Explaining the Duration of Exchange-Rate Pegs in Asia*

Ka-fu Wong and Sze-wan Leung

University of Hong Kong and Pangs Department Store Limited

Abstract We identify factors that may explain the peg durations in nine Asian countries, via a logit model. Despite some fundamental differences between Asian and Latin American countries, our results are similar to Klein and Marion (1997) on Latin American countries. We find that the real exchange rate relative to the US, the level of international liquidity, openness of the economy and its geographical trade concentration contribute to the likelihood of a devaluation in Asian countries. However, we find no evidence that the likelihood of a devaluation in Asian countries first rises and subsequently declines during the first year of a peg.

Keywords: Peg duration, exchange rate, Asia

JEL classification: F31, O53

Introduction

Exchange-rate pegs are not permanent since no single currency regime is right for all countries or at all times. (Frankel, 1999, p.1)

Governments often devalue or revalue a currency or abandon their attempts to peg altogether when facing adverse circumstances. The most recent example is the abandonment of the 11-year-old peg of Chinese Yuan against the dollar on July 21, 2005. Since then, the yuan has been linked to a basket of currencies (The Economist, July 23rd 2005 issue, p.67.). An identification of these circumstances or factors that drive the abandon of peg is important to both the policy-makers and investors. Indeed, policy-makers and investors around the world had been guessing when the Chinese Yuan would abandon the peg (The Economist, May 21st 2005 issue, p.9.).

While previous studies, such as Klein and Marion (1997), had investigated the duration of exchange-rate pegs in Latin American countries and Jamaica, none had done so for Asian currencies. Ours is the first to study the factors that may explain the devaluation of Asian currencies.

Because there are fundamental differences between Asian and Latin American pegs, we also compare the duration of Asian and Latin American exchange-rate pegs. In Latin American countries, currencies are pegged to the US dollar only. In 1960s, most Asian currencies were pegged to the U.S. dollar. When the Bretton Woods System was abolished in 1973, the US dollar devalued against gold by 10% and was very volatile. Subsequently, these Asian countries
switched from a peg with the US dollar to a peg with a basket of their major trading partners’ currencies around 1970s. Pegging to a basket of currencies implies that a country’s exchange rate against the US dollar might adjust even during a (basket) peg. This characteristic makes the identification of pegs in Asia slightly more difficult than those in Latin America. In this paper, we use the government announcements to identify pegs. More details are described in section of Data and Methodology.

We focus on devaluation instead of revaluation for two reasons. First, devaluation happens more often than revaluation. While revaluation is possible, as in the recent Chinese Yuan revaluation, governments are less likely to revalue its currency because doing so may have negative impact on its trade balance. The infrequent occurrence of revaluation makes estimation of the model parameters spurious, if not impossible. Second, we are more concerned about devaluation because currency crisis and devaluation are related. In this sense, our results will also shed some light on the factors that likely caused the crisis in Asia in 1997.

We emphasize that there are important similarities, as well as differences, between a crisis and a devaluation. Crisis, often a result of speculative attack, is a cause of devaluation, but not all devaluations are the result of crises. There are reasons other than crisis that will lead to a devaluation. Examples of these reasons include trade promotion and maintenance of economical balance between these countries and the countries with which their currencies are pegged. In our analysis, we focus on nine Asian countries which were typical victims in the 1997 Asian Financial Crisis: China, Hong Kong, Indonesia, Korea, Malaysia, Philippines, Singapore, Thailand and Taiwan.

Following Klein and Marion (1997), we use logit analysis to consider the effect of a variety of variables on the likelihood of a devaluation over the course of these spells of pegs. The logit analysis yields several interesting results. Similar to Latin American countries, there is strong evidence that a more appreciated real exchange rate and a lower stock of international reserves are associated with a higher likelihood of a devaluation. However, Latin American countries experienced a greater degree of real appreciation during the peg on average. Openness and trade concentration have opposite effects in Latin American countries and Asian countries. In Asian countries, the more open an economy, the higher the likelihood of devaluation of its currency; the greater degree of geographical trade concentration, the lower the likelihood of devaluation. In Latin American sample, there is some evidence that the likelihood of a devaluation first rises and subsequently declines during the first year of a peg. This characteristic is absent in our Asian sample.

Our results are complementary to previous studies on Latin American countries, such as Klein and Marion (1997), and those of Asian Financial Crisis, such as Tornell (1999). Tornell (1999) attempted to answer whether there is a set of fundamentals that help to explain the probability of crises. He investigated two specific events, 1994 Tequila and 1997 Asian Financial Crisis, to see whether the rule that explains the cross country variation in the severity of the Tequila Crisis is also applicable to the Asian Financial Crises. We investigate devaluation in Asian countries between 1960 and 1999 to see whether factors that affect the probability of devaluation in Latin American countries are also applicable to Asian countries. Our focus in devaluation is complementary to Tornell’s (1999) focus in crises. Although our data set, research methodology and focus differ from Tornell (1999), our findings of fundamentals that explain the probability of devaluation are similar to his findings of fundamentals that explain the probability of crisis.
Data and Methodology

The identification of pegs for Asian countries is not as straightforward as for Latin American countries. Because some of the Asian currencies are pegged to a basket of currencies instead of a single currency, as for Latin American countries, we cannot identify the pegs by a simple eye-balling exercise. Indeed, we can roughly divide the exchange rate pattern in Asian currencies into two stages, before and after the 1970s. Before 1970s, most Asian currencies were pegged to the US dollar with a periodical devaluation. We call this kind of exchange-rate peg “fixed peg”. It is easy to identify the fixed pegs because a plot of the exchange rate against its anchor currency will appear as a horizontal line during a peg.

After 1970s, most Asian countries adopted a basket peg system. Their baskets contain mainly the currencies of their major trading partners: the US dollar, the Japanese yen and the German Mark. Government maintains the fluctuation of exchange rate to the US dollar within a certain band. We call this kind of exchange-rate peg “basket peg”. For example, the baht was pegged to a US dollar-dominated basket of currencies from January 1988 to June 1997. Under this basket peg, a plot of the baht against US dollar will not appear as a horizontal line.

In this paper, we use the government announcements and their exchange rate policies to determine the beginning and ending of basket pegs. In the Data Appendix, we list the 24 exchange-rate pegs extracted according to government announcements and exchange rate policies, based on various issues of Asia Yearbook by Far Eastern Economic Review (from 1960 to 1999), Brahm (1993) and Rana (1981).¹

The characteristics of these 24 spells are summarized in Table 1. The average duration of pegs is 60 months while the median duration is 57.5 months. The standard deviation of the duration is 31 months. The range of the peg duration is 7 months to 126 months. Note that pegs in Asian countries last much longer than those in Latin American countries, which have an average duration of 32 months and a median duration of 10 months. In Latin American countries, the exit rate is high in the early months of a peg. Ten percent of the sixty-one spells in Latin American countries ended in their fourth month; more than one-third of the pegs were over by their eighth month; and more than half ended within one year. For Asian countries, we cannot say in what duration these countries have the highest exit rate because the duration of peg distributed quite evenly between 10 to 90 months.

In this paper, we adopt the logit model suggested by Klein and Marion (1997) to identify factors that may explain the peg duration in Asia. The logit methodology has been used often in the analysis of devaluation and currency crises. In addition to Klein and Marion (1997), recent examples include Pazarbasioglu and Otker (1997), and Goldfajn and Valdes (1998).

We construct the data set such that each observation represents the value of variables during one month in one of the 24 pegs in the sample. Thus, the data set contains about 1444 monthly observations. We use logit model to estimate the relation between the devaluation and economic factors.

The dependent variable \( D_{t+1} \) takes a value of zero in any month when the peg is in effect and takes one in the month that the spell ends. Variables from month \( t \) are used to determine the probability of exit in month \( t+1 \). Specifically, the probability of maintaining the peg up until month \( t+1 \) and the probability of a devaluation in month \( t+1 \) are modeled to depend on a vector of variables, \( X_t \):
\[
\begin{align*}
\text{Prob}(D_{t+1} = 0 \mid X_t) &= 1/[1 + \exp(\gamma_0 + \gamma_1 X_t)] \quad (1) \\
\text{Prob}(D_{t+1} = 1 \mid X_t) &= \exp(\gamma_0 + \gamma_1 X_t)/[1 + \exp(\gamma_0 + \gamma_1 X_t)] \quad (2)
\end{align*}
\]

From these equations, the logarithms of odds ratio is

\[
\ln\left[\frac{\text{Prob}(D_{t+1} = 1)/\text{Prob}(D_{t+1} = 0)}{\mid X_t}\right] = \gamma_0 + \gamma_1 X_t \quad (3)
\]

Thus, the elements of the vector \(\gamma_t\) clearly represent the effect on the log-odds ratio of a change in the vector of variables \(X_t\). If \(\gamma_t < 0\), a decrease in \(X_t\) implies an increase in probability of devaluation. If \(\gamma_t > 0\), an increase in \(X_t\) implies an increase in the probability of devaluation. See Greene (2000, Chapter 20) for a general discussion of logit models and their estimation. In our study, the model is estimated using MATLAB with a subroutine developed by James P. LeSage, available at http://www.spatial-econometrics.com/.

As suggested by Klein and Marion (1997), logit analysis allows time-varying determinants and hence is a useful tool for estimating the monthly probability of leaving an exchange-rate peg, particularly for developing countries. In this study, we try to find macroeconomic variables that can explain the duration of an exchange-rate peg. While some of these determinants may remain more or less constant over a peg, others will change. Therefore, when we use the value of an explanatory variable at the beginning or at the end of a peg, or use its change over the spell or its average value during the spell, we will not be able to capture important information about the time path of the variable during the spell. The use of logit analysis allows us to capture the time-varying determinants.

There are a wide range of candidates that determine the duration of an exchange rate peg. Some determinants of peg duration reflect the trade-offs associated with the benefits and costs of ending a peg. Some determinants reflect the signal of devaluation. At the end, our choice of variables is limited by the availability of data.

Economic variables used to explain the peg duration are drawn or calculated from the raw data of International Financial Statistics. The Data Appendix describes the definition and calculation of these variables and their sources. Table 2 lists and summarizes the economic variables of Asian countries at the end of spells. We measure openness as the sum of exports and imports divided by GDP. Using this definition, average openness at the end of a peg is about 6% in our sample. Thus, Asian countries are generally less open than the Latin American countries, which have an average of 21% as reported by Klein and Marion (1997). Trade concentration is calculated as the share of total trade (exports plus imports) with the United States and Japan separately. On average, about 21% and 25% of total trade is conducted respectively with the United States and Japan at the end of peg. Thus, both the United States and Japan are equally important trading partners to Asian countries. Average net foreign asset to M2 ratio is 0.09 while average foreign reserves to M2 ratio is 0.69. Current account to GDP ratio have an average value -0.04. Thus, most countries exit a peg when they have current account deficit at the end of a peg. Inflation differential is calculated as the year to year change in CPI of Asian countries minus year to year change in CPI of the United States. On average, there are almost 6% higher inflation rate in Asian countries than the United States at the end of a peg.

The real bilateral exchange rate indices with the United States, Japan and Germany (set at 100 at the beginning of each peg) all appreciated less than 1% per month on average. The
appreciation is much less than the 4% appreciation per month in Latin American countries. This difference is consistent with the fact that Asian countries have longer duration of pegs than Latin American countries.

The expected effects of the variables used in our study are summarized in Table 3. An explanation of these expected effects may be found either in Klein and Marion (1997) or an additional appendix, available upon request.

Results

Table 4 reports the results obtained from four specifications of logit regressions with all variables. Specification B includes a set of country dummies, one for each country, while other specifications do not. The coefficients of the real exchange rate to U.S. dollar are significant at 5% level and of the expected sign. Furthermore, the likelihood of devaluation increases with openness, decreases with trade concentration, foreign reserves to M2 ratio and current account to GDP ratio. We note, however, that the sign of trade concentration with U.S. changes from negative to positive when country dummies were included.

In Latin American sample, the time on the peg matters: The likelihood of a devaluation decreases with the time on the peg. However, the time on the peg is statistically insignificant in Asian countries. In the table, we also report a goodness of fit measure, suggested by Estrella (1998). The measure suggests that the model does not fit the data very well. The inclusion of countries dummies does improve the goodness of fit marginally, indicating that country specific factors may be important.³

Klein and Marion (1997) consider several other specifications to look at the effect of time on the likelihood of devaluation: (i) including dummies for months 4-6, months 7-9 and months 10-12, and (ii) splitting the data into sub-samples according to the peg duration, i.e. first six months and first year. They found that the likelihood of a devaluation is higher for pegs in their first year than for pegs that have lasted at least 12 months. Since the average duration of pegs in Asian countries are much longer, we cannot perform the same split. When we did with a different split of first twenty-four months and first thirty-six months, we found that the devaluation is less likely to happen in the first three years of a spell.⁴ This finding is consistent with the basic characteristics of the pegs in Asia: an average duration of 60 months.

As discussed before, there are fixed pegs and basket pegs in Asian countries. Therefore, in addition to real exchange rate to U.S., we also consider real exchange rate to Japan and Germany as well. We investigate the robustness of our result when the real exchange rate index against Japan (specification C) and Germany (specification D) are used separately. Results are similar among these three specifications. A possible reason is that most Asian countries pegged their currencies to a basket of currencies. Because all three currencies (U.S. dollar, Yen and Mark) carry heavier weights than other currencies, real exchange rate indices with the United States, Japan and Germany are all expected to have similar effect on the duration of exchange-rate pegs in Asian countries. Indeed, the correlation between these three real exchange rate indices is extremely high.

A comparison of specifications A, C and D shows that real exchange rate to US has a much more significant impact on the probability of devaluation in Asian countries than real exchange rate to Japan and Germany. The relative significance of the US dollar to the Japanese yen and the Mark may be explained by (i) that for fixed peg, Asian currencies were pegged to the
US dollar only and real exchange rates with Japan and Germany may not have explanatory power since the peg was not related to Yen and Mark; (ii) for basket peg, the US dollar tends to carry a heavier weight than other currencies in the basket.

The estimated probabilities of devaluation for the full sample are summarized in Table 5. The probability of devaluation is calculated using the logistic estimates of specification A presented in Table 4. We also used the other specifications to calculate the probability of devaluation. The results are not reported because all of them have similar trends. As the time of the actual devaluation draws closer, these estimated probabilities rise. At 6 months before the devaluation, the average of the estimated probabilities is 0.041. The average rises to 0.074 two months before the actual devaluation, and rises further to 0.108 in the month prior to the actual devaluation. In more than 90% of the spells, the estimated probability of a devaluation rises in the month before the devaluation as compared to the second month before the devaluation. More than 95% of the spells shows a higher probability of devaluation in the sixth month before an actual devaluation. This pattern is similar to the trend documented by Klein and Marion (1997) using the sample of Latin American countries.

We also find that the average percentage change in monthly probability has a peak at three month before actual devaluation in both Asian and Latin American samples. One possible explanation is that most of the adverse effects, such as massive loss of reserves and great appreciation in real exchange rate, tend to turn more serious in three months prior to actual devaluation. In short, sudden increase in the probability of devaluation is an important indicator that the economy has a danger of devaluation.

Comparing the probability of devaluation in Latin American and Asian samples, Latin American sample showed a much higher mean and median in the probability of devaluation. A possible explanation is that the variation of the variables is much smaller in Asian countries, so the effectiveness of these variables in predicting devaluation is much smaller, resulting in a smaller mean and median in the probability of devaluation. Indeed, Kaminsky and Reinhart (1998) measured volatility by calculating the mean absolute deviation for economic indicator in the 18 months prior to the crisis for both Latin America and East Asia, and found all the indicators that included in their model are more volatile in Latin America.

Concluding remarks

Our study on the duration of Asian exchange rate pegs reveals that there are some major distinctions between exchange-rate pegs in Asian countries and those in Latin American countries. Most Asian currencies are pegged to a basket of currencies, such as the US dollar, the Yen and the Mark while Latin American currencies are pegged only with the US dollar. There are small fluctuations in the Asian currencies exchange rate with the US dollar during the exchange-rate peg period. The basket peg in Asia made the definition of exchange-rate peg much more difficult and complicated.

We find that most of the determinants that influence exchange-rate pegs duration in Latin American countries also affect the monthly probability of leaving a peg in the sample of Asian pegs over 1960-1999 period. They are openness, trade concentration, international liquidity, and most significantly, the real exchange rate. In both Asian and Latin American samples, appreciation of real exchange rate to US and the decrease in international liquidity increase the monthly probability of devaluation. We find that an increase in current account deficit and
inflation differential to the US economy also increase the likelihood of devaluation. We also find that although appreciation of real exchange rate to Japan and Germany also increase the monthly probability of leaving a peg, they are less significant than real exchange rate to the US.

The significant negative sign of real exchange rate has important policy implication to governments who want to maintain a stable exchange rate. For these governments, it will be useful to monitor the movement of real exchange rate closely and avoid prolonged period of appreciation in real exchange rate. For instance, the monetary policy may be used to target the inflation rate differentials and hence the real exchange rate. Avoiding a prolonged period of inflation rate differential will help reduce the need to adjust the nominal exchange rate peg.

Footnotes

* Ka-fu Wong’s research was partially supported by a grant from the University Grants Committee of the Hong Kong Special Administrative Region, China (Project No. AoE/H-05/99). We thank Ying-chuen Kam and Tze-shan Kong for their excellent research assistant. We are grateful to K.C. Fung (the guest editor of this special issue) and an anonymous referee for their helpful comments. Please send all correspondence to: Ka-fu Wong, School of Economics and Finance, University of Hong Kong, Pokfulam, Hong Kong, China. Email: kafuwong@econ.hku.hk; tel: (852) 2857-8512; fax: (852) 2548-1152. The MATLAB program and data to compute the results in this paper is available from http://kafuwong.econ.hku.hk/research/asiapegs/.

1. There was a total 28 pegs between 1960 and 1999, four of them are dropped because of missing data on international reserves.

2. For example, we calculate the year to year change in CPI for July 1997 by comparing July 1997 CPI with July 1996 CPI.


4. Tables reporting these results and those of other specifications are included in an additional appendix available upon request.

References


Lisbon, June 14-15.


Table 1: Summary for 24 exchange rate pegs

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of pegs</td>
<td>24</td>
</tr>
<tr>
<td>Mean duration in months (standard deviation)</td>
<td>60 (31)</td>
</tr>
<tr>
<td>Median duration in months</td>
<td>57.5</td>
</tr>
<tr>
<td>Maximum duration in months</td>
<td>126</td>
</tr>
<tr>
<td>Minimum duration in months</td>
<td>7</td>
</tr>
<tr>
<td>Number of pegs by country</td>
<td></td>
</tr>
<tr>
<td>China</td>
<td>3</td>
</tr>
<tr>
<td>Hong Kong</td>
<td>0</td>
</tr>
<tr>
<td>Indonesia</td>
<td>4</td>
</tr>
<tr>
<td>Korea</td>
<td>3</td>
</tr>
<tr>
<td>Malaysia</td>
<td>1</td>
</tr>
<tr>
<td>Philippines</td>
<td>7</td>
</tr>
<tr>
<td>Singapore</td>
<td>1</td>
</tr>
<tr>
<td>Taiwan</td>
<td>1</td>
</tr>
<tr>
<td>Thailand</td>
<td>4</td>
</tr>
</tbody>
</table>
## Table 2: Summary statistics for the macroeconomic variables

<table>
<thead>
<tr>
<th>Variable</th>
<th>Average Openness (Stand Deviation)</th>
<th>5.99 (6.68)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Average trade concentration with U.S. (Stand Deviation)</td>
<td>21.13 (10.09)</td>
</tr>
<tr>
<td></td>
<td>Average trade concentration with Japan (Stand Deviation)</td>
<td>25.19 (10.23)</td>
</tr>
<tr>
<td></td>
<td>Average net foreign asset to M2 ratio (Stand Deviation)</td>
<td>0.095 (1.29)</td>
</tr>
<tr>
<td></td>
<td>Average foreign reserves to M2 ratio (Stand Deviation)</td>
<td>0.69 (0.86)</td>
</tr>
<tr>
<td></td>
<td>Average current account to GDP ratio (Stand Deviation)</td>
<td>-0.039 (0.085)</td>
</tr>
<tr>
<td></td>
<td>Average inflation differential (Stand Deviation)</td>
<td>5.71 (9.09)</td>
</tr>
<tr>
<td></td>
<td>Average monthly rate of change of bilateral real exchange rate to U.S.</td>
<td>-0.64%</td>
</tr>
<tr>
<td></td>
<td>Average monthly rate of change of bilateral real exchange rate to Japan</td>
<td>-0.58%</td>
</tr>
<tr>
<td></td>
<td>Average monthly rate of change of bilateral real exchange rate to Germany</td>
<td>-0.61%</td>
</tr>
</tbody>
</table>

### Notes:
1. Sources: International Monetary Fund, International Financial Statistics; International Monetary Fund, Directions of Trade; and our own calculation.
Table 3: Expected effects of the variables on devaluation probability

<table>
<thead>
<tr>
<th>Variables</th>
<th>Description</th>
<th>Expected sign</th>
</tr>
</thead>
<tbody>
<tr>
<td>ln(R.E.R.)US</td>
<td>Logarithm of real exchange rate with U.S.</td>
<td>-</td>
</tr>
<tr>
<td>ln(R.E.R.)Japan</td>
<td>Logarithm of real exchange rate with Japan</td>
<td>-</td>
</tr>
<tr>
<td>ln(R.E.R.)Germany</td>
<td>Germany Logarithm of real exchange rate with Germany</td>
<td>-</td>
</tr>
<tr>
<td>Openness</td>
<td>Openness</td>
<td>?</td>
</tr>
<tr>
<td>Trade ConcUS</td>
<td>Trade concentration with U.S.</td>
<td>?</td>
</tr>
<tr>
<td>Trade ConcJapan</td>
<td>Trade concentration with Japan</td>
<td>?</td>
</tr>
<tr>
<td>N.F.A/M2</td>
<td>Net foreign asset to M2 ratio</td>
<td>-</td>
</tr>
<tr>
<td>Foreign reserves/M2</td>
<td>Foreign reserves to M2 ratio</td>
<td>-</td>
</tr>
<tr>
<td>Current account/GDP</td>
<td>Current account to GDP ratio</td>
<td>-</td>
</tr>
<tr>
<td>Inflation differential</td>
<td>Inflation differential with respect to U.S.</td>
<td>+</td>
</tr>
<tr>
<td>ln(Foreign reserves/M2)</td>
<td>Logarithm of foreign reserves to M2 ratio</td>
<td>-</td>
</tr>
<tr>
<td>d(ln(Foreign reserves=M2))</td>
<td>Change in logarithm of foreign reserves to M2 ratio</td>
<td>-</td>
</tr>
</tbody>
</table>
Table 4: Estimates of the logit regression based on various specifications

<table>
<thead>
<tr>
<th>Variables</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
</tr>
</thead>
<tbody>
<tr>
<td>ln(R.E.R.)_{US}</td>
<td>-1.0126*</td>
<td>-0.9532</td>
<td>-0.7977</td>
<td>-1.0571</td>
</tr>
<tr>
<td></td>
<td>(0.575)</td>
<td>(0.918)</td>
<td>(0.598)</td>
<td>(0.752)</td>
</tr>
<tr>
<td>ln(R.E.R.)_{Japan}</td>
<td>-0.7977</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.598)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ln(R.E.R.)_{Germany}</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Openness</td>
<td>5.6707</td>
<td>59.9835**</td>
<td>5.2587</td>
<td>5.7860</td>
</tr>
<tr>
<td></td>
<td>(4.480)</td>
<td>(26.792)</td>
<td>(4.477)</td>
<td>(4.500)</td>
</tr>
<tr>
<td>Trade Conc_{US}</td>
<td>-3.1708</td>
<td>1.8275</td>
<td>-3.3125</td>
<td>-3.2647</td>
</tr>
<tr>
<td></td>
<td>(2.684)</td>
<td>(4.453)</td>
<td>(2.689)</td>
<td>(2.691)</td>
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<tr>
<td>Trade Conc_{Japan}</td>
<td>-2.3279</td>
<td>-4.3605</td>
<td>-2.4232</td>
<td>-1.9969</td>
</tr>
<tr>
<td></td>
<td>(3.019)</td>
<td>(3.733)</td>
<td>(3.053)</td>
<td>(3.049)</td>
</tr>
<tr>
<td>Foreign reserves/M2</td>
<td>-1.6315**</td>
<td>-3.2838**</td>
<td>-1.6873**</td>
<td>-1.5899**</td>
</tr>
<tr>
<td></td>
<td>(0.511)</td>
<td>(0.807)</td>
<td>(0.514)</td>
<td>(0.512)</td>
</tr>
<tr>
<td>Current account/GDP</td>
<td>-5.2060*</td>
<td>-2.7694</td>
<td>-5.7037*</td>
<td>-5.8287*</td>
</tr>
<tr>
<td></td>
<td>(3.678)</td>
<td>(4.727)</td>
<td>(3.579)</td>
<td>(3.393)</td>
</tr>
<tr>
<td>Time on peg</td>
<td>0.0037</td>
<td>0.0064</td>
<td>-0.0046</td>
<td>-0.0041</td>
</tr>
<tr>
<td></td>
<td>(0.027)</td>
<td>(0.032)</td>
<td>(0.027)</td>
<td>(0.027)</td>
</tr>
<tr>
<td>Time on peg^2</td>
<td>0.0002</td>
<td>0.0003</td>
<td>0.0003</td>
<td>0.0003</td>
</tr>
<tr>
<td></td>
<td>(0.000)</td>
<td>(0.000)</td>
<td>(0.000)</td>
<td>(0.000)</td>
</tr>
<tr>
<td>Country dummies</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Log likelihood</td>
<td>-105.7229</td>
<td>-99.8683</td>
<td>-106.2358</td>
<td>-105.5956</td>
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<tr>
<td>Estrella R-squared</td>
<td>0.0241</td>
<td>0.0335</td>
<td>0.0233</td>
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<tr>
<td>Number of observations</td>
<td>1444</td>
<td>1444</td>
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<tr>
<td>Number of pegs</td>
<td>24</td>
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<td>24</td>
<td>24</td>
</tr>
</tbody>
</table>

Notes:
   "*"=significant at 10% level. "**"=significant at 5% level.
<table>
<thead>
<tr>
<th>Probabilities</th>
<th>Full Sample</th>
<th>Months before actual devaluation</th>
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<tr>
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<tr>
<td>Mean</td>
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<td>St.Dev</td>
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<td>Av'g % Ch.</td>
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<td>10.40%</td>
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<tr>
<td>Median</td>
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<td>0.025</td>
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</table>

Notes:
1. The probabilities are based on the specification A.
Appendix

This appendix contains two sections: In section 1, we identify the pegs of nine Asian countries used in our analysis. In section 2, we describe the sources and calculation of variables.

Exchange Rate Pegs

Twenty-four exchange pegs are extracted according to government announcements and exchange rate policies, based on various issues of Asia Yearbook by Far Eastern Economic Review (from 1960 to 1999), Brahm (1993) and Rana (1981).

1. China: Three devaluation pegs are extracted.
   (a) July 1986 - November 1989
   In July 1986, the renminbi (RMB) was devalued by an unprecedented 15.8% in an attempt to restrain what the authority considered to be “unnecessary imports”, and at the same time to promote export and foreign investment. It devalued from 3.2 to 3.72 RMB per US dollar and pegged at this rate until the 1989 devaluation.
   (b) December 1989 - October 1990
   On 15 December, 1989, the RMB was lowered by 26.8% against the US dollar, bringing the exchange rate from 3.72 to 4.72 RMB per US dollar. The move was aimed at strengthening China’s export in the wake of the fall-off in China trade following the event of 4 June.
   (c) November 1990 - December 1993
   In November 90, the RMB was devalued from 4.72 to 5.22 RMB per US dollar. And during November 1990 - December 1993, the RMB has continued to devalue with occasional adjustments to narrow the gap between the official and informal markets (monthly change in exchange rate was within 1%). The ending of the dual exchange rate system on 1 January, 1994 drove the exchange rate to devalue to 8.7 RMB per US dollar.

2. Indonesia: Four devaluation pegs are extracted. Because there is missing data on exchange rate before 1966 and on international reserves before 1970, the pegs before 1970 are ignored in our analysis.
   (a) September 1971 - October 1978
   In August 1971, the Indonesian rupiah was lowered by 9.78% from 378 to 415 rupiah per US dollar. In 16 November 1978, the currency was devalued by around 50% against the US dollar, to 625 rupiah per US dollar, with which its seven years old fixed link was ended and changed to a “managed float” system. The object of this devaluation was to provide some relief to the non-oil traded goods industries from the squeeze of high inflation rates resulting from the payments surpluses.
   (b) March 1979 - March 1983
   Since the massive devaluation of the rupiah in November 1978, the Indonesian currency has been pegged to a basket of currencies. The rupiah has no substantial change in the US dollar exchange rate. Though the rupiah continued to weaken against American currency, the monthly change in exchange rate was less than 1% until March 1983. President Suharto in his August 1982 Independence Day address stressed that a devaluation was unnecessary and that government would continue to manage-float the rupiah exchange rate. However, on March 30, 1983, the government devalued the rupiah by 27.6% from 702 to 968 rupiah per
US dollar. This devaluation may be due to deteriorating balance-of-payments situation affected the country’s official foreign reserves levels, which dropped from 4.2 billion US dollars in December 1982 to 3.1 billion US dollars in March 1983.

(c) April 1983 - August 1986
During April 1983 - August 1986, the rupiah underwent depreciation trend, however, the monthly change in exchange rate was within 1%. During this period, the government statements said that there would be no devaluation. However, on September 12, 1986, the Indonesian rupiah was devalued by 31% against the US dollar from 1134 per to 1644 rupiah per US dollar.

(d) November 1986 - July 1997
During this exchange-rate peg, Bank Indonesia, the central bank maintained a measure of control over the exchange rate, which was set against a basket of currencies, of which the US dollar was the most important. An “indication” rate was set by Bank Indonesia each morning, and allowed the rupiah to fluctuate within the trading band. Although government was able to maintain the rate within trading band, the devaluation pressure was increasing during the peg. On two occasions in 1996, first in January and then in September, Bank Indonesia widened the trading band by which the rupiah traded against the US dollar, first from 3% to 5%, and then from 5% to 8%. In August 1997, the currency was devalued in the Asian Financial Crisis from 2518 in July 1997 to 2800 rupiah per US dollar in August 1997. The devaluation continued and the exchange rate was 4908 rupiah per US dollar in December 1997 and 9662 in January 1998.

3. Korea: Three devaluation pegs are extracted. Because there is missing data in international reserves before 1968, the pegs before 1968 are ignored in our analysis.

(a) July 1971 - November 1974
In June 1970, the won was devalued by 13.4% from 332 to 370 wons per US dollar. From July 1971 to December 1974, the rate was fixed at 370. From January 1972 to August 1974, the monthly change in exchange rate was within 1%. Since early 1973, the Korea Exchange Bank had managed to post the buying price of the won at slightly less than 400 wons per US dollar. From May 1974 to November 1974, its exchange rate was fixed at 399 wons per US dollar. In December 1974, won was devalued from 399 to 484 wons per US dollar. This 20% reduction against the US dollar was aimed at off-setting the severe inflation that South Korea had suffered.

(b) January 1975 - November 1979
Since January 1975, the won has been fixed at 484 wons per US dollar. On 7 December, 1979, South Korea devalued the won by 20% from 484 to 580 wons per US dollar.

(c) March 1990 - November 1997
On 1 March, 90, the South Korea authority inaugurated a money market, which allows the won to float within a narrow band. During this peg, South Korea’s foreign exchange market remained hampered by strict government regulations, designed to prevent speculative transactions. Nevertheless, the government took a cautious step towards liberalization on 1 September, 1991 when it widened the daily foreign exchange trading limit from 0.4% to 0.6% of the previous day’s average rate, further widened to 1% in 1993. Due to the spread of Asian financial crises, the trading band failed to maintain the exchange rate in November 1997. The won devalued from 921 to 1484 wons per US dollar.
4. Malaysia: Only one devaluation peg is extracted. Before 1975, Malaysia underwent a revaluation trend and had not experienced any great devaluation before the Asian Financial Crisis.
(a) June 1992 - August 1997
Although the official Malaysian policy since September 1975 has been pegging to an undisclosed basket of currencies, the actual policy seemed to be a continuation of managed floating which was adopted on 21 June, 1973. However, exchange rate fluctuated from 0.5% to 3% monthly until the ringgit’s dramatic rise against the US dollar since the start of 1992 from 2.74 to 2.5 ringgits per US dollar. From June 1992, with the help of aggressive central bank intervention, every time when the ringgit threatened to breach the 2.55 ringgits per US dollar, the central bank held the currency within a narrow band of 2.50 to 2.60 ringgits per US dollar. In August 1997, due to the spread of Asian financial crises, the ringgit devalued from 2.50 to 3.0 ringgit per US dollar and ended this peg.

5. Philippines: Seven devaluation pegs are extracted.
(a) May 1962 - January 1970
During this period, the Philippines Peso was fixed pegged to US dollar at 3.9 pesos to the US dollar. In February 1970, the peso dropped more than 40% in value to 6.4 pesos per US dollar and was allowed to float.
(b) October 1970 - March 1972
During this period, the Philippines peso was fixed pegged to the US dollar at 6.44 pesos (with less than 0.3% monthly adjustment in exchange rate). However, when the US dollar was devalued in February 72, the peso had gone down with it, devalued from 6.44 pesos per US dollar to 6.77.
(c) May 1972 - October 1974
Government still underwent strictly controlled float, which had been operated by the central bank since 1970, kept the rate at 6.78 pesos per US dollar, the rate established in May 1972. Monthly change in exchange rate was less than 0.2% until October 1974 where it devalued 4% from 6.77 to 7.07 pesos per US dollar.
(d) August 1975 - September 1983
During this period, the central bank controlled the movement of exchange rate within a certain unspecified band. Monthly change in exchange rate was less than 2% until October 5, 1983, the peso devalued 24% from 11 to 13.7 pesos per US dollar.
(e) November 1983 - May 1984
During this period, the Philippines peso was fixed pegged to the US dollar at 14 pesoses per US dollar. In June 1983, it devalued 24% to 18 pesoses per US dollar.
(f) April 1986 - October 1990
During this period, the Philippines peso underwent managed-float with the US dollar. However, the monthly change in exchange rate was less than 1% during this period. On October 25, 1990, the central bank devalued the peso to a new rate 28 pesoses per US dollar from 25.7 in the previous month.
(g) November 1990 - August 1997
During this period, government successfully used its reserves to avoid speculative attack. Monthly change in exchange rate maintained within 2%. For example, in October 1992, government purchased an estimated US1 billion from the market to prevent the peso from appreciation, successfully stabilizing it at 25.10-30 pesos per US dollar level. However,
followed the trend of the Asian financial crises, the peso was devalued from 26.3 to 32.3 pesos per US dollar in July 1997. After the crisis and up to now, the level of the Philippines peso exchange rate is determined on the basis of supply and demand, with the authority using intervention whenever they deem necessary.

(a) July 1995 - September 1997
The Singapore dollar did not experience a great depreciation before 1997 Asian Financial Crisis. However, the monthly change in exchange rate was not within a narrow band and shown an appreciation trend until July 1995. It managed to fix at 1.42 Singaporian dollars per US dollar with less than 1% monthly change in exchange rate after July 1995. However, it devalued to 1.6 Singaporian dollars per US dollar in the Asian financial crises.

7. Thailand: Four devaluation pegs are extracted.
(a) January 1965 - January 1973
Fixed exchange rate system was adopted. The baht was fixed to the US dollar at 20.8 bahts per US dollar. In February 1973, the baht was devalued by 10%.
(b) August 1973 - June 1981
From August 1973 to March 1978, the baht was pegged with the US dollar. But from March 8, 1978, baht’s value was determined against a basket of currencies weighted according to their importance in Thai trade and payments. The monthly change in exchange rate was held within 1% until it devalued 8.7% in July 1981.
(c) August 1981 - October 1984
During this period, baht-US dollar exchange rate remained fixed at 23 to the US dollar. On November 5, 1984, the baht was devalued by 15%, from 23 bahts per US dollar to 27 bahts per US dollar.
(d) January 1988 - June 1997
In 1988, the baht was managed pegged to a US dollar-dominated basket of currencies, the baht’s swing against the dollar was limited to less than 1% on either side of the 25.25 bahts per US dollar average exchange rate. Although there were some adjustments during the peg, it successfully held its 25.0-26.0 bahts range against the US dollar. In July 1997, it underwent a great devaluation from 25.5 to higher than 30 bahts to US dollar, even at a low of 47.25 at the end of 1997.

8. Taiwan: Only one devaluation peg is extracted.
(a) June 1990 - September 1997
After four years of steady appreciation, on 10 May 1990, the New Taiwan dollar (NT) was devalued 4%, dropped from 26.44 to 27.50 NT dollars per US dollar. After this devaluation, the NT dollar was fluctuating in a narrow band between 26 and 27.5. (monthly change in exchange rate was within 1.5%). In October 1997, it was devalued from 28 to 31 NT dollars per US dollar.
Description of Macroeconomic Variables

Nominal exchange rate, CPI, total export, total import and GDP are obtained from the International Financial Statistics published by the International Monetary Funds. Export to and import from certain country is obtained from the IMF’s Direction of Trade Statistics. Variables used in our analysis are calculated as follows:

1. Real Exchange Rate Index
   The bilateral real exchange rates were calculated with respect to the U.S., Japan and Germany separately. For example, bilateral real exchange rate of Thailand to US dollar \( (R.E.R._{US}) \) is calculated by the following formula.
   \[
   R.E.R._{US} = \frac{\text{Nominal exchange rate (Baht/USdollar)}}{\text{CPI in US/CPI in Thailand}}
   \]
   The value of R.E.R. in the first month of peg is set at 100, and the relative index in the following months of peg is calculated. The real exchange rate index can reflect percentage change in real exchange rate index the month from the beginning of a peg. A decrease in this index implies a real appreciation in the Thai baht.

2. Openness
   We calculate openness as
   \[
   openness = \frac{\text{Total export + Total import}}{\text{GDP}}
   \]

3. Trade concentration
   We calculate trade concentration by dividing the sum of export to and import from the country that the Asian countries are pegged to by its total export and import. Export to and import from certain country is obtained from the IMF’s Direction of Trade Statistics. This ratio is the trade share of Asian countries to their major trading partners, the United States and Japan separately. For example, trade concentration with respect to the United States \( (Trade Conc_{US}) \) is calculated by the following formula:
   \[
   Trade Conc_{US} = \frac{\text{Export to US + Import from US}}{\text{Total export + Total import}}
   \]
   (We have not included trade concentration with Germany since trade statistics with Germany are not provided in the IMF’s Direction of Trade Statistics.)

4. International Liquidity
   We use two measures to calculate international liquidity. One included net foreign assets and the other included foreign reserves.
   (a) Net foreign asset to M2 ratio
      We used the ratio of M2 to net foreign asset as a proxy for international liquidity. M2 is calculated as the sum of money and quasi-money.
      \[
      N.F.A/M2 = \frac{\text{Net foreign asset}}{\text{M2}}
      \]
   (b) Foreign reserves to M2 ratio
      We used the ratio of M2 to total reserves minus gold as a proxy for reserve adequacy. M2 is calculated as the sum of money and quasi-money. Since total reserves minus gold is measured in million of SDRs, we converted it to national currencies unit by using the monthly exchange rate between SDRs and national currency.
      \[
      Foreign reserves/M2 = \frac{\text{Total reserves minus gold}}{\text{M2}}
      \]
5. Current Account to GDP ratio
   Share of current account to GDP in each month during the peg is calculated.

6. Inflation Differential
   We calculate the year to year change in CPI monthly in order to obtain the monthly inflation rate. For example, monthly inflation rate for July 1997 is calculated by comparing July 1997 CPI with July 1996 CPI. Monthly data for inflation differential is calculated by subtracting the monthly US inflation rate from the monthly inflation rate in the Asian countries. For example, inflation differential between Thailand and the United States is calculated by Thailand inflation rate minus the U.S. inflation rate in monthly basis.