Risk Premiums and Exchange Rate Expectations:
A Reassessment of the So-Called Dollar Peg Policies of Crisis East Asian Countries, 1994-97*

by

Shinji Takagi
Osaka University, Yale University and Economic and Social Research Institute
and
Taro Esaka
Osaka University

June 2001

*The authors thank Ryuzo Miyao, Yasuyuki Sawada, Hiroshi Shibuya and Kazuo Yokokawa for useful comments on an earlier draft. Needless to say, they alone assume responsibility for any remaining errors.
Abstract:

We use an unobserved components model to extract the foreign exchange risk premium from the excess ex post returns of East Asian currency assets over US dollar assets and derive the implied expected future spot rates of East Asian currencies against the US dollar. Empirical results, obtained from monthly data on the crisis East Asian countries of Indonesia, Malaysia, Korea and Thailand for the period January 1994-June 1997, generally indicate that the risk premium was substantial and time-varying and that market participants consistently formed expectations of either appreciation or depreciation over the coming month. The presence of a risk premium means that East Asian currency assets and US dollar assets were imperfect substitutes, so that sterilization was effective. The expectations of short-term depreciation or appreciation suggest that the so-called dollar peg policies were not credible.

JEL Classification: F31, F32, F33, O53
Keywords: East Asian currency crisis, exchange rate policy in East Asia, foreign exchange risk premium, unobserved components models
1. Introduction

This paper will use monthly interest rate data to assess the credibility of the so-called dollar peg policies of the four crisis East Asian countries (i.e., Indonesia, Korea, Malaysia and Thailand) during the 42-month period immediately preceding the onset of the East Asian currency crisis in July 1997. In particular, it will use an unobserved components model to extract foreign exchange risk premiums from interest rate differentials with respect to US dollar-denominated assets, in order to obtain the estimates of expected exchange rate depreciation or appreciation, hence the degree of credibility of the policies of maintaining relative stability against the US dollar. Because the presence of an exchange rate premium, if any, suggests that East Asian currency-denominated assets and US dollar-denominated assets are imperfect substitutes, moreover, this exercise will also help assess the effectiveness of sterilization policies pursued in these countries in controlling the growth of monetary aggregates under pegged exchange rate regimes (Takagi and Esaka 2001). It turns out that, during the period under consideration, (1) there was evidence of time-varying exchange risk premiums between the East Asian currencies and the US dollar (suggesting that East Asian currency assets and US dollar assets were imperfect substitutes, hence sterilization was effective) and that (2) markets apparently displayed systematic expectations of exchange rate depreciation or
appreciation (suggesting that the so-called dollar peg policies were far from being credible).

It is well known that, from the latter part of the 1980s into early 1997, the emerging market economies of East Asia received a large volume of capital inflows (Calvo, Leiderman and Reinhart, 1996; Chuhan, Claessens and Mamingi, 1998; and Montiel, 1998). In fact, the inflows were massive indeed: in terms of GDP, the volume of cumulative inflows from 1988 to 1995, for example, amounted to 51.5 percent in Thailand, 45.8 percent in Malaysia, 9.3 percent in Korea and 8.3 percent in Indonesia (Takagi and Esaka 2001). While responsible for this surge of capital inflows were both internal (or "pull") and external (or "push") factors of various types, the substantial interest rate differentials that existed in favor of assets denominated in East Asian currencies over those denominated in major industrial country currencies were undoubtedly an important contributing factor. For example, the average interest rate differentials favoring short-term money market instruments denominated in East Asian currencies over those denominated in the US dollar during January 1994-June 1997 were over 8 percent for Indonesia, about 8 percent for Korea about one percent for Malaysia and over 6 percent for Thailand (top panel, Table 1; and Figure 1).\(^1\) Adjusted for actual exchange rate changes, the average excess

\(^1\) Negative interest rate differentials were observed for the Malaysian ringgit during the period of appreciation (from late 1994 to mid-1995).
returns over US dollar-denominated instruments remained substantial, amounting to 2.5-6.1 percent per year (bottom panel, Table 1).

In this connection, it is important to remember that these large positive excess returns on East Asian currency assets were observed against the background of the so-called dollar peg policies, the exchange rate policies of maintaining relative stability against the US dollar (Ito, Ogawa and Sasaki 1998; Takagi 1999; and Esaka 2000). The presence of interest rate differentials favoring East Asian currency assets in this environment means that there were risk premiums, expected depreciation, or some combination of both. Equivalently, the presence of positive ex post excess returns means that there were risk premiums, unexpected appreciation, or some combination of both on the part of East Asian currency assets. If the exchange rate policies had been credible in the sense that market participants expected the US dollar exchange rates to remain stable, one would have observed the expected rate of currency depreciation to be small. Then, most of the interest rate differentials would be explained by foreign exchange risk premiums. On the other hand, lack of credibility in the dollar peg policies would have meant that an important component of the interest rate differentials would reflect expected exchange rate change. An important task, therefore, is to decompose the observed interest rate differentials into risk premiums and expected rates of depreciation, which are both
In attempting to make the decomposition, we will use the relatively simple statistical procedure called an unobserved components model, as previously employed by Wolff (1987, 2000a, 2000b), Nijman, Palm and Wolff (1993), and Cheung (1993). An important advantage of this approach is that it absolves us from making strong assumptions about the fundamental determinants of the risk premium, as would be required in the alternative regression-based approach. At a minimum, the regression-based approach would require the availability of consumption and other macroeconomic data and might even require us to specify the explicit form of utility functions (see Engel 1996 for a survey of empirical issues related to foreign exchange risk premiums). In contrast, the unobserved components approach will only require the assumption of rational expectations and the observation of the timeseries property of the sum of unobservable components, the risk premium and a prediction error in this case (see Section 2 for details). While this approach may or may not be the most reliable way of estimating the risk premium, it may well be the only feasible method for our purpose, given the limited availability of high-frequency data on macroeconomic variables and the need to restrict ourselves to a relatively short period of time immediately preceding the East Asian currency crisis, for which testing for policy credibility would be a relevant exercise.
The paper is organized as follows. Section 2 explains the basic methodology of the unobserved components model in extracting the unobservable foreign exchange risk premium from the observable ex post excess return. Sections 3 and 4 report the results of applying the unobserved components model to East Asian data for 1994-97 and discuss their implications. In particular, Section 3 presents the estimates of risk premiums, while Section 4 discusses the credibility of the so-called dollar peg policies of the East Asian countries by estimating the expected future spot rates. Section 5 provides a summary and concluding remarks. Finally, Appendix I summarizes the source and nature of the data, and Appendix II provides an outline of the Kalman filter algorithm for the unobserved components model.

2. An Unobserved Components Model of the Foreign Exchange Risk Premium

(1) Decomposing the Excess Return

For a given East Asian currency (i.e., the Indonesian rupiah, the Korean won, the Malaysian ringgit, or the Thai baht), we begin by decomposing the forward exchange rate into two components, the expected future spot rate and the risk premium, as follows:

\[ f(t, t + 1) = E_s(\sigma(t + 1)) + \rho(t), \]  
\[ (1) \]
where \( f(t, t+1) \) is the natural logarithm of the one period ahead forward rate at time \( t \);

\( E_t(s(t+1)) \) is the rational or efficient forecast of the natural logarithm of the spot rate at time \( t+1 \), based on all information available at time \( t \); and \( \rho(t) \) is the risk premium. Throughout the paper, the exchange rate is defined as the price of the foreign currency (i.e., the US dollar) in terms of the domestic (i.e., East Asian) currency in question, such that an increase in \( f \) or \( s \) denotes a depreciation against the US dollar.

Subtracting \( s(t+1) \), the realized future spot rate, from both sides of equation (1) and defining the forecast error at time \( t+1 \) as \( \nu(t + 1) = E_t s(t + 1) - s(t + 1) \), we obtain:

\[
f(t, t+1) - s(t + 1) = \rho(t) + \nu(t + 1),
\]

where \( \nu(t) \), the forecast error, is serially uncorrelated with zero mean under the assumption of rational expectations. Assuming covered interest parity, equation (2) can equivalently be written as:

\[
ER(t) = i(t) - i^*(t) - (s(t + 1) - s(t)) = \rho(t) + \nu(t + 1),
\]
where \( i \) is the domestic (or East Asian) currency interest rate and \( i' \) is the foreign currency (or US dollar) interest rate. Equation (3) shows that the excess return \( (ER(t)) \) consists of a risk premium and a white noise error, or a signal and noise. We prefer the form of equation (3) to the form of equation (2) because of the simple fact that data on forward exchange rates are not as readily available as data on money market interest rates for the East Asian countries in our sample. Our task is to extract the (unobservable) risk premium from the (observable) excess return.\(^2\)

(2) Identifying the Foreign Exchange Risk Premium

Now, let us first specify the motion of the risk premium so as to isolate it from its noisy environment. To do so, we investigate the time-series property of the excess return \( (ER(t)) \) by using the Augmented Dickey-Fuller (ADF) test. We can then use the observed motion of the excess return to derive information about the time-series property of the underlying risk premium by resorting to a summation theorem for moving-average processes (Wolff 1987),

\(^2\) In contrast, Wolff (1987, 2000b) and Cheung (1993) have extracted the risk premium from the observed difference between the forward rate and the future spot rate, along the lines of equation (2). On the basis of the US dollar exchange rates of the pound sterling, the deutsche mark and the Japanese yen, these studies find that the risk premium was time-varying with a high degree of persistence.
inasmuch as the excess return is made up of the risk premium and a white noise error. Based on
the ADF test statistics for excess returns (Table 2), we find that the excess returns were
integrated of order one, i.e., I(1), suggesting that the risk premium (\( p(t) \)) was also
non-stationary (I(1)), given that \( v(t) \) is a white noise error. Hence, we may characterize the risk
premium as following a random walk process.\(^3\)

The resulting unobserved components model for the risk premium can be specified as the
following system of equations:

\[
ER(t) = i(t) - i^*(t) - (s(t+1) - s(t)) = p(t) + v(t+1),
\]  
\[
p(t) = p(t - 1) + \epsilon(t),
\]  
\[
v(t) \sim i.i.d. N(0, R),
\]  
\[
\epsilon(t) \sim i.i.d. N(0, Q),
\]  
\[
v(t) \text{ and } \epsilon(t) \text{ are independent for all } t.
\]  

\(^3\)While some studies suggest that the risk premium is stationary (e.g., Baillie and Bollerslev 1989; and
Engel 1996), others show that it evolves as a non-stationary process for major currency exchange rates (e.g.,
Crowder 1994; and Evans and Lewis 1995). In either case, the risk premium is shown to have a high degree
of persistence (Cheung 1993; Baillie and Bollerslev 1994), so that we are justified in modeling the premium
This model assumes that $p(t)$ follows a random walk process, such that changes in the parameters are randomly driven by the disturbance $\varepsilon(t)$. The profile of $p(t)$, therefore, evolves over time according to equation (5).

In state-space form, equation (4) is known as a measurement equation, which relates the observed variable to the unobserved component $p(t)$, while equation (5) is a transition equation, which describes the evolution of the unobserved component over time. This model can be estimated by the maximum likelihood method through the application of the Kalman filter (e.g., Harvey 1981, 1989; Hamilton 1994), which recursively updates the estimate of $p(t)$ by utilizing the new information in $ER(t)$. In this sense, the Kalman filter technique can be viewed as a Bayesian method.\textsuperscript{4} An outline of the Kalman filter algorithm for this unobserved components model is presented in Appendix II.

\section*{3. Estimating the Foreign Exchange Risk Premium}

(1) The Overall Performance of the Model

---

\textsuperscript{4} The Kalman filter may be viewed as mimicking a sequential optimal learning process. The predictions are rational in the sense that the agent is assumed to optimally utilize current and past information when learning about his or her stochastic environment (see Harvey 1981; and Hamilton 1994).
The results of applying the unobserved components model, given by equations (4)-(8), to monthly East Asian data for the period January 1994-June 1997 are summarized in Table 3. To begin with, the overall reasonableness of the fitted model may be examined by checking to see how much of the risk premium is captured. If the model has succeeded in adequately capturing the risk premium, the error terms should be serially uncorrelated. This can be checked by the Box-Pierce portmanteau Q-statistics (calculated from the residuals), which indicate that they are indeed serially uncorrelated in all four cases. We thus conclude that the unobserved components model was successful in capturing the essence of the foreign exchange risk premium in all four East Asian currencies.

(2) Mean Foreign Exchange Risk Premiums

Next, we note that, for all currencies, the estimated mean premium was positive and significant at the one percent level, ranging from 0.0028 (for the Indonesian rupiah) to 0.0050 (for the Thai baht). These are large in magnitude because the estimated risk premium of 0.0050 (for the Thai baht), for example, means roughly 0.5 percent per month or 6 percent per year.\(^5\) Likewise, the risk premium was roughly 3.4 percent for the Indonesian rupiah, 5 percent for the

\(^5\) It should be noted that the so-called peso problem may have biased upward the estimate of the risk premium. In other words, the estimated risk premium may include a more permanent component that
Korean won, and 3.8 percent for the Malaysian ringgit. Evidence thus seems to indicate that the interest differentials favoring East Asian currency assets during 1994-97 included substantial risk premium components and that substitutability between East Asian currency assets and US dollar assets were highly imperfect.

This evidence of imperfect asset substitutability is consistent with the evidence of weak causal or structural relationship between an increase in foreign exchange reserves and the growth of monetary aggregates, as documented by Takagi and Esaka (2001) for these and other East Asian countries during 1987-97. Takagi and Esaka (2001) interpreted this evidence to conjecture that the series of tight macroeconomic policy measures taken in these countries to counter the expansionary impact of the massive reserve inflows --- collectively called sterilization --- were effective in limiting the growth of narrow and broad money. The evidence of imperfect asset substitutability, as indicated by the presence of a risk premium, certainly supports the conjectured efficacy of sterilization in the East Asian context. In turn, the apparent efficacy of sterilization may have worked to promote additional capital inflows by raising the level of domestic interest rates, to the extent that international investors willingly took open speculative positions on the risk premium through what became known as “carry trades”.

---

reflects a large yet unrealized change in the exchange rate. See, for example, Evans and Lewis (1995).
The estimated variances of the risk premium and the forecast error may also be of some interest (Table 3). In the case of the Korean won and the Malaysian ringgit, the variance of the risk premium was larger than the variance of the forecast error, whereas the opposite is true for the Indonesian rupiah and the Thai baht. This means that the variation of the risk premium accounted for more than half the variation of the excess return for the Korean won and the Malaysian ringgit, while the variation of the forecast error accounted for more than half the variation of the excess return for the Indonesian rupiah and the Thai baht. This may be a simple reflection of the fact that the Indonesian rupiah (with a crawling peg to the US dollar) and the Thai baht (with a peg to a currency basket) fluctuated more than the other two currencies against the US dollar (Takagi 1999).

(3) The Time Profiles of Risk Premiums

Depicting the time profiles of the estimated risk premiums for April 1994-May 1997, we find that they were time-varying with some degree of persistence (Figure 2). The persistent yet time-varying nature of the estimated risk premium is consistent with a wide range of studies finding similar evidence for major industrial country currencies (Wolff 1987, 2000a; Cheung 1993; Nijman, Palm and Wolff 1993). Several observations are in order. First, the estimated risk premium did vary over time throughout the sample period and took on both positive and
Negative values, as previously demonstrated for industrial country data (see Engel 1996). The risk premium varied between -0.4 and 1.2 percent per month for the Indonesian rupiah, between -1.5 and 2.3 percent for the Korean won, between -1.2 and 2.6 percent for the Malaysian ringgit, and between -0.3 and 2.8 percent for the Thai baht.

Second, unlike the industrial country results (in which the risk premium swings between positive and negative values), the risk premium for the East Asian currencies was for the most part positive, indicating that East Asian currency assets were generally considered to be riskier than US dollar assets. This, however, should not minimize the fact that the East Asian assets were sometimes considered to be safer as in the case of the Indonesian rupiah in early 1997, the Korean won in the second quarter and the latter part of 1996, and the Malaysian ringgit during the first half of 1995. At least on the surface, it appears that the negative risk premiums were associated with the presence of some appreciation pressure against the background of general depreciation (e.g., the rupiah in early 1997, the won in 1996, and the ringgit from mid-1995 to late 1995).  

---

6 During these periods, the currencies in question were generally depreciating. Even so, the Indonesian authorities were easing monetary policy to contain upward pressure on the rupiah, the Korean authorities were containing the appreciating pressure on the won arising from the sharp appreciation of the yen against the US dollar, and the Malaysian ringgit was under appreciating pressure, following the upgrading...
Third, the estimated risk premium was considerably more volatile than the associated interest rate differential (c.f., Figure 1). This means that the covariance of the expected rate of depreciation and the risk premium was negative, the result consistent with the evidence well known in industrial country data (Engel 1996). Fourth, the premium of the Thai baht rose sharply (from 0 to 2.8 percent per month) during the two months preceding the onset of the currency crisis in July 1997, along with the sharply rising interest rate differential. This behavior of the risk premium indicates that the perceived risk of Thai baht assets rose sharply during this period in the minds of market participants. In contrast, the risk premium did not rise during this period in the case of the Indonesian rupiah and the Malaysian ringgit.

4. On the Credibility of the So-called Dollar Peg Policies

(1) Monetary, Exchange Rate and Other Policy Developments

Given the estimated risk premium, we can assess the credibility of the so-called dollar peg policies of the East Asian countries by obtaining the implied expected future spot rate. This can be done by making use of the fact that the interest rate differential is equal to the sum of the

of the credit rating of Malaysia’s long-term and short-term external debt in late 1994 (see EIU, various issues).
risk premium and the expected rate of depreciation. Before proceeding further, however, it may be helpful first to review the salient features of the monetary, exchange rate and other policy developments, which might have affected the market participants' exchange rate expectations, against the overall environment of the continued tight monetary policies designed to contain the expansionary impact of the reserve inflows.⁷

(i) Indonesia

Throughout the period, the Indonesian authorities maintained a tight monetary stance in order to contain inflationary pressure (with year-on-year consumer price inflation of 7.5-10.5 percent from early 1994 through mid-1996) against the recurrent fear of overheating. The measures included increases in the discount rate (e.g., January 1995), increases in reserve requirements (e.g., February 1996; April 1997), tightening of direct credit controls (e.g., 1995/1996). However, when the inflationary pressure appeared contained towards the end of the period (when the year-on-year rate of inflation declined to around 5 percent), they somewhat eased monetary policy as in late 1996 and again in early 1997 in order to encourage growth and to restrain the upward pressure on the rupiah, respectively. Given the higher rate of inflation relative to its most trading partners, the exchange rate was consistently adjusted downward to

⁷ Unless otherwise indicated, the following information comes from EIU, various issues.
maintain the real effective exchange rate. The exchange rate depreciated from 2143 rupiah per US dollar in early 1994 to 2450 in mid-1997 (Figure 2a). There was temporary depreciating pressure on the rupiah from time to time, as in January 1995 (in connection with the Mexican crisis); there was also temporary upward pressure, as in mid-1996 and in early 1997. In June and September 1996, the authorities widened the rupiah's fluctuating band against the US dollar, in order to increase the foreign exchange risk faced by foreign currency traders.

(ii) Korea

Throughout the period, the Korean authorities were faced with the dilemma of containing inflation and maintaining exchange rate stability against the US dollar, against the background of large capital inflows. Inflation was in the range of 3.6-6.9 percent, moderate by emerging market standards but high relative to the industrial country norm. The authorities generally maintained a tight monetary stance by raising interest rates; this stance was supplemented by some fiscal tightening. However, from late 1996, the monetary stance turned more accommodating, with interest rates beginning to decline. Although the won remained relatively stable against the US dollar (fluctuating between 758 and 820) through mid-1996, it began to depreciate sharply in late 1996, reaching almost 900 in the first quarter of 1997 (Figure 3b). This movement of the won was in part influenced by the downward movement of the yen.
against the dollar, which became evident from the summer of 1995: the authorities often
intervened to maintain downward pressure on the won to make Korean exports remain
competitive with Japanese exports.

(iii) Malaysia

Throughout this period, the Malaysian authorities pursued a tight monetary policy
amid the continued concern about excess liquidity. The measures included increases in reserve
requirements (e.g., in January 1994, February and June 1996) and direct controls (e.g., ceiling
on external bank liabilities in January 1994; limit on bank lending in April 1997). Inflation was
modest and falling, declining from the range of 5-6 percent in 1994 to the range of 2-3 percent in
1996 and early 1997. The exchange rate was generally stable, narrowly fluctuating around 2.5
ringgit per US dollar, although there sometimes was moderate pressure for appreciation, as from
mid-1994 to mid-1995 (when the ringgit appreciated from 2.6 to 2.44), and from late 1996 to
early 1997 (Figure 3c). From mid-1995 to early 1996, on the other hand, there was speculation
against the ringgit, which was reversed with a recovery of capital inflows in late 1996.

(iv) Thailand

Particularly from mid-1994, the Thai authorities pursued a tight monetary policy amid
the mounting concern about excess liquidity and inflation. Interest rates rose, reaching the
highest level in 4 years in December 1995. Consumer price inflation remained in the rage of 4-6 percent, although there was a temporary pickup in late 1995 and early 1996 to a range exceeding 7 percent. During the 12-month period preceding the Thai crisis of July 1997, however, the stance of monetary policy was kept easy in part to support the deteriorating balance sheets of finance companies (Fane and McLeod 1999). The exchange rate was relatively stable against the US dollar, fluctuating between 24.66 and 25.97 baht per dollar in quarterly average terms (Figure 3d). The baht, however, was subjected to periodic depreciating pressure, as during the Mexican crisis of January 1995, in the aftermath of the Bangkok Bank of Commerce (BBC) scandal and the subsequent downgrading of the credit rating of Thailand’s external debt in the summer of 1996, in late 1996 and early 1997 (when there were rumors of an impending devaluation associated with weakening economic fundamentals), and during the financial crisis of March 1997.

(2) Estimating the Expected Future Spot Exchange Rate

Figure 3 depicts, for each East Asian currency, the current US dollar exchange rate and the implied expected one-month ahead US dollar exchange rate during the period of April 1994-May 1997. Several interesting observations emerge from this set of figures. First, except for the Indonesian rupiah, it appears that whenever the domestic currency depreciated against
the US dollar, the market participants apparently expected the currency to depreciate further over the coming month. Likewise, whenever the currency appreciated against the US dollar, there were apparent expectations that the currency would further appreciate. This adaptive nature of exchange rate expectations is seen in the observation that the dotted line is above (below) the solid line when the latter moves upward (downward).

Second, in contrast, the dotted line for the Indonesian rupiah almost always exceeded the solid line, indicating that the market participants apparently expected the currency to display trend depreciation. This is consistent with the crawling peg arrangement, under which the rupiah was regularly adjusted downward against the US dollar. Third, for the Thai baht, the market participants were almost consistently expecting the currency to depreciate over the month, from mid-1995 to early 1997, when the expectations of depreciation rose sharply. It appears that the market participants were questioning the sustainability and hence the credibility of the so-called dollar peg policy of the Thai authorities through much of the sample period.

Finally, in general, the periods of expected (as well as actual) depreciation were associated with monetary easing, as in the case of the Indonesian rupiah and the Korean won in late 1996 and early 1997. In the case of the Thai baht, it appears that the expectations of
depreciation were fueled by the reported rumors of an impending devaluation from mid-1996 to early 1997, in connection with the BBC scandal and the financial crisis of March 1997. In contrast, the periods of expected (as well as actual) appreciation were associated with the beginning of monetary tightening, as in the case of the Thai baht in early 1995. All in all, these observations suggest that the market participants held systematic expectations of either appreciation or depreciation for all four East Asian currencies throughout much of the sample period, so that the exchange rate policies of these countries can hardly be characterized as dollar peg policies, at least in terms of the perception of the market participants.

5. Summary and Concluding Remarks

In this paper, we have used an unobserved components model to extract the foreign exchange risk premium from the excess ex post returns of East Asian currency assets over US dollar assets and derived the implied expected future spot rates of East Asian currencies against the US dollar. While the rather mechanical unobserved components model may not be the best way of modeling the risk premium, given the limited availability of monthly macroeconomic data needed to take a more structural approach, it may well be the only feasible method. We have used this model to provide one possible quantitative indication of the nature of the exchange rate
policies of East Asian countries (i.e., Indonesia, Malaysia, Korea and Thailand) prior to the onset of the currency crisis in 1997. Subject to the limitations of the model, the empirical results obtained for the period January 1994-June 1997, have generally indicated that the risk premium was substantial and time-varying and that the market participants questioned the credibility of the so-called dollar peg policies by consistently forming expectations of either appreciation or depreciation over the coming month.

By way of conclusion, three implications can be stated. First, the presence of a risk premium means that East Asian currency assets and US dollar assets were imperfect substitutes, so that the sterilization and other tight monetary measures adopted in these countries were likely effective in limiting the growth of monetary aggregates arising from the large reserve inflows. Second, the consistently observed expectations of short-term depreciation or appreciation suggest that market participants were questioning the credibility of the exchange rate policies. In this sense, the so-called dollar peg policies were by no means promoting a stable external environment for these East Asian countries. Third, if capital inflows were magnified at all, it was not necessarily by the policy of exchange rate pegging, as frequently argued, but rather by the presence of substantial risk premiums. During much of the period under consideration, the existing interest rate differential over US dollar assets was to a large
extent offset by expected depreciation, so that what counted for profit-motivated investors was
the magnitude of the risk premiums.

Appendix I. The Sources and Nature of Interest Rate Data

Data on dollar exchange rates and short-term market interest rates were obtained from
the Asian Wall Street Journal, daily issues. They are end-of-month data for the period from
January 1994 to June 1997 (or from January 1994 to February 1997 for Korea only), covering the
Indonesian rupiah, the Korean won, the Malaysian ringgit and the Thai baht. The East Asian
currency interest rates are 30-day interbank settlements or nearest comparable rates, while the
US dollar interest rate is the 1-month Eurodollar rate. Although both 30-day (or 1-month) and
90-day (or 3-month) rates were available (see Table 1 and Figure 1), we have only used the
30-day (or 1-month) rates in our empirical work so as to avoid autocorrelated residuals resulting
from overlapping observations (with the sampling interval shorter than the forecasting horizon)
when monthly data are used.

Appendix II. An Outline of the Kalman Filter Algorithm

Following Harvey (1981, 1989), the Kalman filter algorithm for the unobserved
components model (expressed by equations 4-8) can be presented as follows.

Let \( a(t) \) denote the minimum mean square linear estimator (MMSLE) of the risk premium \( p(t) \) based on all available information at time \( t \), including the excess return \( ER(t) \).

Let \( a(t|t-1) \) denote the MMSLE of the risk premium \( p(t) \) at time \( t-1 \). We assume that all available information is incorporated in \( a(t-1) \) at time \( t-1 \), with a known covariance matrix \( P(t-1) \).

Then, the following set of equations (A1)-(A5) describes the Kalman filter algorithm:

\[
\begin{align*}
a(t|t-1) &= a(t-1), \\
P(t|t-1) &= P(t-1) + Q, \\
a(t) &= a(t|t-1) + P(t|t-1) \cdot (ER(t) - a(t|t-1)) / f(t), \\
P(t) &= P(t|t-1) - P(t|t-1) \cdot (t|t-1) / f(t), \\
f(t) &= P(t|t-1) + R,
\end{align*}
\]

Note here that \( Q \) and \( R \) are the variances of \( \varepsilon \) (i.e., an innovation for the random walk process for the risk premium) and \( \nu \) (i.e., a prediction error of the spot exchange rate), respectively.

Equations (A1) and (A2) are prediction equations, while equations (A3) and (A4) are updating equations. The first two equations predict the mean and variance of the risk premium \( p(t) \), given the information set at time \( t-1 \). The next two equations update the values
of \( a(t) \) and \( P(t) \) in Bayesian fashion, on the basis of newly available current information, including the current value of \( ER(t) \) and its history (Harvey 1989; and Hamilton 1994).

Equation (A5) gives the variance of the excess return \( ER(t) \), which is made up of the risk premium \( \rho(t) \) and a prediction error of the spot exchange rate \( \nu(t) \).

Noting the definition of a one period ahead prediction error of the spot exchange rate,

\[ \nu(t) = ER(t) - a(t|t-1) \]

the log likelihood function of the model can be written as,

\[
\ln L = -\frac{T}{2} \ln(2\pi) - \frac{1}{2} \sum_{i=1}^{T} \ln f(t) - \frac{1}{2} \sum_{i=1}^{T} \frac{\nu^2(t)}{f(t)}. \tag{A6}
\]

The estimates of \( Q \) and \( R \) are obtained recursively by maximizing this log likelihood function.

The initial values are set arbitrarily. As the starting value of \( \rho \) required in initializing the Kalman filter procedure, we use the OLS estimate obtained from the first five observations. To check for robustness, we have also used different initial values of \( Q \) and \( R \) as well as the OLS estimate of \( \rho \) from the full sample. In either case, we have found virtually the same results, suggesting that estimates are robust with respect to the choice of initial values.

References


Economist Intelligence Unit Limited (EIU), *Country Report: Malaysia/Brunei*, quarterly issues,
1st quarter 1994 through 2nd quarter 1997.


Table 1.
Summary Statistics: Interest Rate Differentials and Excess Returns on East Asian Currency Assets, 1994-97

(a) Interest rate differentials over US dollar assets (in percent per year)

<table>
<thead>
<tr>
<th></th>
<th>Indonesia</th>
<th>Korea</th>
<th>Malaysia</th>
<th>Thailand</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1 month</td>
<td>3 month</td>
<td>1 month</td>
<td>3 month</td>
</tr>
<tr>
<td>Mean</td>
<td>8.288</td>
<td>8.706</td>
<td>7.882</td>
<td>8.256</td>
</tr>
<tr>
<td>Std Dev</td>
<td>1.855</td>
<td>1.902</td>
<td>1.273</td>
<td>0.778</td>
</tr>
<tr>
<td>Min</td>
<td>4.438</td>
<td>4.438</td>
<td>6.625</td>
<td>6.356</td>
</tr>
<tr>
<td>t-statistic</td>
<td>28.95</td>
<td>29.67</td>
<td>27.66</td>
<td>68.80</td>
</tr>
<tr>
<td>p-value</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
</tr>
</tbody>
</table>

(b) Excess returns over US dollar assets (in percent per year) 1/

<table>
<thead>
<tr>
<th></th>
<th>Indonesia</th>
<th>Korea</th>
<th>Malaysia</th>
<th>Thailand</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1 month</td>
<td>3 month</td>
<td>1 month</td>
<td>3 month</td>
</tr>
<tr>
<td>Mean</td>
<td>3.621</td>
<td>4.002</td>
<td>5.053</td>
<td>4.642</td>
</tr>
<tr>
<td>Max</td>
<td>18.59</td>
<td>12.90</td>
<td>36.48</td>
<td>25.65</td>
</tr>
<tr>
<td>t-statistic</td>
<td>3.777</td>
<td>7.016</td>
<td>2.469</td>
<td>3.146</td>
</tr>
<tr>
<td>p-value</td>
<td>0.001</td>
<td>0.000</td>
<td>0.018</td>
<td>0.003</td>
</tr>
</tbody>
</table>

Note: 1/ Adjusted for actual exchange rate changes.
Sources: The Asian Wall Street Journal; authors’ estimates.
<table>
<thead>
<tr>
<th>Indonesia</th>
<th>Korea</th>
<th>Malaysia</th>
<th>Thailand</th>
</tr>
</thead>
<tbody>
<tr>
<td>-2.564 (5)</td>
<td>-2.663 (7)</td>
<td>-3.066 (6)</td>
<td>-2.285 (2)</td>
</tr>
<tr>
<td>[0.296]</td>
<td>[0.252]</td>
<td>[0.115]</td>
<td>[0.442]</td>
</tr>
</tbody>
</table>

Note: The figures are Augmented Dickey-Fuller statistics obtained with a constant term and time trend. The figures in parentheses indicate lag length; and those in brackets are p-values.
### Table 3.
Summary Statistics from the Estimated Unobserved Components Model

<table>
<thead>
<tr>
<th></th>
<th>Indonesia</th>
<th>Korea</th>
<th>Malaysia</th>
<th>Thailand</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean ($r$)</td>
<td>0.0028***</td>
<td>0.0042***</td>
<td>0.0032***</td>
<td>0.0050***</td>
</tr>
<tr>
<td>Var ($r$)</td>
<td>1.26E-05</td>
<td>6.41E-05</td>
<td>5.99E-05</td>
<td>3.02E-05</td>
</tr>
<tr>
<td>t-statistic</td>
<td>5.079</td>
<td>3.219</td>
<td>2.675</td>
<td>5.799</td>
</tr>
<tr>
<td>Var ($v$)</td>
<td>1.39E-05</td>
<td>4.23E-05</td>
<td>5.34E-05</td>
<td>3.14E-05</td>
</tr>
<tr>
<td>Q (7)</td>
<td>10.1</td>
<td>10.1</td>
<td>11.2</td>
<td>6.15</td>
</tr>
<tr>
<td>log L</td>
<td>147.6</td>
<td>112.8</td>
<td>120.6</td>
<td>131.3</td>
</tr>
</tbody>
</table>

Note: The unobserved components models was estimated by the maximum likelihood method through the Kalman filter technique. Mean ($r$) and Var ($r$) are the mean and the variance of the estimated risk premium. Var ($v$) is the variance of the derived noise. Q (7) is the Box-Pierce portmanteau test statistic calculated from residuals. The critical value of the Q (7) statistic is 12.02 at the 10 percent level. *** indicates the statistic is significant at the 1 percent level.
Figure 1.
1-month and 3-month Interest Rate Differentials:
East Asian Currency Assets over US Dollar Assets, 1994-97
(in percent per year)
Figure 1 (continued).

1c. Malaysian ringgit

![Graph of Malaysian ringgit](image)

1d. Thai baht

![Graph of Thai baht](image)

Source: The *Asian Wall Street Journal*.
Figure 2.
1-month Foreign Risk Premiums relative to the US Dollar, 1994-97

2a. Indonesian rupiah

2b. Korean won
Figure 2 (continued).

2c. Malaysian ringgit

2d. Thai baht

Sources: The Asian Wall Street Journal; authors’ estimates based on the unobserved components model.
Figure 3.
Current and Expected 1-month Future Exchange Rates
against the US Dollar, 1994-97
Figure 3 (continued).

3c. Malaysia ringgit

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Rate</td>
<td>2.42</td>
<td>2.47</td>
<td>2.52</td>
<td>2.57</td>
<td>2.62</td>
<td>2.67</td>
<td>2.67</td>
<td>2.67</td>
<td>2.67</td>
<td>2.67</td>
<td>2.67</td>
<td>2.67</td>
<td>2.67</td>
<td>2.67</td>
<td>2.67</td>
<td>2.67</td>
<td>2.67</td>
<td>2.67</td>
<td>2.67</td>
</tr>
</tbody>
</table>

3d. Thai baht

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Rate</td>
<td>24.5</td>
<td>25</td>
<td>25.5</td>
<td>26</td>
<td>26.5</td>
<td>26.5</td>
<td>26.5</td>
<td>26.5</td>
<td>26.5</td>
<td>26.5</td>
<td>26.5</td>
<td>26.5</td>
<td>26.5</td>
<td>26.5</td>
<td>26.5</td>
<td>26.5</td>
<td>26.5</td>
<td>26.5</td>
<td>26.5</td>
</tr>
</tbody>
</table>

Sources: The *Asian Wall Street Journal*; authors’ estimates based on the unobserved components model.