Behavioural equilibrium exchange rate estimates and implied exchange rate adjustments for ten countries.

Ronald MacDonald and Preethike Dias

University of Glasgow and Peterson Institute of International Economics

Abstract
In this paper we estimate the behaviour equilibrium exchange rates (BEERs) of Clark and MacDonald (1999) for the effective exchange rates of ten industrialised and emerging market economies that rank within the top 15 contributory economies to global imbalances. The sample period is 1988, quarter 1 to 2006 quarter 1. The conditioning variables used in the estimation of the BEER are: net exports as a proportion of GDP, a real interest differential, a terms of trade differential and GDP per capita differential. The 'foreign' magnitudes in the differentials were constructed using the trade weights used to construct the effective exchange rates. Using both single country and panel econometric methods, plausible BEER estimates were reported. These estimates were then used to back out the required exchange rate adjustments necessary to fulfil the three scenarios of Williamson (2006). The ball park currency adjustments required are in the range of 27.3 to 46.6 per cent devaluations for the Chinese renminbi, 5 to 11 per cent for the US dollar, approximately 6 per cent for the Japanese yen and no adjustment for the euro or Sterling.

Paper prepared for the workshop on Global Imbalances, Peterson Institute of International Economics, Washington DC February 2007.

Calculating equilibrium exchange rates and assessment issues have become especially topical of late for a variety of reasons. First, a number of countries – such as the Central European countries which recently acceded to the EU, and the UK and Sweden – have an interest in knowing the appropriate exchange rate for entry into the euro area (either in terms of the rate at which to participate in an ERM II arrangement or the appropriate rate at which to lock a currency permanently to the euro). Second, the behaviour of certain currencies, such as the initial sharp and sustained fall in the external value of the euro immediately after its inception in 1999, the sustained appreciated value of sterling in the late 1990's and the post 2005 behaviour of the Chinese renimmbi against the US dollar, has generated a debate about the sources of exchange rate movements. Does such behaviour represent movements in the underlying equilibria, and therefore the currencies are correctly priced, or do they represent misalignments? Third, and of most direct concern to this workshop, is the issue of observed global imbalances and the implications of such imbalances for exchange rate behaviour and particularly the exchange rate movements required to address these imbalances. Clearly, to answer these kinds of issues requires some measure of an equilibrium exchange rate.

Purchasing power parity (PPP) is often the measure economists first turn to when asked to think about the issue of equilibrium exchange rates and exchange rate misalignment. But the implications of the so-called PPP puzzle – the combination of high real exchange rate volatility and the slow mean reversion of real exchange rates – implies that PPP on its own is unlikely to be a useful measure of an equilibrium exchange rate. There is now a considerable body of evidence to indicate that in order to understand the slow mean reversion of real exchange rates and, indeed, calculate useful measures of equilibrium exchange rates, explicit recognition has to be given to the sources of the slow mean reversion of real exchange rates and the persistent violations of PPP. In this paper we consider one such approach, namely the behavioural equilibrium exchange rate, or BEER, approach of Clark and MacDonald (1999) and use it to assess the extent of real exchange rate adjustment necessary to move a number of countries external balances to desired or sustainable levels. The best-known alternative to the BEER, which also takes an explicitly ‘real approach’ to modelling real exchange rates is the internal external balance approach. Within the internal external balance approach we have the Fundamental Equilibrium Exchange rate (or FEER) of Williamson (1983), the IMF CEGR approach of Faruqee et al (1989) and the NATREX approach of Stein (1999). Other approaches to equilibrium exchange rates which allow for explicit deviations from PPP are the Permanent Equilibrium exchange rate (or PEER) approach and the capital enhanced equilibrium exchange rate (or CHEER); see MacDonald (2007) for a further discussion of these approaches.

The outline of the remainder of this paper is as follows. In the next section we briefly sketch the BEER approach and contrast it with the internal external balance approach. In Section 3 we discuss our data set and, specifically, its construction. Our results are sketched in Section 4 for 10 countries using a data sample which runs from 1988 to 2006. The simulation results in which we calculate how much exchange rates would have to move in order to move external balances to their scenario values as given in Williamson (2007) are presented in Section 5. Some concluding remarks are drawn in Section 6.

2. Measuring Exchange Rate Misalignment

The original BEER approach of Clark and MacDonald (1999) is not based on any specific exchange rate model, and in that sense may be regarded as a very general approach to modelling equilibrium exchange rates. That said, a central element of most BEER applications is the condition that the current account should equal zero in equilibrium. Furthermore, the BEER takes as its starting point the proposition that real factors are a key explanation for the slow mean reversion to PPP observed in the data and in this sense is similar to variants of the internal external balance approach such as the FEER. In sum, the BEER approach offers a way of exploiting a theoretical (real) exchange rate model in order to obtain a measure of the equilibrium exchange rate and therefore, by implication, exchange rate misalignment.

The BEER approach is usually argued to have a number of advantages over variants of the internal external balance approach and, specifically, the FEER. For example, in contrast to the FEER, which Wren-Lewis (1998) has argued is a method of calculation rather than an estimated exchange rate model, the BEER has the potential to capture all of the systematic and fundamental movements of exchange rates and can be subject to rigorous statistical testing, in terms of various metrics, such as the speed of mean reversion. The BEER is also a highly tractable approach to gauging an equilibrium exchange rate, usually relying on a single equation approach, using either time series or panel data. In contrast, FEER-based estimates often require a full blown multi-country macroeconomic model which can be cumbersome, although they can also have advantages in terms of ensuring internal consistency of the estimates (see Faruqee et al (1989)). In contrast to some FEER-based estimates, the BEER can produce measures of exchange rate misalignment which are free of any normative elements retaining to, say, sustainability.

Following Clark and MacDonald (1999), we define Z_{1t} as a set of fundamentals which are expected to have persistent effects on the long-run real exchange rate and Z_{2t} as a set of fundamentals which have persistent effects in the medium-run, that is over the business cycle. As we shall see below, the key term in the Z_{1t} vector is usually taken to be net foreign assets and, perhaps also, a relative productivity term and the terms of trade, while the Z_{2t} usually contains real interest rate yields, to capture medium run, or business cycle related influences on the real exchange rate. Given this, the actual real exchange rate may be thought of as being determined in the following way:

$$q_t = \beta_1' Z_{1t} + \beta_2' Z_{2t} + \tau' T_t + \varepsilon_t . \qquad (1)$$

where T is a set of transitory, or short-run, variables and ε_t is a random error. Following Clark and MacDonald (1999), it is useful to distinguish between the actual value of the real exchange rate and the current equilibrium exchange rate, q_t'. The latter value is defined for a position where the transitory and random terms are zero:

$$q_t' = \beta_1' Z_{1t} + \beta_2' Z_{2t} . \qquad (2)$$

The related current misalignment, *cm*, is then given as:

$$cm \equiv q_t - q_t' = q_t - \beta_1' Z_{1t} - \beta_2' Z_{2t} = \tau' T_t + \varepsilon_t , \qquad (3)$$

and so *cm* is simply the sum of the transitory and random errors. As the current values of the economic fundamentals can deviate from the sustainable, or desirable, levels, Clark and MacDonald (1999) also define the total misalignment, *tm*, as the difference between the actual and real rate given by the sustainable, or long-run, values of the economic fundamentals, denoted as :

$$tm_t = q_t - \beta_1^{'} \bar{Z}_{1t} - \beta_2^{'} \bar{Z}_{2t} . \qquad (4)$$

The calibration of the fundamentals at their desired levels may either be achieved by the user placing some judgement on what values the actual variables should have been during the sample period or, perhaps, using some sort of statistical filter, such as the Hodrick-Prescott filter, a Beveridge Nelson decomposition or a Granger-Gonzalo decomposition to produce a PEER. By adding and subtracting $q_t^{'}$ from the right hand side of (4) the total misalignment can be decomposed into two components:

$$tm_t = (q_t - q_t^{'}) + [\beta_1^{'}(Z_{1t} - \bar{Z}_{1t}) + \beta_2^{'}(Z_{2t} - \bar{Z}_{2t})] , \qquad (5)$$

and since $q_t - q_t^{'} = \tau' T_t + \varepsilon_t$, the total misalignment in equation (5) can be rewritten as:

$$tm_t = \tau' T_t + \varepsilon_t + [\beta_1^{'}(Z_{1t} - \bar{Z}_{1t}) + \beta_2^{'}(Z_{2t} - \bar{Z}_{2t})]. \qquad (6)$$

Expression (6) indicates that the total misalignment at any point in time can be decomposed into the effect of the transitory factors, the random disturbances, and the extent to which the economic fundamentals are away from their sustainable values. Other approaches to the equilibrium real exchange rate do not necessarily make this distinction explicit - the FEER and PEER approaches focus on measures of total misalignment, while the CHEERS approach focuses on current misalignment.

To illustrate their approach, Clark and MacDonald (1999) take the risk adjusted real interest parity relationship, which has been used by a number of researchers to model equilibrium real exchange rates (see, for example, Faruqee (1995) and MacDonald (1998), (1999))

$$\Delta q^e_{t+k} = -(r^e_{t,t+k} - r^{*e}_{t,t+k}) + \lambda_t, \tag{7}$$

Where: Δq^e_{t+k} is the difference between the real exchange rate expected in t for $t+k$ ($q^e_{t,t+k}$) and the observed real exchange rate in period t, q_t, where the latter is defined as the foreign currency price of a unit of home currency and a rise denotes an appreciation, $r^e_{t,t+k}$ is the ex ante real interest rate ($r^e_{t,t+k} = i_t - \Delta p^e_{t+k}$), an asterisk denotes a foreign magnitude and λ_t is a measure of the risk premium, usually assumed to be a function of relative bond supplies. Expression (7) may be rearranged as an expression for the real exchange rate as:

$$q_t = q^e_{t,t+k} + (r^e_{t,t+k} - r^{*e}_{t,t+k}) - \lambda_t. \tag{8}$$

If $q^e_{t,t+k}$ is interpreted as the 'long-run', or systematic, component of the real exchange rate, it can be assumed to be the outcome of the expected values of the fundamentals and can be replaced by $\bar{q}_t$ as in (9):

$$q_t = \bar{q}_t - (r^e_{t,t+k} - r^{*e}_{t,t+k}) - \lambda_t, \tag{9}$$

What determines $\bar{q}_t$? Nearly all open economy macro models which have as their focus the long-run equilibrium exchange rate have as a tie down condition that the current account be zero in equilibrium:

$$ca_t = tb_t + r^*_t nfa_t = 0, \tag{11}$$

or:

$$tb_t = -r^*_t nfa_t, \tag{12}$$

and that the real exchange rate will be more depreciated the larger is the steady state surplus:

$$q_t = -\alpha tb_t + \beta X_t , \tag{13}$$

where X_t denotes other factors determining the real exchange rate. Equations (12) and (13) may then be used to solve for the real exchange rate as:

$$q_t = \alpha nfa_t + \beta X_t , \tag{14}$$

where the real exchange rate is increasing in the net foreign asset position. This is the kind of relationship which is normally estimated in BEER type equations (see, for example, Clark and MacDonald (1989), and the survey of equilibrium exchange rate relationships by Egert, Halpern and MacDonald (2006)). However, even using annual data coefficient estimates on the *nfa* term are often imprecisely estimated and Lane and Milesi-Ferretti (2001), *inter alia*, propose estimating a variant of (13) directly. That is the approach adopted in this paper. The variables entering the Z_t vector in our work are measures of relative productivity, measured as per capita GDP, and the terms of trade. In sum, the relationship we propose estimating is:

$$q_t = f(\overset{-}{tb_t}, \overset{+}{toft_t'}, \overset{+/-}{prod_t'}, \overset{+}{r_t'}) ,$$

where tb_t denotes the trade balance expressed as a proportion of GDP, *toft* is the terms of trade, $prod_t$ is productivity, measured as per capita GDP, r_t denotes a real interest rate, and a ′ denotes a relative magnitude (home foreign). We do not model the risk premium term.

In sum, the estimation of the BEER essentially proceeds in four stages:

1) Estimating the statistical long-run relationship between the real exchange rate, the fundamentals and short-run variables, which is tantamount to estimating a reduced form real exchange rate model. This is normally achieved using a VECM approach or a panel estimator;

2) Calculating the actual or current misalignment. Short-term variables are set to zero and actual values of fundamentals identified in step 1) are substituted into the estimated relationship. The actual misalignment is taken as the difference between the fitted and the actual value of the real exchange rate;

3) Identifying long-run, or sustainable, values for the fundamentals. This can be achieved either by decomposing the series into permanent and transitory components (for example, using an HP filter or a Beveridge-Nelson decomposition), or using a subjective evaluation of the long-term values is also possible;

4) Calculating total misalignment. In this case long-term values of fundamentals are substituted into the estimated relationship, relating the real exchange rate to the fundamentals, and short-term variables are again set to zero. Total misalignment is the difference between the fitted and actual value of the real exchange rate when sustainable values of fundamentals are used. Total misalignment depends on the short-term effect and on the departure of fundamentals from their long-term value;

The BEER has been widely used for the calculation of equilibrium exchange rates for the main industrial countries more and recently for the so-called transition countries (for a survey see Egert, Halpern and MacDonald (2006) and MacDonald (2007)).

3. Data and Estimation methods.

The empirical estimations of BEER models provided in this paper are for 10 industrialised and emerging market economies that rank within the top 15 contributory economies to global imbalances. These countries are as follows: Canada, China, Germany, Norway, Singapore, Sweden, Switzerland, U.K and U.S. Germany has been used as a proxy for Euro Area due to data limitations from the Euro zone. Although Germany may be a good proxy for he euro area prior to the creation of the euro, more recently Germany has recorded a current account surplus as opposed to the current account deficit registered by the Euro Area as a whole. Our quarterly data sample, which was mainly determined by the availability of data, ranges from 1988:01 to 2006:01. The main source for the data set is the IFS statistics data-base and in case of few series for which IFS data are unavailable for sufficiently long periods or in the frequency of our estimations, data from Data Stream, taken from OECD were used instead. In cases where the only available data frequency is annual, data interpolation techniques detailed in E-views 4 manual (2000) were used to convert them to comparable quarterly data. Data series of GDP and net exports were annualised in order to obtain the levels of these series as IFS quarterly data reports the changes for some countries. Data appendix-1 provides details of data sources used in this modelling exercise and the main series of interest are detailed below:

a) Real Effective Exchange Rate – This is the log of real effective exchange rate index derived from the nominal effective exchange rate index, adjusted for relative changes in consumer prices. This index is based on the latest trade weights detailed in Bayoumi, Jaewoo Lee and Sarma Jayanthi (2005) which takes account of each country's trade in both manufactured good and primary products of its trading partners. These time series are plotted in figure 4.

b) Net exports - This is the annualised trade balance expressed as a proportion of the annualised GDP in local currency. A positive net exports series indicates that exports are taking a larger proportion of the GDP to that of imports where as a negative trade balance indicates the opposite.

c) Real interest differential - This is the difference between the real interest rate of a particular country in our study e.g. Japan, and the sum of the trade weighted series of real interest rates of the remaining 9 countries. The trade weighting is carried out by multiplying each of the real interest rates of the remaining 9 economies with their respective trade weights in relation to Japan. These trade weights are reported in part b of the data appendix and figure 1in the appendix plots the trade-weighted series for the 10 countries.

d) Terms of trade differential – This is the log of the terms of trade index of a particular country expressed as a proportion of the sum of trade weighted terms of trade indices of the remaining nine countries. Figure 2 in the appendix provides the plots of these series.

e) GDP Per capita differential – This is the log of real GDP per capita of a particular country expressed as a proportion of the sum of trade-weighted real GDP per capita of the remaining nine countries. The plots for these series are found in Figure 3 of the appendix.

In this paper we use two estimators to construct our BEER estimates: the multivariate cointegration estimator of Johansen (1995) and a Panel DOLS estimator.

Since the former estimator is now well know we do not discuss it further here. The latter estimator, which is perhaps not so well known, has the following form:

$$y_{it} = \theta_{1i} + \theta_{2t} + \theta_3 x_{it} + \sum_{j=-p}^{+n} \theta_{4j} \Delta x_{i,t+j} + \omega_{it} .$$

Where y_{it} is a scalar, x_{it} is a vector with dimension k, θ_{1i} is an individual fixed effect, θ_{2t} is a time effect θ_3 represents a cointegrating vector, p is the maximum lag length and n is the maximum lag lead and ω is a Guassian vector error process. The leads and lags of the first differences are included to orthogonalise the error term.

4. Econometric Results

The single country BEER estimates derived using the multivariate cointegration methods of Johansen are given in Table 1. The Table should be read in the following way: Columns 2 to 4 give the coefficient values of the listed variables (with t-ratios in parenthesis); column 5 indicates if cointegration exists (with the number of cointegrating vectors in brackets); the final column indicates the coefficient, and associated t-ratio, of the alpha coefficient on the error correction term in the dynamic exchange rate equation; the row headings indicate the country in question.

All of the estimates shown in Table 1 indicate the existence of one significant cointegrating vector for each of the countries and all of the systems produce a negative loading terms in the exchange rate relationship and all apart from two of these terms are statistically significant. Apart from the UK, the coefficients on the trade balance term are statistically negative. We now turn to a more detailed discussion of the results. For Canada, all of the coefficients are correctly signed and statistically significant. Although the coefficient on the relative productivity term is wrongly signed in terms of the standard neoclassical (Balassa-Samuelson) framework, it is correctly signed in terms of the more recent theoretical interpretation of the effects of productivity on the exchange rate (see, for example, MacDonald and Ricci (2002)). The coefficient on the trade balance suggest that a one percent reduction in the trade surplus requires a 4.13 appreciation of the log of the real effective exchange rate. Note that although the mean reversion speed for Canada is negative, it is also insignificant, a fact that we attribute to the relatively short data span. With the exception of the interest rate term, all of the coefficients are correctly signed in the Chinese BEER relationship and the coefficient on the trade balance is very large, suggesting a very large movement in the real exchange rate is required to adjust the trade balance. The mean reversion coefficient is significantly negative in the Chinese case.

The results for Germany, reported in Table 1, have the coefficient on the trade balance term significantly negative, suggesting that a one percent change in the German trade balance requires a 3 per cent change in the real exchange rate. Other coefficients in the German equation are insignificant, although the mean reversion coefficient is statistically significant. The Japanese estimates produce a very large, in absolute terms, coefficient on the trade balance and a significantly negative mean reversion term. The results for the Norwegian effective give a significantly negative coefficient on the trade balance term of –1.53; other coefficients in this relationship are either wrongly signed or insignificant, although there is clear evidence of significant error correction. The coefficient on the trade balance for Singapore is in the ball-park of the Canadian and German estimates being approximately minus 2.5 and statistically significant. Other coefficients are statistically significant in the Singapore case including the mean reversion speed.

Both Sweden and Switzerland have significantly negative coefficients on their trade balance terms of –4.52 and -1.85, respectively with other coefficients being something of a mixed bag; mean reversion speeds are both significant and Switzerland has the second highest adjustment of any of the countries. The UK results are something of an outlier in the sense that the coefficient on the trade balance term is positive, although insignificantly so, and it produces the largest alpha term, in absolute terms, of any of the countries. The results for the United States indicate a coefficient on the trade balance of around -1.3, with a t-ratio that is only slightly above one; the coefficients on the productivity and real interest rate terms are significant although that on the real interest rate is wrongly signed. The mean reversion speed for the US although correctly signed is statistically insignificant. We argue that the variance between these results and those of Clark and MacDonald (1999) can be attributed to the relatively short time series dimension of the data.

The panel DOLS estimates are presented in Tables 2 through 4. In columns two and three of Table 2 the results for the full sample of 10 countries, with the full time sample, are presented, with and without time dummies. In both specifications the coefficient on the trade balance term enters with the wrong sign and is small in magnitude, although statistically significant. The coefficients on the relative productivity and terms of trade variables are correctly signed and significant in both cases. The coefficient on the real interest rate term is wrongly signed, although insignificant. In columns 4 and 5 of Table 2 these tests are repeated with the real interest rate term dropped. The story on the remaining coefficients is essentially unchanged relative to columns 2 and 3.

In Table 3 we present a similar set of panel DOLS estimates for the G3 countries. Here, strikingly, the coefficient on the trade balance term is significantly negative with a ball park figure of around 3; that is, a one percentage point improvement in the trade balance requires a 3 per cent movement in the real exchange rate. Other coefficients values and their significance are also broadly similar to those reported in Table 2. The results for the panel of non-G3 countries, reported in Table 4 are in broad conformity with those reported in Table 2, although the coefficient on the trade balance becomes statistically insignificant in the specification with time effects.

Our panel DOLS estimates are broadly similar to those reported in Lane and Milesi-Ferretti (2002) for a panel of 20 countries over the period 1970 to 1998. Specifically, they find a statistically significant coefficient on the trade balance of around -6 for the G3, but a statistically insignificant, although negative, coefficient of -0.3 for the non-G3 (with the full sample being a significant and -0.72).

5. BEER Estimates and Target Current Accounts

The simulation exercises are reported in Table 5 for the scenarios I to III in Williamson (2006). Scenario I involves the identified surplus countries reducing the size of their surpluses by 41% of their predicted 2011 values, the US cutting its deficit to 3% of GDP and other deficit areas staying the same. In Scenario II the surplus countries cut their surplus to 1.1% of GDP. Scenario III, which takes some account of welfare maximising objectives, has China and Malaysia moving to a zero current balance. The other surplus countries, are assumed to have the same current account surplus as in the base case and the remaining adjustment needed to achieve a similar residual to Scenario I is spread evenly over the other surplus areas, with the two oil exporters expected to adjust by only one-half as much as the other countries.

Our results are based on the implied trade balance changes necessary to achieve the above scenarios (in terms of trade balance adjustment, rather than current account adjustment) using the coefficients on the trade balance reported in Tables 1 and 3. For all, countries apart from Japan, we use the point estimates from Table 1 and for Japan we use the point estimate from the panel G3 results (Table 3). For the United States we report two estimates – one based on the point estimated of -1.3 (Table 1) and the other based on the G3 estimate of -3.

All of the scenarios show dramatic devaluations for the renminbi, ranging from 27.3 per cent in Scenario I to 46.6 in Scenario III, which requires China to move to a zero current account position. For the United States, the implied devaluations are between 5 and 11 per cent depending on the point estimates used in the evaluation (see above). Interestingly, for both the Euro area and the UK effectively no adjustment is required, suggesting that appropriate adjustment has already taken place for these countries. The suggested adjustment of the Japanese yen is approximately 6 per cent in each of the scenarios.

6. Summary and Conclusions

In this paper we have estimated behaviour equilibrium exchange rates for the effective exchange rates of ten industrialised and emerging market economies that rank within the top 15 contributory economies to global imbalances. The sample period is 1988, quarter 1 to 2006 quarter 1. The conditioning variables used in the estimation of the BEER are: net exports as a proportion of GDP, a real interest differential, a terms of trade differential and GDP per capita differential. The ‘foreign’ magnitudes in the differentials were constructed using the trade weights used to construct the effective exchange rates. Using both single country and panel econometric methods, plausible BEER estimates were reported. These estimates were then used to back out the required exchange rate adjustments necessary to fulfil the three scenarios of Williamson (2006). The ball park currency adjustment required are in the range of 27.3 to 46.6 per cent for the Chinese renminbi, 5 to 11 per cent for the US dollar, approximately 6 per cent for he Japanese yen and no adjustment for the euro or Sterling.

References

Clark, P.B. and R. MacDonald, (1999), "Exchange Rates and Economic Fundamentals: A Methodological Comparison of BEERs and FEERs" in R. MacDonald and J Stein (eds) *Equilibrium Exchange Rates*, Kluwer: Amsterdam.
And IMF Working Paper 98/67 (Washington: International Monetary Fund, March 1998)

Clark, P.B. and R. MacDonald, (2000), "Filtering the BEER a permanent and transitory decomposition', IMF Working Paper 00/144 (Washington: International Monetary Fund) and *Global Finance Journal*

Égert, B. and L. Halpern and R. MacDonald (2006), 'Equilibrium Exchange Rates in Transition Economies: Taking Stock of the Issues', *Journal of Economic Surveys*.

Faruqee, H., "Long-Run Determinants of the Real Exchange Rate: A Stock-Flow Perspective", *Staff Papers*, International Monetary Fund, Vol. 42 (March 1995), pp. 80-107.

Faruqee, H., P. Isard, and P.R. Masson (1998), A Macroeconomic Balance Framework for Estimating Equilibrium Exchange Rates, R MacDonald and J Stein, (eds) *Equilibrium Exchange Rates*, chapter 4. Boston: Kluwer.

Johansen, S. (1995), *Likelihood-based Inference in Cointegrated Vector Autoregressive Models*, Oxford: Oxford University Press.

Lane, Philip R., and Gian Maria Milesi-Ferretti, (2001), "The External Wealth of Nations: Measures of Foreign Assets and Liabilities for Industrial and Developing Countries," *Journal of International Economics,* Vol. 55, pp. 263–94.

MacDonald, R. (1998), "What Determines Real Exchange Rates? The Long and the Short of It", *Journal of International Financial Markets*, *Institutions and Money*, 8, 117-153. [reprinted in R. MacDonald and J Stein (eds) *Equilibrium Exchange Rates*, Kluwer: Amsterdam.]

MacDonald, R. (1999), "Asset Market and Balance of Payments Characteristics: An Eclectic Exchange Rate Model for the Dollar, Mark, and Yen", *Open Economies Review* 10, 1, 5-30.

MacDonald, R. (2007), Exchange Rate Economics: Theories and Evidence (Second Edition of Floating Exchange Rates: Theories and Evidence), Routledge, 2007.

MacDonald, R. and L. Ricci (2002), "Real Exchange Rates, Imperfect Substitutability, and Imperfect Competition", *IMF working paper* and *Journal of Macroeconomics*, forthcoming.

Stein, J. (1999), “The Evolution of the Real Value of the US Dollar Relative to the G7 Currencies”, Chapter 3, Equilibirum Exchange Rates, (eds) R. MacDonald and J. Stein. Amsterdam: Kluwer Press.

Williamson, J. (1983), *Estimating Equilibrium Exchange Rates*, Washington, DC: Institute for International Economics.

Williamson, J. (2006), The target current account outcomes, *mimeo*, Peterson Institute for International Economics

Wren-Lewis, S. (1992), “On the Analytical Foundations of the Fundamental Equilibrium Exchange Rate”, in *Macroeconomic Modelling of the Long Run* (ed.) Colin P. Hargreaves, Edward Elgar.

Table 1. Single country VECM-based BEER estimates.

	tb	*toft*	*prod*	*R*	Coin?	Mean R?
Canada	-4.13(3.28)	1.25(3.32)	-0.81(3.16)	0.02(1.56)	Yes (1)	-0.04(0.96)
China	-7.31(2.04)	1.69(3.00)	0.28(2.04)	-0.03(3.61)	Yes (1)	-0.03(2.77)
Germany	-3.022(2.98)	-1.52(1.47)	-0.10(1.41)	-0.02(0.64)	Yes(1)	-0.098(4.03)
Japan	-177.77 (-7.56)	2.44 (1.85)	-1.47 (-2.29)	0.06 (1.28)	Yes (1)	-0.02(-2.39)
Norway	-1.53(-3.53)	-1.00(-5.39)	0.09(0.53)	0.01(1.25)	Yes (1)	-0.13(-3.08)
Singapore	-2.57(3.12)	-3.29(6.02)	0.48(6.38)	0.02(4.18)	Yes(1)	-0.14(2.24)
Sweden	-4.52(-3.86)	-3.22(-5.23)	-0.30(-2.94)	0.04(3.49)	Yes(1)	-0.11(-2.18)
Swiss	-1.85(-5.96)	0.89(1.26)	0.40(3.03)	-0.01(-0.67)	Yes(1)	-0.20(-4.14)
UK	-5.63(-2.78)	-4.13(-4.86)	1.33(4.57)	0.21(-6.85)	Yes(1)	-0.01(0.42)
US	-1.34(1.18)	1.36(1.28)	1.53(4.95)	-0.093(4.93)	Yes(1)	-0.03(0.93)

Notes: Row headings denote a country, while column headings indicate the coefficients on the model variables (columns 2 to 5), and the existence of cointegration (Coin, column 6) and the mean reversion coefficient (Mean R); t-ratios are in parenthesis.

Table 2. Panel Estimates of the BEER model – Full Sample.

	Full	Full	Full	Full
Tb	0.353 (4.41)	0.228 (2.33)	0.363 (4.54)	0.221 (2.30)
Prod	0.110 (5.22)	0.104 (4.54)	0.096 (4.75)	0.092 (4.33)
Toft	0.511 (9.02)	0.484 (8.09)	0.512 (9.23)	0.489 (8.44)
R	-0.003 (1.68)	-0.002 (0.93)	-	-
Adjusted R^2	0.42	0.38	0.42	0.40
Nobs	730	730	730	730
N Countries	10	10	10	10
Time Effects?	No	Yes	No	Yes

Notes: Equations estimated with a Panel DOLS (1,1) estimator; t-ratios in brackets.

Table 3. Panel Estimates of the BEER model – G3 Sample.

	G3	G3	G3	G3
Tb	-2.924 (6.97)	-2.916 (4.71)	-2.976 (7.04)	-2.332 (4.15)
Prod	0.122 (3.45)	0.136 (2.29)	0.154 (4.52)	0.092 (1.69)
Toft	0.902 (7.35)	0.775 (4.18)	0.756 (6.86)	0.843 (4.53)
R	-0.012 (2.54)	-0.018 (2.09)	-	-
Adjusted R^2	0.60	0.57	0.59	0.55
Nobs	210	210	210	210
N Countries	3	3	3	3
Time Effects?	No	Yes	No	Yes

Notes: Equations estimated with a Panel DOLS (1,1) estimator; t-ratios in brackets.

Table 4. Panel Estimates of the BEER model – Non G3 Sample.

	Non-G3	Non-G3	Non-G3	Non-G3
Tb	0.414 (4.93)	0.179 (1.44)	0.431 (5.12)	0.191 (1.57)
Prod	0.109 (4.11)	0.103 (3.58)	0.088 (3.64)	0.083 (3.26)
Toft	0.454 (7.11)	0.349 (4.61)	0.467 (7.42)	0.363 (4.97)
R	-0.002 (1.38)	-0.002 (0.96)	-	-
Adjusted R^2	0.40	0.37	0.39	0.37
Nobs	511	511	511	210
N Countries	7	7	7	3
Time Effects?	No	Yes	No	Yes

Notes: Equations estimated with a Panel DOLS (1,1) estimator; t-ratios in brackets.

Table 5. Simulations

Baseline

Country	$b	%GDP	Coefficient of TB
Canada	24	1.8	-4.13
China	224	6.3	-7.4
Germany	-23	-0.2	-3.022
Japan	131	3.2	-3
Norway	59	19.4	-1.53
Singapore	39	25.6	-2.57
Sweden	27	7.1	-4.52
Switzerland	44	13.3	-1.85
U.K	-67	-2.6	-5.63
U.S	-946	-6.8	-1.34/-3

Scenario I

Country	$b	% of GDP	Change in the exchange rate implied by the TB
Canada	10	.75	4.33
China	93	2.61	27.3
Germany/Euro proxy	-23	-0.2	-
Japan	54	1.31	5.67
Norway	24	7.89	17.6
Singapore	16	10.50	38.8
Sweden	11	2.89	19.02
Switzerland	18	5.44	14.54
U.K	-67	-2.6	-
U.S	-417	-3	5.1/11.4

Scenario II

Country	$b	% of GDP	Change in the exchange rate implied by the TB
Canada	15	1.12	2.9
China	39	1.09	38.5
Germany/Euro proxy	-23	-0.2	-
Japan	45	1.10	6.3
Norway	3	0.98	28.18
Singapore	2	1.31	22.23
Sweden	4	1.05	27.34
Switzerland	4	1.20	11.00
U.K	-67	-2.6	-
U.S	-417	-3	5.1/11.4

Scenario III

Country	$b	% of GDP	Change in the exchange rate implied by the TB
Canada	7	0.52	5.28
China	0	0	46.62
Germany/Euro proxy	-23	-0.2	-
Japan	36	0.88	6.96
Norway	30	9.86	14.59
Singapore	10	6.56	48.93
Sweden	7	1.84	23.77
Switzerland	13	3.92	17.35
U.K	-67	-2.6	-
U.S	-417	-3	5.09/11.4

Notes: See section 5 for an explanation of scenarios.

Data Appendix.

A. Data Sources

Country	Frequency	Data Field	Data Source
U.S	Quarterly	REER	IFS Statistics November 2006
	Do	CPI	Do
	Do	C/A	Do
	Do	Bond Yield	Do
	Do	GDP	Do
	Do	Trade Balance	Do
	Annual	GDP Per capita	Data Stream – Economic Intelligence Unit
	Monthly	Terms of Trade	Data Stream
	Latest Update*	Trade Weights	IMF
China	Quarterly	REER	IFS Statistics November 2006
	Do	CPI	Do
	Annual	C/A	Data Stream – State Administration of foreign exchange. BOP C/A goods & services
	Quarterly	Bond Yield	IFS Statistics November 2006
	Annual	GDP	Data Stream – OECD Main economic indicators
	Quarterly	Trade Balance	Data Stream – OECD Main economic indicators
	Do	Foreign exchange rate	IFS Statistics November 2006
	Annual	GDP Per capita	Data Stream – Economic Intelligence Unit
	Annual	Terms of Trade	Data Stream
	Latest Update*	Trade Weights	IMF
Japan	Quarterly	REER	IFS Statistics November 2006
	Do	CPI	Do
	Do	C/A	Do
	Do	Bond Yield	Do
	Do	GDP	Do
	Do	Trade Balance	Do
	Do	Foreign exchange rate	Do
	Annual	GDP Per capita	Data Stream – Economic Intelligence Unit
	Monthly	Terms of Trade	Data Stream
	Latest Update*	Trade Weights	IMF
U.K	Quarterly	REER	IFS Statistics November 2006
	Do	CPI	Do
	Do	C/A	Do
	Do	Bond Yield	Do
	Do	GDP	Do
	Do	Trade Balance	Do
	Do	Foreign exchange rate	Do
	Annual	GDP Per capita	Data Stream – Economic Intelligence Unit
	Monthly	Terms of Trade	Data Stream
	Latest Update*	Trade Weights	IMF
Norway	Quarterly	REER	IFS Statistics November 2006
	Do	CPI	Do
	Annual	C/A	Data Stream - IFS
	Quarterly	Bond Yield	IFS Statistics November 2006
	Do	GDP	Do
	Do	Trade Balance	Data Stream – Statistics Norway - BOP external trade balance
	Do	Foreign exchange rate	IFS Statistics November 2006
	Annual	GDP Per capita	Data Stream – Economic Intelligence Unit
	Quarterly	Terms of Trade	Data Stream
	Latest Update*	Trade Weights	IMF
Switzerland	Quarterly	REER	IFS Statistics November 2006
	Do	CPI	Do
	Do	C/A	Data Stream – OECD Main Economic Indicators
	Do	Bond Yield	IFS Statistics November 2006
	Do	GDP	Do
	Monthly	Trade Balance	Data Stream – OECD Main Economic Indicators
	Quarterly	Foreign exchange rate	IFS Statistics November 2006
	Annual	GDP Per capita	Data Stream – Economic Intelligence Unit
	Monthly	Terms of Trade	Data Stream
	Latest Update*	Trade Weights	IMF
Singapore	Quarterly	REER	IFS Statistics November 2006
	Do	CPI	Do
	Do	C/A	Data Stream – Department of Statistics, Singapore
	Do	Bond Yield	IFS Statistics November 2006
	Annual	GDP	Data Stream - IFS

	Quarterly	Trade Balance	Data Stream – Department of Statistics, Singapore
	Do	Foreign exchange rate	IFS Statistics November 2006
	Annual	GDP Per capita	Data Stream – Economic Intelligence Unit
	Quarterly	Terms of Trade	Data Stream
	Latest Update*	Trade Weights	IMF
Sweden	Quarterly	REER	IFS Statistics November 2006
	Do	CPI	Do
	Do	C/A	Do
	Do	Bond Yield	Do
	Do	GDP	Do
	Do	Trade Balance	Do
	Do	Foreign exchange rate	Do
	Annual	GDP Per capita	Data Stream – Economic Intelligence Unit
	Quarterly	Terms of Trade	Data Stream
	Latest Update*	Trade Weights	IMF
Canada	Quarterly	REER	IFS Statistics November 2006
	Do	CPI	Do
	Do	C/A	Do
	Do	Bond Yield	Do
	Do	GDP	Do
	Do	Trade Balance	Do
	Do	Foreign exchange rate	Do
	Annual	GDP Per capita	Data Stream – Economic Intelligence Unit
	Quarterly	Terms of Trade	Data Stream
	Latest Update*	Trade Weights	IMF
Germany	Quarterly	REER	IFS Statistics November 2006
	Do	CPI	Do
	Do	C/A	Do
	Do	Bond Yield	Do
	Do	GDP	Do
	Do	Trade Balance	Do
	Do	Foreign exchange rate	Do
	Annual	GDP Per capita	Data Stream – Economic Intelligence Unit
	Monthly	Terms of Trade	Data Stream
	Latest Update*	Trade Weights	IMF
* Data pertains to the following IMF working paper: New Rates from New Weights (2005) Tamim Bayoumi, Jaewoo Lee and Sarma Jayanthi			

B. Trade Weights

	Canada	China	Germany	Japan	Norway	Singapore	Sweden	Switzerland	U.K	U.S
Canada	0	0.028256	0.029067	0.045311	0.002132	0.004731	0.004787	0.004741	0.023324	0.654722
China	0.023439	0	0.064829	0.191924	0.003089	0.01916	0.009052	0.0077	0.027591	0.233493
Germany	0.012103	0.032693	0	0.05134	0.006109	0.008546	0.019885	0.039132	0.074472	0.121463
Japan	0.022825	0.117231	0.062016	0	0.003599	0.028099	0.008381	0.010527	0.034091	0.272602
Norway	0.014614	0.02783	0.124426	0.05322	0	0.006205	0.0128821	0.012491	0.087081	0.095347
Singapore	0.011199	0.060029	0.051286	0.144582	0.001822	0	0.005185	0.009106	0.036802	0.206135
Sweden	0.013471	0.031743	0.139101	0.048068	0.042452	0.006024	0	0.016651	0.081927	0.0108335
Switzerland	0.011188	0.022231	0.227298	0.05038	0.003706	0.008788	0.013824	0	0.64554	0.111696
U.K	0.016987	0.025143	0.137264	0.051269	0.007735	0.011185	0.021659	0.020508	0	0.150011
U.S	0.1482	0.066396	0.067989	0.12765	0.00282	0.018787	0.008722	0.010819	0.04583	0
* Data pertains to the following IMF working paper: New Rates from New Weights (2005) Tamim Bayoumi, Jaewoo Lee and Sarma Jayanthi										

Figure 1. Trade weighted real interest rate series.

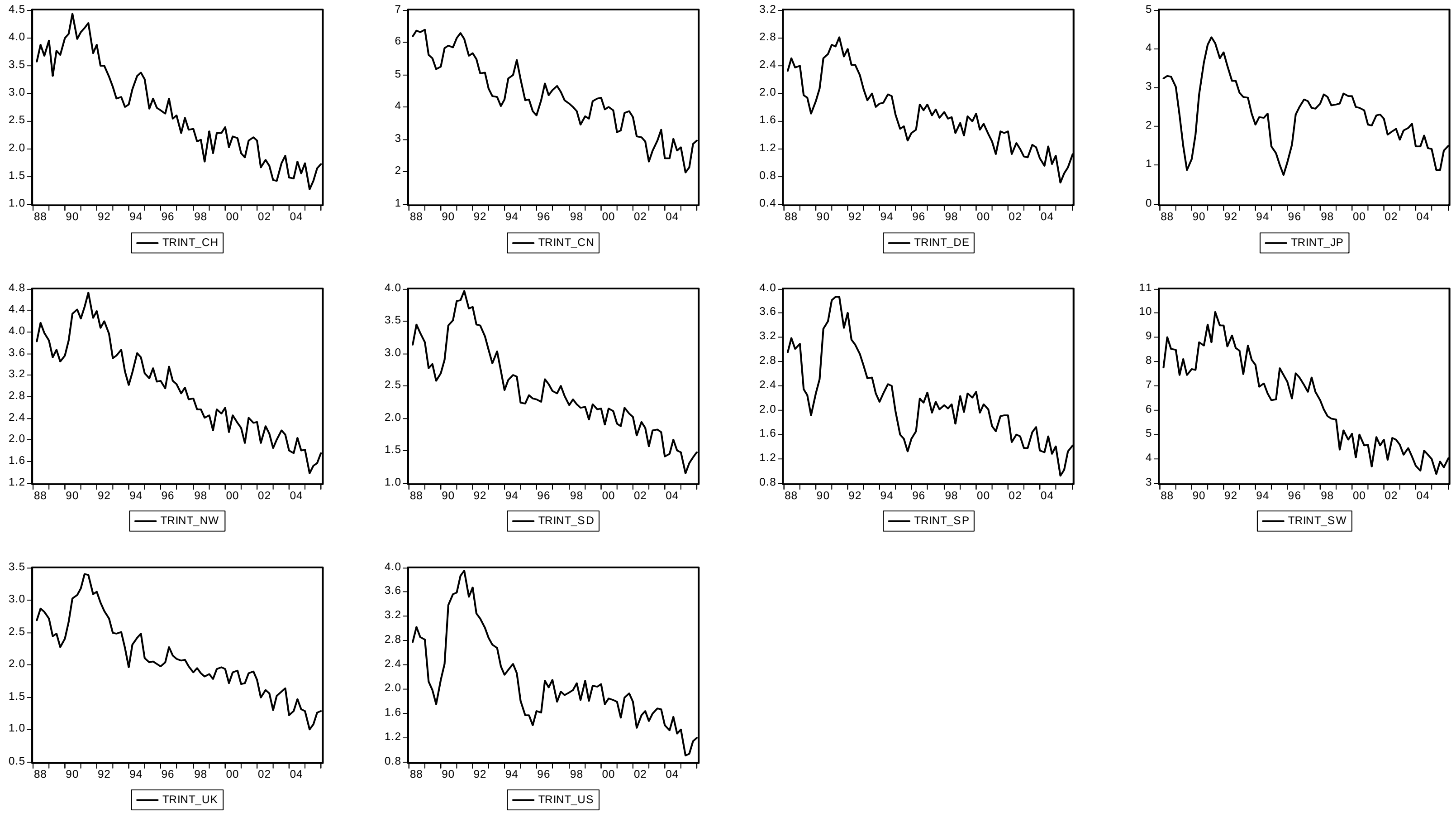

Figure 2. Trade weighted terms of trade series.

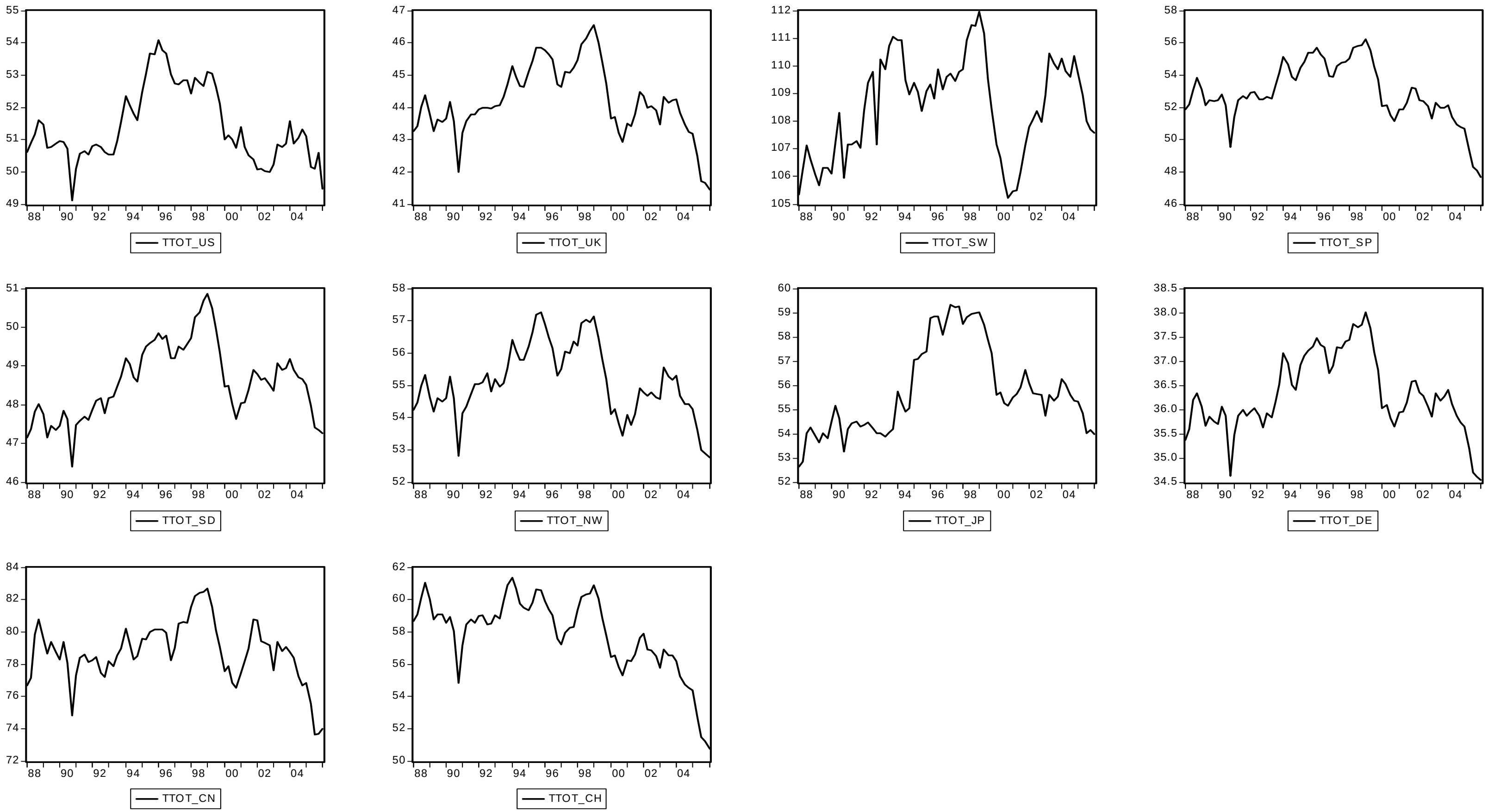

Figure 3. Trade weighted real GDP percapita series.

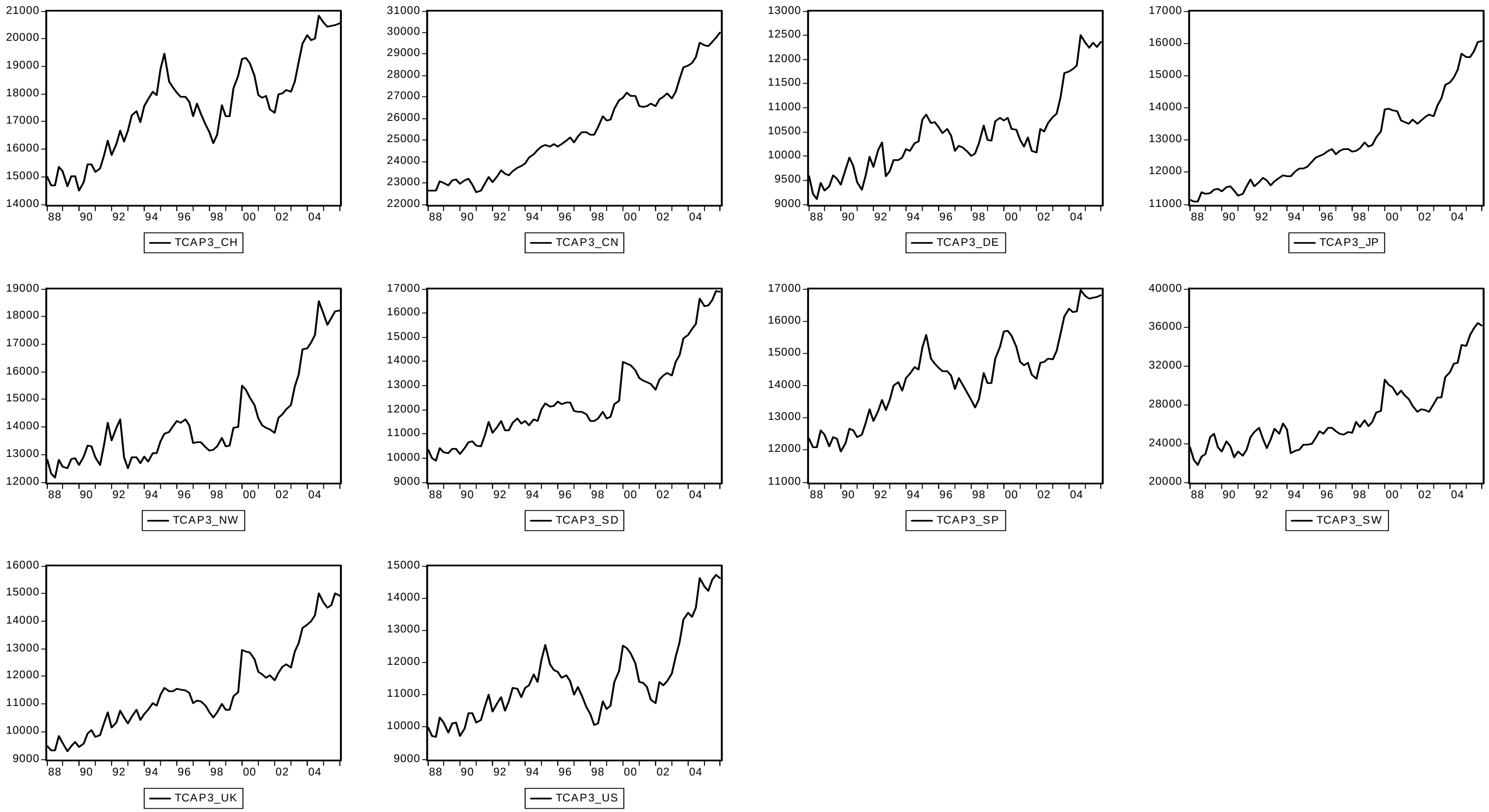

Figure 4. Log of REERs.