Were East Asian Currencies Overvalued?

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1 Introduction

The East Asian economies were successful for nearly a generation. They received very large investment inflows and enjoyed an Asian economic miracle in the years leading up to the crisis. True, there were some Asia skeptics including Krugman [8], who argued that Asia was bound to run into diminishing returns eventually, but there were few warning signs. Why, then, have the East Asian economies collapsed?

The recent East Asian financial crises had certain shared some characteristics: weak financial systems; excessive unhedged foreign borrowing by the domestic private sector; a lack of transparency about the ties among government, business, and banks. But these features are apparent in other developing countries. In the wake of crises of 1994 and 1995 (Argentina, Mexico, Turkey, and Venezuela), doubts arose as to the sustainability of its exchange rate arrangement. Dornbusch *et al.* [4], pointed out that the Achilles' heel of the Mexican Peso crisis in 1994-1995 was an overvalued exchange rate.[1]

In this paper, I attempt to assess the role of the real exchange rate as the cause of East Asian Crises from an econometric standpoint. Several studies suggested that Asian currencies had appreciated in the 1990s, although the degree of real appreciation had not been as large as in Mexican Peso crisis in 1994, and there had been different in the degree of real appreciation across countries: by 1997 the extent of real appreciation was evident in Malaysia and the Philippines, while less in South Korea, Thailand and Indonesia.[2] They take the issue of "overvaluation" using the purchasing power parity approach, its variants, calculations of the change in a real exchange rate measure from a base year, and calculation based on monetary models. This paper applies the non-traded model to investigate whether East Asian currencies were overvalued.[3]@

The paper is organized as follows. Section 2 describes the non-traded model to capture "overvaluation" of East Asian currencies. Section 3 presents the empirical results including cointegration tests and unit root test, the test for the non-traded model undertaken, and the calculation of equilibrium rates reported. Section 4 contains concluding remarks.

[1] Sachs *et al.* [13] [14] suggested that the real exchange rate played an indirect role; the more important was creditor panic.

[2] See Chinn [2].

[3] Warner [15] offered analysis of the Mexican crisis using the non-trade model, focussing on testing that model of exchange rate misalignment. See Warner [15] as to the precise non-traded model.

2 Model Based Measures of Equilibrium Real Exchange Rate

There are at least three broad definitions of overvaluation.[4]

1. Price based criteria, such as purchasing power parity (PPP) and its variants.

2. Model based criteria, based on a formal model of nominal exchange rates.

3. Solvency and sustainability based criteria, which make as reference to trends in the current account and the external debt to GDP ratio.

Price based criteria such as PPP are very simple proposition, and relatively easy to implement. There is today an enormous empirical literature on PPP. We have arrived at consensus on a couple of basic facts that (i) real exchange rates (nominal exchange rates adjusted for differences in national price levels) tend toward PPP, but its speed of convergence to PPP is extremely slow; (ii)short-run deviations from PPP are large and volatile.[5] On the other hand, the sustainability measures are very difficult to implement (*e.g.* see Bayoumi *et al.* [1]). Consequently, I take the second criteria to test "overvaluation" of East Asian currencies.

2.1 The non-trade model

We begin with a framework of the non-traded model, describing the equilibrium nominal exchange rate. We suppose that there are two sectors in the supply side: a trade sector producing a traded goods sold at the price P^T (expressed in units of foreign currency), and a non-trade sector producing a non-traded goods whose price is P^N (expressed in units of the domestic currency). Let P^M represent the price of imported goods, such as natural resources, expressed in units of the foreign currency. We also make the assumption that the quantity of import is normalized to unity.
The production functions of both sectors are as follows;

$$Q^T = F(n) \tag{1}$$

$$Q^N = H(1-n) \tag{2}$$

where the size of labor force is normalized to unity, with n, employed in the trade sector, and with 1-n, employed in the non-trade sector. Let E denote the nominal exchange rate giving the quantity of domestic currency that can be purchased with one unit of the foreign currency.

[4]See Milesi-Ferretti and Razin [10] and Williamson [16].
[5]See Rogoff [12] for recent empirical survey of PPP.

Each household wishes to maximize overall utility, U, as given by

$$U = \int_t^{\infty} e^{-\rho(s-t)}[\ln(C^T) + \beta \ln(C^N)]ds \tag{3}$$

subject to the solvency constraint:

$$\begin{aligned} \int_t^{\infty} e^{-r(s-t)}\Big(P^T C^T + \frac{P^N}{E} C^N\Big)ds + D(t) \quad = \\ \int_t^{\infty} e^{-r(s-t)}\Big(P^T Q^T + \frac{P^N}{E} Q^N - P^M\Big)ds \end{aligned} \tag{4}$$

where we denote C consumption, $D(t)$ the level of the external debt. The first-order condition for a maximum of U is

$$\beta P^T C^T = \frac{P^N}{E} C^N \tag{5}$$

If we assume that the discount rate, ρ is equal to the real interest rate, r, we can get a tractable constant consumption profile over time from the Euler equation.

Next, we define national wealth, $W(t)$ such as;

$$W(t) = \int_t^{\infty} e^{-r(s-t)}\Big(P^T Q^T - P^M\Big)ds - D(t) \tag{6}$$

which simplifies to:

$$W(t) = \frac{1}{r}(P^T Q^T - P^M) - D(t) \tag{7}$$

Considering the solvency constraint and equilibrium in the non-trade market, we get next equation:

$$P^T C^T = rW(t) \tag{8}$$

Substituting eq.(7) into eq.(8), we get traded goods consumption:

$$P^T C^T = P^T Q^T - P^M - rD(t) \tag{9}$$

Next, labor market equilibrium requires that value marginal products are equated across the two sectors,

$$P^T F'(n) = \frac{P^N}{E} H'(1-n) \tag{10}$$

Finally, equilibrium in the nontradeables market hold when

$$C^N = H(1-n) \tag{11}$$

Our non-traded model consists of 6 equations: (1)(2)(5)(9)(10)(11). These equations can be reduced into single equation:

$$\frac{F'(n)H(1-n)}{H'(1-n)} - \beta F(n) = -\beta(\frac{rD}{P^T} + \frac{1}{t}) \tag{12}$$

where t is the terms of trade, equal to $\frac{P^T}{P^M}$. Also, we can determine the equilibrium price of non-trade goods:

$$\frac{P^N}{EP^T} = \frac{F'(n)}{H'(1-n)} \tag{13}$$

From equations (12)(13), the equation below summarize the determinants of the equilibrium relative price of non-tradeables.

$$\left(\frac{P^N}{EP^T}\right) = z(\beta, t, rD) \qquad z_1, z_2 > 0, z_3 < 0 \tag{14}$$

3 Empirical Results

First, we examine the overvaluation of exchange rate for Korean won. Then, we examine the cases for Thailand's baht and Indonesian rupiah.[6]

3.1 Case for Korean Won

3.1.1 Testing for Unit Root and Cointegration

Before estimating equation (14), let us have the test for a unit root in time series included in it and cointegration. Dickey and Fuller [3] suggest a method for computing a test for a unit root in a time series. Applying the Dickey-Fuller test for the variables in equation (14), the log of relative price of non-traded goods, the log of terms of trade, and capital inflow, the resulting statistics were -1.459 with a corresponding asymptotic P-value of 0.877, -1.327 with a corresponding asymptotic P-value of 0.908, and -3.093 with a corresponding asymptotic P-value of 0.117 respectively.[7] Then we can conclude that the null of a unit root cannot be rejected at the .05 level.

To show whether there is evidence for cointegration between three variables stated above, we adopt a methodology pioneered by Engle and Granger [5]. In this case, we get the Engle-Granger statistic was -2.149, with a P-value of 0.876. The null hypothesis of a unit root in the cointegration regression would not be rejected at the .05 level, so we could not conclude that these three variables are cointegrated.

[6] We could not examine the cases for Malaysia due to limitations of their data.

[7] These statistics are based on the model: $\triangle Y_t = \mu + \alpha t + \delta Y_{t-1} + \varepsilon_t$, $H_0 : \delta = 0, H_1 : \delta < 0$.

3.1.2 Estimates of Long Run Equilibria

The estimates of equation (14) using ordinary least squares are shown in Table 1. This result in column (1) suggests that two variables, the terms of trade, and capital inflows are both statistically and quantitatively important, and have had the largest effects on the real exchange rate during sample period. Warner [15] applied the non-traded model into Mexican peso. The evidence presented there suggests that Mexican peso was overvalued by about 25 percent on the eve of the Peso Crisis. Figure 1 suggests that Korean won was overvalued about 6.23 percent (1996:3-97:3)[8], so that the Korean won was overvalued relatively less than currencies of Mexico and other Latin American countries (see Table 2 and Figure 1). This finding is consistent with Chinn [2] and other studies.

However, the conclusion of cointegration stated above includes an important problem, known as *spurius regression*, that can arise if the error term in a regression is $I(1)$, so t-test and regression's estimates become unreliable. To avoid this problem, we apply a methodology recommended by Hamilton [7] for equation (14).[9] Our model to be estimated is as follows:

$$PN_t = \alpha_0 + \alpha_1 Term_t + \alpha_2 CF_t + \alpha_3 Term_{t-1} + \alpha_4 CF_{t-1} + \alpha_5 PN_{t-1} \quad (15)$$

where PN is $\log(\frac{P^N}{EP^T})$, $Term$ is log of terms of trade, CF is capital inflow. Empirical results are shown in column (2) of Table 1. These results suggest that two variables, the terms of trade, and capital inflows are both statistically and quantitatively significant even in this Hamiltonian case.

3.2 Overvaluation of Thailand's Baht and Indonesian Rupiah

The estimates of equation (14) in case of Thailand and Indonesia are reported in the column (3) and (4) in the Table 1 respectively. The regression result in case of Thailand shows the the coefficient of the terms of trade is exhibiting statistical insignificance in the correct direction. The coefficient of capital inflow (=CF) is significant and in the correct direction.
In case of Indonesia, the coefficients of two variables are exhibiting statistical significance in the correct direction. Let's pay attention to the degree of overvaluation of both countries defined as in the footnote 8. The figure 2 and 3 are plots of actual and fitted values of real exchange rate (defined as $\frac{P^N}{EP^T}$) in both countries.[10] The figure 2 suggests that Thailand's baht was overvalued by about 14.5% on the eve of the crisis. We also see from the

[8] We here define the overvaluation as the deviation from the equilibrium rate: (= (actual real exchange rate - equilibrium exchange rate)/equilibrium exchange rate*100).

[9] This methodology guarantees OLS estimates have consistency and t-distribution of α_1 and α_2 in equation (15) converge asymptotically to normal distribution.

[10] Fitted values mean the equilibrium of real exchange rate.

figure 3 that Indonesian rupiah was overvalued by about 18.5% on the eve of the crisis. These results show that the degree of overvaluation of both countries was not so small. These findings are not similar to Chinn [2].

4 Conclusion

In this paper, we applied non-traded model to evaluate the degree of overvaluation of East Asian currencies. We find there capital inflow and terms of trade are significant determinants for real exchange rate. These variables in case of Korea have a unite root, but are not cointegrated. Another way put this is that deviation from the equilibrium exchange rate would not be stationary.[11] Our estimation suggests overvaluation of Korean won on the eve of Korean financial crisis was much milder than Mexican peso on the eve of Peso crisis. In our interpretation, the Korean financial crisis resulted not from currency overvaluation, but vulnerability to financial panic that arose from growing short-term debt, a series of mismatched policy. Contrary to that, East Asian currencies such as Thailand's baht and Indonesian rupiah were overvalued so much. This result suggests that the crises in Thailand and Indonesia were caused by creditor's panic or speculative attack.

[11] Most of exchange rate models often do not satisfy cointegration. See Frankel and Rose [6].

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Table 1. Estimates of Long Run Equilibria

Dependent variable is $\log(\frac{P^N}{EP^T})$

Estimation Method: OLS

independent variables	(1)	(2)	(3)	(4)
Constant	4.531	0.585	4.591	4.598
	(386.49)	(2.536)	(240.78)	(223.39)
Term	0.305	0.390	0.0748	0.477
	(2.286)	(2.391)	(0.177)	(19.279)
Term(-1)		-0.368		
		(-2.274)		
CF/1000	0.0167	0.672E-02	0.0287	0.0282
	(4.842)	(3.947)	(3.882)	(3.04)
(CF/1000)(-1)		-0.1452E-02		
		(-0.676)		
$\log(\frac{P^N}{EP^T})(-1)$		0.870		
		(17.068)		
Adjusted R^2	0.285	0.882	0.318	0.848
D.W.	0.305	1.232	0.668	0.660
Sample	80:1-97:4	80:2-97:4	90:3-97:4	81:1-97:4

Table 2. Real Exchange Rate Index
(Based on WPI; Trade-Weighted, 1990=100)

Year	Indonesia	Thai.	Korea	Argentina	Brazil	Chile
Dec. 1988	98	102	102	156	159	94
Dec. 1989	93	98	95	692	175	99
Dec. 1990	100	100	100	100	100	100
Dec. 1991	99	97	99	66	112	91
Dec. 1992	92	90	94	49	119	74
Dec. 1993	88	88	93	42	148	71
Dec. 1994	92	89	91	44	53	66
Dec. 1995	89	87	88	46	39	65
Dec. 1996	80	80	88	44	35	61
Mar. 1997	75	75	89	42	33	55
Jun. 1997	78	76	89	42	33	55
Sep. 1997	99	104	88	42	33	53
Dec. 1997	150	124	157	41	33	53

Source: Radelet and Sachs [11].

Appendix

Data used in estimating eq.(14) is as follows:

$\frac{P^N}{EP^T}$**:**	The issues involved in the measurement of the price of nontradeables are discussed extensively in Little *et al.* [9]. I chose the domestic CPI, rather than the domestic WPI, in order to achieve higher coverage of non-trade goods prices. P^* is foreign country index of external prices, E is an effective nominal exchange rate (won (or baht) per unit of foreign currency) available at J.P. Morgan's web site(http://www.jpmorgan.com/). This effective exchange rates are adjusted by CPI. This relative price of nontarde goods is expressed in natural log.
$Term$**:**	The natural log of the terms of trade. This data is from the International Monetary Fund, *International Financial Statistics*: CD-ROM.
CF**:**	Capital account balance measured so that a positive number is a capital inflow. *Source*: Bank of Korea's web site(http:/www.bok.or.kr/), the International Monetary Fund, *International Financial Statistics*: CD-ROM.

Figure 1: Plot of Actual and Fitted Values of Real Exchange Rate (Korean Won)

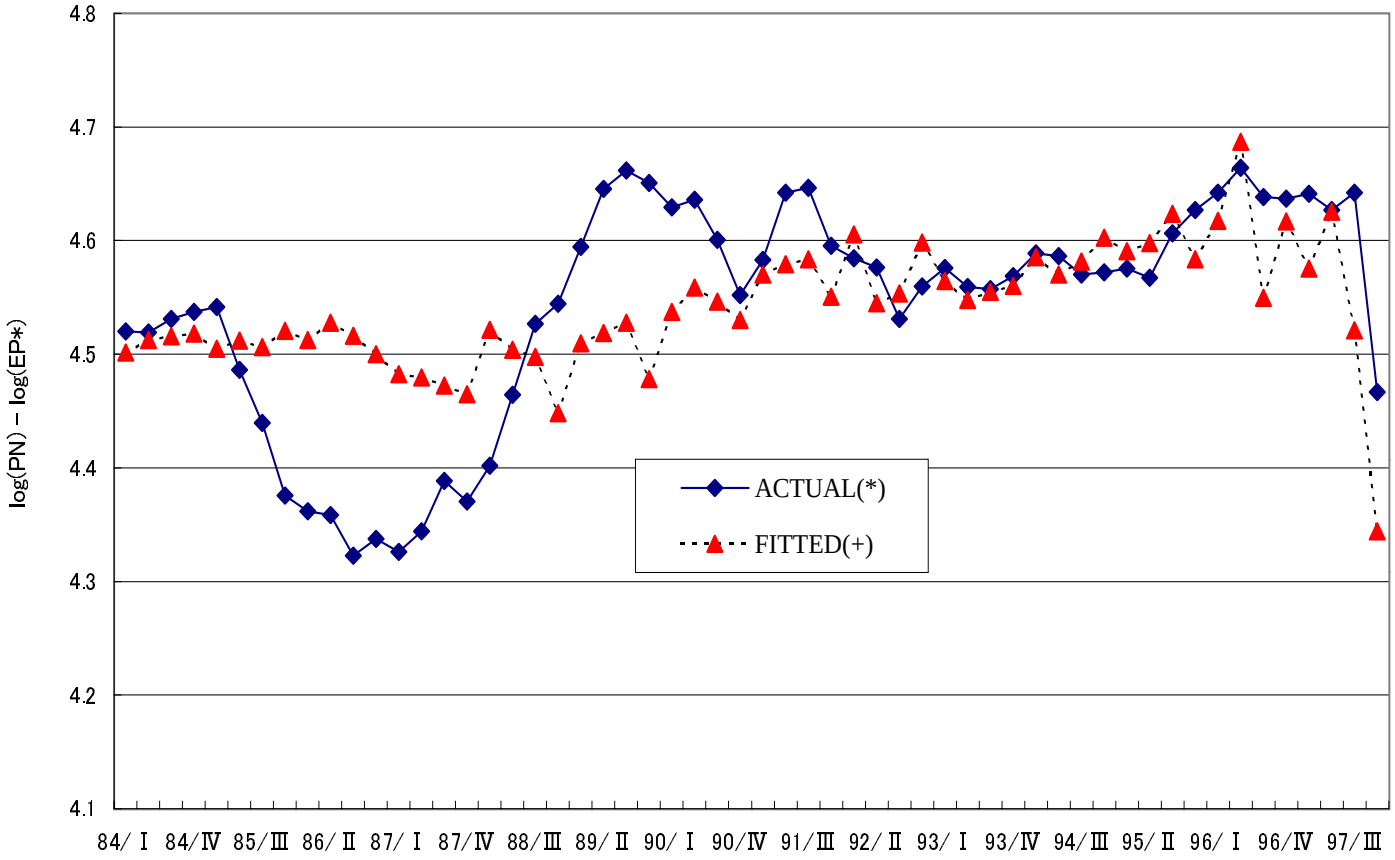

Figure 2: Plot of Actual and Fitted Values of Real Exchange Rate (Thailand's Baht)

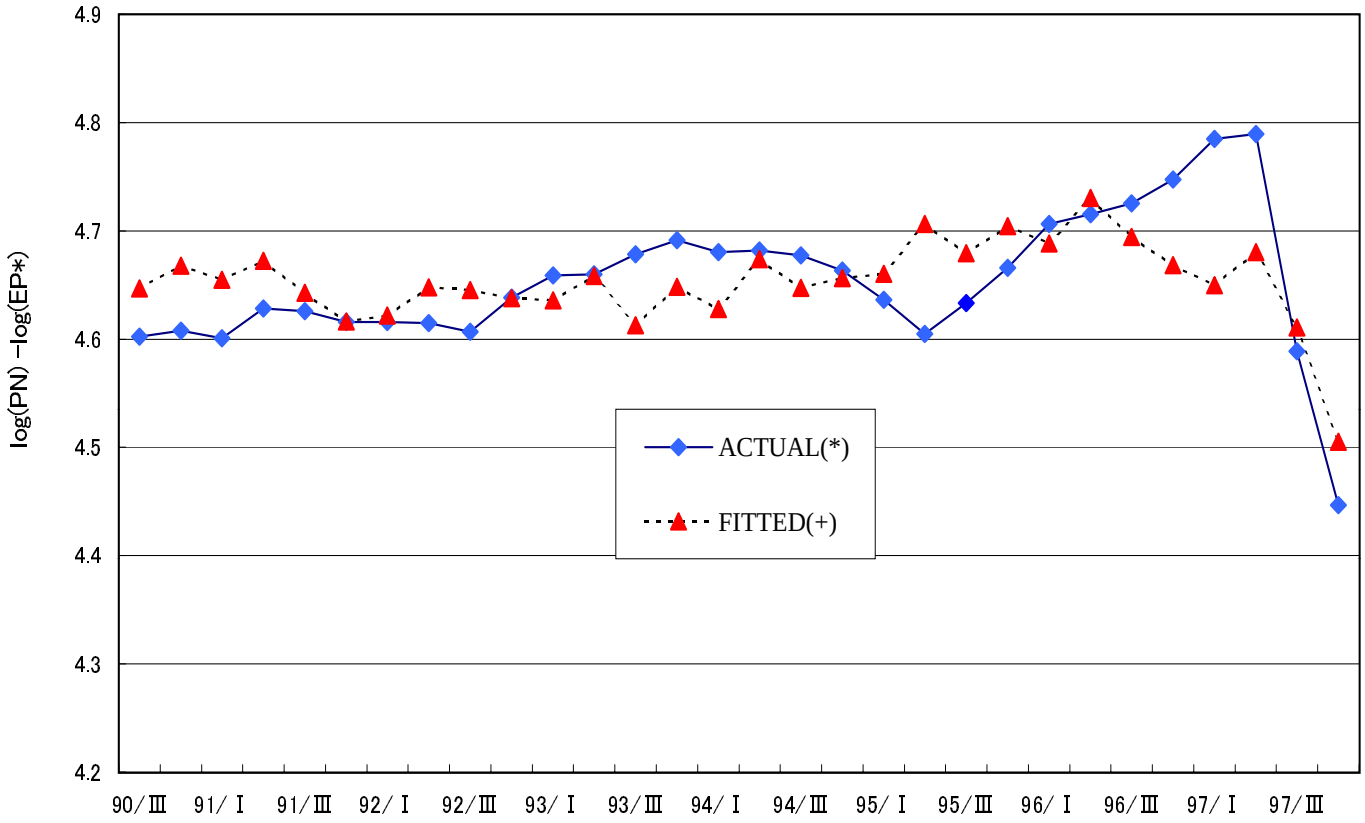

Figure 3: Plot of Actual and Fitted Values of Real Exchange Rate (Indonesian Rupiah)