CHAPTER 11

ECONOMIC COMPETITIVENESS AND THE EQUILIBRIUM REAL EXCHANGE RATE: THE CASE OF SINGAPORE

by

Ramkishen S. Rajan and Reza Siregar

Abstract

A key component of maintaining economic competitiveness in an open economy involves ensuring that the real exchange rate is maintained at a level that is consistent with underlying economic fundamentals. This chapter introduces the Natural Equilibrium Exchange Rate or NATREX approach to modeling equilibrium real exchange rates. It estimates the NATREX for the Singapore dollar over the 1980s and 1990s and attempts to ascertain whether there has been any clear evidence of structural misalignment in the city-state's currency.

1. Introduction

A key component of maintaining economic competitiveness in an open economy involves ensuring that the real exchange rate is maintained at a level that is consistent with underlying economic fundamentals. On the one hand, a severe and persistent currency undervaluation can lead, among other things to higher domestic inflation and may preclude upgrading of domestic economic activity to higher value added production. On the other hand, sustained currency overvaluation can lead to worsening of the trade balance, speculative attacks, increased foreign debt, declines in the rate of investment, productivity as well as overall growth (Gylfason, 2002)[1].

The Monetary Authority of Singapore (MAS) manages the Singapore dollar against a basket of currencies of Singapore's main trading partners and competitors[2]. The central parity/level is determined in the basis of countries that are the main sources of imported inflation and competition in export markets. Estimates of derived weights suggest that the US dollar had a weight of about 0.6, the remainder being divided between the yen and other currencies (Rajan, 2002). The Singapore dollar is allowed to float within an undisclosed target band around the computed central parity. Neither the central parity nor the bandwidth is completely fixed, being periodically reviewed so as to ensure that they are “consistent with economics fundamentals and market conditions”. In effect, the MAS seems to have adopted a “monitoring band” as opposed to a more conventional “crawling band”, in which there is an obligation to defend the edges of the band. The obligation in the case of a monitoring band is “instead to avoid intervening within the band” (notwithstanding intermittent intervention to “smooth out” exchange rate fluctuations as opposed to trying to defend the currency) (Williamson, 1998).

To illustrate the degree of flexibility of the Singapore exchange rate policy, the MAS allowed the Singapore dollar to depreciate by about 20 % during the height of the East Asian crisis; while more recently, it is suspected to have intervened heavily in the market to prop up the Singapore dollar during the bearishness against regional currencies following sharp falls in the NASDAQ (The Straits Times, May 12, 2000). Admittedly, this sort of monitoring band may be interpreted by some as being no different from a dirty floating regime. However, unlike a floating regime, with a monitoring band, the threat of possible intervention by the monetary authority may suffice to reduce speculative attacks. The point of a monitoring band (or a crawling band with soft edges) is that if the authority decides that market pressures are overwhelming, it can choose to allow the rate to take the strain even if this involves the rate going outside the band (Williamson, 1998).

Throughout the 1980s and 1990s as a whole, Singapore’s adjustable peg regime has been complemented by a policy of steady appreciation of the Singapore dollar against a basket of major trading partner currencies so as to contain domestic cost pressures (Lu and Yu, 1999). The key objective has been to insulate the domestic economy from imported inflation.

Figure 1 indicates close co-movements between Singapore's real effective exchange rate (REER) and nominal effective (i.e. trade weighted) exchange rate (NEER) for the period between 1980 and 2001. As can be seen, Singapore's NEER outpaced that of its REER[3]. The relatively moderate rise in its REER ensured that the country's domestic exports remained fairly buoyant. For instance, the city-state's merchandise exports grew at an average annual rate of about 11 % since the early 1980s (Figure 2). When overall exports are decomposed into its two components of domestic exports and re-exports, both domestic exports and re-exports are found to have contributed to the city-state's impressive performance of overall exports in the last two decades (also see Wilson and Abeysinghe, 2002).

While the preceding discussion of trends in effective exchange rates is indicative, it is important to determine the consistency of the observed REER of the Singapore dollar against the underlying macroeconomic fundamentals of its economy. As noted by Edwards (2000):

> Exchange rate overvaluation is very costly, and has been at the heart of most recent currency crises. Defining effective methodologies to determine the presence of overvaluation is essential (p.2)[4].

In other words, we need to ascertain some sort of "equilibrium benchmark" such that any deviations from that equilibrium rate can be construed as at least indicative evidence of the currency's misalignment. To this end, we draw on the concept of a Natural Equilibrium Real Exchange Rate (NATREX) model developed by Stein (1994, 1996).

The remainder of this chapter is organized as follows. The next section briefly discusses the NATREX approach developed by Stein (1994, 1996), focusing specifically on its operationalization. After all, the NATREX framework "is a theoretical model that implies testable econometric equations" (Stein and Lim, 2002, p.6). Section 3 goes on to estimate the equilibrium real exchange rate (i.e. NATREX) for the Singapore dollar, an issue that is of paramount importance to export-oriented economies. In particular, we attempt to ascertain whether there is any clear evidence of structural misalignment in the city-state's currency in the 1980s and 1990s. The final section concludes the paper.

2. The NATREX Model

The NATREX approach to real exchange rate estimation does not require that the observed REER and the equilibrium real exchange rate be stationary. In fact, the NATREX will vary through time depending on the changes in the fundamentals. It is a moving equilibrium exchange rate, a marked contrast to the underlying hypothesis of the simplistic PPP model, for instance (Stein and Lim, 2002). The NATREX is the rate that is determined by the prevailing real economic fundamentals in the economy. As Stein and Paladino (1998) have emphasized, the NATREX model

> is based upon the attempt of micro agents, who make independent saving, investment, import and export decisions, to optimize when they know that there is significant uncertainty.. The NATREX model is positive not normative---it is precisely the real exchange rate associated with both internal and external balance (pp.1688-89 and 1712).

2.1 Basic Structure of the NATREX Model

The NATREX treats the real exchange rate as an endogenous variable. The basic structural equations of the NATREX model are as follows:

$$S(k, F; Z, u) - I (k, y, R, r:Z, u) = CA (R, y, F, r:Z, u); u = 0, \quad (1)$$

$$r + ?(t) = r^*; ?(t) = E\{?R * [Z(t)]\}, \quad (2)$$

$$dF/dt = -A(R, y, F, r:Z, u) = L(R, k, F, r:Z), \quad L = I - S, \quad (3)$$

$$dK/dt = I \quad (4)$$

where: R = real exchange rate; r = domestic real interest rate; r* = foreign real interest rate; S = saving; I = investment; k = capital stock; F = foreign debt; CA = Current Account; y = productivity; u = deviation of rate of capacity utilization; ?(t) = risk premium; Z = the vector of fundamental variables. This vector Z includes mainly real exogenous fundamental variables explaining the movements of real exchange rate and current account variable.

Equation (1) is the macroeconomic balance equation. It states that excess investment over saving (I-S) equals the current account deficit. The equilibrium real exchange rate will adjust to ensure that the current account deficit equals to investment (I) less saving (S). (I-S) > 0. Equation (2) is the uncovered interest rate parity model with Asymptotically Rational Expectation a la Stein (1994). It is basically the portfolio balance equation. Equation (3) and (4) capture the changes in the foreign debt level and the investment level respectively over the period.

Thus, the NATREX model adds dynamic stock-flow interactions to the standard macroeconomic approach balance model. Their inclusion of the dynamic equations allows the NATREX to vary over time, reflecting the changes on the fundamental variables. In the medium run, an economy may face a current account imbalance. In the long run, however, the foreign debt and capital stabilize. What is important for the empirical application of the model is to find the appropriate set of fundamental variables included in Z_t which is a vector of economic fundamentals

2.2 Single Equation Estimation

The general working model of the NATREX we rely on is the following single-equation econometric model:

$$natrex_t = f(Z_t) \tag{5}$$

For most applications of the NATREX the vector (z) includes the following four variables: *terms of trade variable (tot)*, *productivity (prd)*, *world real interest rate (r*)* and *real government spending (g)*[5]. This set of variables captures the open economy properties of Singapore which relies heavily on international trade (*tot*) and cross-border capital flows (*r**) as well as domestic factors that are important to domestic economic performance such as high productivity (*prd*) and government expenditure (*g*)[6]. This set of variables is also consistent with other equilibrium-based models which may otherwise lack the theoretical foundations of NATREX (Edwards, 2000 and Edwards and Savastano, 1999).

Because the NATREX is not observable, we estimate the following equation[7]:

$$reer_t = b_0 + b_1 g_t + b_2 r_t^* + b_3 prd_t + b_4 tot_t + b_5 pol_t + e_t \tag{6}$$

where: $reer_t$ is a natural log of observable REER.

Table 1 briefly describes each variable. A dummy variable (*pol*) is also introduced to capture the country's policy shift from a steady nominal depreciation managed floating to a gradual nominal appreciation policy in early 1986 (Rajan and Siregar, 2002). We construct the NATREX for the Singapore dollar using the coefficient estimates obtained from regressing the above two equations.

2.3 Coefficient Estimates: What Theory Tells Us

It is important to briefly highlight the prior signs of the coefficients that should be expected based on theory.

Government Expenditure (g): Following Obstfeld and Rogoff (1996), we assume that government expenditure is disproportionately devoted to nontradables. As g rises, the relative demand for nontradables also goes up, triggering an increase in the relative price of nontradables, i.e. $\beta_1 > 0$[8].

World Real Interest Rate (r*): International interest rate arbitrage implies that when the return on foreign currency dominated assets (*r**) exceeds that on local currency dominated assets (*r*), investors shift their portfolios away from local assets to foreign ones. Eventually, the rise in the world real interest rate will lead to a decline in the steady state capital intensity and a rise in the steady state debt. In the long run, the rise in the world real interest rate will depreciate the real exchange rate, i.e. $\beta_2 < 0$.

Terms of Trade (*tot*): An improvement in the terms of trade will cause international capital to flow into the tradables sector, causing a rise in investment in the domestic economy. As discussed above, this should appreciate the real exchange rate, $\beta_4 > 0$.

Productivity (*prd*): An increase in productivity should stimulate investment and therefore improve the economy's balance of payments position. This will be the "medium term effect". In the long run, capital accumulation will increase the economy's overall productive capacity. In turn, the real exchange rate is expected to appreciate, i.e. $\beta_3 > 0$[9].

By incorporating both macroeconomic and productivity variables, the NATREX model is able to effectively link these two components of competitiveness. Wilson and Abeysinghe (2002) have noted:

> There are two key areas in which Singapore worries about it capacity to compete internationally: whether it can improve the quality of growth sufficiently to compete with developed countries – the total factor productivity growth debate, and whether it can cope effectively with pressures on costs and prices (p.273).

3. Empirical Analysis

The analysis is based on quarterly movements of the Singapore dollar between 1984 and 2000. As noted, the observation period encompasses the East Asian financial crisis of 1997-98. We conduct three sets of sequential tests. The first is the Unit Root test. If the variables are all found to be integrated of order 1 or I(1), we apply the Johansen Cointegration test to check for existence of cointegration relationship(s) among all variables given in Equation 6. Having estimated the *NATREX*, we conduct another Unit Root test to evaluate the stability of misalignment rates of the currency, particularly for the post 1990 period.

3.1 Statistical Preliminaries

Unit Root test: In order to determine the order of integration of each variable, we use the Augmented Dickey Fuller Unit Root test with all variables in log form. The Akaike Criteria test determines the appropriate number of lag periods for the ADF. Table 2 reports the results. The ADF test statistics indicate that all relevant variables are I(1).

However, given the potential presence of structural breaks in many time series variables, the low power of the ADF test may not be sufficiently sensitive to differentiate a stationary series from one that is non-stationary. In order to evaluate the unit root property more structurally, we apply the next set of tests introduced by Banerjee, Lumsdaine and Stock (1992) - henceforth BLS - who provide a more in-depth investigation of the possibility that aggregate economic time series can be characterized as being stationary around "a single or multiple structural breaks". BLS do so by extending the Dickey-Fuller t test by constructing the time series of **rollingly computed estimators** **– can this be explained in the endnote?** and their t statistics. Following BLS we compute the smallest (minimal) and the largest (maximal) Dickey-Fuller t test statistics from the rolling test, both of which are compared to their respective critical values (Table 3). Both the minimum and maximum Dickey-Fuller t test statistics of the BLS rolling test are significantly larger than each respective critical value. These test results confirm the findings of the ADF tests that the null hypothesis of nonstationarity at the 5 % critical value cannot be rejected for all the key variables[10].

Johansen Maximum Likelihood-Cointegration test: Given that all variables are I(1), we next conduct the Johansen cointegration tests on the single equation model (Equation 6). Since the observation set spans the post-1997 financial crisis period we will also include a crisis dummy (*crisis*) in the regressions. In addition, due to a possible presence of deterministic time trend in long run macroeconomic variables such as exchange rate, following Enders (1995), Montiel (1997) and others, we also include a time trend in our cointegration regression equations.

The trace statistics (likelihood-ratio) indicate that there is one cointegrating relationship (significant at the 1 % level) among variables in Equation 6 (Table 4). All fundamental variables have theoretically consistent coefficient estimates. We find the coefficient estimate for real government expenditure variable is the only insignificant variable at the 10 % Chi-square critical value. We excluded the crisis dummy variable from the regressions as the estimated coefficients are statistically insignificant. Furthermore, the inclusion of the dummy variable only worsens the overall results of the cointegration tests. We retain the time trend (t) as the coefficient estimate is significant.[11] Based on the Chi-square statistics, among the statistically significant explanatory variables, the productivity rate variable is the most significant.

3.2 Tests for Misalignment and Stability

We next construct the *NATREX* series by using the estimated coefficients. Figure 4 plots the fundamentally derived equilibrium exchange rates (NATREX) of the Singapore dollar against its observed REERs. As stated earlier, a positive (negative) difference between the REER and NATREX implies an overvaluation (undervaluation) of the currency. Several interesting observations warrant highlighting.

The Singapore's REER was undervalued between mid 1993 to mid 1996 before returning to its equilibrium or NATREX rate in late 1996 and early 1997. Overall, the currency does not appear to have been severely misaligned prior to mid 1997 (recall the outbreak of the financial crisis began in June-July 1997 with the devaluation of the Thai baht)[12]. Table 5 further reveals that between Q1: 1990 and Q1: 1997 the Singapore dollar experienced a mild rate of undervaluation. During the post financial crisis period of 1997-98, Singapore's average REER was undervalued at basically the same rate as during the pre-crisis period. As expected, we find the currency was more volatile during the crisis period, with the standard deviation having risen, albeit at a relatively small increment from 0.7 % during the pre-crisis period to about 1.0 % during the first three years of the crisis period.

Stability test: In order to further evaluate the overall performance of the Singapore dollar, we apply the following standard criterion as a condition for judging the stability of exchange rate regime:

$$reer_t - natrex_t = e_t, \text{ such that } e_t \text{ is } I(0) \qquad (7)$$

That is, for the REER to be stable, its misalignment (captured by ε_t) from the equilibrium rate must be stationary. The ADF Unit Root test and the Phillips-Perron test are both applied to e_t [13]. We focus only on the period between 1990 and 2000. The results indicate that ADF and the Phillips-Perron test statistics for the REER were less than the 5 and 10 % critical values, respectively. Hence, the stability tests suggest that the misalignment of Singapore's REER was stable (Table 6).

4. Concluding Remarks

The foregoing empirical analysis indicates that Singapore's monitoring band-based exchange rate regime *a la* Williamson (1998) and Rajan (2002), accompanied by a policy of crawling appreciation since 1981, has been relatively successful in insulating the Singapore economy from external shocks until mid 1997. This exchange rate-centered monetary policy has also ensured that Singapore's REER was maintained at a level that has been broadly consistent with the underlying macroeconomic fundamentals of the economy in the 1990s. In the spirit of the monitoring band arrangement, the Singapore dollar was temporarily floated during the midst of the 1997-98 crisis and particularly after the devaluation of the Taiwanese currency, which was an important export competitor. Against the backdrop of the spate of devaluations of the regional currencies, the Singapore dollar promptly depreciated and lost one fifth of its value. This expenditure-switching policy, which facilitated adjustment to the external shocks, was matched by severe and credible expenditure-reducing and cost-cutting ones (Rajan, Sen and Siregar, 2002), hence ensuring that domestic prices remained relatively stable. Consequently, the nominal depreciation was translated into an undervalued REER (where equilibrium is based on the NATREX model).

References

Banerjee, A., R. Lumsdaine and J. Stock (1992). "Recursive and Sequential Test of the Unit Root and Trend-Break Hypotheses: Theory and International Evidence", Journal of Business & Economic Statistics, 10, pp.271-87.

Edwards, S and M. Savastano (1999). "Exchange Rates in Emerging Economies: What Do We Know? What Do We Need To Know?", Working Paper No. 7228, NBER.

Edwards, S. (2000). "Exchange Rates Systems in Emerging Economies", mimeo (January).

Enders, W. (1995). Applied Econometrics Time Series, New York: John Wiley & Sons.

Gylfason, T. (2002). "The Real Exchange Rate Always Floats", Australian Economic Papers, forthcoming, December.

Lu, D. and Q. Yu (1999). "Hong Kong's Exchange rate regime: Lessons from Singapore", China Economic Review, 10, pp.122-140.

Luis Espert, J. and R. Maino (2000). "On the Relationship Between Real Exchange Rate and Public Spending: The Case of Argentina", mimeo (June).

Montiel, P. (1997). "Exchange Rate Policy and Macroeconomic Management in ASEAN Countries", in J. Hicklin, D. Robinson and A. Singh (eds.), Macroeconomic Issues Facing ASEAN Countries, Washington, DC: IMF.

Obstfeld, M. and K. Rogoff (1996), Foundations of International Macroeconomics, Cambridge, MA: MIT Press.

Rajan, R. (2001). "(Ir)relevance of Currency-Crisis Theory to the Devaluation and Collapse of the Thai Baht", Princeton Studies in International Economics No.88, International Economics Section, Princeton University, February.

Rajan, R. (2002). "Exchange Rate Policy Options for Southeast Asia: Is there a Case for Currency Baskets?", The World Economy, 25, pp.137-63.

Rajan, R., R. Sen and R. Siregar (2002). "Hong Kong, Singapore and the East Asian Crisis: How Important were Trade Spillovers?", The World Economy, 25, pp.503-37. Longer version entitled "Twin Cities and the East Asian Crisis: Hong Kong, Singapore and Trade Spillovers", mimeo (July) available at: http://www.economics.adelaide.edu.au/rrajan/unpub/contaghksing3.pdf.

Rajan, R. and R. Siregar (2002). "The Choice of Exchange Rate Regime: Currency Board (Hong Kong) or Monitoring Band (Singapore)?", Australian Economic Papers, forthcoming, December.

Razin, O. and S. Collins (1997), "Real Exchange Rate Misalignments and Growth" (mimeo).

Stein, J. (1994). “The Natural Real Exchange Rate of the US Dollar and Determinants of Capital Flows”, in J. Williamson (ed.), Estimating Equilibrium Exchange Rates, Washington, DC: Institute for International Economics.

Stein, J. (1996). “The Natural Real Exchange Rate: Theory and Application to the Real Exchange Rate of the US Dollar Relative to the G-8 and to the Real Effective Exchange Rate of Germany”, Working Paper No. 96-4, Brown University.

Stein, J. and G. Lim (2002). “Introduction to Exchange Rates in Europe and Australasia: Fundamental Determinants, Adjustments and Policy Implications”, Australian Economic Papers, forthcoming, December.

Stein, J. and G. Paladino (1998). “Recent Developments in International Finance: A Guide to Research”, Journal of Banking and Finance, 21, pp.1685-720.

Williamson, J. (1998). “Crawling Band or Monitoring Bands: How to Manage Exchange Rates in a World of Capital Mobility”, International Finance, 1, pp.59-79.

Wilson, P. and T. Abeysinghe (2002). “International Competitiveness”, in A.T. Koh, K.L. Lim, W.T. Hui and B. Rao (eds.), Singapore’s Economy in the 21st Century: Issues and Strategies, Singapore: McGraw Hill.

Table 1
Variable Desc riptions

Singapore	
Variable	**Description**
reer	Real effective exchange rate of Singapore dollar against 23 trading partners. The sources is IFS-CD ROM and (http://www.jpmorgan.com).
tot	Terms of Trade is calculated as direct price of export / direct price of import. The source is the IFS, IMF (various years).
g	Real government expenditure is derived by adjusting nominal government expenditure by the country's GDP deflator. The source is Monthly Digest of Statistics, Singapore Department of Statistics (various years).
prod	Total factor productivity index is represented by GDP (gross domestic product) per capita. All information are obtained from Monthly Digest of Statistics, Singapore Department of Statistics (various years).
pol	Policy dummy to capture the shift to a managed appreciation. The variable equals to zero from quarter 1, 1983 to quarter 2, 1986. Otherwise, it is equal to one.
r*	World real interest rate. To derive the series, we subtracted the three month annualized US consumer price index inflation from the three-month US dollar LIBOR rate. The source is IFS, IMF (various years).
t	Time trend (see Montiel 1997).
crisis	Dummy variable for the East Asian crisis. It equals to 1 from quarter 2, 1997 to quarter 3, 2000, and equals to zero otherwise.

Table 2
ADF Unit - Root Test
(all variables are in log)

Variable	Singapore
reer	at level: -2.678 AIC(4)*: -8.028 (trend and intercept) at first diff : -1.998 AIC(3)*:-8.004 (no intercept, no trend)
tot	at level: -2.539 AIC(2)*: -7.195 (trend and intercept) at first diff : -6.518 AIC(2)*:-7.155 (no intercept, no trend)
g	at level: - 2.058 AIC(4)*: -5.984 (intercept and trend) at first diff : -4.923 AIC(3)*: -5.973 (intercept only)
r*	at level: - 2.003 AIC (3)*: -4.454 (intercept only) at first diff :-4.010 AIC(3)*:-4.449 (no intercept, no trend)
prod	at level: - 2.621 AIC(4)*: -9.063 (trend and intercept) at first diff : -4.106 AIC(3)*: -9.017 (intercept only)

Notes: */ AIC: Akaike Information Criterion; ( ): represents number of lags included.
All variables are found to be an I(1) variable at 5 % significant level.

Table 3
Rolling Unit-Root Test
(all variables are in log)

Variable	Singapore	
	Maximum	Minimum
Tot	-1.020	-3.900
G	0.217	-4.080
prod	0.837	-0.410
r*	-0.850	-4.820
reer	2.030	-1.145
Critical Values: a). Max t_{df} at 5 % level for sample <100: -1.49; b). Min t_{df} at 5 % level for sample <100: -5.01		

Table 4
Cointegration Test for Singapore
Sample Period: Q1: 1983 – Q2: 2000

(lags = 1 (based on Akaike Info Criteria))

Eigenvalue	Trace Statistics	1 % Critical Value	Hypothesized No. of CE(s)
0.5559	137.27	133.57	None [a]
0.4011	80.44	103.18	At most 1
0.2267	44.55	76.07	At most 2
0.1732	26.55	54.46	At most 3
0.1265	13.24	35.65	At most 4
0.0491	3.78	20.04	At most 5

[a]/ Likelihood-Ratio indicates 1 cointegrating equation at 1 % significance level

The Normalized Cointegrating Coefficients:

Reer = -16.24 + 0.042g – 0.040r* + 2.490prd + 0.434tot – 0.112pol – 0.023t
(0.053) (0.020) (0.338) (0.215) (0.036) (0.004) (standard errors)

(0.628) (4.00) (54.29) (4.07) (9.679) (33.06) (Chi-squares)

Chi- square critical values: at 1 % = 6.6349; at 5 % = 3.8415; and at 10 % = 2.7055

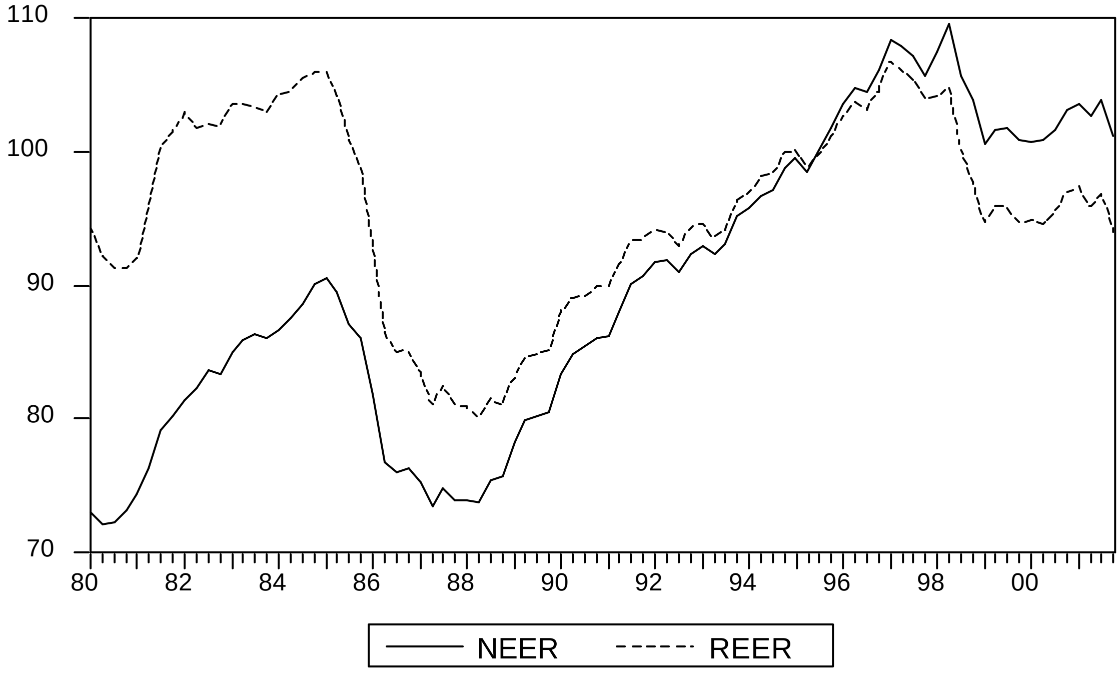
Table 5
Quarterly Rate of Over-and Under-valuation (in %)

	Mean	**Maximum**	**Minimum**	**Standard Deviation**
Singapore				
1990:1 – 1997:1	-0.49	0.72	-1.47	0.70
1998:1 – 2000:2	-0.43	0.87	-1.96	0.97

Table 6
ADF Unit-Root Test for (REER - NATREX)

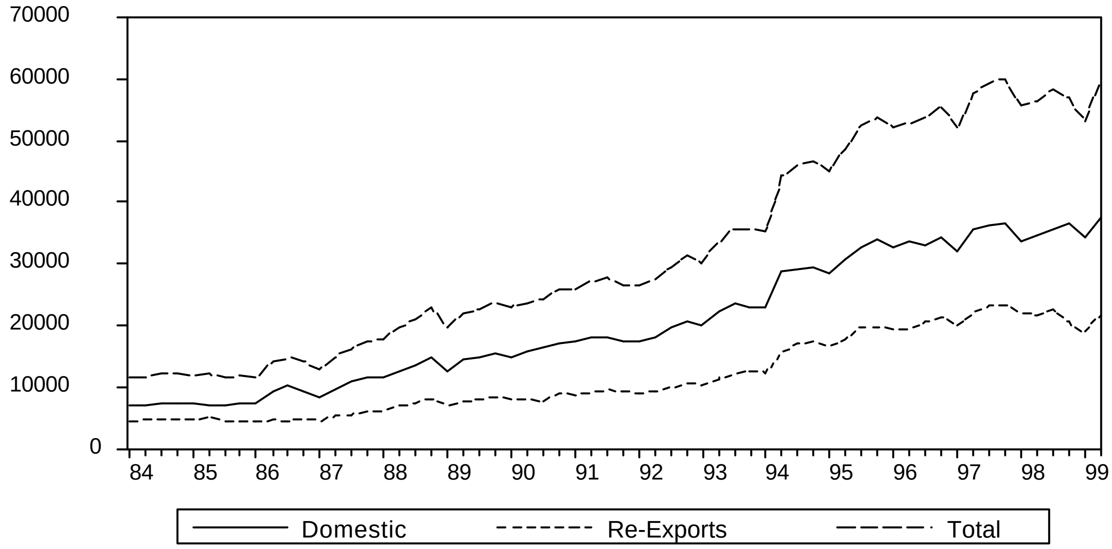
Country	ADF	Phillips – Perron (PP)
Singapore:	At level: ADF test–statistics: -3.5067 Critical Value: At 5 %: -2.9320 At 10 %: -2.6039 # of lags = 1; Only intercept included	At level: PP test–statistics: -1.9088 Critical Value: At 5 %: -1.9488 At 10 %: -1.6199 # of lag truncation = 2 No trend and No intercept
Period: Q1: 1990 to Q2: 2000		

Figure 1
Singapore Dollar's Nominal Effective Exchange Rate (NEER) and Real Effective Exchange Rate (REER)



Note: A rise in the index implies an appreciation of the Singapore dollar against the country's major trading partners' currencies.
Source: IFS CD-ROM, IMF. (Average 1995 = 100), and (http://www.jpmorgan.com).

Figure 2
Exports of Singapore
(in millions of Singapore dollars)



Source: IFS, IMF for various years

Figure 3
NATREX and REER for Singapore
(1990 = 100)

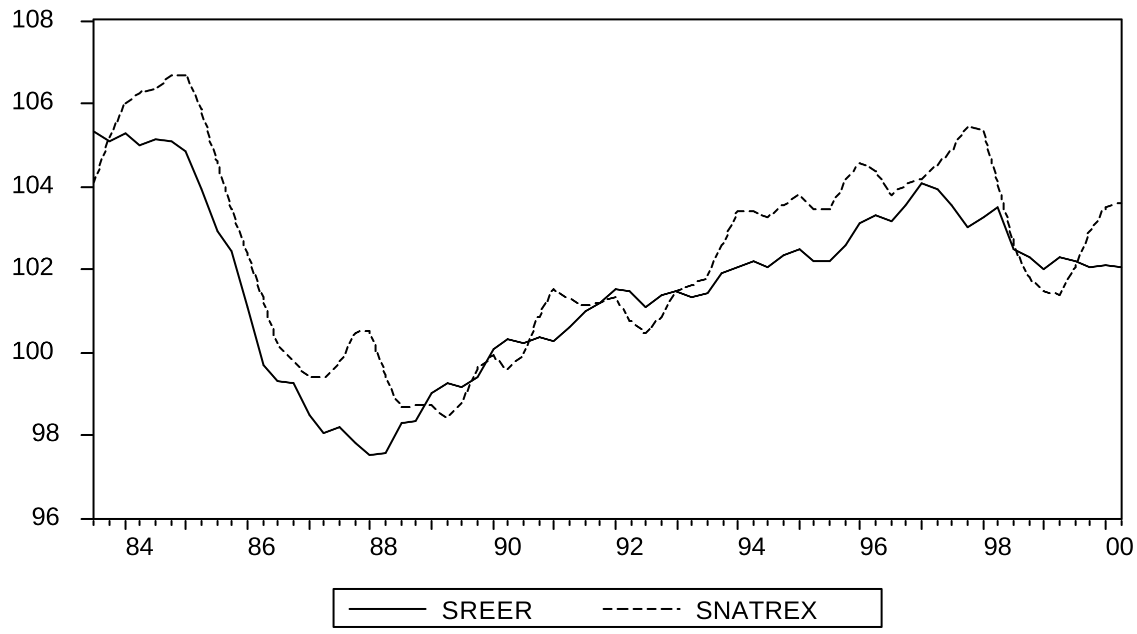
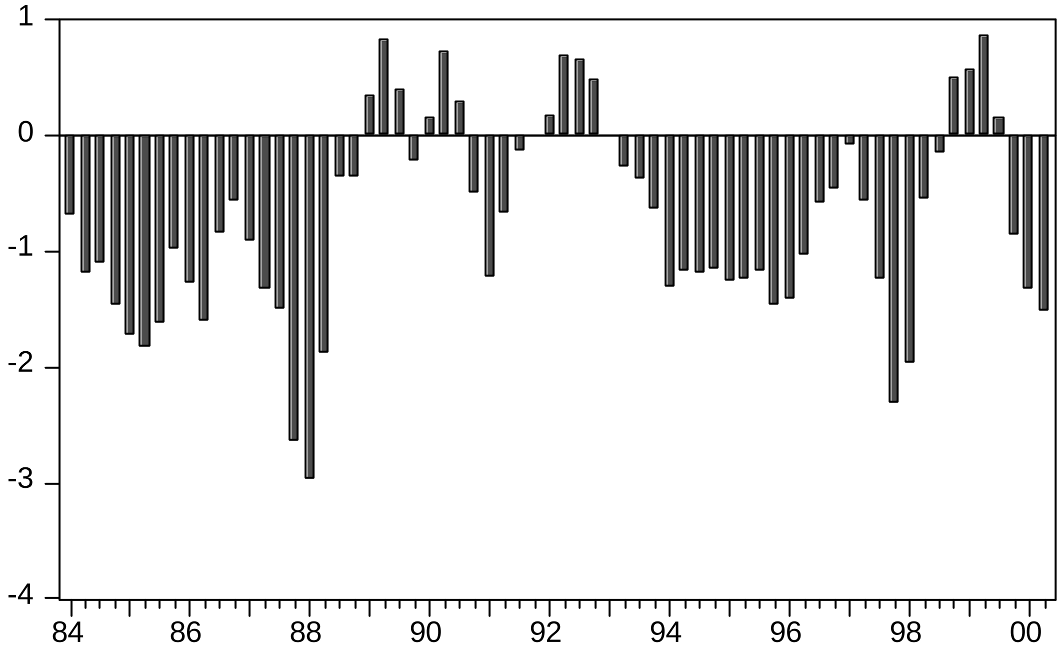


Figure 4: Rate of Misalignment

(in %)



Note: Misalignment Rate = $\left[\dfrac{NATREX_t - REER_t}{REER_t}\right] * 100\%$

A positive (negative) rate implies an overvaluation (an undervaluation) of the Singapore dollar.

Endnotes

[1] Using data for a large sample of developed and developing countries, Razin and Collins (1997) find that only "very high" overvaluations appear to be associated with slower economic growth. However, "moderate" undervaluations appear to be associated with more rapid economic growth. As noted, undervaluations however could cause other problems such as higher rates of imported inflation.

[2] See Lu and Yu (1999) for a discussion of the historical background, evolution and institutional arrangements supporting Singapore's managed exchange rate regime.

[3] An increasing trend in the REER and NEER implies an appreciation of the domestic currency. A stronger appreciation of the REER than the NEER implies that the domestic price level is rising faster than the prices of the major trading partners. See Gylfason (2002) for a useful discussion on the interplay between real and nominal exchange rate changes.

[4] Also see Edwards and Savastano (1999).

[5] Small letters represent natural logs.

[6] Government spending may also be interpreted as a proxy for the rate of social time preference.

[7] Such single equation econometric models are commonly used in the literature on the determination of equilibrium real exchange rates (Edwards, 2000 and Edwards and Savastano, 1999).

[8] For instance, Luis Espert and Maino (2000) find government spending in Argentina to have produced a real exchange rate appreciation of the Argentine peso in the short and long run for the period 1961 to 1999.

[9] The may also be a reflection of the Balassa-Samuelson hypothesis.

[10] The BLS rolling unit root test results at the first difference for all variables are found to be significantly smaller than their respective 5 % critical values. Hence, all variables are found to be I(1), confirming the ADF test-results. The crisis and policy dummy variables for Singapore (pol) were excluded in this test.

[11] The explanatory variables remain significant even if we drop the deterministic time trend (t) from the regressions. However, given that it is significant and that its inclusion improves the overall results, we retained the time trend in the cointegration tests. Thus, the explanatory variables introduced by NATREX model explain the stochastic component of the REER series.

[12] For details of the Thai crisis, see Rajan (2001).

[13] Since we break the observations into several periods, the sub-sample set is too small for the BLS unit-root test.