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The Long-Run Real Effective Exchange Rate of Singapore: A Behavioural Approach

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THE LONG-RUN REAL EFFECTIVE EXCHANGE RATE OF SINGAPORE: A BEHAVIOURAL APPROACH*

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ABSTRACT

In this paper we use the behavioural equilibrium exchange rate (BEER) approach to identify a long-run equilibrium exchange rate for the real effective exchange rate of Singapore. We demonstrate that a well-founded measure of the equilibrium value of this country's exchange rate may be recovered from a relatively small set of fundamental variables and that this can be used to produce an assessment of the currency in terms of periods of misalignment. Using this relationship, the behavioural equilibrium exchange rate was estimated and it showed that, on average, there was an undervaluation of the currency in the post-1998 period. Nevertheless, the currency was close to its equilibrium in the final sample period (2003Q2), a finding confirmed by our estimates derived from the permanent equilibrium exchange rate (PEER).

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1. INTRODUCTION

1.1 In this paper we use the behavioural equilibrium exchange rate (BEER) approach of Clark and MacDonald (1999) to produce a measure of the long-run equilibrium exchange rate for the effective real exchange rate of Singapore. Given that it is well known that currencies can spend long periods, or take long swings, away from their fundamental, or fair, value, the usefulness of a measure of the equilibrium exchange rate is now widely accepted. Furthermore, there is now a lot of evidence to suggest that BEER-based estimates of an equilibrium exchange rate have advantages over competing approaches, in terms of their tractability and transparency. For the Singapore real effective exchange rate, we demonstrate that a well-founded measure of the equilibrium value of the dollar may be recovered from a relatively small set of fundamental variables and that this can be used to produce an assessment of the dollar in terms of periods of misalignment.

1.2 The remainder of this paper is organised as follows. In the next section we present a brief overview of the BEER-based approach to assessing equilibrium exchange rates. Our econometric estimates for the real effective exchange rate of Singapore are presented in Section 3. In section 4 we discuss some assessment issues using the BEER, a Hodrick-Prescott-adjusted BEER and a measure of the permanent equilibrium exchange rate (PEER). A final section concludes.

2. THE BEHAVIOURAL EQUILIBRIUM EXCHANGE RATE APPROACH

2.1 In this paper we propose using the Behavioural Equilibrium Exchange Rate (BEER) approach of Clark and MacDonald to estimate the equilibrium path of the Singapore effective exchange rate. The BEER approach takes as its starting point the evident failure of purchasing power parity (PPP) hypothesis as a useful construct for producing an equilibrium exchange rate relationship and focuses on the so-called real determinants of real exchange rates.[1] Other approaches to modelling equilibrium exchange rates also use real fundamentals (see MacDonald (1997) and Driver and Westaway (2001) for overviews), but we choose the BEER approach here because of its tractability and transparency, and also because it has been used successfully to model the equilibrium values of a number of currencies (see, for example, Clark and MacDonald (1999) and MacDonald (1997)). The BEER approach is a two-step procedure. In the first step, a simple behavioural equilibrium exchange rate relationship is estimated using cointegration-based methods, while in a second stage this estimated relationship is used to construct an assessment of whether an exchange rate is overvalued or not. In the latter stage some normative structure and interpretation may be placed on the calculated equilibrium.

2.2 Since at the heart of the BEER approach is the use of a behavioural model, a range of different exchange rate models – from monetary to real – may be deemed consistent with this approach.[2] The vehicle we have chosen in this paper to motivate the BEER approach exploits the familiar uncovered interest parity (UIP) condition:[3]

$$E_t(\Delta s_{t+k}) = -(i_t - i_t^*), \tag{1}$$

where s_t is the log of the foreign currency price of a unit of home currency, with an increase in s_t corresponding to an appreciation in the home currency. i_t denotes a nominal interest rate (expressed as a proportion), Δ is the first

[1] For an empirical testing of the PPP hypothesis for Singapore, see the following MAS Occasional Papers, MAS (1998) and MAS (2000).

[2] Our discussion here draws on Clark and MacDonald (2000).

[3] It is straightforward to modify (3) to include a risk premium – see Meese and Rogoff (1988). However, in the work of Clark and MacDonald (1999) the risk premium always proved to be insignificant and therefore it is not included in the present analysis.

difference operator, E_t is the conditional expectations operator, $t+k$ defines the maturity horizon of the bonds, and the foreign variables are denoted by the superscript *. Equation (1) can be converted into a relationship between real variables by adding the expected inflation differential, $E_t(\Delta p_{t+k} - \Delta p^*_{t+k})$, to both sides of the equation. After rearrangement this gives:

$$q_t = E_t(q_{t+k}) + (r_t - r^*_t) + e_t \qquad (2)$$

where $r_t = i_t - E_t(\Delta p_{t+k})$ is the home ex ante real interest rate, $q_t = s_t + p_t - p^*_t$, is the ex ante real exchange rate, and e_t is a disturbance term. Expression (2) describes the current equilibrium exchange rate as determined by two components, the expectation of the real exchange rate in period $t+k$ and the real interest differential with maturity $t+k$.

2.3 The use of the uncovered interest parity relationship may appear suspect, as many researchers (see, for example, Meese and Rogoff (1988), Campbell and Clarida (1987), Froot (1990), and Edison and Pauls (1993)) have failed to uncover a systematic, robust relationship between exchange rates and interest rates. However, some recent research provides greater support for UIP. For example, Meredith and Chin (1998) find that looking at longer time horizons, namely, from three years up to ten years, reveals quite a strong and consistent relationship between the change in the nominal exchange rate and the level of the interest differential across a range of currencies. MacDonald (1997), Edison and Melick (1999) and MacDonald and Nagayasu (2000) confirm that the findings of Meredith and Chin also holds for the real uncovered interest differential. Thus there is greater support than a few years ago for using UIP as our point of departure in modelling real exchange rates.[4]

2.4 We assume that the unobservable expectation of the exchange rate, $E_t(q_{t+k})$, represents the influence of fundamentals exclusive of interest rates on the equilibrium exchange rate and we label this component $\bar{q}_t$. The current equilibrium rate is defined as q'_t to distinguish it from the actual rate q_t:

[4] Indeed, the UIP condition for Singapore has been empirically validated in the MAS Occasional Paper No. 20, MAS (2000). The empirical results indicate that the covered and uncovered interest parity relationship holds for the short-term nominal Singapore Dollar and the US Dollar interest rates.

$$q_t^{'} = \bar{q}_t + (r_t - r_t^*) \tag{3}$$

2.5 In summary, our approach posits that the current equilibrium exchange rate given by (3) comprises two components: a systematic component, $\bar{q}_t$, and the real interest differential.

2.6 The factors likely to introduce systematic variability into $\bar{q}_t$ have been discussed extensively elsewhere in some detail (see Faruqee (1995), MacDonald (1997) and Stein (1999)) and are therefore not considered here in any depth. Suffice to say that in our analysis of the Singapore REER, we start from a position where the long-run equilibrium exchange rate is a function of a number of key variables:

$$\bar{q}_t = f(\overset{+}{nfa}_t, \overset{+}{lprod}_t, \overset{+}{gapd}_t, \overset{+}{ltot}_t, \overset{-}{ltotta}_t, \overset{+}{lprop}_t, \overset{+}{lpcon}_t, \overset{+}{lfcon}_t), \tag{4}$$

where *nfa* is the ratio of net foreign assets to GDP and, from the perspective of a stock-flow consistent exchange rate model (such as the portfolio balance of Obstfeld-Rogoff (1996) models), would be expected to be positively related to the real exchange rate. As in the internal-external balance approach to modelling the real exchange rate, *nfa* would be driven by the determinants of national savings and investment and, in particular, demographics and structural fiscal balances.[5] $lprod_t$ is defined as Singapore's labour productivity relative to that of her trading partners. With linearly homogeneous production technology, this may be interpreted as a Balassa-Samuelson effect and on this basis, should be positively related to the real exchange rate, i.e., if Singapore has relatively fast productivity growth in its tradable sector, its currency will appreciate.[6] The variable *gapd* is the output gap in Singapore relative to the output gap in the trading partner countries. This variable is included for two reasons. First, it may be viewed as an alternative measure of growth, or growth potential, in an economy. Recent hypothecation over the relative strength of the US dollar against the euro have emphasised this kind of variable. The second reason for including this is to facilitate counterfactuals to be conducted where output can be calibrated at its full

[5] For a recent analysis that derives this relationship from internal and external balance considerations, see Alberola, et al (1999).

[6] The importance of net foreign assets as a determinant of real exchange rates has recently been highlighted in Lane and Milesi-Ferretti (2000).

employment, or potential level, as in the FEER approach. *ltot* represents the terms of trade of Singapore while *ltotta* is the ratio of total trade to GDP and is a measure of openness – it is expected to be negatively related to the real effective exchange rate. *lprop* is the log of the property price, which has been shown to be important for the equilibrium value of the Singapore REER. *lpcon* and *lfcon* represent the log of private and government consumption, respectively. The definitions of the variables entering (4) are described in some detail in the data appendix.

2.7 The effects of most of the above set of variables on effective exchange rates are well known and we do not elaborate on them here. Two variables that are worth elaborating are *ltotta* and *lprop*. The openness variable has been used by both Edwards (1989) and Baffes, Elbadawi and O'Connell (1997) and an increase in this variable is expected to depreciate a currency because a liberalisation of trade would be expected to depreciate the equilibrium value of a currency. In an internal-external balance setting, the increased openness would be represented by an upward movement of the external balance schedules, which requires a depreciation of the exchange rate. The property price index is included as a proxy for wealth and is therefore expected to be positively related to the exchange rate.

3. ECONOMETRIC RESULTS

3.1 We used the methods of Johansen (1995) to determine both the existence of cointegration, or long-run relationships, and to produce estimates of the BEER. These estimates are based on a vector x:

$$x_t = \begin{bmatrix} q_t, (r_t - r_t^*), nfa_t, lprod_t, gapd_t, \\ ltot_t, ltotta_t, lprop_t, lpcon_t, lfcon_t \end{bmatrix}', \tag{5}$$

where variables are as defined above. Our approach involved starting from this general specification and moving, if possible, to a more parsimonious representation in which variables are deleted from the long-run representation and any weak exogeneity restrictions are imposed. On this basis the x vector became:

$$x_t = [q_t, nfa_t, ltot_t, ltotta_t, lprop_t]', \tag{5´}$$

and the variables entering this vector are plotted in Figures 1 to 5.

Figure 1: The Log of the Real Exchange Rate

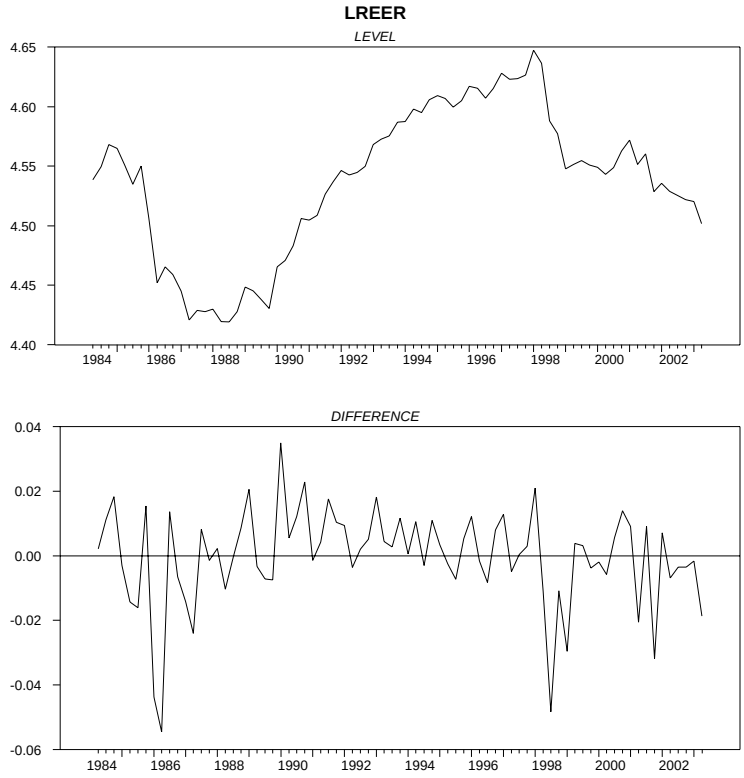


Figure 2: The Log of Total Trade (as a proportion of GDP)

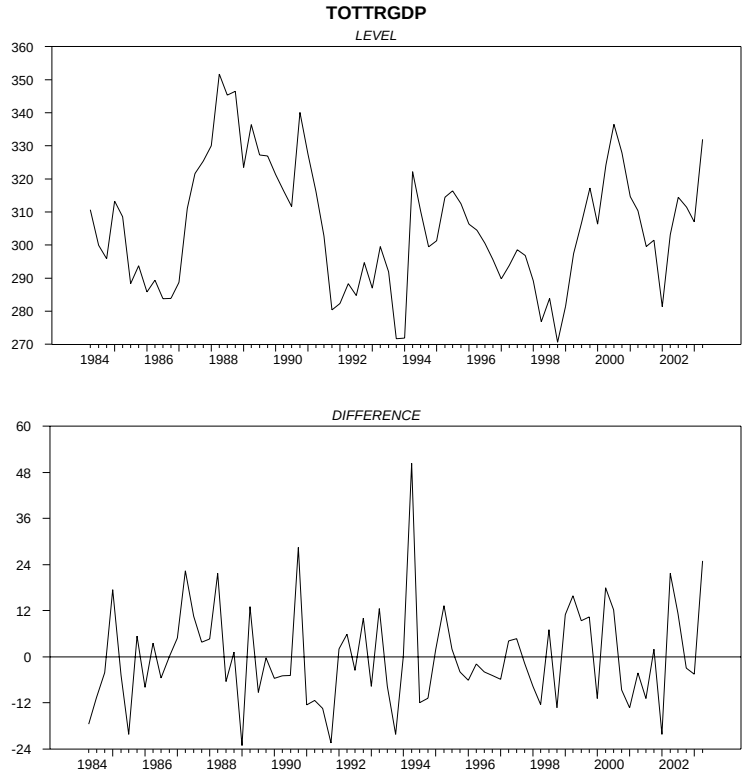


Figure 3: Net Foreign Assets (as a proportion of GDP)

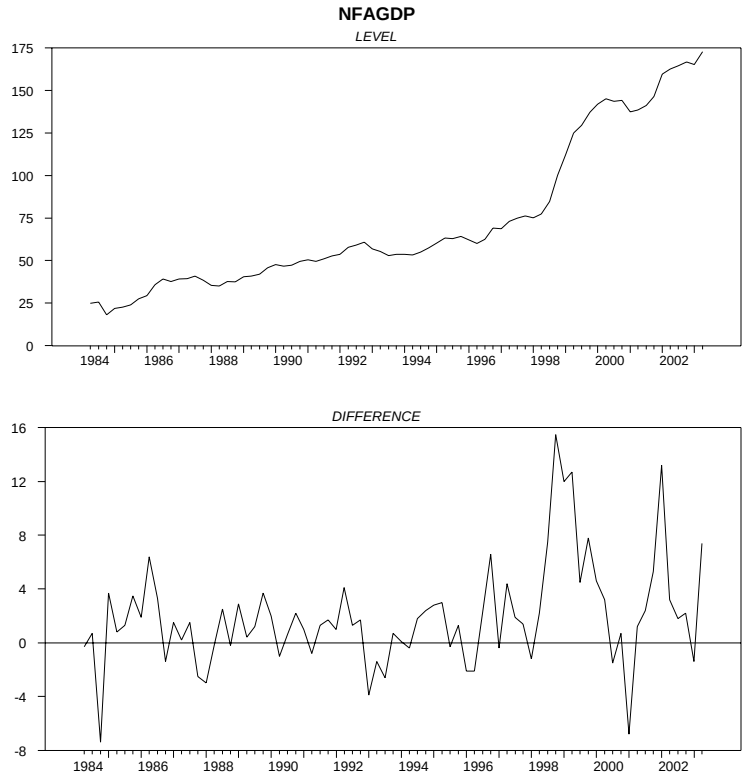


Figure 4: The Log of Property Prices

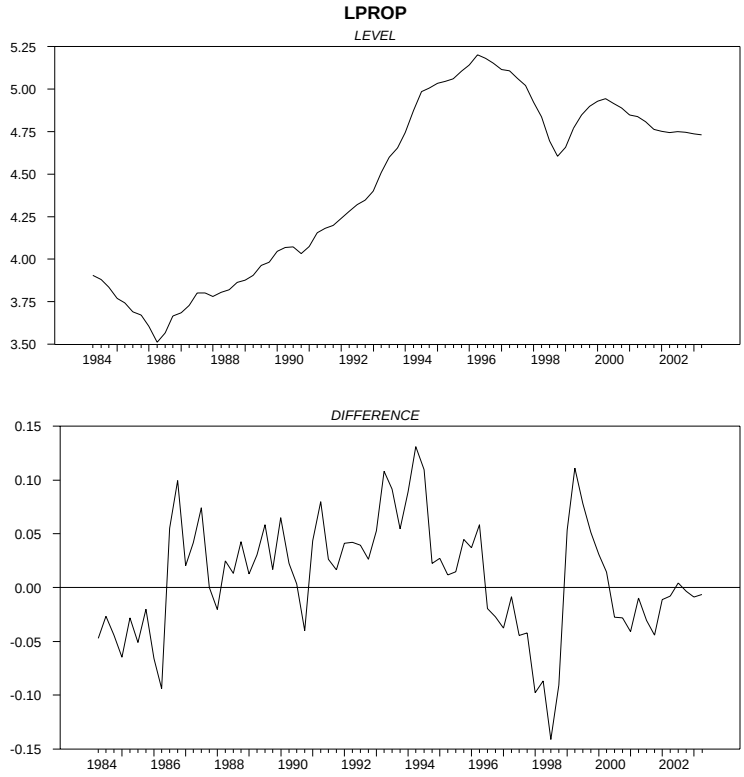
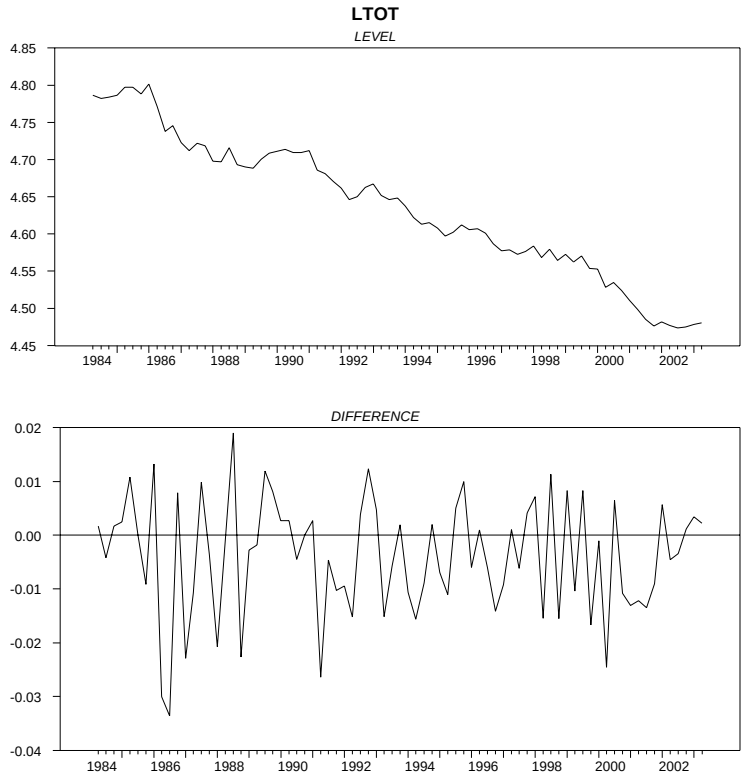


Figure 5: The Log of the Terms of Trade



3.2 In summary form, the Johansen approach involves the following. Assume that the (nx1) vector has an autoregressive representation of the form:

$$x_t = \eta + \sum_{i=1}^{p} \Pi_i \, x_{t-1} + \varepsilon_t \tag{6}$$

where η is a (nx1) vector of deterministic terms, p is the lag length and ε is a (nx1) vector of white noise disturbances, with mean zero and covariance matrix Ξ. Expression (6) may be re-parameterised into the vector error correction mechanism (VECM) as:

$$\Delta x_t = \eta + \sum_{i=1}^{p-1} \Phi_i \Delta x_{t-i} + \Pi x_{t-1} + \varepsilon_t \tag{7}$$

where Δ denotes the first difference operator, Φ_i is a (nxn) coefficient matrix (equal to $-\sum_{j=i+1}^{p} \Pi_j$), Π is a (nxn) matrix (equal to $\sum_{i=1}^{p} \Pi_i - I$) whose rank determines the number of cointegrating vectors. If Π is of either full rank, n, or zero rank, Π=0, there will be no cointegration amongst the elements in the long-run relationship (in these instances it will be appropriate to estimate the model in, respectively, levels or first differences). If, however, Π is of reduced rank, r (where r<n), then there will exist (nxr) matrices α and β such that $\Pi=\alpha\beta'$ where β is the matrix whose columns are the linearly independent cointegrating vectors and the α matrix is interpreted as the adjustment matrix, indicating the speed with which the system responds to last period's deviation from the equilibrium level of the exchange rate. Hence the existence of the VECM model, relative to say a VAR in first differences, depends upon the existence of cointegration.[7]

3.3 We test for the existence of cointegration amongst the variables contained in x_t using the Trace test proposed by Johansen (1995). It tests the null hypothesis that there are at most r distinct cointegrating vectors, using the trace statistic:

[7] The so-called Granger representation theorem (see Engle and Granger (1987)) implies that if there exists cointegration amongst a group of variables there must also exist an error correction representation.

$$TR = T \sum_{i=r+1}^{N} \ln(1 - \hat{\lambda}_i), \tag{8}$$

where $\hat{\lambda}_{r+1}, ..., \hat{\lambda}_N$ are the N - r smallest squared canonical correlations between x_{t-k} and Δx_t series (where all of the variables entering x_t are assumed I(1)), corrected for the effect of the lagged differences of the x_t process.[8] Asymptotic critical values are provided in Doornik (1998), Osterwald-Lenum (1992), and Pesaran, Shin and Smith (2000). Large values of the trace statistic relative to the critical value result in the rejection of the null hypothesis of at least r cointegrating vector. The cointegration test then proceeds sequentially to the next null hypothesis of r + 1 cointegrating vector until the null hypothesis is accepted.

3.4 The sample period is 1983Q1 to 2003Q2 (with the first five observations used to construct the lags in the VAR) and *p* is set equal to 5.[9] The deterministic specification consisted of three seasonal dummies and a constant which was restricted to lie in the cointegrating space. The Trace tests, reported in Table 1, indicate that there may be up to three cointegrating vectors on the basis of the standard 95 per cent critical value (see Johansen (1995)). However, given the relatively small period, we err on the side of caution and use a 99 per cent significance level. On the basis of this, there is clear evidence of one significant cointegrating vector. The trace test confirms that r = 1, since the test statistic of 60.13 is less than 60.16 (99 per cent significance level).

Table 1: Significance of Cointegrating Vectors

H_0:r	Trace	Trace95	Trace99
0	91.63	76.07	84.45
1	60.13	53.12	60.16
2	37.62	34.91	41.07
3	19.32	19.96	24.60
4	2.75	9.24	12.97

Notes: The numbers in the column labelled Trace are the estimated values of (8), while those in the Trace95 and Trace99 columns are the 95% and 99% significance levels from Osterwald- Lenum (1992).

[8] For details of how to extract the λ's see Johansen (1988), and Johansen and Juselius (1992).

[9] Two lags proved sufficient to produce well-behaved residuals.

3.5 Using the residuals from the VAR model, we calculated a number of portmanteau statistics. They are: LM(1) and LM(4), which are multivariate Godfrey (1988) LM-type statistics for first and fourth-order autocorrelation; and NM(12) is a Doornik and Hansen (1994) multivariate normality test. The estimated values of these statistics (p-values in parentheses) are reported in Table 2. The LM(1) and NM(12) tests are insignificant, although the LM(4) statistics is marginally significant.[10]

Table 2: Multivariate Residual Diagnostics

LM (1)	LM(4)	NM(12)
29.72	41.87	15.30
(0.23)	(0.02)	(0.12)

3.6 In Figures 6 to 10 we present the standardised residuals for each of the equations in the system. They confirm that the model is statistically well-determined in the sense that each of the distributions is close to the normal distribution and the residual correlograms indicate that the equations are remarkably free of autocorrelation.

[10] The significance of the LM(4) statistic seems to be attributable to significant fourth order serial correlation in the productivity and real interest rate equations. However, increasing the lag length of the VAR to 4 does not remove these significant terms and we suggest that they probably represent (multiplicative) seasonal spikes.

Figure 6: Residuals from Net Foreign Asset Equation

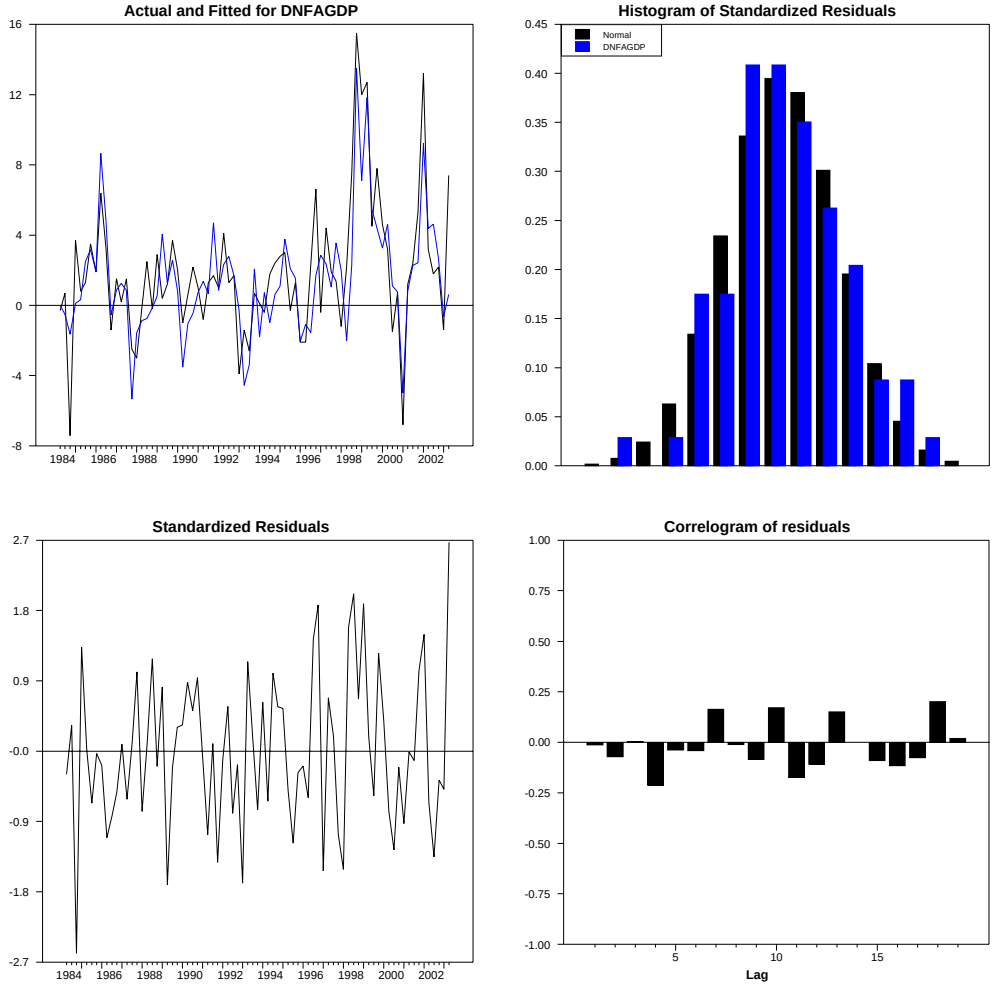


Figure 7: Residuals from Total Trade Equation

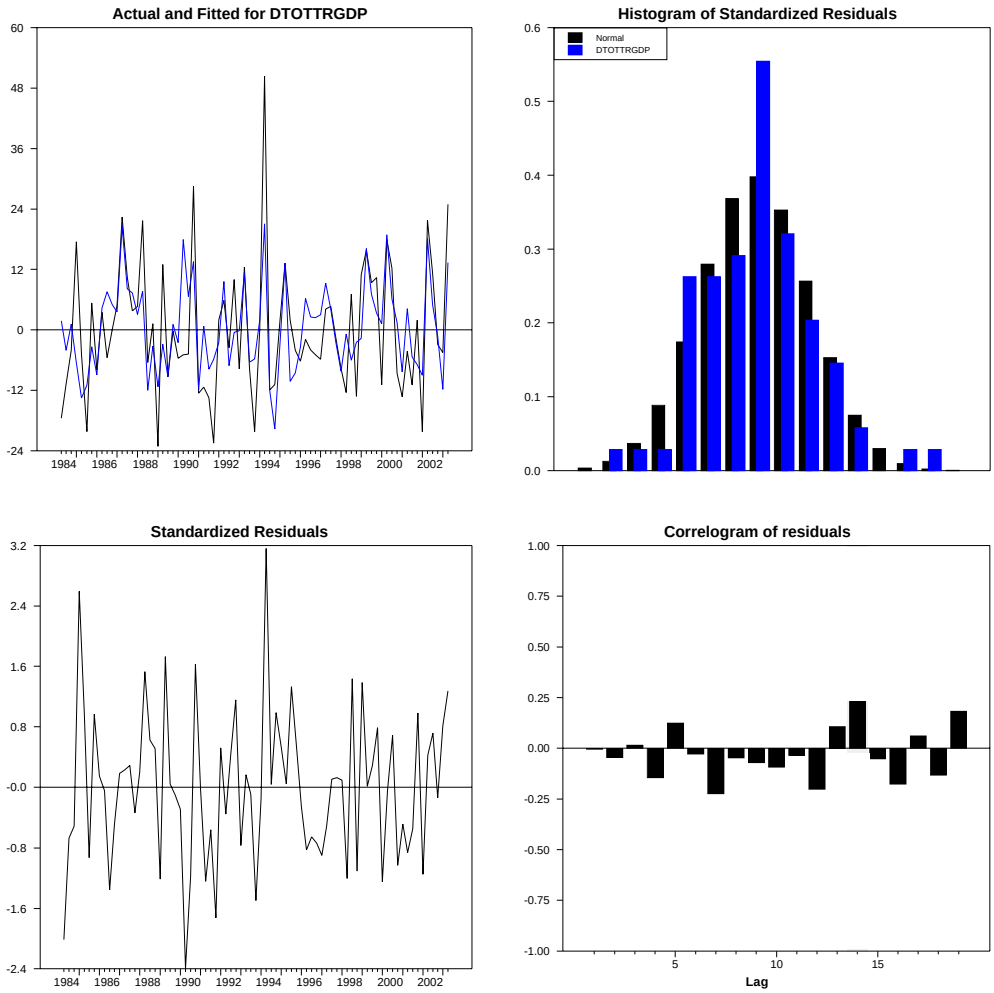


Figure 8: Residuals from Property Equation

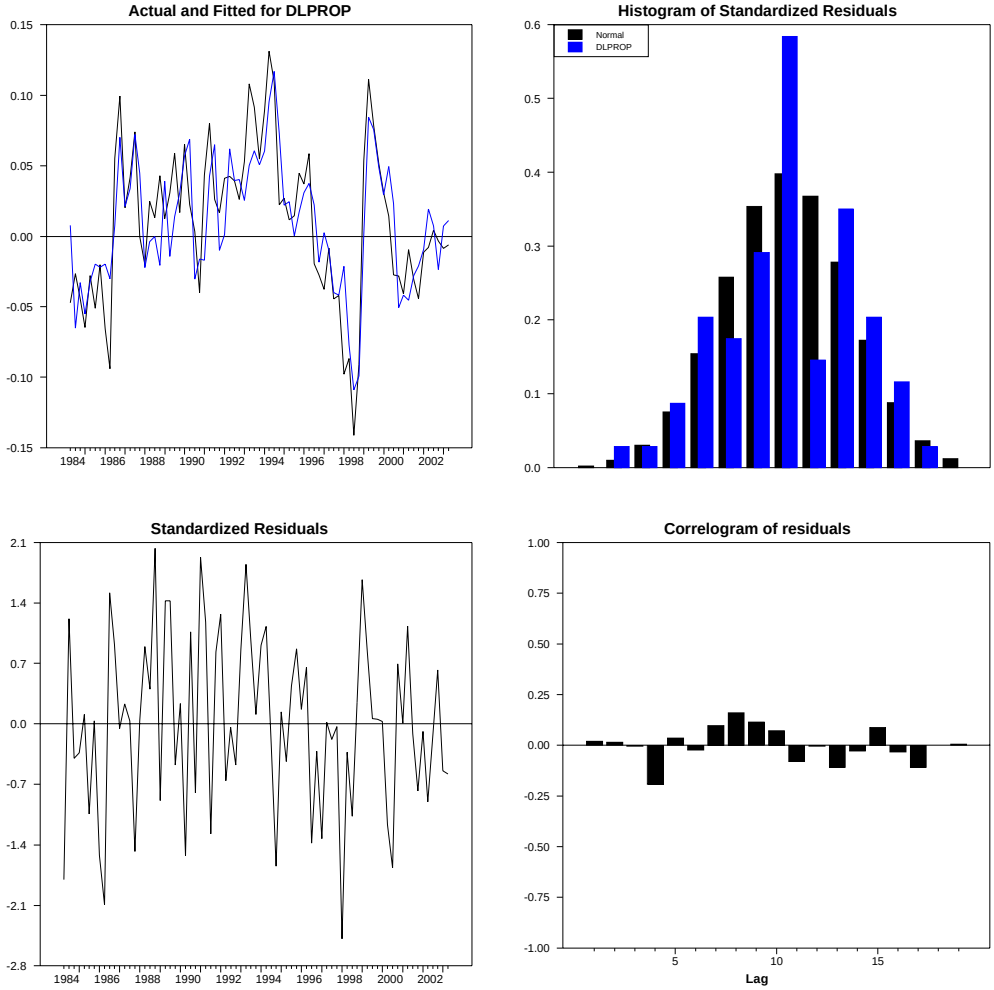


Figure 9: Residuals from Terms of Trade Equation

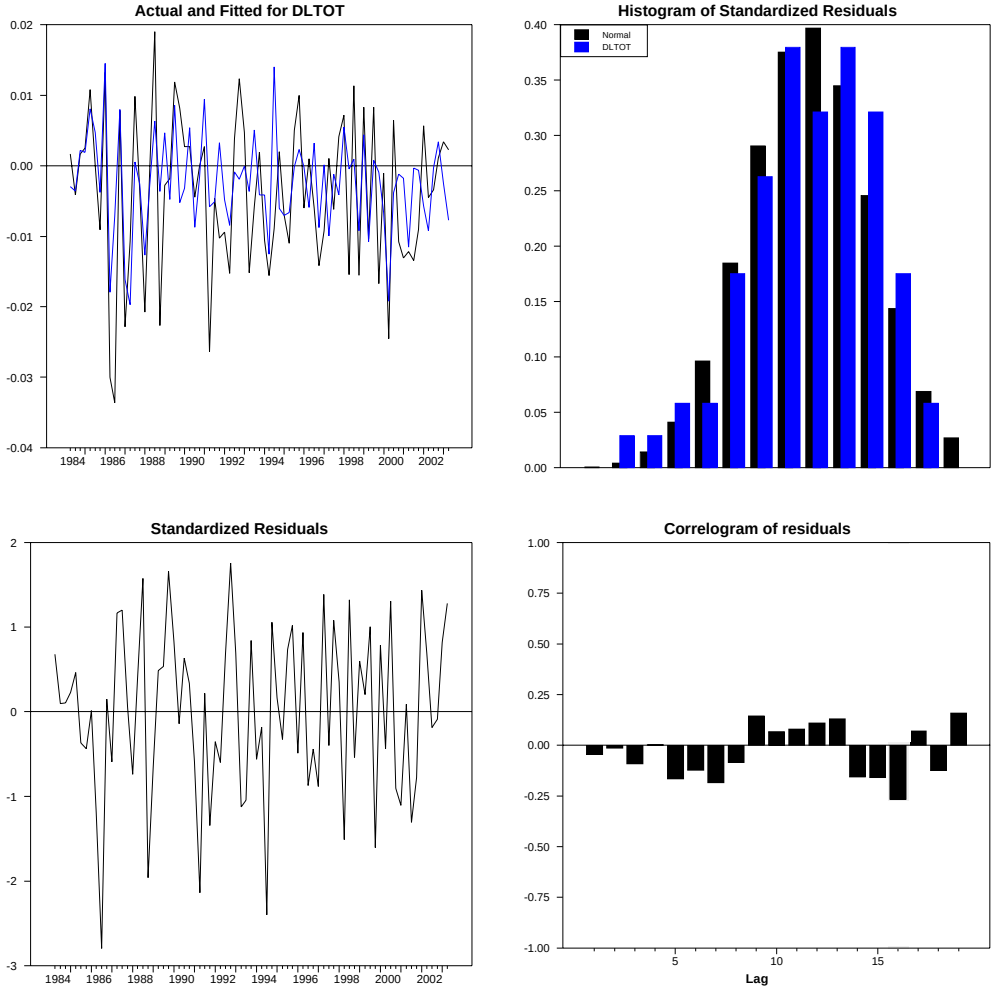
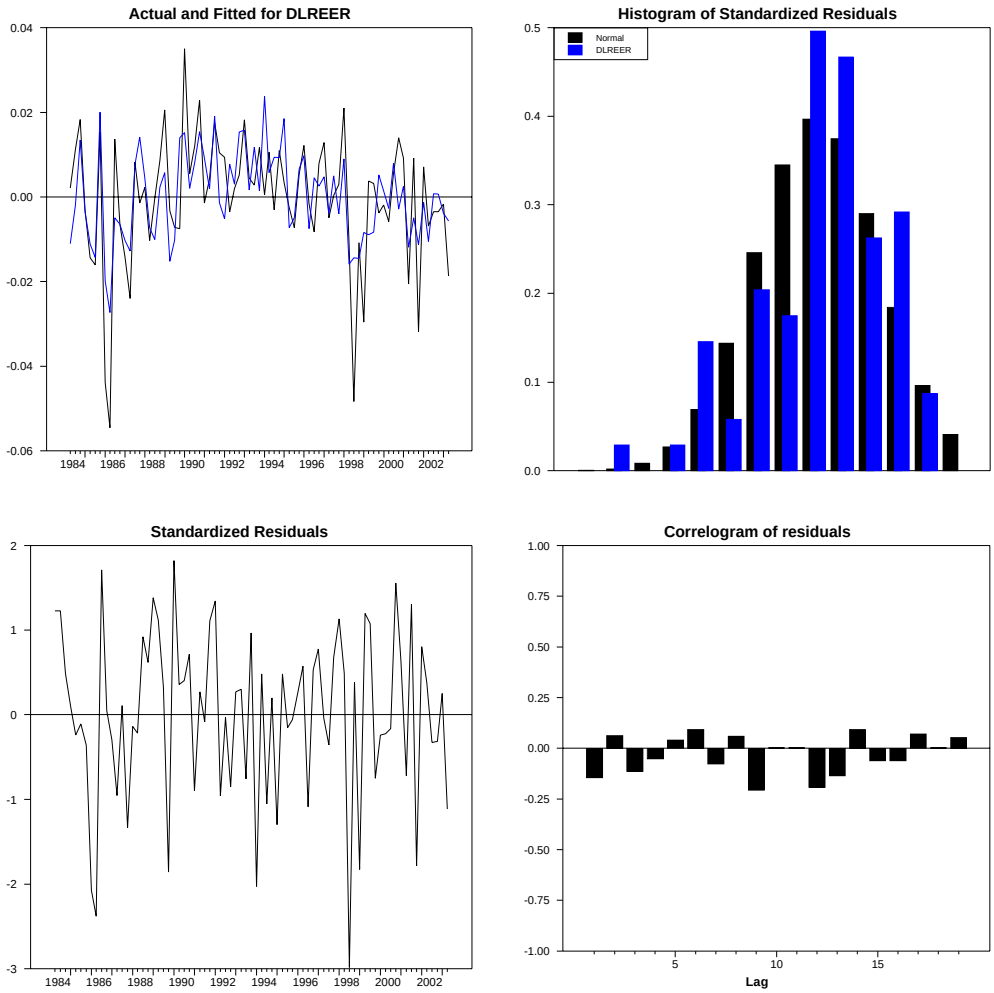


Figure 10: Residuals from Real Exchange Rate Equation



3.7 In Figure 11 we report plots of $\beta' z_t$ and $\beta' R_{kt}$ from the first cointegrating vector. The alpha adjustment terms (in $\Pi=\alpha\beta'$ in equation 7), along with their associated t-ratios are reported in Table 3. We note that both the real effective exchange rate and the openness terms are significantly error correcting to the error correction term. The implied half-life of exchange rate adjustment is approximately five quarters, which is much faster than the typical half-life reported in simple PPP-based regressions (which typically give half-lives of around 4 years), although it is similar to the half-lives recovered in other BEER estimates. For example, MacDonald (2002) reports a half-life of 0.75 years for New Zealand and MacDonald and Ricci (2003) report a half life of 2.5 years for South Africa.

Figure 11: Plots of $\beta' z_t$ and $\beta' R_{kt}$ from the First Cointegrating Vector

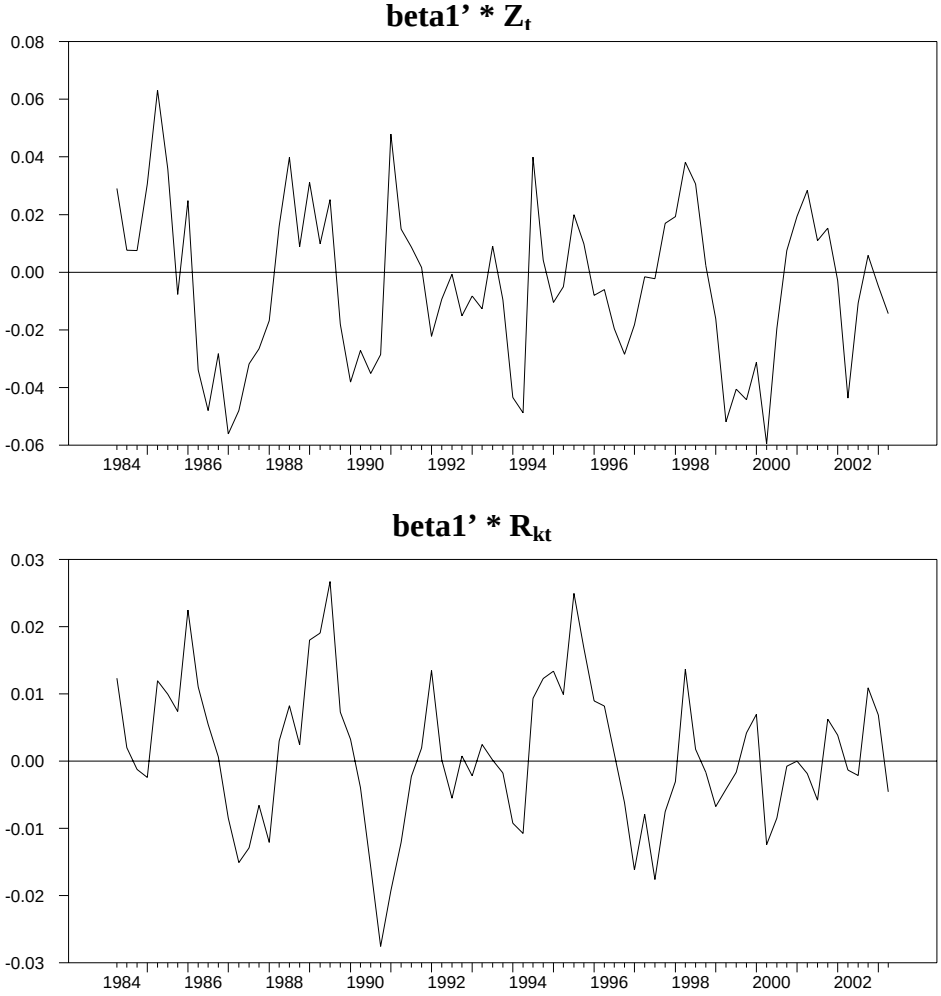


Table 3: Alpha (α) Adjustment Matrix

Variable	alpha1	t-alpha
$\Delta lreer$	-0.295	-2.421
$\Delta ltot$	0.178	1.826
$\Delta lprop$	-0.090	-0.269
$\Delta nfagdp$	25.83	0.993
$\Delta tottrgdp$	404.55	-3.957

3.8 We believe that this rapid adjustment speed illustrates the value of conditioning the real exchange rate on 'real' fundamentals. Normalising the significant cointegrating vector on the real exchange rate we obtain the following relationship (with p-values of significance in parentheses):

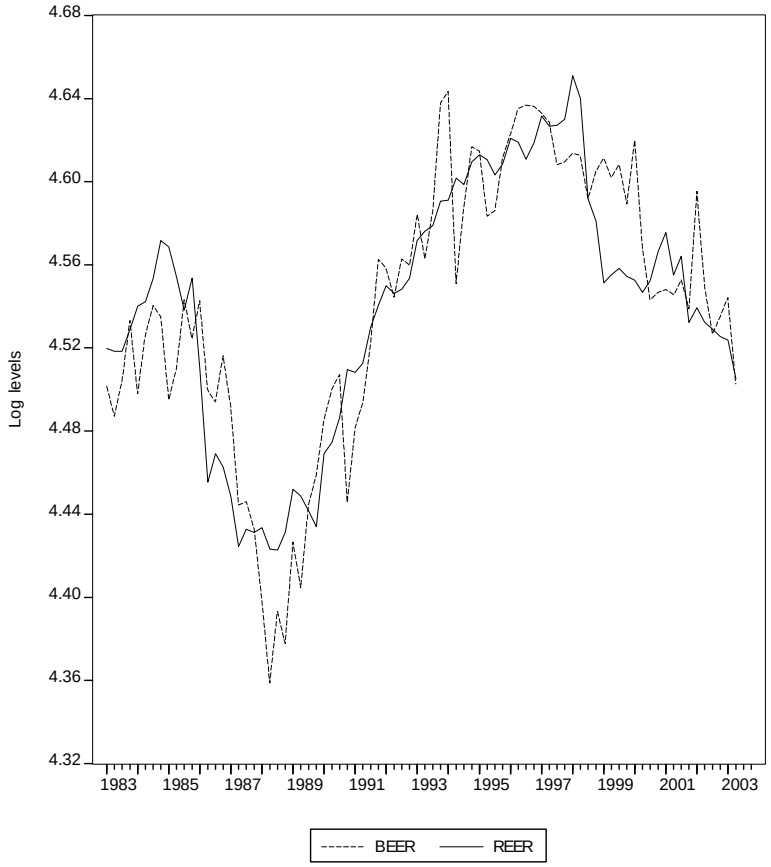
$$lreer_t = \underset{(0.44)}{0.548} + \underset{(0.08)}{0.807}\, ltot_t + \underset{(0.01)}{0.163}\, lprop_t + \underset{(0.00)}{0.001}\, nfa_t - \underset{(0.00)}{0.002}\, ltottra_t . \qquad (9)$$

All of the coefficients are correctly signed, of plausible magnitude and statistically significant. Indeed, on the basis of the Johansen exclusion test, none of the variables can be excluded from the long-run space. The coefficient on the terms of trade is of the same order of magnitude as that reported in other studies (see, for example, MacDonald (2002)). The coefficient on the property price term suggests that a one percent increase in the property price index leads to 0.2 of one per cent appreciation of the real exchange rate. The coefficient on the net foreign asset term is relatively small, although of course this reflects scaling and is consistent with that reported elsewhere in the literature.

4. EXCHANGE RATE MISALIGNMENT

4.1 In Figure 12[11] the estimated BEER derived from equation (9) is plotted against the actual real effective exchange rate. The first thing to note about the estimated BEER is that its volatility is similar to the actual real exchange rate series. Second, we note periods of clear over and undervaluation of the currency. For example, for the period post-1998 the currency has clearly been undervalued, although towards the very end of the sample there is a close alignment between the actual and equilibrium rates.

Figure 12: Measures of Singapore's Equilibrium Effective Exchange Rates - REER and BEER

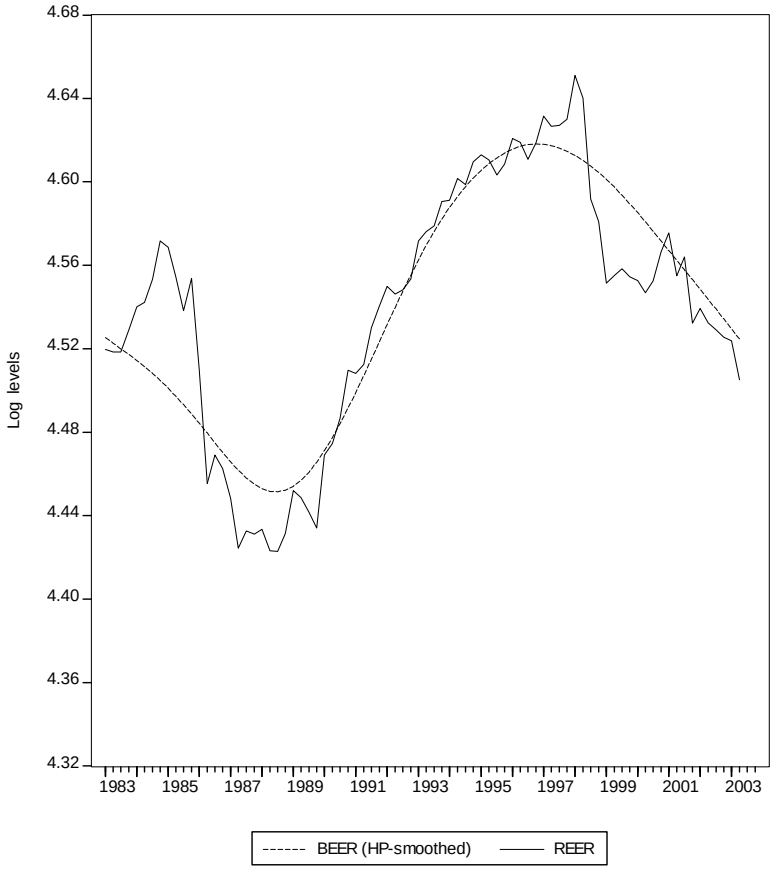


4.2 Of course the BEER measure of undervaluation and overvaluation discussed above is contingent on what is effectively a data-determined measure of equilibrium. Clark and MacDonald (1999) refer to this as a 'current measure of misalignment'. However, it may be that the variables

[11] The BEERs and PEER reported in Figures 12 to 14 were originally constructed in demeaned form. In order to transform them into comparable units to the REER we added the mean value of the REER to each of the BEER and PEER series.

entering the BEER calculation are not themselves at what are deemed to be equilibrium values. A measure of misalignment in which one or all of the forcing variables are calibrated at some measure of equilibrium is labelled a total misalignment by Clark and MacDonald. One simple way of calibrating the BEER is to remove the business cycle from the data using a Hodrick-Prescott (HP) filter and this is reported as Figure 13. This figure confirms the pattern of misalignment in Figure 12, especially in the post-1998 period, but in contrast to Figure 12 shows a degree of undervaluation at the end of the sample period.

Figure 13: Measures of Singapore's Equilibrium Effective Exchange Rates – REER and BEER (HP-smoothed)



4.3 Since the HP filter may be biased, especially at the tail end of the sample, we also propose calculating the total misalignment using the Permanent Equilibrium Exchange Rate (PEER) of Clark and MacDonald (2000). Like the HP filter, this involves using a theoretical decomposition of the series into their permanent and transitory components. The PEER approach may be explained in the following way. Johansen (1995) has demonstrated that equation (7) has a vector moving average representation of the following form:

$$\mathrm{x}_t = C\sum_{i=1}^{t}\varepsilon_i + C\eta + C(L)(\varepsilon_t + \eta)\,, \tag{10}$$

where $C = \beta_\perp(\alpha_\perp'(I - \sum_{1}^{k-1}\Phi_i)\beta_\perp)^{-1}\alpha_\perp'$, $\alpha\perp$ and $\beta\perp$ denote the orthogonal complements to α and β (that is, $\alpha'\alpha\perp = 0$ and $\beta'\beta\perp = 0$) and $\alpha\perp$ determines the vectors defining the space of the common stochastic trends, and therefore should be informative about the key 'driving' variable(s) in each of the systems. The $\beta\perp$ vector gives the loadings associated with $\alpha\perp$, i.e., the series which are driven by the common trends. Thus the C matrix measures the combined effects of these two orthogonal components.

4.4 If the vector x is of reduced rank, r, then Gonzalo and Granger (1995) have demonstrated that the elements of x can be explained in terms of a smaller number (n - r) of I(1) variables called common factors, f_t, plus some I(0) components, the transitory elements, $\tilde{x}_t$:

$$\mathrm{x}_t = A_1\mathrm{f}_t + \tilde{\mathrm{x}}_t\,. \tag{11}$$

The identification of the common factors may be achieved in the following way. If it is assumed that the common factors, f_t, are linear combinations of the variables x_t:

$$\mathrm{f}_t = B_1\mathrm{x}_t\,, \tag{12}$$

and if $A_1 f_t$ and $\tilde{\mathrm{x}}_t$ form a permanent-transitory decomposition of x_t, then from the VECM representation (7), the only linear combination of x_t such that $\tilde{\mathrm{x}}_t$ has no long-run impact on x_t is:

$$\mathrm{f}_t = \alpha_\perp'\mathrm{x}_t\,. \tag{13}$$

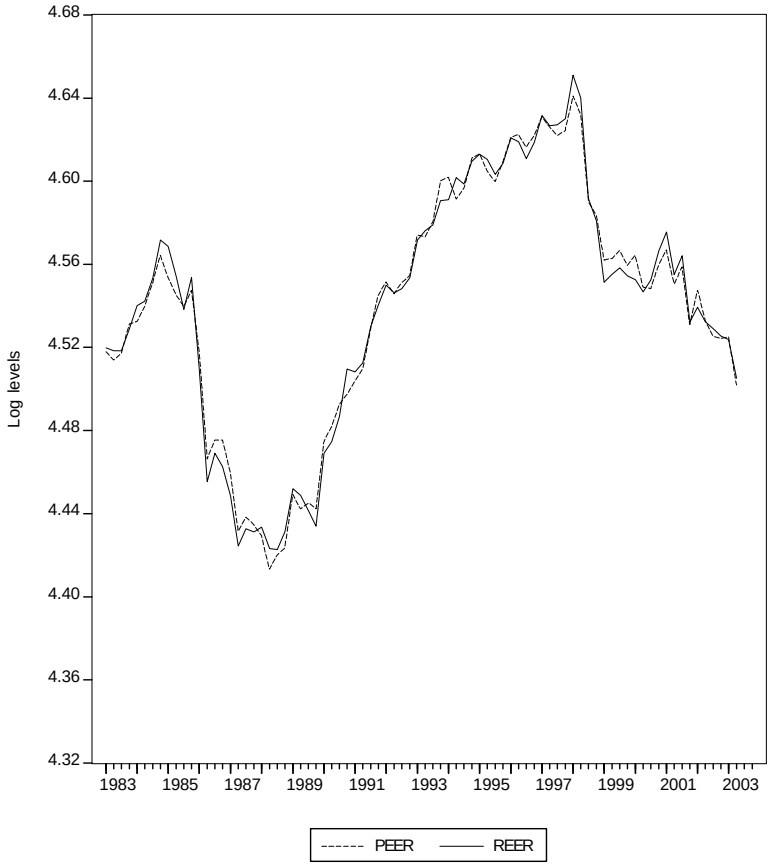
4.5 As Gonzalo and Granger point out, these are the linear combinations of Δx_t which have the 'common feature' of not containing the levels of the error correction term in them. This identification of the common factors enables Gonzalo and Granger to obtain the following permanent-transitory decomposition of x_t :

$$x_t = A_1 \alpha_\perp' x_t + A_2 \beta' x_t, \quad (14)$$

where, of terms not previously defined, $A_1 = \beta_\perp (\alpha_\perp' \beta_\perp)^{-1}$ and $A_2 = \alpha(\beta'\alpha)^{-1}$. It is straightforward to demonstrate that the common factor, f_t, corresponds to the common trend in the analysis of Stock and Watson (1988).

4.6 In Figure 14 we also present the estimated PEER calculated using (14) alongside the actual REER. We note that the basic difference between the BEER and PEER estimates of equilibrium is that the latter provides a much smoother – less volatile - measure of equilibrium, and this in large measure reflects the origin of the PEER as the 'permanent' component of the REER. The closeness between the PEER and REER means that periods of over and undervaluation do not appear to be so dramatic in this picture and this is most marked in the final period where there is, as in the BEER-based estimates, very little evidence of misalignment.

Figure 14: Measures of Singapore's Equilibrium Effective Exchange Rates - REER and PEER



5. CONCLUDING COMMENTS

5.1 In this paper, we have estimated a BEER-based measure of the equilibrium exchange rate for Singapore over the sample period 1983Q1 to 2003Q2. Using the multivariate cointegration methods of Johansen (1995), we demonstrated that there is a statistically significant cointegrating vector which comprises, in addition to the log of the real effective exchange rate, the log of the terms of trade, the log of property prices, net foreign assets and a measure of openness. All of the variables entered the cointegrating vector with the correct sign and all were statistically significant. Using this cointegrating relationship we then estimated the BEER and this showed, on average, an undervaluation of the currency in the post-1998 period, although the currency was close to its equilibrium in the final sample period (2003Q2), a finding confirmed by our estimates derived from the PEER.

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VARIABLES : DEFINITIONS AND SOURCES

q : Log of Real Effective Exchange Rate deflated by Singapore's CPI relative to trading partner countries
Sources for Exchange Rates: MAS
Sources for Singapore's CPI: Department of Statistics, Singapore
Sources for partner countries' CPI: IFS, IMF; CEIC; Datastream

r-r* : Nominal Interest Rate relative to trading partner countries
Sources for Singapore: MAS
Sources for partner countries: IFS, IMF; CEIC; Datastream

nfa : Net Foreign Assets
Source: MAS internal estimates.

lprod : Singapore's Labour Productivity relative to trading partner countries
Sources for Singapore: Department of Statistics, Singapore
Sources for partner countries: National Sources; Datastream

gapd : Output Gap in Singapore less the trade-weighted foreign output gap
Sources for Singapore GDP: Department of Statistics, Singapore
Sources for partner countries GDP: IFS, IMF, CEIC, Datastream
The Singapore output gap measure was calculated by adopting a multivariate filter method, estimated using the Kalman filter.
The world output gap measure was calculated by running an HP filter through a trade-weighted measure of GDP for Singapore's trading partners.

ltot : Terms of Trade
Source : Department of Statistics, Singapore

ltotta : Ratio of Total Trade to GDP
Sources: International Enterprise, Singapore (for Total Trade) and Department of Statistics (for GDP)

lprop : Log of Private Residential Property Price Index
Source: Urban Redevelopment Authority of Singapore

lpcon : Log of Private Consumption at 1995 Market Prices
Source: Department of Statistics, Singapore

lfcon : Log of Government Consumption at 1995 Market Prices
Source: Department of Statistics, Singapore