

# HAVE EXCHANGE RATE REGIMES IN ASIA BECOME MORE FLEXIBLE POST CRISIS? RE-VISITING THE EVIDENCE

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## Abstract

There is a broad consensus that the soft US dollar pegs operated by a number of Asian countries prior to 1997 contributed to the regional financial crisis of 1997-98. There is, however, much less agreement on the types of exchange rate regimes operated by many Asian countries since the crisis. Can they still be characterized as soft US dollar pegs, or have they become genuinely more flexible? This paper revisits the evidence regarding the extent of exchange rate flexibility in the five crisis-affected Asian countries (Indonesia, Korea, Malaysia, the Philippines and Thailand) using alternative methodologies and data spanning the pre- and post-crisis time period. Given the diversity of measures of *de facto* regimes in the literature, the use of alternative methodologies in this paper is critical as a means of obtaining an accurate and robust indication of the type of exchange rate regime operated by a country.

*Keywords:* Asia, exchange rate regime, inflation targeting, interest rates, reserves, soft dollar peg

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## 1. Introduction

There is a broad consensus that the soft US dollar pegs operated by a number of Asian countries prior to 1997 contributed to the regional financial crisis of 1997-98. There is, however, much less agreement on the types of exchange rate regimes operated by many Asian countries since the crisis. To be sure, among the crisis-hit countries, the Malaysian ringgit has been unambiguously fixed to the US dollar (at 3.80 Malaysian Ringgit per US dollar) since September 1998. In contrast, the four other crisis-hit countries, viz. Indonesia, Korea, the Philippines and Thailand, officially proclaimed to have floated their exchange rates while adopting a monetary policy strategy based on inflation targeting (see Table 1 and Cavoli and Rajan, 2005).

There is a burgeoning literature documenting that there can be a significant divergence between *de facto* and *de jure* exchange rate policies and regimes. Just how flexible have exchange rates in Asia become post crisis? Can they still be characterized as soft US dollar pegs as suggested by Calvo and Reinhart (2002), Fukuda (2002) and McKinnon (2001), or have they become genuinely more flexible as suggested by Baig (2001), Hernández and Montiel (2001), Kawai (2002), and others.<sup>1</sup>

At a first glance, Figure 1 reveals that exchange rates appear to have become more flexible in recent years for all the countries except Malaysia. Even if the Asian currencies have become more flexible, what form has the flexibility taken, i.e. free floating, managed floating, basket pegging, etc? The extent and form of flexibility of Asian currencies post crisis is not solely of academic interest, being directly related to the ongoing debate on the need for global macroeconomic adjustments and the manner in which such adjustments are to be attained (Rajan, 2004).

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<sup>1</sup> Of course, apart from differences in methodologies and estimating techniques, divergences in results could be because of different time periods and frequency of data used (daily, monthly or quarterly).

This paper revisits the evidence regarding the extent of exchange rate flexibility in the five Asian countries post crisis using alternative methodologies and data up to mid 2004. Different measures of *de facto* regimes inevitably capture different characteristics of any regime. As such, using a number of methodologies is critical as a robustness exercise – the existence of similar results from alternative methods allows us to form conclusions about exchange rate regimes with significantly greater confidence than if only one method was employed.

An important caveat is in order before proceeding. There are a number of recent papers on the topic of *de facto* regime classification -- for instance, see Bénassy-Quéré et al. (2004), Bubula and Otker-Robe (2002, 2003), Frankel et al. (2001), Calvo and Reinhart (2002), Kim (2003), Levy-Yeyati and Sturzenegger (2002), Reinhart and Rogoff (2002) and Shambaugh (2004). This paper does not concern itself with the methodology of actually classifying exchange rate regimes but instead concentrates on detecting possible regime changes in the five Asian countries pre and post crisis.

The remainder of the paper is organized as follows. Section 2 examines the *de facto* regimes by investigating the unconditional volatilities of exchange rates, interest rates and international reserves using monthly data for the period January 1990 to July 2004. It also conducts more formal tests to ascertain the degree of exchange rate flexibility and the extent of intervention employed to control the volatility of the currency for the same period. The focus is on the difference in the variability of exchange rates, interest rates and international reserves in each Asian country pre and post crisis, as well as between the Asian countries and noted ‘floaters’ (Australia, New Zealand, Canada, UK and USA) post crisis.<sup>2</sup> Section 3

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<sup>2</sup> The monthly data are from the IMF-IFS CD and from the ADB-ARIC database from January 1990 to June 2004. Exchange rates per US dollar are taken from line *RF* of IFS, exchange rates per yen are calculated from the US/yen rate, and real effective exchange rate (REERs) are from the ADB-ARIC

computes a set of exchange market pressure (EMP) indices to provide a summary measure of the degree of flexibility (or inversely, the degree of intervention). Section 4 presents more formal tests on the extent to which each of the currencies examined have been pegged to the US dollar and to the Japanese yen using an extension of the methodology pioneered by Frankel and Wei (1994). Section 5 offers a summary and some concluding remarks.

## **2. Pre and Post Crisis Behaviour of Exchange Rates, Interest Rates and Reserves**

We attempt to do two things in this section. One, we investigate the behaviour of exchange rates, interest rates and reserves for the crisis-affected countries using monthly data for the period 1990 to 2004. The nexus between the volatilities of exchange rates, interest rates and reserves is important from a policy perspective in that it offers some insight into whether central banks used interest rates or reserves to manage currency movements. Two, in order to assist with the comparison we split the sample into the pre crisis and post crisis subsamples. The volatilities of exchange rates, interest rates and reserves for the pre and post crisis samples are compared for each country and between the crisis-hit countries and the known ‘floaters’ of Australia, New Zealand, Canada, UK and USA (as defined by Calvo and Reinhart, 2002).

### **2.1 Standard Deviations of Exchange Rates, Interest Rates and Reserves**

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database. Reserves data are taken from lines *11*, *14* and *16c* of IFS, and interest rates are taken from line *60B* of IFS.

Figures 2a to 2c present annual (calendar year) standard deviations of monthly percentage changes in exchange rates for the crisis-affected countries.<sup>3</sup>

The extreme volatility of the exchange rates during the crisis of 1997-98 notwithstanding, the exchange rate volatilities in Korea, Thailand and Indonesia are significantly higher in the post crisis period, while there is no volatility of the ringgit against the US dollar, as would be expected (Figure 1). The differences in variability for the Philippines seem economically insignificant when eyeballing the data. Exchange rate volatility of the regional currencies against the yen does not appear to have increased discernibly pre and post crisis, except possibly for Indonesia (Figure 2b). The results for the real effective exchange rates (REERs) show similar but not as marked differences between the two periods compared to the volatilities of local currencies per US dollars (Figure 2c). Overall, the exchange rate volatilities offer some indicative initial evidence to support the claim that exchange rate regimes in Korea, the Philippines and Thailand have become more flexible post crisis.

It well known that unconditional exchange rate volatility alone cannot adequately describe the currency regime adopted by a country. This is because central banks could use interest rates and reserves as policy instruments to help actively manage or influence currency movements. Accordingly, in order to present a more complete account of the possible change of regime (i.e. degree of conditional exchange rate flexibility), the volatilities of interest rates and reserves must also be taken into account. Specifically, a regime considered to be less flexible will have relatively low exchange rate volatility, *ceteris paribus*.<sup>4</sup> If, in the event of

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<sup>3</sup> The standard deviations for 2004 are for the first half of the year (January to June).

<sup>4</sup> Of course the *ceteris paribus* condition is critical as the implicit assumption is that there is no substantive change in the external environment. In order for a full analysis to be undertaken we would need to estimate a monetary model or a related model that is able to capture the external factors that might have an impact on the exchange rate. The problems with fundamentals-based models of

relatively low exchange rate volatility and where reserve volatility is high but interest rate volatility is low, then it might be posited that reserves are the primary policy instrument (i.e. exchange rate intervention). If reserve volatility is low but interest rate volatility is high, then plausibly, interest rates might be the primary instrument for stabilizing the currency (Reinhart, 2000).<sup>5</sup>

Figure 3 examines the money market interest rates in annual standard deviation of monthly first differences. As is apparent, interest rates are clearly less volatile after the crisis, particularly for Korea, Thailand and the Philippines.<sup>6</sup>

Figure 4 shows the annual standard deviations of the monthly deviation of foreign reserves (net foreign assets) scaled by lagged base money from its Hodrick-Prescott (HP) filtered trend. This adjustment for trend is made to remove the effects of possible reserve accumulation by central banks that do not specifically related to day-to-day exchange rate management. Specifically, it is common knowledge that Korea and other Asian countries (except the Philippines) have been accumulating reserves since 1998, a reflection of the fact that the currencies have been undervalued (Kim et al., 2004 and Hernández and Montiel, 2001). However, we are principally interested here in the management of volatility as opposed to management of the value of the exchange rate. In addition, reserves are scaled by lagged domestic monetary base in order to compare the magnitude of the reserve change in relation to the stock of money base in the system. Since reserves are used to alter relative monies, scaling

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exchange rates are well known and do not need to be repeated here. Also see Willett (2004) for a useful discussion of the issue of trends versus volatilities when attempting to decipher exchange rate behavior.

<sup>5</sup> We are abstracting here from issues relating to sterilization of reserve intervention. See Ouyang et al. (2007).

<sup>6</sup> Money market rates (IFS line 60B) are used as they appear to adequately represent the policy rate and offer sufficient volatility for the purposes of analysis.

the change in reserves offers some information about the proportion of the money base that is being used for intervention. From Figure 4, it can be seen that the differences in reserve volatility between the pre and post crisis periods are not easily detectable for most countries. Korea is a notable exception where it seems that reserves volatility has increased significantly post crisis (also see Willett, 2004). There is also evidence to suggest that reserve volatility for Indonesia may have diminished after the crisis.

Comparing Figures 2a and 2c, it can be seen, at least for the local currency per US dollar and the REERs, that exchange rate volatility is higher post crisis and that interest rates have become less volatile. The implication regarding the volatility of reserves is harder to categorically determine. The conclusion is that the exchange rate regimes for Korea, Thailand, Indonesia and the Philippines have become more flexible post crisis. The reverse is true for Malaysia. However, this conclusion is clouded somewhat by the volatility of reserves, where there is little evidence to support a conclusion of increased flexibility. In fact, Korea seems to be using reserves more aggressively after the crisis than before, while the volatility of international reserves does not appear to have materially decreased post crisis for Thailand and the Philippines.

## **2.2 Pre versus Post crisis Volatilities and Comparison with Known Floaters**

Table 2 presents the standard deviations of exchange rates, interest rates and reserve changes as before for the five Asian countries and for the known floaters for the pre and post crisis sample periods. We define the pre crisis sample as spanning the period 1990:1 to 1997:3, while the post crisis sample period is 1999:6 to 2004:6.<sup>7</sup> We aim to do two things

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<sup>7</sup> Thus, we define the crisis period as being between 1997:4 and 1999:5. There is, admittedly, a degree of ad-hocism in the choice of these periods. For instance, Hernández and Montiel (2001) Taguchi (2004) take the post crisis period to be 1999:1. Our choice of 1999:5 as being the end of the crisis is derived from simple robustness tests -- we found that, by and large, the post crisis results were

here. First, we compare the relative volatilities in a single country over the two sample periods. Second, we compare the post crisis samples of the five Asian countries with the known floaters.

A comparison of each sample confirms the conclusions of the previous section. Irrespective of how the exchange rate is expressed (i.e. vis-à-vis the US dollar, yen or REER), its volatility after the crisis increased for Korea, Thailand and Indonesia, decreased for Malaysia, and remained more-or-less stable (with a bias to a slight decrease) in the Philippines. Correspondingly, interest rate and reserve volatility decreased after the crisis for the most part, although there are a few important exceptions. The first relates to interest rates in Indonesia. Unlike in the other countries, they have become more variable after the crisis. Along with a post crisis reduction in reserve volatility, this suggests that interest rates are possibly used more frequently as a policy instrument.<sup>8</sup> The second exception is the increase in reserve volatility in Korea. Is this an indication of some desire to continue to use reserves as an exchange rate management tool?

As in Baig (2001) and Calvo and Reinhart (2002) and others, we compare the post crisis volatilities for the Asian countries and the known floaters. For the most part the exchange rate variation is lower for those countries in the Asian sample than for the floaters. The interest rate volatility in the floaters is also lower, suggesting that they are less inclined to intervene using interest rate policy. (Interest rate smoothing appears to be a more important

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reasonably robust as we kept working backwards from the end of the sample and expanding the sample size until 1999:6, beyond which the results began to change (quite significantly in some cases).

<sup>8</sup> Of course, it could also be that the market risk element of interest rates (i.e. risk premium) has become more volatile as well.

objective among industrial countries). With regard to the volatility of reserves, it appears that New Zealand is an outlier here, and that the floaters possess less variation in reserves<sup>9</sup>.

The simple analysis undertaken thus far leads to the conclusion that, with the exception of Malaysia, the Asian countries have moved towards more flexible exchange rates. However, the Asian currencies are clearly far less flexible than the known floaters, suggesting some degree of continued market intervention to stabilize the exchange rate.<sup>10</sup> Results of this nature have led many to hypothesize about a possible “Fear of Floating” in some emerging market economies (for instance, see Baig, 2001 and Calvo and Reinhart, 2002).

### **3. Exchange Market Pressure (EMP) Indices**

#### **3.1 Defining the Indices**

As discussed, it is important to simultaneously consider the three variables (viz. exchange rates, interest rates and reserve changes) to obtain a proper perspective on the extent of exchange rate flexibility (or inversely, the extent of intervention). One way of incorporating all these variables would be to compute an exchange rate pressure (EMP) index. This section presents two sets of simple EMP indices based on Baig (2001), Bayoumi and Eichengreen (1998), Glick and Wihlborg (1997) and Calvo and Reinhart (2002):<sup>11</sup>

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<sup>9</sup> New Zealand is an interesting case in that it has not chosen to hold its own reserves, the bulk of its reserves having been borrowed. However, the Reserve Bank of New Zealand (RBNZ) has recently taken steps to bolster its capacity to intervene in the foreign exchange market to influence the level of the New Zealand dollar in certain circumstances.

<sup>10</sup> Of course, it could also be that the floaters are faced with a different set of shocks to the Asian countries.

<sup>11</sup> The indices presented in this paper are essentially second order constructions of the simple EMP measures derived from a simple monetary model. For examples of models of this type, see Girton and Roper (1977), Pentecost et al (2001) and Tanner (2001).

$$Index\ 1 = \sigma_{ER} / (\sigma_{ER} + \sigma_{NFA}) \quad (1)$$

$$Index\ 2 = \sigma_{ER} / (\sigma_{ER} + \sigma_{NFA} + \sigma_{IR}) \quad (2)$$

where  $\sigma_{ER}$  is the annual standard deviation of monthly (log) percentage difference in the exchange rate,  $\sigma_{IR}$  is the annual standard deviation of monthly first differences in money market rates, and  $\sigma_{NFA}$  is the annual standard deviation of the monthly deviation of reserves from its HP trend (and scaled by lagged Money Base). All standard deviations are calculated as in the previous sections.

While there are a number of different types of EMP indices (for instance, see Guimãeres and Karacadag, 2004), the particular set of indices were chosen because they are easily aligned with the discussion of the previous section about the role of interest rates and/or reserves as policy instruments. For instance, a low index value in this instance may imply less exchange rate flexibility or a higher level of intervention. Other things being equal, higher reserve volatility will reduce the index value, possibly suggesting that reserves are being employed as a monetary policy tool in order to limit exchange rate flexibility.

Index 1 measures the possible effects of reserve intervention but ignores the effects of interest rates. Baig (2001) and Bayoumi and Eichengreen (1998) are primarily concerned with this type of index as interest rate movements contain market as well as policy determinants<sup>12</sup>. While this is true, the same can be said of reserves data – which are not cleansed of currency valuation changes.<sup>13</sup> It may be worth evaluating the effects of interest rate based intervention

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<sup>12</sup> Willett (2004) uses a measure referred to as the “intervention index”, which is merely *1- Index 1*, i.e.  $\sigma_{NFA} / (\sigma_{ER} + \sigma_{NFA})$ .

<sup>13</sup> Cleansing the data to focus only on reserves change due to policy intervention rather than valuation changes is not possible as most countries do not provide data on the currency composition of reserves.

in light of the move by some Asian central banks towards inflation targeting and the use of interest rate rules (Cavoli and Rajan, 2005). Hence, Index 2 is a generalized index capturing both reserve and interest rate intervention. By construction, each index presents values bounded by 0 and 1, and the weights attributable to each variable in the denominator of the index are equal.<sup>14</sup>

### 3.2 Interpreting the Results

As in the previous section, three measures of the exchange rate are used, viz. local against the US dollar, the yen, and the REER. The results are presented in Figures 5 and 6. Figures 5a to 5c show Index 1 for the US dollar, yen and REER, respectively. Figures 6a to 6c show Index 2 for the US dollar, yen and REER, respectively

Focussing on Index 1, an examination of Figures 5a to 5c tends to confirm that pre-crisis, there was a greater inclination on the part of central banks to intervene in the market against the US dollar, most so in the case of Indonesia and Thailand. Both these countries appear to have become fairly flexible post crisis, as evidenced by the rise in their respective EMPs, especially vis-à-vis the US dollar. Less obvious results are obtained in the case of the Philippines, while the Malaysian ringgit has become completely inflexible vis-à-vis the US dollar. Somewhat surprisingly, after a period of some flexibility, the Korean won appears to be becoming somewhat less flexible against the US dollar.

Looking at the local currency per yen, pre crisis the regional currencies appeared to have been fairly flexible vis-à-vis the yen. This suggests that local central banks allowed their currencies values relative to the yen to be determined by the yen/US rate, so-called “third

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<sup>14</sup> The calculation of weights in indices of this type is a critical feature of the literature on EMP. In some cases theory is used as the basis for determining the weights (for instance, see Girton and Roper, 1977), while in other cases, empirical methods are employed to select the weights (for instance, Pentecost et al., 2001 make use of principal components analysis).

currency phenomenon”. Thus, prior to 1997, if regional countries had given greater weight to the yen in their baskets pre crisis, there would have been lower degrees of regional real exchange rate overvaluations following the nearly 50 percent nominal appreciation of the US dollar relative to the yen between June 1995 to April 1997 (which in turn led to a rise in the value of the regional currencies relative to the yen) (Bird and Rajan, 2002 and Rajan, 2002). Post crisis, while there does not appear to be any discernible change in the degree of flexibility of the Indonesian rupiah, the Philippine peso, the Thai baht and the Malaysia ringgit vis-à-vis the yen post crisis, while the Korean won has become relatively less flexible vis-à-vis the yen post crisis<sup>15</sup>.

Based on the foregoing analysis, as would be expected, while the Thai baht has become more flexible in REER terms, the won seems to have become less so. Indeed, comparing Figures 5a, 5b and 5c, it is apparent that while the EMP of the Korean won vis-à-vis the US dollar was lower than the yen or the REER pre crisis, post crisis its EMP vis-à-vis the REER was equivalently low for all three. This suggests that while the won may have been heavily managed relative to the US dollar prior to the crisis, there is some evidence to suggest it has become more managed relative to a basket (involving the yen and US dollar), such that the won’s REER is relatively stable.

How robust are these results? If one examines Figures 6a to 6c (using Index 2), we reach the same conclusion that the regional currencies with the exception of the Malaysian ringgit have become more flexible vis-à-vis the US dollar post crisis. As discussed above, it appears as though the Korean won is reverting to a soft dollar peg. Interestingly, however, the further conclusion that the won may be more heavily pegged to the REER than the US dollar

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<sup>15</sup> Oh (2004) also finds that the Korean won has displayed increasing co-movements with the yen post crisis.

post crisis no longer holds. The reason for this is the rise in the Korean won's EMP post crisis relative to the yen compared to the previous conclusion of a decline (compare Figure 5b and 6b). However, the finding that the Thai baht has become relatively more flexible in general (relative to the US dollar, the yen and in REER terms) continues to hold.

#### **4. Extent of Influence of the US Dollar and the Yen in Asian Currencies**

One of the main results from the previous two sections is that the extent of intervention in the US dollar has decreased for the most part, but there appears to be evidence supporting a reversion to a US dollar peg in some instances, particularly in the case of Korea. However, there is some degree of uncertainty as to whether the Korean won is following (pegged to?) the yen more closely post crisis. This section presents two sets of formal tests (OLS and Kalman Filter based estimates) to ascertain the degree to which local currencies have been and continue to be influenced by the US dollar and by the yen

##### **4.1 Influence of the US Dollar and Yen – Time Invariant Results**

The first set of tests is based on the well-known work by Frankel and Wei (1994). The method essentially involves conducting an OLS test of the local currency on other currencies that are considered to influence the former. Each currency is expressed in terms of an 'independent' numeraire. The equation examined is as follows:

$$ER_t = \alpha + \beta_1 US_t + \beta_2 JP_t + \mu_t \quad (3)$$

where  $ER$  refers to the local currency. All currencies are expressed in log differences and the numeraire currency used is the Swiss franc.<sup>16</sup> As with the empirical results in the previous section, the pre crisis sample is 1990:1 to 1997:3 and the post crisis sample is 1999:6 to 2004:6.

Table 3 presents the pre and post crisis values of  $\beta_1$  and  $\beta_2$  for Korea, Thailand, Indonesia, and the Philippines<sup>17</sup>. Only the pre crisis regressions are presented for Malaysia given the country's stated post crisis rigid fix to the US dollar. The coefficient values are interpreted as the degree of influence of the US dollar and yen, respectively, on the local currency. A larger  $\beta$  value is suggestive of a high degree of influence of the US dollar and hence possible intervention in the market for that currency. This said, it is important to note that a large positive and significant coefficient on  $\beta_1$  does necessarily imply strong US dollar pegs. As Hernández and Montiel (2001) observe "(such) results are consistent either with a tight peg against the U.S. dollar...or with a much looser currency link to the dollar combined with tight economic links to the dollar area and a relative absence of independent shocks during the sample period".

The results based on the simple OLS in Table 3 reveal that the value of  $\beta_1$  has fallen after the crisis. By and large, this validates the results from the previous sections in that the degree of flexibility against the US dollar has increased after the crisis. Not only has the value fallen, but the level of significance has declined as well, possibly an indication of a reduction in the tightness of the peg to the US dollar. Also noteworthy is the increase in the degree of influence of the yen after the crisis. This is noticeable across-the-board. It should be noted though that the significance levels are lower for the yen than for the US dollar. This is broadly

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<sup>16</sup> A common choice in studies of this type (see Baig, 2001)

<sup>17</sup> When interpreting the significance levels of the coefficient estimates, it is important to be aware of the possible existence of multicollinearity in models of this type.

consistent with the results in Section 3, whereby the EMPs of the currencies using the US dollar have generally risen post crisis and have fallen relative to the yen, but the former still exceeds the latter.

#### 4.2 Influence of the US Dollar and Yen – Time Varying coefficients

The relative degree of significance between the US dollar and the yen can be explored further by applying the Kalman Filter to the regressions. Such regressions allow for the coefficient's evolution to be tracked over the entire sample. The model used is as follows:

$$ER_t = \alpha + \beta_t X_t + \mu_t \quad (4)$$

$$\beta_t = \beta_{t-1} + \varepsilon_t \quad (5)$$

Equation (4) once again describes the measurement equation of the system ( $X_t = [US_t, JP_t]$ ), but each coefficient ( $\beta_t = [\beta_{1t}, \beta_{2t}]$ ) is assumed to vary over time, the evolution of which is given by Equation (5). This particular simple version of the Kalman Filter method applies a recursive algorithm that uses a log likelihood function to estimate the value of each  $\beta_t$  at each iteration. The likelihood function is used to update the state estimates,  $\beta_t$  and the estimated state covariance,  $P_t$  conditional on information obtained at time  $t-1$ .<sup>18</sup> The result is that the evolution of each  $\beta$  can be examined for the pre crisis and post crisis periods without the need to split the sample<sup>19</sup>.

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<sup>18</sup> The update estimates of the state and covariance are given as follows:

$$\beta_{t|t} = \beta_{t-1|t-1} + S_{t-1} X_t (X_t' S_{t-1} X_t + R_t)^{-1} (ER_t - \alpha - X_t' \beta_{t-1|t-1})$$

$$P_{t|t} = S_{t-1} + S_{t-1} X_t (X_t' S_{t-1} X_t + R_t)^{-1} X_t' S_{t-1}$$

$$\text{where: } S_{t-1} = P_{t-1|t-1} + Q_t$$

$$\mu \sim N(0, Q_t)$$

$$\varepsilon \sim N(0, R_t)$$

<sup>19</sup> The  $\beta$ s are assumed to follow a random walk and the covariance matrix of the measurement and the transition equation is diagonal. This is the usual practise (see Cuthbertson et al., 1992 for a

One of the advantages of the Kalman Filter technique over the simple Frankel-Wei OLS tests is that the volatility of a coefficient can be observed over time. This may offer us greater insight into central bank behaviour. A smooth time path of the coefficient might imply that the central bank intervenes to maintain the influence of one currency over the other. A high but erratic coefficient value possibly implies a strong correlation that is not necessarily brought about by central bank behaviour. Rather, it could imply a strong correlation that occurs naturally in the market for that particular currency pair, driven by market conditions, trader behaviour or noise.

Figure 6 shows the one-step ahead forecasts of  $\beta_1$  and  $\beta_2$  (for the US dollar and the yen) at each iteration over the sample period 1990:1 to 2004:6 for the five Asian countries. As with the EMP indices, the crisis period is easy to detect for both the US dollar and the yen. The results lend weight to those of the previous section in that the won, baht, and rupiah are all seemingly less influenced by the US dollar after the crisis. For Korea and Thailand, the value of  $\beta_1$  is more volatile post crisis. Volatility of the coefficient values over time might possibly be interpreted as a loosening of the degree of influence of a particular currency over the local currency -- perhaps a reflection of a loosening of a peg to that currency. This is consistent with Kim and Lee (2004) who find that Thai and Korean interest rates have become less sensitive to US interest rates post crisis, suggesting greater flexibility of these currencies relative to the US dollar.

As expected, the  $\beta_1$  coefficient for Malaysia is 1 after the crisis. Interestingly, the influence of the yen ( $\beta_2$ ) is more volatile after the crisis for Thailand and higher in value for Korea and Indonesia, but also more volatile, especially for Korea. The results for the

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discussion). The robustness of the Kalman Filter tests can be checked against recursive OLS estimations of Eq. 3. This exercise has been performed and results are quite robust. They are available from authors.

Philippines accord to those in the last section. There appears to be little difference in the influence of the US dollar or the yen between the pre and post crisis periods.

Figure 7 presents the time variation of  $\beta_1$  and  $\beta_2$  on the same graph for each country. It can be seen here that, in general, the influence of the US dollar has decreased after the crisis, but that the influence of the yen has increased. For Korea, there is a sizeable difference between the influence of the dollar and that of the yen before the crisis. After the crisis there is evidence of convergence, as the coefficient for  $\beta_1$  has decreased and  $\beta_2$  increased. This is consistent with the conclusions drawn based on the EMP using Index 1, but not Index 2. The extent to which the baht is driven by the dollar is more erratic post crisis and is matched by the yen. This is in line with the conclusions in the previous section which suggest that the baht may have become more flexible vis-à-vis both the yen and the US dollar post crisis. Indonesia's coefficient for the US dollar is relatively smooth compared to the yen, suggesting a possible inclination to continue to fix to the US dollar. The comparative results for the Philippines show that while the degree of influence of the US dollar may be high, it is not smooth. This is representative of a scenario where a high correlation does not necessarily imply a peg. The yen maintains a small influence over the Philippine peso. Needless to say, the results for Malaysia are as expected, the ringgit being influenced entirely by the US dollar post crisis.

## 5. Concluding Remarks

This paper has reviewed the pre and post crisis exchange rate regimes for Korea, Thailand, Indonesia, Malaysia and the Philippines. The *de jure* regimes for Korea, Thailand and Indonesia seem to suggest that exchange rates underwent a transition from soft US dollar pegs to floating exchange rates (cum inflation targeting) after the crisis. Malaysia's regime

reverted to a fully fixed exchange rate vis-à-vis the US dollar since September 1998. The Philippines, which was least impacted by the crisis, maintained its status as operating a ‘dirty’ floating exchange rate regime.

We return to our basic question posed in the Introduction, viz. have the Asian countries (except Malaysia) moved to more flexible exchange rate regimes, or have they reverted to soft US dollar pegs post crisis? From the various measures of *de facto* regimes presented in this paper, it appears that there is definitely an increase in exchange rate flexibility after the crisis in the case of Thailand. There is some evidence of a possible reversion to a US dollar peg for Indonesia (also see Siregar and Rajan, 2003). The results for Korea are arguably most interesting in that they suggest that while there is still a significant and possibly increasing degree of influence by the US dollar on local currencies after the crisis, the influence of the yen has increased materially post crisis. However, the variability of this influence has also increased. As such, it is unclear whether the Korean monetary authorities are consciously placing more weight to the yen in managing the Korean won as suggested by Taguchi (2004), or they have genuinely let the currency float and the market has caused a higher co-movement between local currencies and the yen. This is an area for future research<sup>20</sup>.

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<sup>20</sup> Eichengreen (2004) and Willett (2004) explore Korean exchange rate and monetary policies in some detail. However, neither specifically addresses or entangles the issue of the won-yen nexus. Also see Oh (2004).

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**Table 1**  
**Highlights of Inflation Targeting Regimes in Selected Asian Countries**

<b>Country</b>	<b>Date</b>	<b>Target price index</b>	<b>Target horizon</b>	<b>Escape Clauses</b>	<b>Accountability</b>	<b>Target set by</b>	<b>Publication and accountability</b>
Indonesia	May 1999	Core CPI (excluding food and energy)	1-2 years	none	None, but parliament can request reports at any time	Central Bank	Quarterly Inflation report, Annual report to public
Philippines	Dec 2001	Core CPI (excluding food and energy)	2 years	Yes, in the event of oil price shocks, food supply shocks	Public explanation of the nature of the breach and steps to address it	Central Bank	Quarterly inflation report, publication of monetary policy meetings
Thailand	Apr 2000	Core CPI (excluding food and energy)	Indefinite	None	Public explanation of breach and steps taken to address it	Central Bank in consultation with Government	Inflation Report, inflation forecasts and publication of models used
Korea	Jan 1998	Core CPI (excluding non-cereal agricultural products and petroleum products)	indefinite	Changes caused by major force	None	Central Bank in consultation with Government	Inflation report and submission to parliament, publication of monetary policy meetings

Source: Compiled by authors from Bank of Korea, Bank Indonesia, Bank of Thailand, Bangko Sentral ng Pilipinas websites

**Table 2**  
**Standard Deviations Pre and Post Crisis**

	ER/US		ER/Yen		REER		Mon Market Rate		[(NFA-Hp Trend)/MB(-1)]	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
Indonesia	0.24	6.09	2.87	6.42	1.57	4.88	1.97	2.67	23.74	14.31
Korea	0.79	2.29	2.69	2.89	1.15	1.48	1.28	0.10	7.81	21.51
Philippines	2.24	2.17	3.82	3.11	2.33	2.05	5.68	0.60	11.83	7.23
Thailand	0.50	2.11	2.57	3.01	1.08	1.37	2.26	0.25	10.61	5.79
Average	<b>0.94</b>	<b>3.17</b>	<b>2.99</b>	<b>3.86</b>	<b>1.53</b>	<b>2.45</b>	<b>2.80</b>	<b>0.91</b>	<b>13.50</b>	<b>12.21</b>
Malaysia	1.25	--	2.80	2.45	1.58	1.46	0.41	0.06	23.62	30.28
Australia	2.06	3.25	3.67	3.63	2.10	2.08	0.32	0.15	5.79	9.13
Canada	1.22	1.91	2.85	4.09	1.25	1.39	0.56	0.21	6.02	5.05
New Zealand	1.57	3.55	3.20	2.94	1.43	2.15	0.71	0.16	43.43	22.63
UK	3.25	2.29	3.87	2.86	1.76	1.22	0.64	0.82	10.77	3.46
USA	--	--	2.87	2.45	1.64	1.78	0.18	0.21	1.25	0.38
Average	<b>2.03</b>	<b>2.75</b>	<b>3.29</b>	<b>3.19</b>	<b>1.64</b>	<b>1.73</b>	<b>0.48</b>	<b>0.31</b>	<b>13.45</b>	<b>8.13</b>

Source: IMF IFS and ADB-ARIC data, monthly observations. Notes: Standard deviations for exchange rates are calculated from percentage first differences for interest rates, first differences and for net foreign assets, the deviation from the HP Trend is taken and divided by lagged money base. Pre sample period: 1990:1 to 1997:3. Post Crisis data: 1999:6 2004:6 (except REER for East Asian countries, 1999:6 to 2004:5)

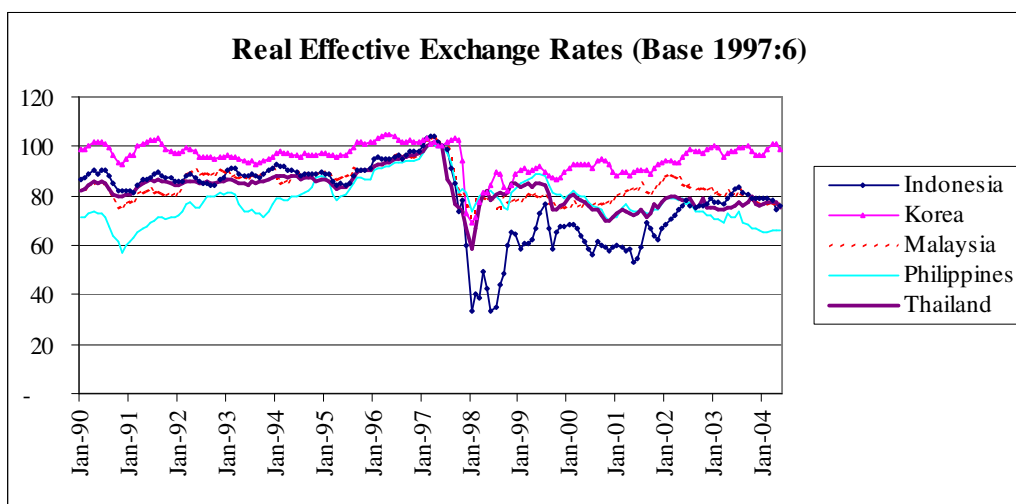
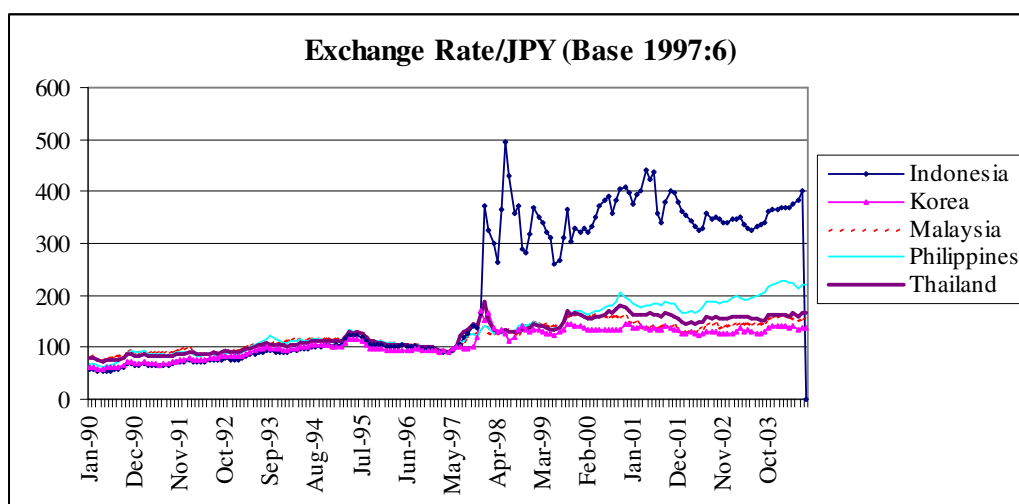
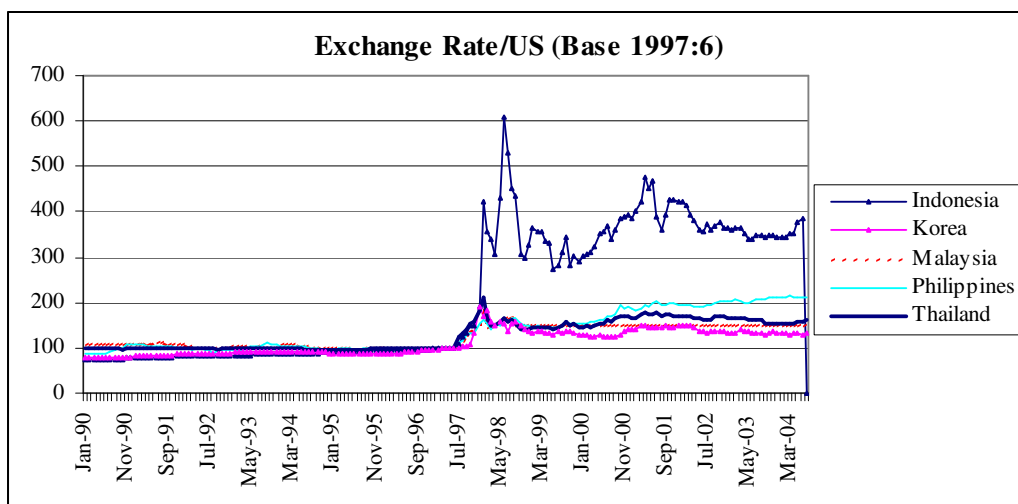
**Table 3**  
**OLS Estimates using Frankel and Wei (1994) Method**

$$\text{Equation: } ER_t = \beta_0 + \beta_1 US_t + \beta_2 JP_t + \mu_t$$

	Korea		Thailand		Indonesia		Malaysia	Philippines	
	Pre	Post	Pre	Post	Pre	Post	Pre	Pre	Post
$\beta_0$	0.00 (0.84)	-0.00 (-0.02)	0.00 (2.16)**	0.00 (0.88)	0.00 (14.78)†	0.00 (1.69)*	-0.00 (-0.55)	0.00 (0.67)	0.01 (2.61)†
$\beta_1$	0.93 (36.59)†	0.70 (4.74)†	0.84 (101.22)†	0.68 (5.23)†	0.99 (95.87)†	0.13 (0.36)	0.89 (21.27)†	1.10 (16.32)†	0.75 (5.53)†
$\beta_2$	0.11 (3.13)†	0.45 (3.80)†	0.11 (14.27)†	0.20 (1.83)*	0.02 (3.15)†	0.44 (1.64)	0.09 (1.81)*	-0.03 (-0.37)	0.06 (0.51)
$R^2_{adj}$	0.97	0.72	0.99	0.60	0.99	0.31	0.89	0.75	0.54
DW	1.92	1.74	2.06	1.98	1.97	2.01	1.80	1.92	2.20
Obs	87	61	87	61	97	61	87	87	61

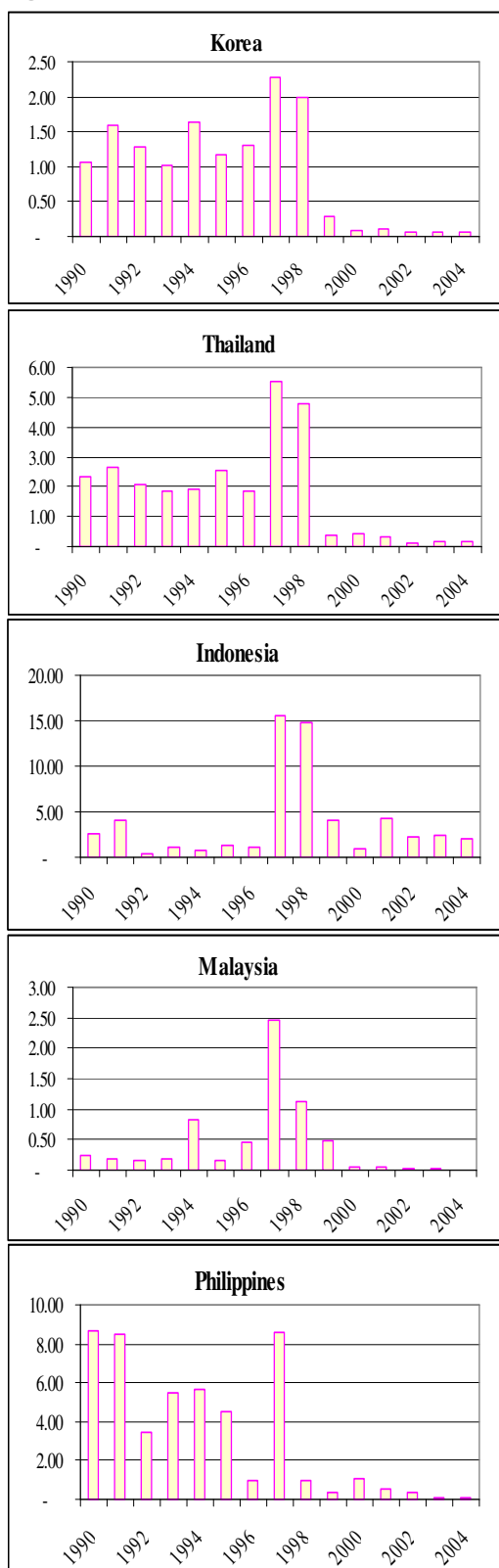
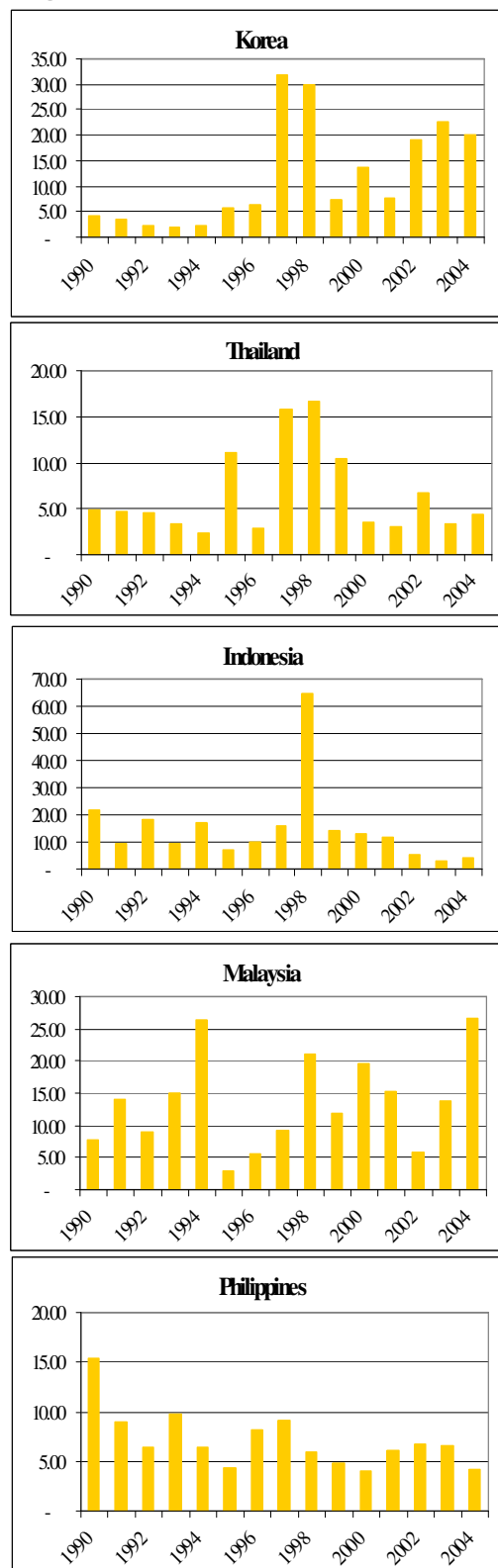
Notes: \*(\*\*)(†), 10% (5%)(1%) significant levels, respectively. Malaysia post crisis regressions not included. Korea pre crisis results, Indonesia pre and post crisis results contained serial correlation. To correct for this and to reduce the incidence of biased parameter estimates, Korea pre crisis and Indonesia post crisis model includes ARMA(1,1) terms and Indonesia post crisis includes ARMA(3,3) terms.

**Figure 1: Exchange Rates, 1990-2004**



Source: IMF IFS and ADB-ARIC.

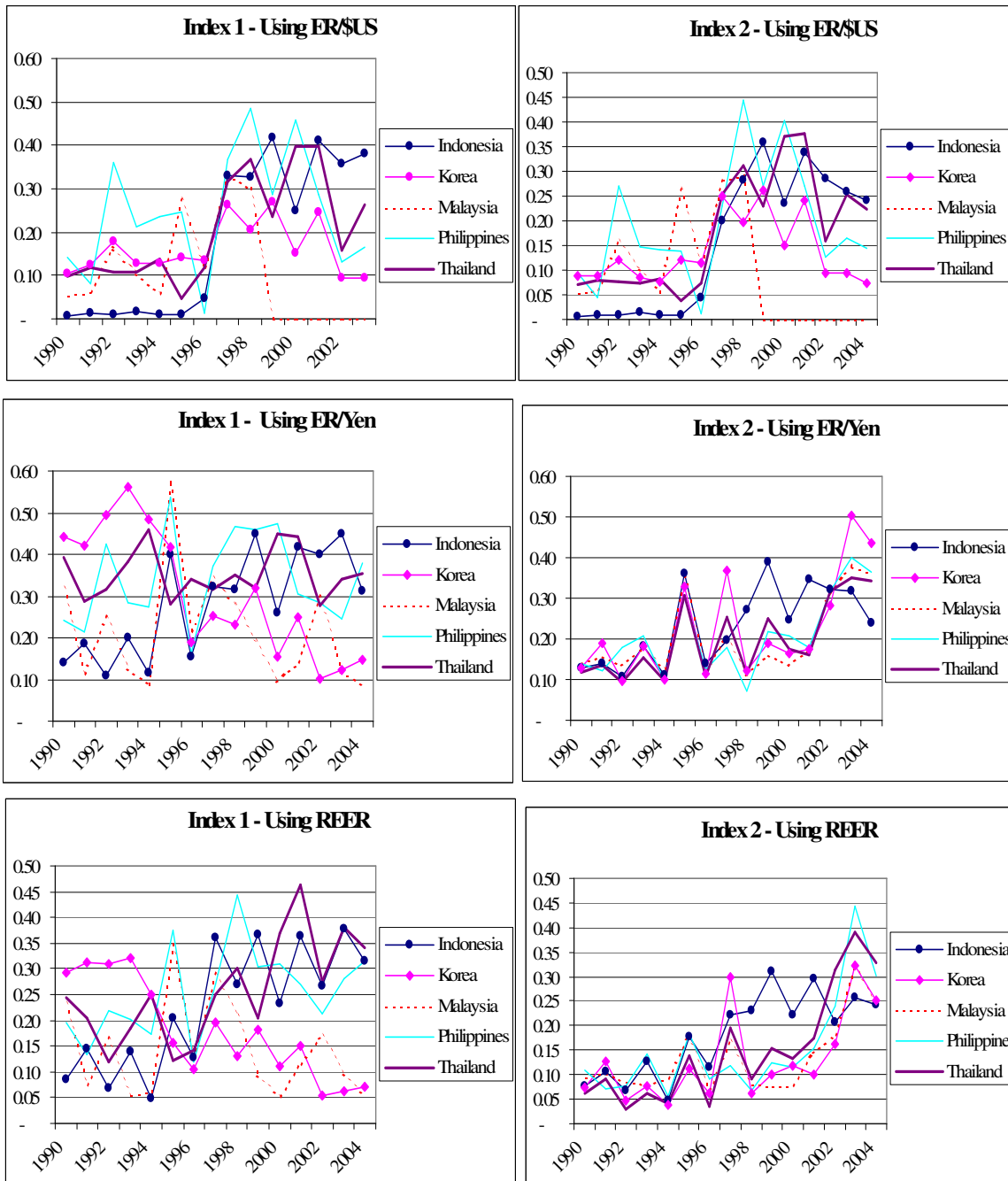


**Figure 3: Interest Rate Std Deviations****Figure 4: Reserve Std Deviations**

Source: IMF IFS. Interest Rate standard deviations are calculated as the annual standard deviation of monthly first differences. Reserve standard deviations are calculated as annual standard deviation of monthly deviations of net foreign assets from their Hodrick-Prescott trend, then scaled by lagged base money.

Figure 5a – 5c: Flexibility Index 1

Figure 6a – 6c: Flexibility Index 2



Source: IMF IFS and ADB-ARIC

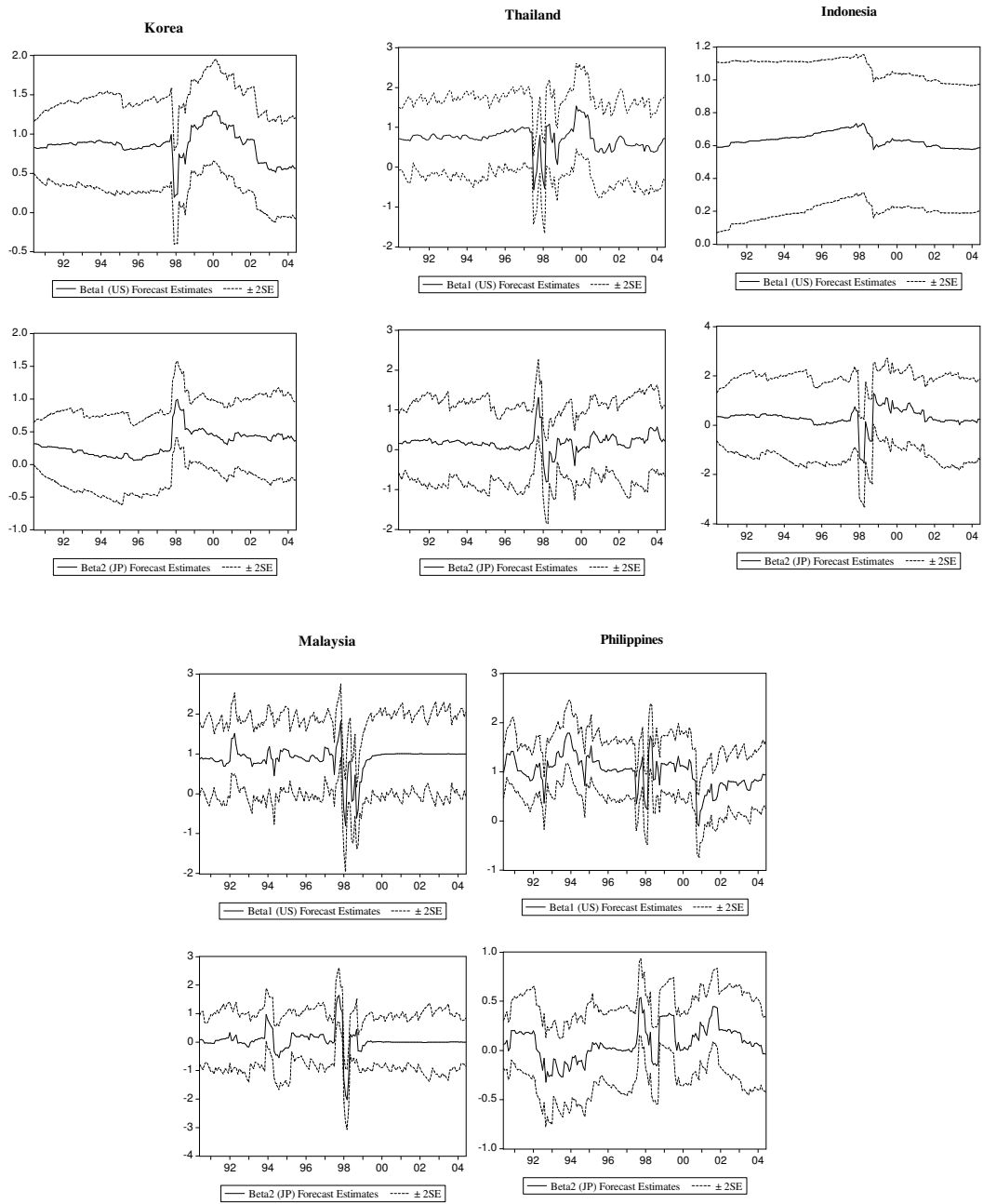
**Figure 7: Kalman Filter Results**

Figure 8: Kalman Filter Results

