 General Statistics Office of Vietnam http://www.gso.gov.vn/default_en.aspx?tabid=472&idmid=3&ItemID=6537 Jul, Aug & Sep 2007 General Statistics Office of Vietnam http://www.gso.gov.vn/default_en.aspx?tabid=462&idmid=2&idmid=2&ItemID=6722

Part II

RMU Indicators for Economic and Financial Stability

In this section, we examine how the RMU and its deviation measures could be used as additional tools by the East Asian monetary authorities to conduct surveillance for economic and financial stability in the region. Our approach builds on the early warning system (EWS) which the Asian Development Bank has recently developed for its developing member countries. We will incorporate the RMU real deviation measures in the ADB methodology that employs the Kaminsky-Reinhart non-parametric signaling approach (ADB, 2005) and empirically test the effectiveness of these deviation measures in anticipating crisis episodes. In particular, simulations studies are carried out using the *Vulnerability Indicators and Early Warning Systems* (VIEWS) software, with the help of ADB's technical staff, especially Mr. Ivan de Leon of ADB's OREI division.

In other words, the questions we are addressing are: if we had included the AMU real divergence indicators as proposed by Ogawa and Shimizu (2005) into the EWS in late 1996, how much better would we have been to predict the Asian crisis compared to the current EWS system? How do the AMU indicators compare with the real effective exchange rates (REER) in terms of their ability to predict crises, particularly the 1997 Asian crisis? Based on the relative performance, an assessment can be made as to whether the information content in the AMU real divergence indicators is sufficient to replace the REER for use as an early warning to crisis.

II.1 Construction of Pre-crisis Real RMU Indicators

In order to empirically assess the usefulness of AMU and its associated divergence indicators for signaling the 1997 Asian crisis, we need to construct these time series using pre-crisis data. However, due to data unavailability, we consider an AMU that only comprises the eight currencies of ASEAN5 plus 3 i.e. the currencies of China, Indonesia, Japan, South Korea, Malaysia, Philippines, Singapore and Thailand. For comparability with current AMU series, we follow the method of construction as proposed by Ogawa and Shimizu (2005). First, the base year is chosen as the period with small trade balances for the APT countries with the rest of the world, with Japan and within the grouping which are recorded in Table 5 below. Based on this criterion we chose the period 1990 to 1991 to be the benchmark years, i.e. the benchmark rates are the exchange rates averaged over these two years. As noted earlier, there is usually an element of arbitrariness in the determination of base period.

Table 5. Trade Balance of ASEAN5+3 in Pre-crisis Period

	Within ASEAN5+3	With Japan	With World
1988	-2,686	-21,346	77,784
1989	-5,367	-22,838	54,374
1990	-4,411	-26,268	34,976
1991	-7,661	-36,717	55,875
1992	-3,854	-44,970	87,046
1993	-6,941	-58,346	88,007
1994	8,827	-69,113	98,435
1995	15,332	-78,554	68,099
1996	12,881	-65,019	14,891
1997	25,522	-60,424	87,020

Next, we determine the pre-crisis weights of the constituent currencies in the basket based on the regional trade shares and PPP-based GDP of the individual APT countries. Suppose we are in 1996, allowing for a two year publication lag means we would have updated the weights and average these two variables over the three years of 1992, 1993 and 1994. Table 6 below provides the weights and quantities of the component currencies in a pre-crisis RMU. The external value of the AMU for the post 2000 period is expressed in terms of a weighted average of the US$ and the euro. Given that the euro is available only from 2000, we use the German mark to replace the euro during the pre-crisis period. For convenience, we continue to call this basket of external currencies the duro. Figures 10 and

11 below give the time plots of the pre-crisis RMU constructed for the ASEAN5 plus 3 countries, and the associated divergence indicators.

Table 6: Weights and Quantities for Pre-crisis AMU

	Regional Trade weights	PPP-based GDP weights	Average Weight	Benchmark Exchange rate	Quantities
China	27.84	39.78	33.81	0.298826	1.13
Indonesia	3.74	6.69	5.22	0.027325	1.91
Japan	32.96	36.57	34.77	0.008927	38.95
Korea	11.30	7.06	9.18	0.001829	50.20
Malaysia	6.36	1.81	4.09	0.465377	0.09
Philippines	2.00	2.93	2.46	0.054951	0.45
Singapore	10.42	0.81	5.61	0.054951	1.02
Thailand	5.37	4.35	4.86	0.049084	0.99

Figure 10. External Value of Pre-crisis AMU (1988 to 2000)

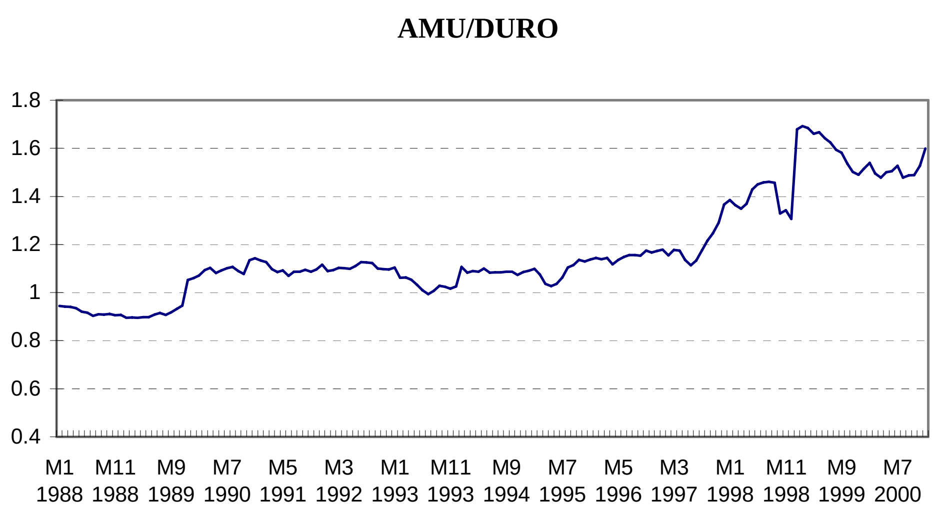
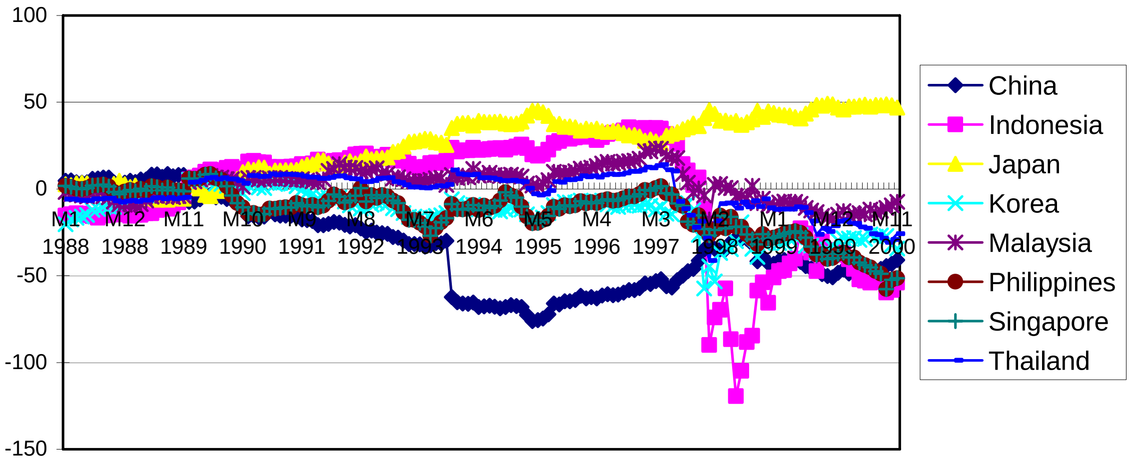


Figure 11. Nominal Divergence Indicators for Pre-crisis AMU (1988 to 2000)



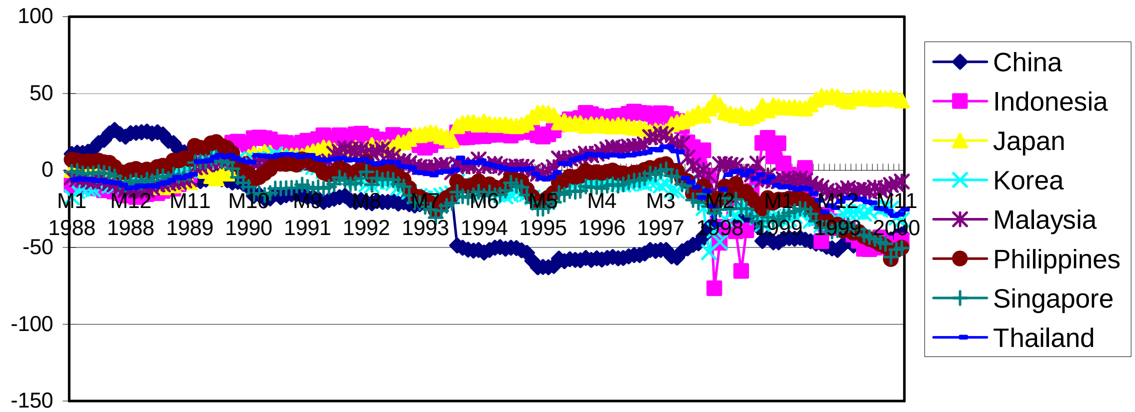
To incorporate the nominal divergence indicators (*nomdev*) along with other economic indicators into the early warning system, it is necessary to express the deviations in real terms. Following Ogawa and Shimizu (2005), we obtain the real divergence indicator (*realdev*) for country i as:

$$realdev_i = nomdev_i - (\inf lation_{AMU} - \inf lation_i) \qquad (9)$$

where $\inf lation_{AMU}$ is the computed from the weighted average of the CPI of the ASEAN5+3 countries using the same weights for computing the currency basket (see Table 6). In other words, the real deviations are simply nominal deviations adjusted for the inflation differential between the country and the region comprising the ASEAN5+3 countries. Figure 12 depicts a plot of the real divergence indicators.

A comparison between the real and nominal divergence indicators reveal that countries with high inflation relative to the inflation rate of the whole region will have real divergence indicators that are at a higher level than nominal divergence indicators. A case in point is the divergence indicator of Indonesia during the crisis period.

Figure 12. Real Divergence Indicators for Pre-crisis AMU (1988 to 2000)



II.2 Performance of AMU Real Deviation Indicators in EWS

This section provides a preliminary report of our empirical analysis of the usefulness of real deviations from AMU in anticipating currency crises in Asia. Our empirical analysis covers two sample periods: 1988 – 2000 and 2000 – 2007. For the first sample period, we employed our constructed AMU real deviation indicators for the ASEAN5+3 grouping with the US dollar and the German deutschmark as external reference rates, as explained in earlier sections of this report. For the second sample period, we used the AMU real deviation indicators (with the US dollar and the Euro as external reference rates) as provided in the REITI's website (http://www.rieti.go.jp/users/amu/en/index.html).

To address the main issue, we looked at alternative simulations of ADB's early warning system (VIEWS). VIEWS, as explained in ADB (2005), is based on Kaminsky-Reinhart's nonparametric signaling approach. Essentially this EWS model is developed in five steps: (1) date historical episodes of crisis; (2) identify leading indicators with predictive quality; (3) set threshold value for each selected indicator; (4) construct composite indices and (5) predict crises. In this methodology, it has been observed that the real effective exchange rate (REER) invariably shows up as an important early warning indicator. Thus our alternative simulations of VIEWS used real deviations from AMU either as an additional indicator or as a substitute for trend deviations of REER in VIEWS. We judge the usefulness of AMU as a surveillance tool by looking at its calculated noise to signal ratio, consistency of its own signals with crisis events, and the tracking ability of the models when AMU is used, especially with reference to the tracking ability of REER.

Based on our preliminary findings, our main conclusion is that deviations from AMU, in conjunction with other early warning indicators, has potential contribution in flagging down impending currency crises, but its performance does not differ much from that of REER. When considered in isolation from other indicators, that is, when looking at the warning signals coming from either AMU deviations alone and from trend deviations in REER alone, trend deviations in REER perform better than deviations from AMU.

Alternative Scenarios

Now, we take a closer look at our empirical results. Our simulations of VIEWS entertained alternative cases with regard to sample period, inclusion of either RMU or REER or both, and countries covered. Concerning the last item, the Kaminsky-Reinhart signaling approach combines data from different countries to have a more substantial number of crisis time points over the sample period covered. The countries covered in the original ADB simulations of VIEWS include ASEAN5 (Indonesia, Malaysia, Philippines, Singapore, and Thailand) and Korea. For our additional simulations, China was added to the list. The country coverage of the simulations over 2000 – 2006 only included ASEAN5 and Korea since no crisis episodes were identified during this period for China (using the formula of "mean + 2 standard deviations" of month-to-month percentage changes in nominal exchange rate as explained later).

Table 7 below lists the scenarios covered by the alternative simulations. Details of all the simulation results can be obtained upon request from the authors. In this study, the focus is on pre-crisis discussions using the scenarios whereby China is covered. We first examine that the overall picture provided by scenario 6 that includes both the AMU and REER deviation indicators. Then for comparison purposes, we study the results of scenarios 3 and 4 where either the AMU or REER deviations are included in the list of early warning indicators.

Table 7: Description of Alternative Scenarios

Scenario	Sample Period	Countries	RMU Included?	REER Included?
1	1988 - 2000	ASEAN5 + Korea	Yes	No
2	1988 - 2000	ASEAN5 + Korea	No	Yes
3	1988 - 2000	ASEAN5 + Korea + China	Yes	No
4	1988 - 2000	ASEAN5 + Korea + China	No	Yes
5	1988 - 2000	ASEAN5 + Korea	Yes	Yes
6	1988 - 2000	ASEAN5 + Korea + China	Yes	Yes
7	2000 - 2006	ASEAN5 + Korea	Yes	No
8	2000 - 2006	ASEAN5 + Korea	No	Yes

Noise to Signal Ratios and Conditional Crisis Probabilities

In order to assess the performance of an indicator on its ability to emit early warning of a crisis, two measures are used. First is the noise to signal ratio (NSR) of indicator which is the ratio of the probability that it incorrectly signals a crisis during a tranquil period, to the probability that it correctly signals a crisis during the pre-crisis period. Hence, the smaller the NSR the higher the predictive power of the early warning indicator. In particular when the NSR of an indicator takes the value one, it is said to have no predictive power since there is equal chance that it correctly or incorrectly signals a crisis. The second measure is the conditional crisis probability (CP) which is the probability of a crisis occurring within 24 months, conditioned on a warning signal being emitted by the indicator. It follows that the higher the value of CP, the greater the predictive power of the early warning indicator.

Table 8 below provides the noise-to-signal ratios as well as the conditional crisis probabilities for all the fifty–six early warning indicators used in the model in Scenario 6. In this scenario, both the AMU real deviations indicators (coded ky 99) and the REER deviations from trend (coded cy 4) are included in the model and the sample period covered is 1988-2000.

Table 8. Noise-to-Signal Ratios and Conditional Crisis Probabilities in Scenario 6

Early Warning Indicator	Noise-to-Signal Ratio	Conditional Crisis Probability
cy1 Exports, 12 m % change	0.81	0.33
ry3 Industrial/manufacturing production index, 12 m % change	1.87	0.15
cy2 Imports, 12 m % change	1.16	0.26
sx1 Fiscal balance to GDP	1.54	0.20
kx11 Foreign reserves in months of imports	0.77	0.34
kx2 Short-term external debt to reserves	0.47	0.46
kx3 Foreign liabilities to foreign assets	0.51	0.44
fx7 Loans to deposits	0.72	0.36
kx4 M2 to reserves	0.48	0.45
cy3 Real exchange rate against US$, deviation from trend – HP filter	0.07	0.85
cx7 Trade balance to GDP	0.43	0.48
cy7 Trade balance to GDP, 12 m change	0.74	0.35
kx6 Domestic real interest rate differential from US rate	1.01	0.28
ky2 Short-term external debt to reserves, 12 m change	0.77	0.34
ky4 M2 to reserves, 12 m change	0.50	0.44
ky5 Deposits in BIS banks to reserves, 12 m change	0.70	0.37
ky8 Short-term capital flows to GDP, 12 m change	1.09	0.27
ky11 Foreign reserves in months of imports, 12 m change	1.24	0.24
fx2 M2 multiplier	1.14	0.26
fy2 M2 multiplier, 12 m % change	0.85	0.32
fx3 M1 to GDP	0.72	0.36
fx4 Domestic credit to GDP	3.76	0.10
fy4 Domestic credit to GDP, 12 m change	0.86	0.32
fy5 Domestic real interest rate, 12 m change	0.69	0.36
fx6 Lending-deposit rate spread	2.39	0.14
fy6 Lending-deposit rate spread, 12 m change	1.41	0.22
fx8 Deposits to M2	0.72	0.35
fy8 Deposits to M2, 12 m change	1.16	0.25
ry1 Stock price index in local currency, 12 m % change	1.73	0.17
gy1 US real interest rate, 12 m change	2.17	0.15
gy2 Oil price, 12 m % change	0.44	0.47
gy4 Real US$/yen exchange rate, deviation from trend - HP filter	1.13	0.26
sx3 Central bank credit to the public sector to GDP	1.64	0.20
sy3 Central bank credit to the public sector to GDP, 12 m change	1.48	0.21
sx4 Net credit to government to GDP	2.16	0.16
sy4 Net credit to government to GDP, 12 m change	1.36	0.23

kx8 Short-term capital flows to GDP	2.90	0.12
sx2 Government consumption to GDP	1.59	0.20
fy1 Real commercial bank deposits, 12 m % change	1.62	0.20
fy7 Loans to deposits, 12 m change	0.49	0.45
gx1 US real interest rate	1.40	0.22
gy3 US annual growth rate	2.25	0.15
ky3 Foreign liabilities to foreign assets, 12 m change	0.37	0.52
ry4 Domestic consumer price index, 12 m % change	0.88	0.31
ky1 Foreign reserves, 12 m % change	0.91	0.30
ky6 Domestic real interest rate differential from US rate, 12 m change	0.58	0.41
fy3 M1 to GDP, 12 m change	1.35	0.23
sy1 Fiscal balance to GDP, 12 m change	0.92	0.30
cy4 Real effective exchange rate, deviation from trend - HP Filter	0.18	0.67
kx5 Deposits in BIS banks to reserves	0.51	0.44
cx6 Current account balance to GDP	0.25	0.61
cy6 Current account balance to GDP, 12 m change	0.72	0.35
sy2 Government consumption to GDP, 12 m change	1.15	0.26
gx2 Oil price	0.39	0.51
fx5 Domestic real interest rate	1.54	0.21
ky99 AMU_REER	0.12	0.77

It is evident from the table that the RMU variable and the REER variable are two of the best performing indicators in terms of noise-to-signal ratio, coming in second and third lowest, respectively. The list of indicators with low NSRs and conditional crisis probabilities over 50% (values in parentheses are NSR and CP respectively) is as follows:

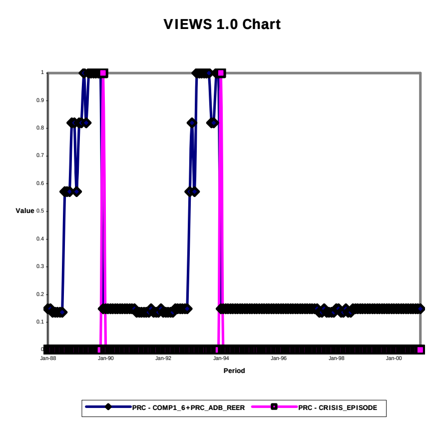
1. Real exchange rate against US$, deviation from trend (0.07; 0.85)
2. AMU real deviation indicators (0.12; 0.77)
3. REER, deviation from trend (0.18; 0.67)
4. Current account balance to GDP (.25; 0.61)
5. Foreign liabilities to foreign assets (0.37; 0.52)

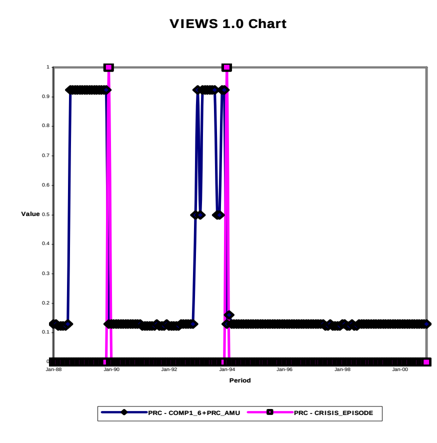
These results suggest that real deviation indicators from AMU have similar if not slightly better performance than the REER deviations when used together in flagging down impending currency crises in the region.

Crisis Probabilities for Composite Indexes based on AMU and REER Deviations

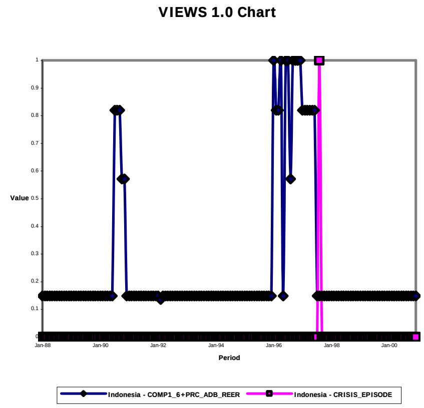
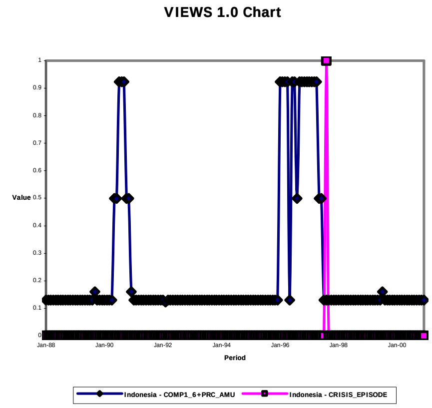
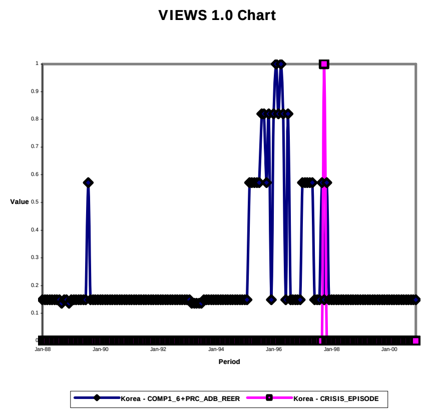
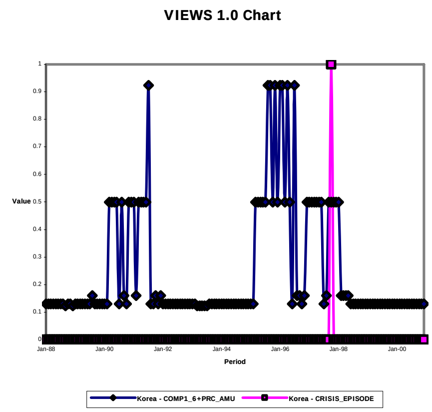
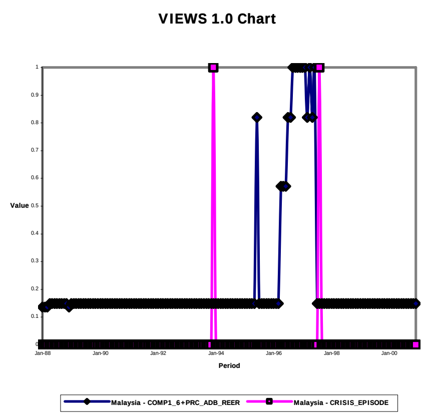
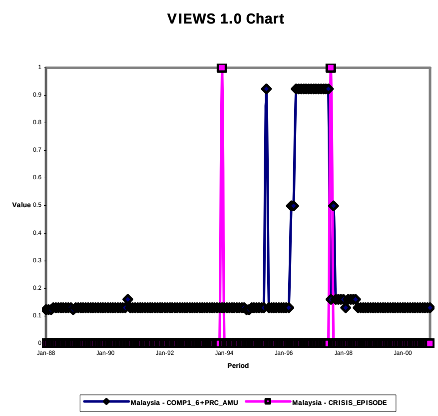
As seen above, the number of early warning indicators is large and this can lead to difficulty in interpretation of signals. Hence, the individual indicators are often times aggregated into a composite index. Under Scenario 3 (4), the composite index was constructed with the inclusion of AMU (REER) deviation indicators only. The charts in Figures 1a and 1b depict the crisis episodes as well as the crisis probabilities under Scenarios 3 and 4 respectively for each of the seven countries. We follow the ADB (2005) methodology in defining a crisis episode, instead of using the exchange market pressure index. In the words of ADB "a crisis episode is considered occurring in a country in a particular month if the month-on-month percentage change in the country's nominal exchange rate against the US dollar exceeds its sample mean by two standard deviations". As acknowledged by ADB, some of the crisis episodes identified would not have been considered a crisis in practice.

Figure 13. Currency Crisis Episodes and Crisis Probabilities Predicted by Composite Index including (a) REER (Scenario 4) and (b) AMU Deviations Indicators (Scenario 3)

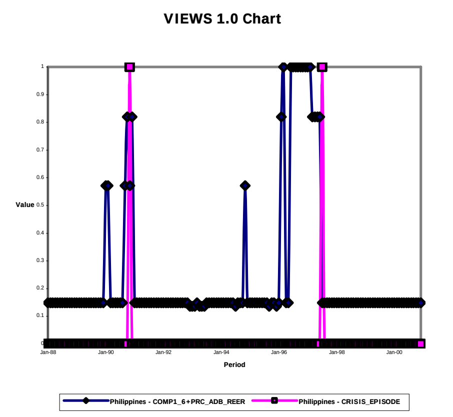
<table>
<tr><td></td><td>a. REER (Scenario 4)</td><td>b. AMU (Scenario 3)</td></tr>
<tr><td>China</td><td>


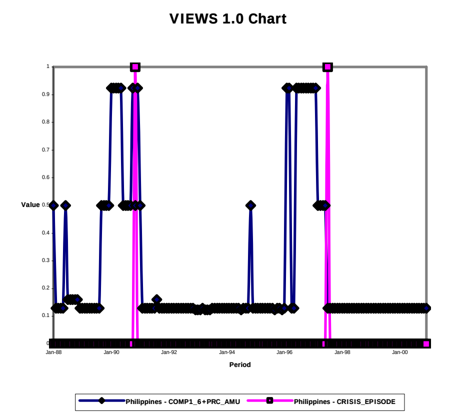
</td><td>


</td></tr>
</table>

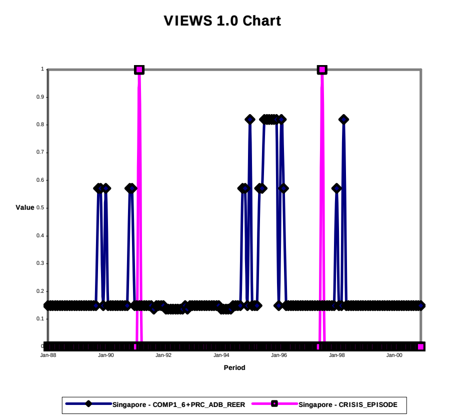
Indonesia		
Korea		
Malaysia		

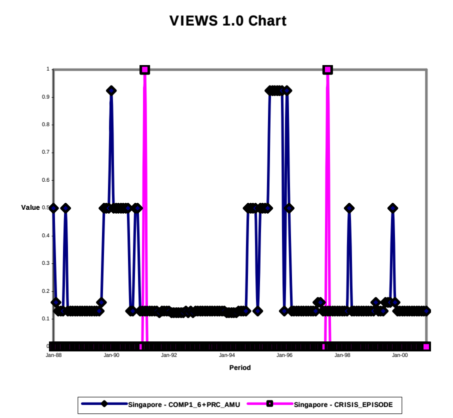
Philippines



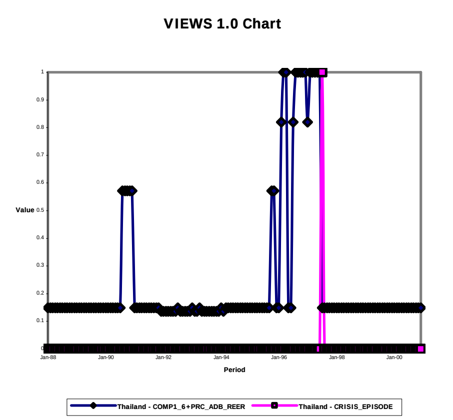


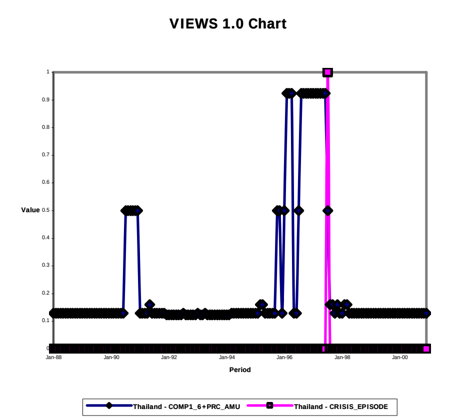
Singapore





Thailand





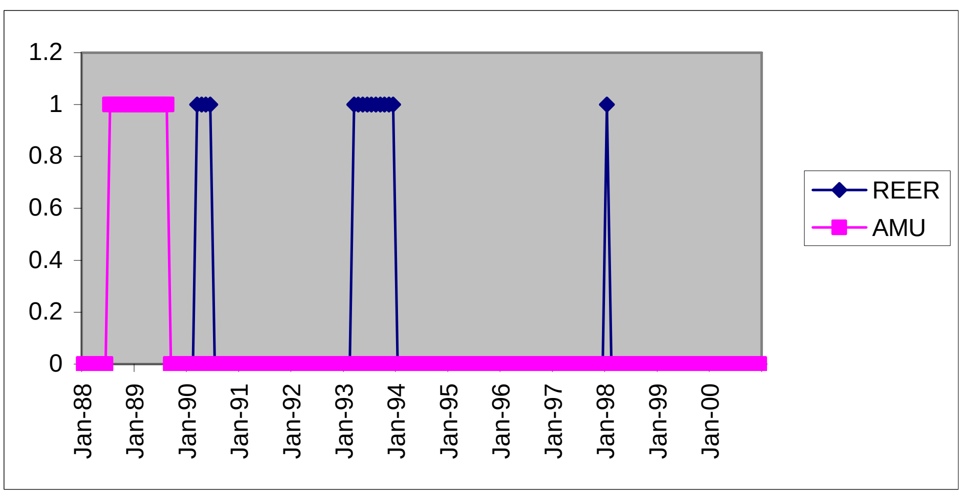
The crisis probability charts in these figures show a pretty similar ability to anticipate the crisis episodes during the sample period – in particular the 1997 crisis – and any other episodes during the period, for all the countries under analysis. These findings suggest that there may not be any significant difference in terms of signaling performance whether we use the REER or the AMU deviation indicators in conjunction with other early warning indicators in the composite index.

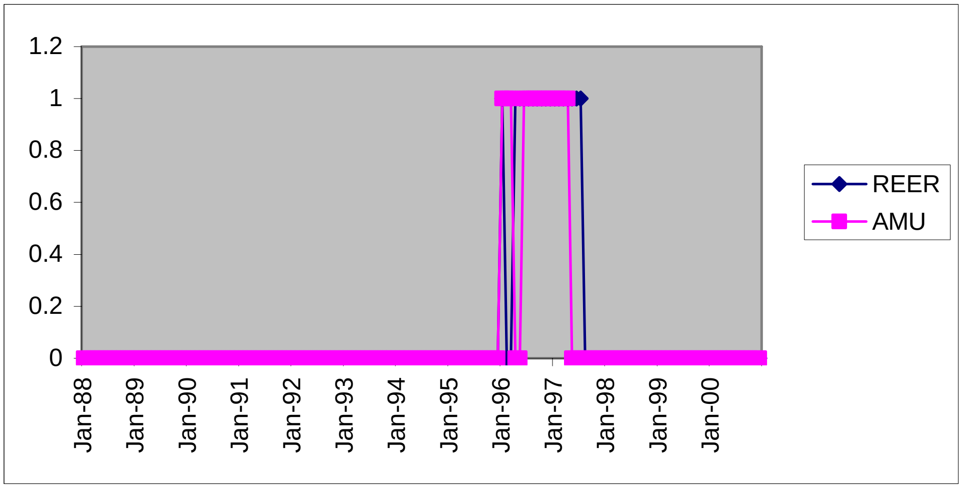
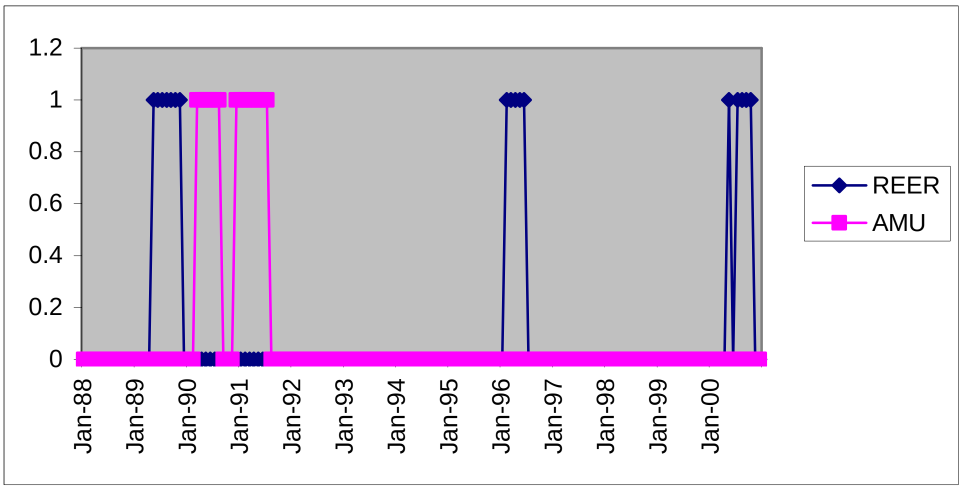
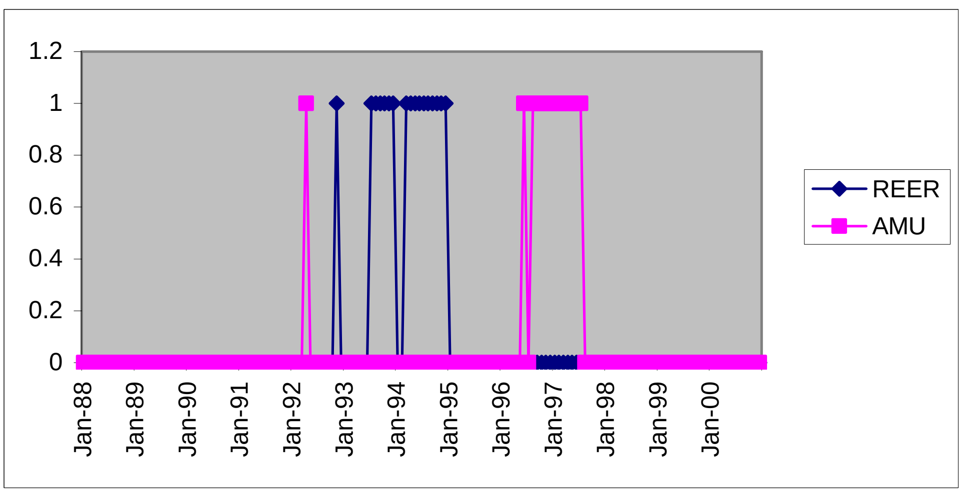
Warning Signals from AMU and REER Indicators

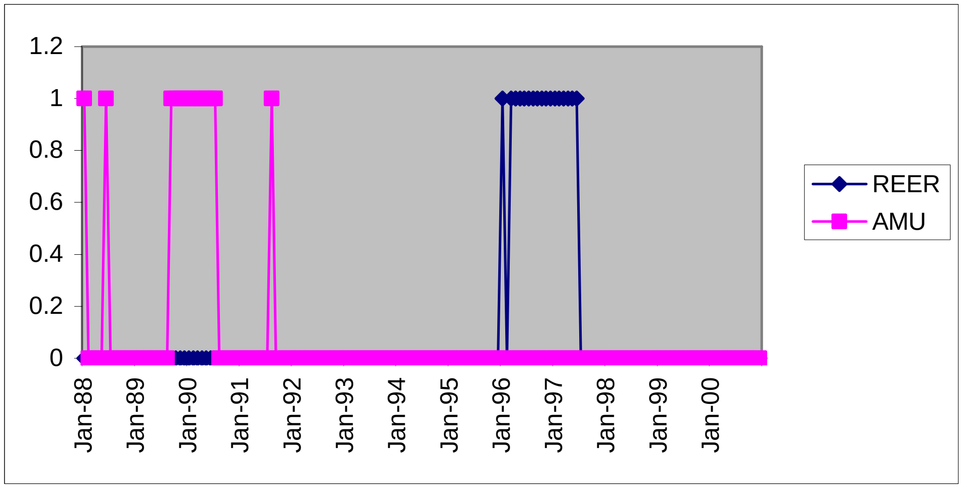
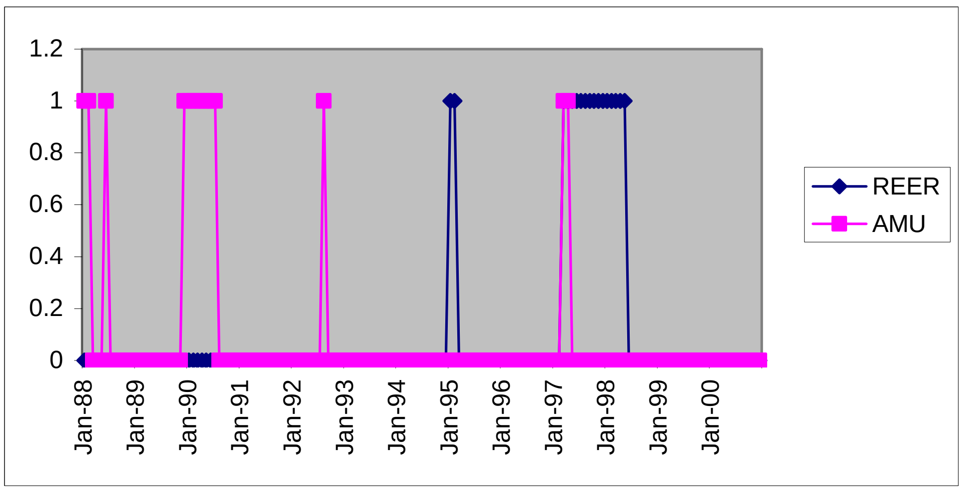
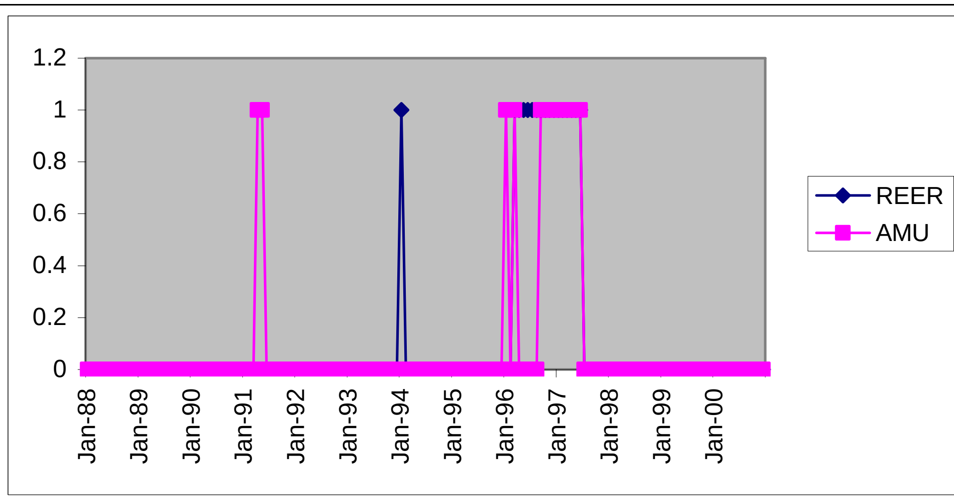
Could the above results on the comparable performance of composite indices be due to the huge overlap of fifty-five other early warning indicators? To investigate the individual performance of the AMU real deviation indicator in Scenario 4 vis-à-vis the REER deviation indicator in Scenario 3, we examine the signals emitted from these two indicators only. Each indicator is assigned a threshold so that when the indicator value crosses the threshold an early warning of crisis is issued. The threshold is identified using a grid search procedure to minimize the indicator's signal-to-noise ratio. A uniform threshold is set across all countries under consideration in terms of the percentile: 90th percentile for AMU deviation indicators and 88th percentile for the REER deviation indicators. However, the actual value of the threshold varies across countries depending on the country-specific distribution of the indicator. For comparison purposes, Figure 14 overlays the warning signals emitted by the AMU and REER deviations for each country.

Figure 14. Warning Signals by REER and AMU Deviations Indicators

China



Indonesia	
Korea	
Malaysia	

Philippines	
Singapore	
Thailand	

With the lone exception of Indonesia, the warnings signals from the two indicators are rather different. If we focus on the Asian crisis as the sole crisis episode, there are many more wrong warning signals from AMU relative to those from REER deviation indicators. In particular, AMU deviations send false positive signals for a currency crisis in mid-1992 for most countries including Korea, Malaysia, Philippines, Singapore and Thailand. There are relatively fewer such false alarms emitted by the REER deviation indicators which mostly occurred in the case of China. As for missing signals, the AMU deviations also failed to anticipate the 1997 crisis in Korea and Philippines. Apart from the case of Malaysia, the REER deviation indicators did manage to signal the 1997 Asian crisis for al the countries.

Based on these results, the AMU deviation indicators do not perform as well as the REER deviations indicators in predicting crises. This contradicts the results in the two previous subsections which could be attributed to the identification of the crisis episodes. Referring to Table 13, all countries except Indonesia and Thailand are deemed to have other currency crises in the period from 1988 to 2000 in addition to the 1997-98 Asian crisis. Unlike the REER indicators, the AMU deviation indicators must be signaling for these additionally identified crisis episodes.

Post 2000 Results

We do not analyze the simulation results for the post 2000 period because the noise to signal ratio for the AMU real deviation indicators turn out to be 1, while the conditional probability of crisis is only 0.25. As mentioned earlier, this implies that the AMU does not have predictive power as a currency crisis early warning indicator. The corresponding noise-to-signal ratio and conditional probability of crisis for the REER are 0.18 and 0.65 respectively for the same time period.

II.3 Probit Models as an Alternative Approach

In this section, we check the relative performance of REER deviations from trend and AMU deviation indicators in predicting the Asian crisis using an alternative approach. In particular, we employ probit models[3] to the crisis countries of Indonesia, Malaysia and Thailand. All sample periods in this analysis end in 2000m12 while the start dates are 1995m1, 1991m1 and 1993m1 for the three countries respectively. Using monthly data from these countries, we fit a probit model between the exchange market pressure index (EMP) against several macroeconomic and financial variables.

Adapting the proposal by Eichengreen, Rose and Wyplosz (1994), the exchange pressure index (EMP) takes on the value one in a particular month (i.e. an identified crisis episode) if there are large movements in exchange rates and foreign reserves. More specifically, we first define the exchange pressure as a weighted average of two terms with weights that ensure either component has the same sample volatility:

$$ER_t - \delta_{ER} FR_t / \delta_{FR} \qquad (10)$$

where ER_t and FR_t are the month-on-month percentage change in the country's nominal exchange rate against the US dollar and foreign reserves respectively; and δ_{ER} and δ_{FR} are the standard deviations of the respective changes. If the exchange pressure exceeds its sample mean by more than two standard deviations, the index EMP_t takes on the value one, otherwise EMP_t assumes the value zero. According to this classification, the identified crisis episodes for the regional countries correspond more directly to the Asian crisis. This can be seen in Figure 15 below which depicts the time plots of the variables used in the probit models.

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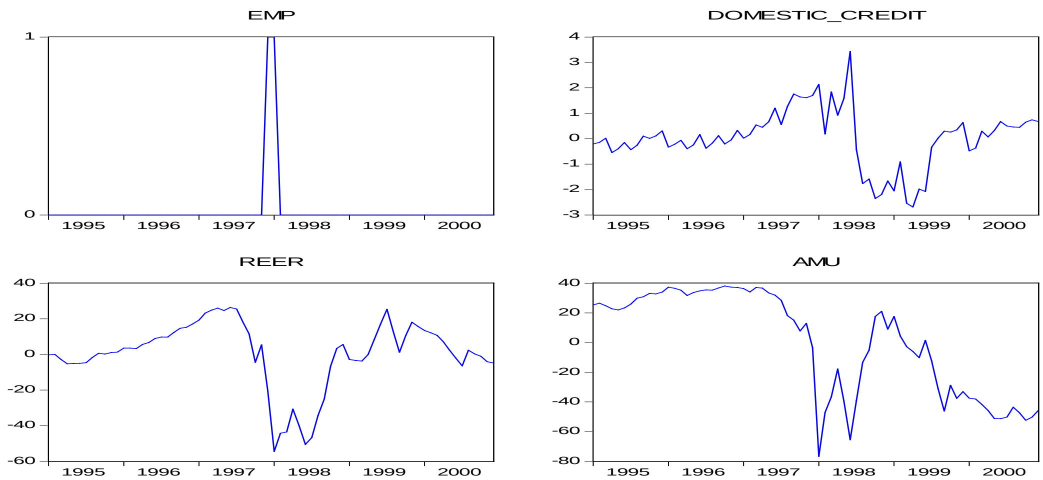
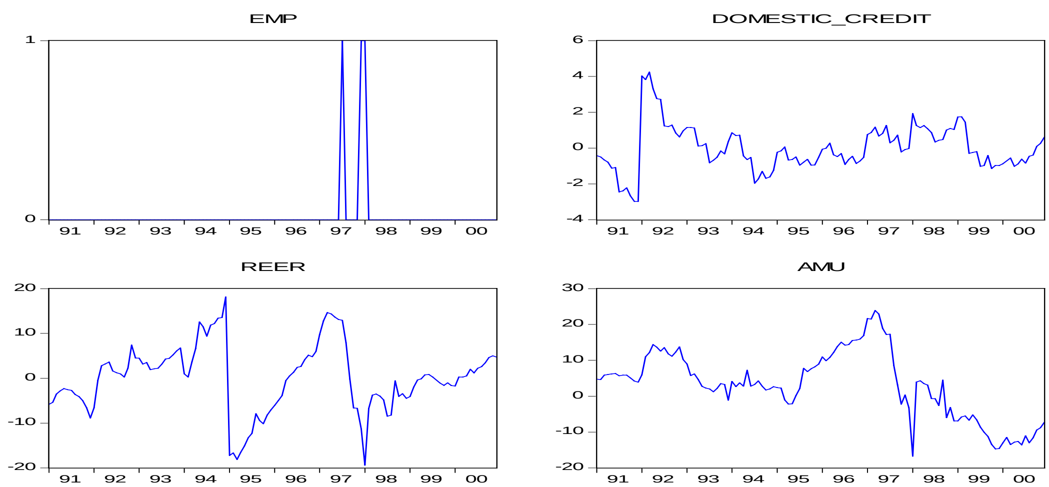
[3] Choice of countries and indicator variables included in the analysis is constraint by the non-availability of data.

Figure 15. Variables used in Probit Model

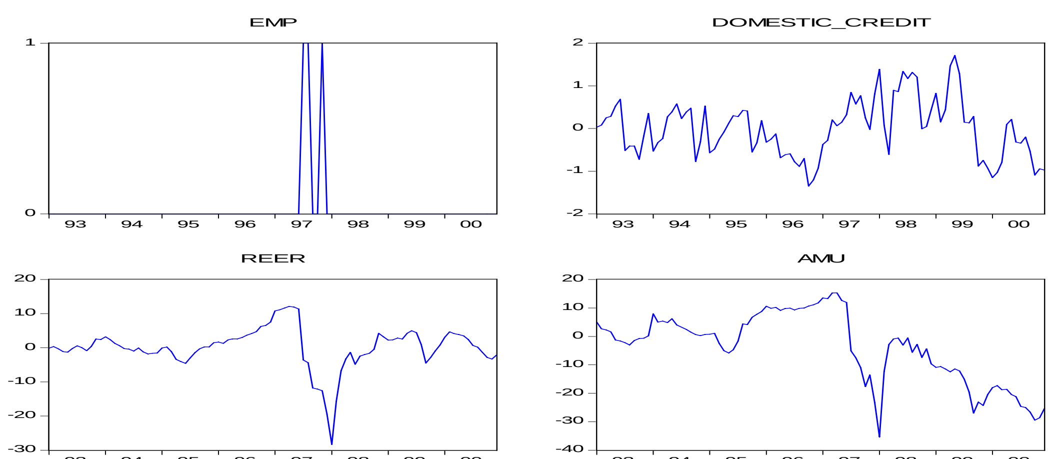
a. Indonesia



b. Malaysia



c. Thailand



For each country, we estimate two models. In the first model (Model I), the explanatory variables are real domestic credit and real effective exchange rates. In contrast to VIEWS (which is a non-parametric model), the number of variables that can be considered in a probit model (which is parametric) is limited. This is particularly so in our case where the data series are rather short. When more variables are added to the model, the estimated coefficients tend to be statistically insignificant due to the loss of degrees of freedom. These two indicators are chosen based on empirical evidence of their importance for the regional countries in association with the Asian crisis (Mariano *et al.*, 2003). Both variables are expressed in terms of deviations from trend estimated with the Hodrick-Prescott filter. In the second model (Model II), the REER variable is replaced by the AMU deviation indicator.

Figure 15 above depicts the time plot of these variables for the three countries. We observe from the figure that for each of the three countries, the REER variable appreciates with respect to its trend, thereby showing signs of overvaluation, during the period prior to the outbreak of the crisis. Similarly, just before the onset of the crisis, the real domestic credit variable also tends to positive that is expands above trend for all three countries under consideration. We observe that the general pattern of the AMU deviation indicator is broadly similar to that of the REER deviations from trend for each individual country.

Since the explanatory variables are supposed to provide early warning of an impending crisis, they enter into the model with a one-quarter lag. Again, higher lags are not feasible due to the limited degrees of freedom arising from the short data series. To determine the significance of each explanatory variable, we estimate its standard error using the GLM robust covariance estimators. The results are summarized in Table 9 below.

Table 9. Results from Probit Models

a. Indonesia (1995m1 to 2000m12)	**Model I**	**Model II**
C	-4.27 (0.64) ***	-11.02 (1.89)***
REER(-3)	0.06 (0.01)***	
Domestic_Credit (-3)	1.99 (0.38)***	5.50 (1.00)***
AMU (-3)		0.14 (0.02)***

b. Malaysia (1991m1 to 2000m12)	**Model I**	**Model II**
C	-1.99 (0.26)***	-2.07 (0.31)***
REER (-3)	0.02 (0.03)	
Domestic_Credit (-3)	0.10 (0.19)	0.07 (0.20)
AMU (-3)		0.02 (0.03)

a. Thailand (1993m1 to 2000m12)	**Model I**	**Model II**
C	-2.21 (0.46) ***	-2.16 (0.46)***
REER (-3)	0.11 (0.07)**	
Domestic_Credit (-3)	0.53 (0.56)	0.83 (0.67)
AMU (-3)		0.08 (1.58)

Notes: (i) standard error in parentheses;
(ii) ** and *** denote statistical significance at 5% and 10% levels respectively.

In the case of Malaysia, neither the REER nor the AMU deviation indicator turns out to be statistically significant. The reverse is true for Indonesia, i.e. both REER and AMU is statistically significant in the respective models. As for Thailand, only the REER variable is statistically significant while the AMU deviation indicator is not statistically significant in the respective models. In summary, we do not find strong empirical evidence of one variable dominating the other in terms of predictive ability for crisis. These empirical findings are obviously dependent on the specifications of the models. Should longer time series be available, more variables and their lags could be included into the models which could yield different results.

II.4 Conclusion

The empirical findings of the previous sections are not particularly surprising as it is unlikely for the AMU deviation indicators to outperform the REER in terms of predicting a currency crisis. Perhaps the REER has relatively greater information content in relation to the cause of currency crises. After all, the AMU and its associated divergence indicators have been constructed under the imperative to foster greater intra-regional exchange rate stability. By contrast, the purpose of the EWS is to monitor and assess financial vulnerabilities originating from macroeconomic shocks and macroeconomic policy inconsistencies. Clearly, the extra-regional currency value does play a significant role in influencing the internal as well as external balance of the domestic economy and hence is useful for anticipating crisis.

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