Journal of Applied Economics, Vol. VI, No. 2 (Nov 2003), 341-359

REAL EFFECTS OF MOVEMENTS IN NOMINAL EXCHANGE RATES: APPLICATION TO THE ASIAN CRISIS

E. Sibel Yelten*
University of Chicago

Submitted April 2002; accepted April 2003

This paper analyzes the ad hoc decision of three Asian countries to peg their currency to the U.S. dollar prior to the Asian crisis. It uses the Sjaastad model to estimate the optimal basket weights for Thailand, Korea, and Singapore. The analysis in this paper differs from the optimal basket research since we are not searching for an ad hoc optimal basket; rather, the basket is the solution to the problem. For Thailand and Korea, the correct weights of the dollar in the basket are estimated to be 44 and 65 percent, respectively, which differ significantly from the actual weight of 100 percent for the U.S. dollar in their currency basket prior to the 1997 Asian crisis. Singapore, with a weight of 85 percent for the U.S. currency, is closer to a dollar peg, and therefore was less affected by the large depreciation of the European currencies and the yen toward the dollar that occurred prior to the Asian exchange rate crisis. Besides the fact that Singapore had better economic fundamentals prior to the crisis, the fact that the optimal basket for that country is closer to a dollar peg is an additional reason why its economy was less severely hit by the crisis.

JEL classification codes: E 32, F31
Key words: optimum currency area, Asian crisis, exchange rate basket, currency peg

I. Introduction

This paper analyzes the policy choice of Thailand, Korea, and Singapore to peg their currency to a single currency. The results of this analysis suggests that these countries, particularly Thailand and Korea, should have pegged

* Yelten: esyelten@alumni.uchicago.edu (tel.: 312-493-6410). I am grateful to Larry Sjaastad for long and helpful discussions on this paper and I received valuable comments from Marvin Zonis and George Tolley.

their currency to a basket of currencies rather than to the U.S. dollar alone. If they had pegged their currencies to a basket that included the German mark and the Japanese yen as well as the dollar, their currencies would have been automatically depreciated against the dollar during the large appreciation of the dollar against all other currencies that occurred prior to the Asian exchange rate crisis.

This paper uses the Sjaastad (1998 and 2000) model to determine to which currency bloc(s) those countries belong. The model demonstrates that, if the price level in a country is affected by more then one currency bloc, then this country can isolate itself from shocks to its inflation and real interest rates by choosing a peg to a currency basket. The optimal weights for that basket, according to Sjaastad's model, are the relative price-making powers that major currency countries have over that country. A single-currency peg is a special case of a currency basket, and is a possible solution if a country is affected by a single currency. If the United States were to have one hundred percent price-making power over the traded goods of those Asian countries, then the optimal "basket" that would isolate their inflation and real interest rates from external price shocks would be a U.S. dollar peg.

The basket weights are estimated for Thailand, Korea, and Singapore. Thailand and Korea are of special interest since both countries were severely affected by the Asian crisis. To have a comparison, the weights for Singapore, a country that was far less affected by the Asian crisis, are also estimated. The estimation results, using Autoregressive Distributed Lag Models, show that while the weights for the U.S. dollar in the baskets for Thailand and Korea are relatively low, 44% and 65%, respectively, the weight for the U.S. dollar in the basket for Singapore is around 85%. Singapore's basket, with an 85% weight for the US dollar, is closer to a dollar peg than Korea's and Thailand's basket weights. Therefore, the sharp appreciation of the dollar against all other currencies prior to the Asian crisis had a greater effect on Thailand and Korea, which were further away from their optimal basket than was Singapore. Besides the fact that the Singapore economy had better economic fundamentals prior to the crisis, as described in Corsetti, Pesenti, Roubini (1999), the fact that they were closer to a dollar peg is an additional reason why the economy of Singapore was not so severely hit by the crisis. Data limitations precluded estimates for additional countries.

II. Various Explanations for the Crisis

One of the most common causes of an exchange rate crisis is that even though a country has an exchange rate peg, it still acts as if it had an independent monetary policy. The monetary data for Korea, Thailand, and Singapore show no evidence of a monetary expansion that could have led to the collapse of the exchange regime in 1997. The monetary base for Korea stayed constant, between 1995 and late 1996, with a noticeable drop of 13 percent from late 1996 to mid July 1997. This contraction was also reflected in the monetary base in real terms and in real M1, and was accompanied by low inflation rates (4%-5%). The money supply of Thailand dropped significantly in 1997 without putting deflationary pressure on the prices. The monetary and price data in Thailand and Singapore show a similar pattern of decline, as observed in the Korean data. Overall, the monetary data shows that there was a recent contraction in money supply. Since there were no extreme price changes, the money supply must have accommodated changes in the money demand.

Another traditional explanation for a currency crisis is that of speculative attacks. According to this view, sudden shifts in market expectations and confidence are the key sources of the initial financial turmoil, its propagation over time, and regional contagion. Radelet and Sachs (2000) argue along those lines, and suggest that the 1997 Asian crisis was a financial panic. This view has attracted many proponents as an explanation for that crisis. Most standard explanations for speculative attacks argue that the collapse of a fixed exchange rate is preceded by fiscal deficits, rising debt levels, and inflationary deficit financing. However, the Asian economies, prior to the 1997 crisis, were characterized by budget surpluses, low levels of debt, high foreign exchange reserves, and low levels of inflation.

Since traditional fiscal models could not explain the Asian crisis, a second generation of fiscal models have emerged. For example, Corsetti, Presenti and Roubini (1999) use a moral hazard model to explain the Asian Crisis. In their model, the economy operates as if bad outcomes by firms are fully insured by the government. Eventually, foreign creditors refuse to refinance the countries' cumulative losses, and this refusal forces governments to step in and guarantee the outstanding stock of external liabilities through the use of seigniorage revenues. Speculation, driven by expectations of inflationary finance, causes a collapse of the currency and anticipates the event of a financial crisis. The government uses international reserves (that otherwise could have been used to bail out insolvent private firms) to defend the currency, and a financial crisis ensues. Similarly, Burnside, Eichenbaum, Rebelo (2000) argue that the crisis was caused by large prospective deficits associated with implicit bailout guarantees to failing banking systems. Again, the expectation that seignorage revenues would finance these future deficits led to a collapse of the fixed exchange rate regimes.

Chang and Velasco (1998) offer another explanation, when they argue that the Asian crisis was a consequence of international illiquidity. They trace the emergence of illiquidity to financial liberalization, a shortening of the foreign debt structure, and the unbalanced currency denomination of assets versus liabilities.

In what follows, I will argue that, in addition to the financial sector and banking sector weaknesses, the exchange rate policies, particularly in Thailand and Korea, were not optimal. The analysis concludes that, in the cases of Thailand and Korea, pegging to a basket containing U.S. dollars, German marks and Japanese yen would have been more appropriate than pegging their currencies to a single currency. The interesting feature of the analysis is that we are not searching ad hoc for an optimal basket. Rather we have found that the basket presents the solution to our problem.

In other literature concerning this subject, authors have searched for an optimal basket starting with the assumption that a basket is the best exchange rate policy.[1] Studies by Bhandari (1985), Flanders and Helpman (1979), Turnovsky (1982), Flanders and Tishler (1981), and Lipschitz and Sundararajan (1980) focused on an optimal basket based on *ad hoc* criteria such as minimizing the variance in the balance of payments, and found that trade weighted baskets are the optimal policy choice. Those solutions assumed that a basket is the optimal solution and, since most countries trade with more than one country, the optimal basket under those criteria includes the currencies of all trading partners. Therefore, those solutions are unlikely to lead to a corner solution (a basket that includes only one country).

[1] See for example Ito, Ogawa, Sasaki (1998).

In this paper, corner solutions that allow a pure US dollar peg are acceptable solutions. This is possible because in the Sjaastad (2000) model the weights of the basket are chosen according to the relative price-making power that countries have over the prices of traded goods of a given country. Trade flows are a significant component in deciding which countries may have price-making power, but they are not the only determinants. For example, most Asian countries have significant trade with Singapore. In the case of Malaysia, 23.3 percent of total exports go to Singapore, and 15.4 percent of total imports come from Singapore; but Singapore obviously does not determine the world prices of Malaysia's traded goods, such as electrical machinery, crude petroleum, telecommunications, vegetable oil, etc. Since the price-making power of Singapore over Malaysia is likely to be low, the Singapore dollar does not need to be present in the Malaysian currency basket. If we were to follow the optimal currency basket literature described above, however, we would need to give a significant weight to the Singapore dollar in a basket for Malaysia.

Recent optimal basket studies such as those derived by Ito, Ogawa and Sasaki (1998) improve upon the earlier models by building a model based on micro-foundations. In their model the oligopolistic exporter maximizes his profits so that the export price is endogenously determined in response to the exchange rates. Therefore, price "stickiness" is a result of optimizing behavior and is not an assumption as in the earlier models. The optimal solution in their model is to minimize fluctuations in trade balances. Their result is closely related to the trade pattern seen in a particular country.

Independent of the model used, most optimal basket estimations conclude that, if an appropriate basket had been chosen prior to the crisis, the Korean won and the Thai baht would have been automatically depreciated against the US dollar. Since, in fact, the major currencies depreciated strongly against the dollar from April 1995 until mid-1997. Instead, as the dollar appreciated, these Asian currencies also appreciated against the yen and the mark, since they were pegged to the US dollar. Market participants anticipated that, with the dollar's appreciation, and with their currencies pegged to the dollar, there was pressure on the existing peg. Prior to the crisis, the Koreans had already accelerated the rate of won depreciation against the dollar — indicating that the Koreans also had recognized the dangers of an appreciating US dollar.

III. The Model

Sjaastad (1998 and 2000), assuming that excess demand for goods q is a function of their real price and that excess demand has to add up to zero, derives the following key equations:

$$PT_x = \sum_j \Theta_x^j \cdot (P_j + E_{x,j}) + \text{“fundamentals,”} \qquad \text{where } \sum_j \Theta_x^j = 1 \tag{1}$$

In this text, capital letters indicate natural logarithms. PT_x, P_j, $E_{x,j}$, Θ_x^j represent the price index for traded goods in country x, an index of the price level of country j, country j's currency in terms of country x's currency, and non-negative fractions that sum up to one (100%), respectively. The term Θ_x^j, measures the share of power possessed by country j in the world market for the goods traded internationally by country x. For example, if the United States has the entire price-making power over country x's traded goods, Θ_x^{US} would be equal to one and all other Θ_x^j's would be equal to zero.

As indicated in equation (1) the sum of Θ_x^j over j is equal to one. An intuitive explanation for this is the following hypothetical experiment. Keeping all exchange rates constant, if the price levels of the countries of the world were to double, then the prices of country x's traded goods would also have to double.

Using the identities $E_{x,j} = E_{x,i} + E_{i,j}$, $E_{x,i} = -E_{i,x}$, $\sum \Theta_x^j = 1$ and adding $E_{i,x}$ on both sides of the equation (1), we can rewrite the equation as:

$$PT_x + E_{i,x} = \sum_j \Theta_x^j \cdot (P_j + E_{i,j}) \tag{2}$$

The term $PT_x + E_{i,x}$ in equation (2) is the price of traded goods of country x converted to the currency of country i. For notational simplicity we define $PTF_x \equiv PT_x + E_{i,x}$, where the capital F after the variable indicates that the variable is expressed in the currency of country i. Similarly, the term $P_j + E_{i,j}$ is the price level of country j expressed in currency i. Again, to simplify the notation, we define $PF_j \equiv P_j + E_{i,j}$. Using these definitions equation (2) becomes:

$$PTF_x = \sum_{j=1}^{M} \Theta_x^j \cdot PF_j, \qquad where \sum_j \Theta_x^j = 1 \tag{3}$$

In the following estimations we use the US dollar as currency *i*, and all variables are transformed to US dollar terms using equation (2). Since price data is available as a monthly variable, monthly exchange rate averages are used for the conversion of the prices. Note that the derivation does not depend on what currency is chosen as currency *i*. As long as the left hand side and the right hand side variables in equation (3) are expressed in a common currency, the choice of currency *i* does not affect the estimation of the Θ_x^j's.

We would like to use equation (3) to estimate the Θ_x^j's. However, the data for PTF_x is not available for the individual countries. In order to estimate equation (3) we need to replace PTF_x with variables that we have data for. For this purpose, we can construct the traded good index as a weighted average of import price index IMP_x, and export price index EXP_x:

$$PT_x = \Omega \cdot EXP_x + (1-\Omega) \cdot IMP_x \tag{4}$$

$$= IMP_x + \Omega \cdot TT_x,$$

where $TT_x = EXP_x - IMP_x$ is the terms of trade and PT_x is a domestic-currency price index of traded goods. Rewriting the equation (4) in terms of currency *i* we arrive at:

$$PTF_x = IMPF_x + \Omega.TTF_x \tag{5}$$

Here, PTF_x is a price index of traded goods for country *x* in currency *i*, $IMPF_x$ a price index for import goods for country *x* in currency *i*, and $EXPF_x$ a price index for export goods for country *x* in currency *i*. Further, $TTF_x = EXPF_x - IMPF_x$.

Price changes do not affect the economy instantaneously, and the effects are accumulated over several periods. Therefore to allow for lags in the transmission of the price effects, we have parameterized the model as an autoregressive distributed lag (ARDL) model. Using equation (5) and parameterizing the model as an ARDL, we can write equation (3) as:

$$A_x(L) \cdot IMPF_{x,t} = \sum_j [B_x^j(L) \cdot PF_{j,t}] - \Omega \cdot [A_x(L) \cdot TTF_{x,t}] \tag{6}$$

$$\textit{where} \quad A_x(L) = \sum_{i=0}^{N} a_{x,i} \cdot L^i \quad \textit{and} \quad B_x^j(L) = \sum_{i=0}^{M} b_{x,i}^j L^i$$

We have time series data for all variables in equation (6). Writing out the details of equation (6) we get:

$$IMPF_{x,t} = \tilde{a}_{x,1} \cdot IMPF_{x,t-1} \ldots + \tilde{a}_{x,n} \cdot IMPF_{x,t-N} \qquad (7)$$

$$+ \sum_j [\tilde{B}_x^j (L) \cdot PF_{j,t}] + \Omega \cdot [\tilde{A}_x (L) \cdot TTF_{x,t}],$$

where we define: $-a_{x,i}/a_{x,0} \equiv \tilde{a}_{x,i}$, $-A_x(L)/a_{x,o} \equiv \tilde{A}_x(L)$, and $B_x^j(L)/a_{x,0} \equiv \tilde{B}_x^j(L)$. First, equation (7) was estimated as individual linear regression equations for Thailand, Korea, and Singapore. The residuals from those regressions were somewhat correlated, therefore a SUR (seemingly unrelated regression) estimation was used. All regression coefficients were slightly more significant using the SUR estimation, however the coefficient values themselves (and the Θ_x^j's) did not change significantly between the two methods. The "RATS" software package is used to estimate the system of equations (SUR) for all three countries. The SUR function computes estimates of a system of linear equations using the techniques of joint GLS. In the estimations that follow the price indices of Germany, Japan, and USA were used as explanatory variables. Including other countries as explanatory variables, such as other European or Asian countries, did not alter the results. Coefficients for those countries were not significant and were dropped. Finally, the following system of linear regressions was estimated using the price indices of the United States, Germany, and Japan as explanatory variables:[2]

$$IMPF_{x,t} = \tilde{a}_{x,1} \cdot IMPF_{x,t-1} \ldots + \tilde{a}_{x,n} \cdot IMPF_{x,t-N} \qquad (8)$$

$$+ [\tilde{B}_x^{USA} (L) \cdot PF_{USA,t}] + [\tilde{B}_x^{Germany} (L) \cdot PF_{Germany,t}]$$

$$+ [\tilde{B}_x^{Japan} \cdot PF_{Japan,t}] + \Omega \cdot [\tilde{A}(L) \cdot TTF_{x,t}],$$

where x = Thailand, Korea, Singapore.

Using the estimation coefficients, we can calculate the Θ_x^j's as:

[2] It is assumed that the small countries Thailand, Korea, and Singapore are price takers, they cannot influence the world price of their traded goods. Therefore, their price making power in the world market for their traded goods is negligible.

$$\Theta_x^j = \frac{B_x^j(1)}{A_x(1)} = \frac{\tilde{B}_x^j(1)}{1 - \sum_{i=1}^{N} \tilde{a}_{x,i}}, \tag{9}$$

$$where \quad \tilde{B}_x^j(1) = \sum_{i=0}^{M} \tilde{b}_{x,i}^j, \;\; A_x(1) = \sum_{i=0}^{N} a_{x,i}, \;\; B_x^j(1) = \sum_{i=0}^{M} b_{x,i}^j$$

IV. Estimation Results

The data used are monthly export and import prices for Thailand, Korea, and Singapore (International Financial Statistics (IFS) lines 74 and 75). Monthly CPI's for Germany, Japan and the USA (IFS line 64). Monthly exchange rate averages for all countries (IFS line rf).

In this section, the regression results — the weights Θ_x^j for the currency basket — are presented. Singapore, which was not as seriously affected by the 1997 Asian crisis, was included in the estimates as a counter example to Thailand and Korea.

The Akaike Information Criteria (AIC) was used to determine the appropriate lag length for the regressions. The estimations were repeated, using several countries as explanatory variables, including Germany, United States, Japan, England, Switzerland, Singapore, Australia, and many other Asian and European countries. The only significant coefficients were those for Germany, United States, and Japan.

Table 1 summarizes the results of the augmented Dickey Fuller test for all variables. The appropriate lag length for the augmented DF test was determined using AIC. According to the DF test all variables in levels are either I(1) or I(0). To achieve stationarity, we first differenced the data. The unit root hypothesis can be rejected for all variables in the first differences.

We ran the unrestricted SUR estimation as in equation (8). According to the model the basket weights Θ_x^j's must add up to one. The hypothesis that the basket weights add up to one cannot be rejected, with $\chi^2 = 9.61$ and significance level of 0.03. Therefore we run the same regression, equation (8), imposing the following unit sum restriction:

$$\Theta_x^{USA} + \Theta_x^{Germany} + \Theta_x^{Japan} = 1, \tag{10}$$

where x= Thailand, Korea, Singapore.

Table 1. Augmented Dickey Fuller Test Results.
(Sample: 01/1980-01/1997)

	DF test w. constant and trend	Joint test: trend = 0 root = 1	DF test with constant	Joint test: const. = 0 root =1	DF test w. no constant, no trend	Conclusion
$IMPF_{Thailand}$	-0.82	1.63	0.95	4.11	2.82	Unit root w. zero drift
$IMPF_{Korea}$	-1.87	1.82	-1.21	0.86	-0.57	Unit root w. zero drift
$IMPF_{Singapore}$	-1.68	2.37	-0.53	0.35	0.64	Unit root w. zero drift
$TTF_{Thailand}$	-3.35	5.98	-3.32			Unit root rejected
TTF_{Korea}	-1.39	1.72	-1.81	1.65	-1.72	Unit root w. zero drift
$TTF_{Singapore}$	-2.98	4.56	-0.37	1.62	-1.69	Unit root w. zero drift
PF_{USA}	-3.89					Unit root rejected
$PF_{Germany}$	-2.81	4.18	-0.54	0.60	0.91	Unit root w. zero drift
PF_{Japan}	-1.83	2.05	-1.35	2.34	-2.17	Unit root rejected
$\Delta IMPF_{Thailand}$	-11.23					Unit root rejected
$\Delta IMPF_{Korea}$	-6.59					Unit root rejected
$\Delta IMPF_{Singapore}$	-7.64					Unit root rejected
$\Delta TTF_{Thailand}$	-11.65					Unit root rejected
ΔTTF_{Korea}	-7.39					Unit root rejected

Table 1. (Continued) Augmented Dickey Fuller Test Results. (Sample: 01/1980-01/1997)

	DF test w. constant and trend	Joint test: trend = 0 root = 1	DF test with constant	Joint test: const. = 0 root =1	DF test w. no constant, no trend	Conclusion
$\Delta TTF_{Singapore}$	-7.49					Unit root rejected
ΔPF_{USA}	-7.56					Unit root rejected
$\Delta PF_{Germany}$	-8.95					Unit root rejected
ΔPF_{Japan}	-9.60					Unit root rejected
Critical value	-3.41	6.25	-2.86	4.59	-1.95	

Table 2 summarizes the results of the restricted regression. All variables except for the coefficient for $\tilde{B}_{Korea}^{Germany}$ (which is almost zero) are highly significant. Dropping that variable from the regression does not change the results. We use the regression coefficients to calculate the basket weights as in equation (9).

Table 3 summarizes the basket weights. Thailand with a $\Theta_{Thailand}^{j}$ of 22% for Japan, 34% for Germany, and 44% for the United States is strongly influenced by fluctuations in the yen, the DM, as well as the dollar. If the Thai baht had been pegged to a basket choosing the weights accordingly, the currency would have been automatically depreciated towards the US dollar prior to the crisis, as will be shown in the next section.

The price making power of the United States, Germany and Japan over Korea, Θ_{Korea}^{j}, is 65%, 19%, and 16%, respectively. The United States seems to have a larger influence on the local price level in Korea than it does on Thailand.

The basket weights for Singapore are estimated as a benchmark. Singapore has a comparable economic and geographic situation to Thailand and Korea,

Table 2. Regression Results. (Sample: 01/1980-01/1997)

Summary of sum of lag coefficients for variables	Value	Standard error	T-statistic	Significance value
$\sum_{i=1}^{N} \tilde{a}_{Thailand,\,i}$	0.349	0.15	2.20	0.02
$\tilde{B}_{Thailand}^{USA}$	0.284	0.16	1.69	0.09
$\tilde{B}_{Thailand}^{Germany}$	0.224	0.07	3.27	0.00
$\tilde{B}_{Thailand}^{Japan}$	0.143	0.04	3.21	0.00
$\sum_{i=1}^{M} \tilde{a}_{Korea,i}$	0.523	0.07	7.64	0.00
$\tilde{B}_{Korea}^{USA}$	0.309	0.06	4.86	0.00
$\tilde{B}_{Korea}^{Germany}$	0.091	0.04	2.13	0.03
$\tilde{B}_{Korea}^{Japan}$	0.077	0.03	2.22	0.02
$\sum_{i=1}^{K} \tilde{a}_{Singapore,\,i}$	0.341	0.11	2.97	0.00
$\tilde{B}_{Korea}^{USA}$	0.561	0.10	5.48	0.00
$\tilde{B}_{Korea}^{Germany}$	0.022	0.07	0.31	0.75
$\tilde{B}_{Korea}^{Japan}$	0.076	0.04	1.88	0.05

Table 3. Basket Weights for Korea, Thailand and Singapore: the Weights for Germany, Japan, and USA in the Basket. (Sample: 01/1980-01/1997)

	Basket weights for x = Thailand	Basket weights for x = Korea	Basket weights for x = Singapore
Θ_x^{usa}	44%	65%	85%
$\Theta_x^{Germany}$	34%	19%	3%
Θ_x^{Japan}	22%	16%	12%

but it did not experience as severe a crisis as the other two countries in 1997. The basket weights for Singapore, $\Theta_{Singapore}^{j}$, are 85% for the United States, and 12% for Japan, and 3% for Germany. The regression coefficient for Germany (which is used to calculate the basket weight for Germany) is not statistically significant. However, the coefficient is almost zero and dropping it from the regression does not alter the result.

The higher weight of the dollar in the currency basket of Singapore suggests that pegging its currency to the dollar has caused less pressure on the currencies of Singapore than it did on Korea, and particularly on Thailand, during the sharp appreciation of the US dollar prior to the Asian crisis.

V. Depreciation in the Baht and in the Won

An interesting question to ask is the following: Suppose Thailand and Korea had pegged their currency to a basket of currencies using the Θ_x^j's estimated in this paper as their basket weights. How much would the won and the baht have depreciated prior to the crisis? Using Sjaastad's model and our estimates in section IV, we have calculated the depreciation in those currencies as if they had been pegged to a currency basket with the optimal basket weights, Θ_x^j (for a derivation of equation (11) please refer to the Appendix).

$$\dot{E}_{x,\$} = \dot{E}_{x,B} - \Theta_x^{Japan} \cdot \dot{E}_{\$,Yen} - \Theta_x^{Germany} \cdot \dot{E}_{\$,DM} \tag{11}$$

Equation (11) indicates that the depreciation in the currency of country x against the US dollar is determined by changes to the exchange rate rule between the currency of country x and basket B ($\dot{E}_{x,B}$), and by the depreciation of the yen and the DM vis a vis the U.S. dollar. Note that since, in our example, the Thai baht and the Korean won are pegged to basket B, $\dot{E}_{x,B} = 0$.

In April 1995, the U.S. dollar started to appreciate against all major currencies. The German mark depreciated against the U.S. dollar from 1.38 in April 1995 to 1.79 at the beginning of the Asian crisis in July 1997 — a thirty percent depreciation. The yen depreciated against the U.S. dollar from 83.67 in April 1995 to 115.16 in July 1997 (depreciating even further thereafter) — a thirty-eight percent depreciation. If at that time, Thailand and Korea had had their currencies pegged to the baskets as suggested in this paper, equation (11) indicates that the Thai baht and the Korean won would have depreciated against the U.S. dollar by 18 and 12 percent, respectively.

Equation (12) is a general expression for the inflation rate in the small country x when that country pursues an exchange rate rule based on a basket of the three major currencies (see Appendix for derivation):

$$\Pi_x = \Pi_W + \dot{E}_{x,B} + (\Theta_x^2 - \gamma_2) \cdot \dot{E}_{1,2} + (\Theta_x^3 - \gamma_3) \cdot \dot{E}_{1,3} \tag{12}$$

Since country x pegs its currency to the basket B, $\dot{E}_{x,B} = 0$, so it is clear that choosing the basket weights γ_j such that $\gamma = \Theta$ will eliminate external price shocks. The inflation rate in the small country is going to be the world inflation rate, which is represented here by a weighted average of the inflation rates of the three major currency countries: $\Pi_x = \Pi_W = \sum_{j=1}^{M} \Theta_x^j \Pi_j$.

The exception, in which a single exchange rate rule could eliminate shocks to the inflation rate, occurs when the Θ_x^j for the anchor country is one, and thus all other Θ_x^j's are zero. In that case, the inflation in the small country would be the same as the inflation in the anchor country. For example, if Korea and Thailand were in a U.S. dollar currency area (Θ_x^{usa} = 100%), then once they pegged their currency to the U.S. dollar, their inflation (and real interest rates) would be equivalent to those in the United States.

VI. Conclusions

In this paper, I have attempted to determine if pegging their currencies to the U.S. dollar was a good policy choice for Thailand, Korea and Singapore, and whether an alternative policy choice might have reduced the effect of the 1997 Asian crisis on those countries. The results of the regression analysis indicates that Thailand and Korea are not only affected by the U.S. dollar, but also by the German mark and the Japanese yen; and that a basket of currencies including the mark and yen would have been more appropriate than pegging to a single currency. Singapore is mainly influenced by the US dollar, therefore pegging to the US dollar alone was a more appropriate policy choice for Singapore.

The author's view is that, without a currency basket that included the German mark and the Japanese yen, Thailand and Korea were very adversely affected by the appreciating dollar prior to the Asian Crisis; due to their exchange rate peg, their currency appreciated together with the U.S. dollar against all other currencies. If they had pegged to a currency basket, as suggested in this paper, their currencies would have been automatically depreciated against the U.S. dollar as a consequence of the depreciation of the Japanese yen and the German mark.

Appendix

Equations (13) to (20) summarize the Sjaastad (2000) model. Defining $E^R_{x,j} \equiv P_j + E_{x,j} - P_x$ as the purchasing power parity (PPP) real exchange rate of country *x* with respect to that of country *j*, and ignoring the "fundamentals," we can rewrite equation (1) as:

$$PT_x = P_x + \sum_j \Theta^j_x \cdot E^R_{x,j} \tag{13}$$

Assume now that a small country *x* has adopted a credible exchange rate rule with respect to currency *k*. After some manipulations and using the identity $E_{x,j} = E_{k,j} + E_{x,k}$, equation (13) can be written as:

$$PT_x = E_{x,k} + P_k + \sum_j \Theta^j_x \cdot E^R_{k,j} \tag{14}$$

Writing equation (14) in terms of changes, we get (15), where the notation is obvious.

$$\Pi_x^T = \dot{E}_{x,k} + \Pi_k + \sum_j \Theta_x^j \cdot \dot{E}_{k,j}^R \qquad (15)$$

In the standard analysis of sources of external inflation, only the second term on the right hand side of equation (15) is taken into account. However, since the breakdown of the Bretton Woods system, real exchange rates have been very volatile, and the third term has been a quantitatively important source of external price shocks, where $\dot{E}_{k,j}^R$ are changes in the real exchange rate between country *k* and *j*.

The price level of a country is a weighted average of the prices for its traded and nontraded goods $P_x = \alpha_x \cdot PNT_x + (1-\alpha_x) \cdot PT_x$. Therefore equation (14) can be extended to the overall price level of country *x*:

$$P_x = \alpha_x \cdot (PNT_x - PT_x) + (E_{x,k} + P_k) + \sum_j \Theta_x^j \cdot E_{k,j}^R \qquad (16)$$

An important implication of equation (16) is that, while a credible exchange rate rule may result in interest rate parity, it is not sufficient to assure equality of real interest rates, and in the inflation rate. Ignoring the first term in equation (16) and writing it in terms of changes gives us:

$$\Pi_x = \dot{E}_{x,k} + \Pi_k + \sum_j \Theta_x^j \dot{E}_{k,j}^R \qquad (17)$$

As can be seen from the equation (17), movements in the real exchange rate in the *j* countries lead to shocks in the inflation rate of country *x* that has pegged its currency to country *k*. While a single-currency exchange rate rule cannot eliminate the shocks to the inflation rate arising from real exchange rate movements, a rule based on a basket of currencies — whereby a basket that is chosen such that the weights are equal to the Θ_x^j's — can eliminate those shocks. A single-currency exchange rate rule is a special case of a currency basket. As explained in Sjaastad (2000), a rule based on a basket allows yet another degree of freedom, namely the choice of the basket weights. Therefore the basket weights can be chosen to eliminate deflationary and inflationary shocks to the inflation and the real interest rates.

To illustrate this, consider three major currency blocs (the U.S. dollar, the German mark, and the yen) referred to as currencies *1*, *2*, and *3*, respectively. The number of units of currency j in the basket is referred to as x_j and $e_{1,j}$ denotes the value of currency *j* in terms of currency *1*, where ln(*e*) = E. The basket is labeled *"B"* and its value in terms of currency *1* is given by:

$$e_{1,B} = \sum_{j=1}^{M} e_{1,j} \cdot x_j = x_1 + e_{1,2} \cdot x_2 + e_{1,3} \cdot x_3 \tag{18}$$

To get the price of the basket in terms of the currency of the small country *x*, we multiply the two exchange rates.

$$e_{x,B} = e_{x,1} \cdot e_{1,B} \tag{19}$$

$$= e_{x,1} \cdot (x_1 + e_{1,2} \cdot x_2 + e_{1,3} \cdot x_3)$$

And this also defines the exchange rate rule adopted by country *x*. By letting γ be the weight of the three *j* currencies in that basket and writing equation (19) in terms of logarithmic changes, we get:

$$\dot{E}_{x,1} = \dot{E}_{x,B} - \gamma_2 \cdot \dot{E}_{1,2} - \gamma_3 \cdot \dot{E}_{1,3}, \tag{20}$$

$$where: \ \gamma_j \equiv (e_{1,j} \cdot x_j)/(x_1 + e_{1,2} \cdot x_2 + e_{1,3} \cdot x_3)$$

Note that equation (20) in the Appendix is identical with equation (11) in the text, where the countries choose $\gamma = \Theta$ as their basket weights.

We set *k* = *1* in equation (17) and replace $E_{x,j}$ in equation (17) with equation (20), further, we use $\dot{E}^{R}_{1,j} = \Pi_j + \dot{E}_{1,j} - \Pi_1$, to obtain equation (12) in the text.

References

Bhandari, J.S. (1985), "Experiments with the Optimal Currency Composite," *Southern Economic Journal* **51**: 711-730.

Bhandari, J.S. (1985), "The Flexible Exchange Basket: A Macroeconomic Analysis," *Journal of International Money and Finance* **4**: 19-41.

Burnside, C., Eichenbaum, M., and S. Rebelo (2000), "Understanding the Korean and Thai Currency Crisis," *Economic Perspectives* **24**: 45-68

Chang R. and A. Velasco (1998), “The Asian Liquidity Crisis,” Working Paper 6796, NBER.

Corsetti, G., Pesenti, P., and N. Roubini (1999), “Paper Tigers? A Model of the Asian Crisis,” *European Economic Review* **43**: 1211-1236.

Flanders, M.J. and A. Tishler (1981), “The Role of Elasticity Optimism in Choosing an Optimal Currency Basket with Applications to Israel,” *Journal of International Economics* **11**: 395-406.

Flanders, M.J. and E. Helpman (1979), “An Optimal Exchange Rate Peg in a World of General Floating,” *Review of Economic Studies* **46**: 533-542.

Frankel, J. and S. Wei (1994), “Yen Bloc or Dollar Bloc? Exchange Rate Policies of the Asian Economies,” in T. Ito and A. Krueger, eds., *Macroeconomic Linkage: Savings, Exchange Rates and Capital Flows,* Chicago, University of Chicago Press.

Furman, J. and J. Stiglitz (1998), “Economic Crises: Evidence and Insight from East Asia,” *Brookings Papers on Economic Activity* **2**: 1-136.

Goldfajn, I. and R. Valdés (1999), “The Aftermath of Appreciations,” *Quarterly Journal of Economics* **114**: 229-262.

Hamada, K. and H. Akiyoshi (1987), “Monetary, Financial and Real Effects of Yen Internationalization,” in S.W. Arndt and J.D. Richardson, eds., *Real-Financial Linkages among Open Economies*, Cambridge, MIT Press.

Ito, T., Ogawa, E., and Y.N. Sasaki (1998), “How did the Dollar Peg Fail in Asia?,” *Journal of the Japanese and International Economies* **12**: 256-304.

Kaminsky, G. and C. Reinhart (2002), “Financial Markets in Times of Stress,” *Journal of Development Economics* **69**: 451-470.

Kenen, P.B. (1969), “The Theory of Optimum Currency Areas: An Eclectic View,” in R.A. Mundell and A.K. Swoboda, eds., *Monetary Problems of the International Economy*, Chicago, University of Chicago Press.

Lipschitz, L. and V. Sundararajan (1980), “The Optimal Basket in a World of Generalized Floating,” *IMF Staff Papers* 27: 80-100.

Mundell, R. (1961), “A Theory of Optimal Currency Areas,” *American Economic Review* **51**: 657-665.

Radelet, S. and J. Sachs (2000) “The Onset of the East Asian Financial Crisis,” in P. Krugman, ed., *NBER Conference Report Series, Currency Crisis,* Chicago, University of Chicago Press.

Rats (2002), *Rats Econometrics Software Package Version 5.02*, Estima, Evanston, IL.

Sjaastad, L. (1998), "Why PPP Real Exchange Rates Mislead." *Journal of Applied Economics* **1**: 179-207.

Sjaastad, L. (2000), "Exchange Rate Strategies for Small Countries," *Zagreb Journal of Economics* **4**: 3-33.

Turnovsky, S.J. (1982) "A Determination of the Optimal Currency Basket," *Journal of International Economics* **12**: 333-354.