IMF Working Paper

WP/98/69

INTERNATIONAL MONETARY FUND

Asia and Pacific Department

Deviations of Exchange Rates from Purchasing Power Parity: A Story Featuring Two Monetary Unions

Prepared by Tamim Bayoumi and Ronald MacDonald

Authorized for distribution by Charles Collyns

May 1998

Abstract

We examine the mean-reverting properties of real exchange rates, by comparing the unit root properties of a group of international real exchange rates with two groups of intra-national real exchange rates. Strikingly, we find that while the international real rates taken as a group appear mean-reverting, the intra-national rates are not. This is consistent with the view that while monetary shocks may be mean-reverting over the medium term, underlying real factors do generate long-term trends in real exchange rates.

JEL Classification Numbers:
C12; C23; F31

Keywords: Exchange rates, stationarity

Author's E-mail Address:
Tbayoumi@imf.org

Contents

Page

Summary 3

I. Introduction 4

II. Panel Unit Rood Methods 5

III. Data Sources and Data Description 8

IV. Univariate and Panel Unit Root Results 9

V. Conclusion 10

Tables
1. Augmented Dickey Fuller Unit Root Tests: Levels, International Results 11
2. Augmented Dickey Fuller Unit Root Tests: United States Results 12
3. Augmented Dickey Fuller Unit Root Tests: Canadian Results 13
4. Panel Unit Root Tests 14

References 15

SUMMARY

The proposition that nominal and real exchange rates are volatile when allowed to float freely, and hence deviate from their long-run level, has become something of a stylized fact in international finance. There is now growing evidence, however, to suggest that although purchasing power parity (PPP) does not hold in the short term, it does hold as a long-run phenomenon. The main explanation is that if the predominant force upsetting the PPP relationship is nominal, or monetary, it will have only a transitory effect on deviations from PPP. If, however, the sources of PPP disturbances are truly "real" in nature, many would argue they will have a permanent, or more permanent, effect on the real exchange rate.

In this paper, we propose a way of gaining a perspective on the importance of nominal—interpreted as monetary—shocks in generating deviations from PPP. We do this by comparing the behavior of relative prices across countries with the behavior within countries. Although exchange rates across countries include both real and monetary disturbances, we assume that relative prices movements within countries are dominated by real factors. Examining relative prices within a country thus allows us to focus on the real factors that influence relative prices.

We confirm the findings of others that relative price variability within countries is considerably lower than across countries, and that real exchange rates appear stationary, or mean-reverting, across countries. We also find however, that relative prices within countries appear nonstationary. The implication for real exchange rates is that, although they may appear stationary in the longer-run compared to their short-term behavior, these results in all probability mask long run trends caused by real behavior. The next task for empirical researchers is to identify and quantify these effects.

I. Introduction

The proposition that exchange rates are volatile when allowed to float freely has become something of a stylized fact in the international finance literature (see, for example, Frenkel and Mussa (1980), MacDonald and Taylor (1992) and Frankel and Rose (1995)). Indeed, the volatility of exchange rates during the recent floating experience has led economists to advocate moving from an international monetary regime based on flexible exchange rates towards one based on greater exchange rate fixity (McKinnon (1988), Mundell (1992) and Williamson (1994)) and is also one of the central arguments made by proponents of greater monetary integration in Europe. The volatility of nominal exchange rates has also had implications for the behavior of real exchange rates. In particular, because prices in goods markets are generally regarded as being sticky (certainly in the short run), volatility in nominal exchange rates is transferred into comparable real exchange rates. This violation of PPP may be viewed as a second stylized fact in international finance.

The failure of PPP to hold continuously is well documented empirically (see the summaries in Froot and Rogoff (1995) and MacDonald (1995)). However, there is now growing evidence to suggest that although PPP does not hold on a month-to-month or quarter-to-quarter basis, it does holds as a long-run phenomenon (see, for example, Edison (1987), Frankel (1988) and Diebold, Husted and Rush (1991)). The main explanation for this follows on directly from our discussion in the previous paragraph and the perceived source of the deviations from PPP. If the predominant force upsetting the PPP relationship is nominal, or monetary, then this will have only a transitory effect on deviations from PPP (this is essentially the story in the seminal Dornbusch (1976) model). If, however, the source of PPP disturbances are truly "real" in nature (as suggested by Stockman (1987)) we would argue this will have a permanent, or more permanent, effect on the real exchange rate.[1]

In this paper, we propose a way of gaining a perspective on the importance of nominal, which we interpret as monetary, shocks in generating deviations from PPP. We do this by comparing the behavior of relative prices within countries.[2] While exchange rates across countries include both real and monetary disturbances, it appears reasonable to assume that relative prices movements within countries are dominated by real factors, with little or no

---

[1]The issue of whether the mean reversion observed in long-runs of data—a half life of four years is the standard finding (see MacDonald (1995))—is in fact consistent with purely nominal shocks is not uncontroversial (Rogoff (1995), for example, argues it is not). One way in which such reversion could be consistent with purely nominal shocks is if the initial real exchange rate deviation is not immediately offset because of the pricing to market policies pursued by multinational companies and the inability of agents to arbitrage away potentially profitable misalignments. That is the interpretation we offer.

[2]Previous work comparing the behavior of real exchange rates in inter- and intra-national data sets includes Engel and Rogers (1995) and Engel, Hendrickson and Rogers (1997).

monetary influence.[3] In this context, it is interesting to know whether relative prices within countries are dominated by long-run trends, and hence are non-stationary or not.

Our method involves constructing a panel data set for the real exchange rates of 20 countries and comparing the time series properties of these data with comparable data sets within two monetary unions (namely, the United Sates and Canada). To anticipate our conclusions, we confirm the findings of others that relative price variability within countries is considerably lower than across countries,[4] and that real exchange rates appear stationary, or mean-reverting, across countries.[5] However, we also find that relative prices within countries are nonstationary. The implication is that underlying real factors can create long-run trends in relative prices even within a fairly homogeneous economic environment. The implication for real exchange rates is that, although they may appear stationary in the longer run compared to their short-term behavior, these results in all probability mask long-run trends caused by real behavior.

The outline of the remainder of this paper is as follows. In the next section we present a brief discussion of the panel unit root method used to test time series properties of our real exchange rates. In Section 3 our data definitions and sources are listed, and the results of our panel unit root tests are presented in Section 4. The paper closes with a concluding section.

II. Panel Unit Root Methods

In order to compare the time series properties of real exchange rates within and across countries we use panel unit root methods. Such tests have a clear statistical advantage over univariate tests, such as the Dickey-fuller class of statistics, because they have greater power to reject the null of a unit root when it is in fact false. Panel unit root tests may be motivated by considering the following regression equation:[6]

$$\Delta q_{it} = \alpha_i + \delta\, q_{t-1} + \sum_i \gamma_i D_i + \sum_t \gamma_t D_t + \sum_i \beta_i t_i + \upsilon_{it}, \qquad (1)$$

---

[3]Although price connections might be different within and between countries, we believe that the fundamental distinguishing feature of an intra- and inter-country comparison is the absence of differential monetary disturbances within a monetary union.

[4]See, for example, Vaubel (1978), Eichengreen (1992), Bayoumi and Thomas (1995), Engel (1993) and Wei and Parsley (1995).

[5]See, for example, Frankel and Rose (1996) and MacDonald (1996a).

[6]A similar equation forms the basis of a cross country panel study by Frankel and Rose (1996).

where q denotes a real exchange rate, i denotes a currency, D_i and D_t denote, respectively, country-specific and time-specific fixed effects dummy variables, a t_i denotes a country specific time trend.[7] Equation (1) is essentially the panel analogue to the standard Dickey-Fuller autoregression and of particular interest is the magnitude of δ, which indicates the speed of mean reversion, and its significance as judged by the estimated t-ratio. As Levin and Lin (1992, 1993) have demonstrated the critical values for the latter statistic are affected by the particular deterministic specification used.

In circumstances where all of the deterministic elements in (1) are excluded apart from the single constant term, α, Levin and Lin (1992) demonstrate that the t-statistic on δ converges to a standard normal distribution. Including individual specific effects (either $\{\Sigma_i \gamma_i D_i\}$ or $\{\Sigma_i \beta_i t_i\}$ or both), but excluding time specific intercepts, Levin and Lin (1992) demonstrate that the t-ratio converges to a non-central normal distribution, with substantial impact on the size of the unit root test (and they tabulate critical values). However, Levin and Lin (1993) argue that unless there are very strong grounds for exclusion, time specific intercepts should always be included in these kind of panel tests. The reason for this is that the inclusion of such dummies is equivalent to subtracting the cross section average in each period. This subtraction may be dispensed with in cases where the units in the panel are independent of each other; however, in cases where this is not the case such a subtraction is vital to ensure independence across units.

In addition to facilitating the removal of time means, the panel methods of Levin and Lin (1993) have a number of other advantages such as allowing the residual term to be heterogeneously distributed across individuals (in terms of both non-constant variance and autocorrelation), rather than a white noise process. The testing method has the null hypothesis that each individual time series in the panel has a unit root, against the alternative that all individual units taken as a panel are stationary. The procedure consists of four steps which we now briefly note (these steps do not correspond exactly to the steps in Levin and Lin).

The first step involves subtracting the cross section mean from the observed exchange rate series. Thus we now have q_{it} where i runs from 1 to N, where N denotes the total number of real exchange rates in the panel, and we construct $\bar{q}_t=(1/N)\Sigma_{i=1}^{N}q_{it}$. In the following steps the term q_{it} is interpreted as having been adjusted by $\bar{q}_t$. Step two involves performing regression (2) and (3) for the demeaned data:

---

[7]Hence our tests are robust to the criticism made by Pappel (1997). Additionally, our subtraction of cross sectoral means for each time period addresses the point made by O'Connell (1997) that the q_i's within a given panel are not independent. Hussed and MacDonald (1997) have demonstrated that having controlled for cross sectional means, the use of a S.U.R.E. type estimator makes little difference to the adjusted t-ratios reported in this paper.

$$\Delta q_{it} = \sum_{L=1}^{P_i} \hat{\pi}_{iL} \Delta q_{it-L} + \hat{a}_{mi} d_{mt} + \hat{e}_{it}, \tag{2}$$

$$q_{it-1} = \sum_{L=1}^{P_i} \hat{\Phi}_{iL} \Delta q_{it-L} + \hat{a}_{mi} d_{mt} + \hat{v}_{it-1}, \tag{2'}$$

and then constructing the following regression equation:

$$\hat{e}_{it} = \delta_i \hat{v}_{it-1} + \varepsilon_{it} \tag{3}$$

The t-ratio calculated on the basis of $\hat{\delta}_i$ is the panel equivalent to an Augmented Dickey Fuller statistic. In order to control for heterogeneity across individuals both $\hat{e}_{it}$ and $\hat{v}_{it-1}$ are deflated by the regression standard error from (3); these adjusted errors are labeled, $\tilde{e}_{it}$ and $\tilde{v}_{it-1}$. Under the null hypothesis these normalized innovations should be independent of each other and this may be tested by running the following regression:

$$\hat{e}_{it} = \delta \hat{v}_{it-1} + \tilde{S}_{it} \tag{4}$$

Under the null hypothesis that δ_i=0 for all i=1,...N, the asymptotic theory in Section 4 of Levin and Lin indicated that the regression t-statistic, t_δ, has a standard normal distribution in a specification with no deterministic terms, but diverges to negative infinity in models with deterministic terms. However, Levin and Lin demonstrate that the following adjusted t-ratio has a N(0,1) distribution and the critical values of the standard normal distribution can be used to test the null hypothesis that δ_i=0 for all i=1,....,N:

$$t_\delta^* = \frac{t_\delta - N\tilde{T}\,\hat{S}_{NT}\,\sigma_\epsilon^{-2}\,RSE(\delta)\,\mu_{mT}^*}{\sigma_{m\tilde{T}}^*} \tag{5}$$

The terms in (5), other than t_δ, are calculated under step 4. In particular, $\hat{S}$=(1/N) $\Sigma_i^n \hat{q}_i$, where $\hat{q}_i = \hat{\sigma}_{qi}/\hat{\sigma}_{ei}$, and $\hat{\sigma}_{ei}$ is the residual standard error from (4) and $\hat{\sigma}_{qi}$ is an estimate of the long-run standard deviation of q_i, RSE(δ) is an estimate of the reported standard error of the least squares estimate of δ, $\hat{\sigma}_{\varepsilon}$ is the estimated standard error of regression (4), $\tilde{T}$ = ($T-\bar{p}-1$) is the average number of observations per individual in the panel and

$$\bar{p} \equiv (1/N)\sum_{i=1}^{N} p_i \tag{6}$$

is the average lag order for the individual ADF statistics. $\sigma^*_{m\tilde{T}}$ and $\mu^*_{m\tilde{T}}$ represent the mean and standard deviation adjustments, respectively, and are tabulated in Table 1 of Levin and Lin for different deterministic specifications.

III. Data Sources and Data Description

In line with our earlier discussion we have constructed three annual data sets: an international data set and two intra-national data sets. The international data set consists of two real bilateral exchange rates defined for twenty countries relative to the US (the countries are listed in Table 1), constructed using relative wholesale and consumer prices (which are the most widely studied real exchange rates in the literature). The international data runs from 1973 through to 1993, and the wholesale and consumer prices and the exchange rates are taken from the IMFs *International Financial Statistics* (CD-Rom disc).[8]

The two monetary unions we focus on are Canada and the United States. For the former country, real exchange rates are defined using consumption indices, while for the U.S. production indices are used. Although these series were chosen because of their availability, there is a debate in the literature regarding the most appropriate price series to use in defining a real exchange rate (see, for example, Frenkel (1976)). Since our chosen indices may be interpreted as representing two extreme forms of prices series, they should help to determine if a particular intra-country result is driven by the choice of price index or is independent of the index used. More specifically, for Canada we have collected data on provincial non-durable consumption and the real exchange rate is measured as (the log of) the relative price of a particular province with respect to Ontario. The Canadian sample period is 1972 to 1994. The U.S. data consists of gross state product data for 48 states (we exclude Alaska and Hawaii) and the real exchange rates are constructed relative to New Jersey (again in logs). The total U.S. sample period runs from 1963 through to 1992. We have used this full sample, but, to be consistent with the international data sample, we have also constructed two sub-samples corresponding to the recent floating period; one consisting of all 47 real exchange rates and the other with a sub-sample of 20 real exchange rate. We believe it is important to

---

[8]The wholesale price series is line 62, the consumer price series is line 63 and the exchange rate is line ae. As our interest is in the low frequency characteristics of the data, annual data is sufficient.

run our panel tests for a variety of samples since it is well known that our panel estimators are most efficient when the dimensions of the panel are approximately square; that is, when the cross sectional dimensions are approximately equal to the time series dimensions. For the international data set, this will be true for the recent floating period and it will also be approximately true for the US data over the full sample period and for the 73–92 period with 20 real rates.

IV. Univariate and Panel Unit Root Results

Before implementing the panel unit root tests we examine the univariate unit properties of each of the real exchange rates, using standard Augmented Dickey Fuller statistics. These results for our range of real exchange rates are reported in Tables 1 through 3. With very few exceptions the international data set, reported in Table 1, confirms the now standard result that on a univariate basis, and for the recent float, real exchange rates are non-stationary variables. Tables 2 and 3 confirm that this international result also holds for real exchange rates within our two monetary unions. What happens, though, when we take these groupings as panels? There are two aspects of our panel results which we would wish to emphasize. First, the speed of adjustment, as represented by δ, and second, our estimated t-ratios.

The estimated adjustment speeds for our different panels are reported in the rows labeled 'δ' in Table 4 (the layout of the Table is explained in the notes). It is noteworthy that the adjustment speeds in the international and intra-national panels are negative and are therefore all indicative of mean-reversion. However, adjustment is much more rapid in the international data sets relative to the national ones. For example, the average value across the latter regressions is –0.09, while the average for the international data sets is three times greater at –0.29. These figures translate into half-lives of two and six years, respectively, for the international data and intra-national data sets. The average half-life from our international data sets is faster than the estimates reported by Frankel and Rose (1996) (they report average half-lives of four years), but nevertheless reinforces the importance of using panel data when defining PPP deviations. The average half-life for the intra-national data although much slower than the international value, is still more rapid than the average value culled from single country estimates for the recent float (which would imply a very slow half-life of around 20 to 30 years—see MacDonald (1995)). However, a crucial issue is whether the mean-reversion exhibited in our panel data sets is statistically significant; that is, are the negative adjustment speeds significantly different from zero or not?

The estimated unadjusted t-ratio, that is t_δ, is in all but one case larger in absolute value than –4.0 and, in terms of the original Levin and Lin (1992) critical values, these t-ratios would be statistically significant. However, as we have noted the unadjusted t-ratios are biased to minus infinity and it is not appropriate to draw inferences on the basis of these test statistics. Interestingly, the estimated adjusted t-ratios, the t_δ^* values, give a dramatically different picture. Thus, for all of the currency union samples the estimated value of t_δ^* is insignificantly different from zero, but for the international data set both real exchange rate data sets produce statistically significant adjusted t-ratios. Given that we use two very different price series for the monetary unions we do not believe our results are a result of the particular series used. We offer an interpretation in the following concluding section.

V. Conclusion

Recent empirical work on the behavior of exchange rates has gone through a number of distinct phases. The first phase involved testing the hypothesis that rates were a random walk, and hence unpredictable in the long run. More recent work indicates that while the random walk model is a reasonably good approximation to short-run dynamics, real exchange rates show mean-reverting tendencies over the medium to long term.

The evidence in this paper can be seen as adding a further layer of complexity to this story. To abstract from the monetary factors, which are often thought to generate much of the short-term dynamics, we studied the behavior of relative prices across regions within a country. The results indicate that these relative prices have significant long-run trends. This implies that underlying real factors can create long-run trends in relative prices even in a fairly homogeneous environment. The implication we draw is that, while **monetary shocks** may be mean-reverting over the medium term, generating the observed mean-reversion in real exchange rates, this medium-term effects obscure the fact that underlying **real factors** generate long-term trends in real exchange rates. The next task for empirical researchers is to identify and quantify these effects.[9]

---

[9]Some evidence on this can be found in Faruqee (1995), Gagnon and Rose (1996) and MacDonald (1996b).

Table 1. Augmented Dickey Fuller Unit Root Tests:
Levels, International Results

Country	CPI		WPI	
	t_μ	t_τ	t_μ	t_τ
Australia	-1.98	-2.08	-1.21	-1.99
Austria	-2.28	-2.26	-2.05	-2.13
Belgium	-1.12	-0.79	-1.69	-2.51
Canada	-2.27	-1.46	-1.71	-1.71
Denmark	-1.54	-1.36	-1.58	-1.51
Finland	-4.17*	-4.42*	-2.91	-3.58
France	-3.58*	-5.68*	-1.64	-1.64
Germany	-1.84	-1.76	-1.95	-1.99
Greece	-1.84	-2.09	-1.50	-1.57
Ireland	-2.44	-3.87*	-0;89	-1.62
Italy	-0.46	-1.45	-0.91	-3.27
Japan	-1.77	-2.56	-1.44	-2.26
Netherlands	-1.87	-1.53	-1.22	-2.28
New Zealand	-2.05	-1.89	-2.14*	-3.05
Norway	-3.92*	-3.77*	-4.29*	-4.34*
South Korea	-1.80	-2.14	-2.28	-2.29
Spain	-1.46	-1.90	-0.83	-1.53
Sweden	-2.47	-2.44	-1.66	-0.88
Switzerland	-3.12*	-2.99	-2.89	-3.16
UK	-1.10	-1.61	-1.41	-1.45

Notes: The numbers in the columns labeled t_μ and t_τ are Augmented Dickey Fuller t-ratios from an autoregression with, respectively, a constant and a constant plus a time trend included. An asterisk denotes significance at the 5 percent level.

Table 2. Augmented Dickey Fuller Unit Root Tests: United States Results

	Full Sample	
State	t_μ	t_τ
Connecticut	-1.98	-1.76
Maine	-1.81	-1.68
Massachusetts	-1.53	-1.53
New Hampshire	-0.75	-0.99
Rhode Island	-2.08	-2.00
Vermont	-1.42	-0.91
Delaware	-2.22	-1.14
Maryland	-1.19	-1.75
New Jersey	-1.69	-1.60
Philadelphia	-1.73	-2.61
Illinois	-1.53	-1.56
Indiana	-0.37	-0.86
Minnesota	0.07	-0.91
Ohio	-2.62	-3.09
Wisconsin	-0.47	-1.13
Idaho	-0.18	-1.18
Kansas	-0.73	-1.48
Minnesota	-1.65	-0.95
Missouri	-0.85	-1.53
Nebraska	-0.22	-1.10
North Dakota	-1.18	-1.32
South Dakota	-1.97	-1.61
Alabama	-1.96	-2.11
Arkansas	-1.34	-0.92
Florida	-0.95	-0.79
Georgia	-1.92	-0.93
Kentucky	-0.87	-1.59
Louisiana	-0.95	-1.03
Mississippi	-1.63	-1.71
North Carolina	-1.59	-1.07
South Carolina	-3.04*	-3.02
Tennessee	-0.39	-1.41
Virginia	-0.27	-1.56
West Virginia	-1.28	-1.90
Arkansas	-1.31	-1.05
New Mexico	-0.95	-0.79
Oklahoma	-1.74	-1.25
Texas	-1.71	-1.39
Colorado	-1.73	-1.50
Idaho	-2.02	-1.14
Montana	-1.76	-1.66
Utah	-1.62	-1.25
Wyoming	-1.73	-0.63
California	-1.61	-1.26
Nevada	-1.97	-1.11
Oregon	-2.19	-0.72
Washington St	-2.04	-1.83

Notes: See Table 1.

Table 3. Augmented Dickey Fuller Unit Root Tests: Canadian Results

Province	t_μ	t_τ
Alberta	-1.41	-1.97
British Columbia	-1.68	-2.51
Manitoba	-0.75	-0.99
New Brunswick	-2.08	-2.00
New Foundland	-1.42	-0.91
Nova Scotia	-2.22	-1.14
Prince Edward Island	-1.19	-1.75
Quebec	-1.69	-1.60
Saskatchewan	-1.73	-2.61

Notes: See Table 1.

Table 4. Panel Unit Root Tests

International panel

	INT/CPI	INT/WPI
t_δ	-8.23	-8.72
t_δ^*	-2.28	-2.58
2 Tail	(0.02)	(0.00)
1 Tail	(0.01)	(0.00)
δ	-0.276	-0.308

United States Panel

	US/47/full	US/47/sub	US/20/full	US/20 sub
t_δ	-10.11	-10.21	-5.27	-1.21
t_δ^*	-1.04	0.49	-0.08	5.39
2 Tail	(0.29)	(0.62)	(0.93)	(0.69)
1 Tail	(0.14)	(0.31)	(0.46)	(0.34)
δ	-0.079	-0.146	-0.067	-0.029

Canadian Panel

	Prov/Ont	Prov/Can
t_δ	-4.47	-4.07
t_δ^*	-0.39	0.28
2 Tail	(0.69)	(0.78)
1 Tail	(0.34)	(0.39)
δ	-0.126	-0.106

Notes: The numbers in the rows labeled t_δ and t_δ are respectively, the unadjusted and adjusted panel unit root t-ratios, defined in the text. The latter statistic has a standard normal distribution; numbers in parenthesis are marginal significance levels. The numbers in the rows labeled δ are the adjustment speeds defined in the text. The columns labeled INT/CPI and INT/WPI denote the international panels using, respectively, consumer and wholesale prices to define the real exchange rate. The columns labeled US/47/full/sub, US/20/full and US/20sub denote the US panel samples for, respectively, all the states over the full and sub-sample period and 20 of the states over the full and sub-sample period (see text for further details). The columns headed prov/ont and prov/can denote the Canadian real exchange rates defined for each province with respect to Ontario and each province with respect to the Canadian average.

References

Abuaf, N. and P. Jorion (1990), "Purchasing Power Parity in the Long Run", *Journal of Finance*, Vol 45 157–74.

Bayoumi, T. and A. Thomas (1995), "Relative Prices and Economic Adjustment in the US and EU: A Real Story About European Monetary Union", IMF *Staff Papers*, 42:1, 108–133.

Diebold, F.X., S. Husted, and M. Rush (1991), "Real Exchange Rates Under the Gold Standard", *Journal of Political Economy*, Vol 99, 1252–71.

Dornbusch, R. (1976), "Expectations and Exchange Rate Dynamics", *Journal of Political Economy*, 84, 1161–76.

Edison, H. (1987), "Purchasing Power Parity in the Long Run: A Test of the Dollar-Pound Exchange Rate (1890–1978)", *Journal of Money Credit and Banking*, Vol. 19, 376–87.

Eichengreen, B (1992), "Is Europe an Optimum Currency Area?" in Silvio Borner and Herbert Gruebel (eds.), *The European Community After 1992: The View from Outside*, London: Macmillan.

Engel, C (1993), "Real Exchange Rates and Relative Prices: An Empirical Investigation", *Journal of Monetary Economics*, 32, 35–50.

Engel, C. and J. Rogers (1996), "How Wide is the Border?", *American Economic Review*, 86, 1112–1125.

Engel, C., M. Hendrickson and J. Rogers (1998), "Intra-national, Intra-continental and Inter-Planetary PPP", *Journal of Japanese and International Economies*, 480–501.

Faruqee, H (1995), "Long-Run Determinants of the Real Exchange Rate: A Stock-Flow Equilibrium Approach", *Staff Papers*, International Monetary Fund.

Frankel, J.A. (1988), "International Capital Flows and Domestic Economic Policies", in *The United States in the World Economy,* NBER Conference Report, ed. By Martin Feldstein (Chicago: Chicago University Press) pp559–627.

Frankel, J.A. and A.K. Rose (1995), "A Survey of Empirical Research on Nominal Exchange Rates", in Grossman and Rogoff (eds) *The Handbook of International Economics*, Vol 3, Amsterdam: North Holland.

Frankel, J.A. and A.K. Rose (1996), "A Panel Project on Purchasing Power Parity: Mean Reversion Within and Between Countries", *journal of International Economics*, Vol 40, ½, 209–224.

Frankel, J.A. and M. Mussa (1980), "The Efficiency of Foreign Exchange Markets and Measures of Turbulence", *American Economics Review*, 70, 374–81.

Froot, K. and K. Rogoff (1995), "Perspectives on PPP and Long-Run Real Exchange Rates", in E Grossman and K Rogoff (eds), *The Handbook of International Economics*, North Holland.

Gagnon, J. and A.K. Rose (1996), "Panel Evidence on the Determinants of Real Exchange Rates", paper given at AEA meeting in San Francisco, January 5–7.

Hussed, S. And R. MacDonald (1998), "Monetary-Based Models of the Exchange Rates: A Panel Perspective", *Journal of International Financial Markets, Institutions, and Money*, forthcoming.

Levin, A. and Lin, C.F. (1992), "Unit Roots in Panel Data: Asymptotic and Finite Sample Properties" [revised version], *mimeo*, University of California.

MacDonald, R. (1988), *Floating Exchange Rates: Theories and Evidence*, London: Routledge, Keegan and Paul (RKP).

MacDonald, R. (1995), "Long-Run Exchange Rate Modeling: A Survey of the Recent Evidence", *Staff Papers*, International Monetary Fund, Vol 42, No 3, 437–489.

MacDonald, R. (1996a), "Panel Unit Root Tests and Real Exchange Rates", *Economics Letter*, 50, 7–11.

MacDonald, R. (1996b), "What Determines Real Exchange Rates?: The Long and Short of It", *Journal of International Financial Markets, Institutions, and Money*, forthcoming.

MacDonald, R. and M.P. Taylor (1992), "Exchange Rate Economics: A Survey", *Staff Papers*, International Monetary Fund, Vol 40, No 1, 1–53.

McKinnon, R. (1988), "Monetary and Exchange Rate Policies for International Financial Stability", *Journal of Economic Perspectives*, 2(1), 83–103.

Mundell, R. (1992), "The Global Adjustment System", in M. Baldassarri, J. McCallum and R. Mundell, (eds.) *Global Disequilibrium in the World Economy*. New York: St Martin's, 351–464.

O'Connell (1997), "The Overvaluation of Purchasing Power Parity", *Journal of International Economics*.

Papell, D. H. (1997), "Searching for Stationarity: Purchasing Power Parity Under the Current Float", *Journal of International Economics*.

Shiller, R. and P. Perron (1985), "Testing the Random Walk Hypothesis : Power versus Frequency of Observation", *Economics Letters*, 18, 381–386.

Stourman, A. C. (1987), "The Equilibrium Approach to Exchange Rates", Federal Reserve Bank of Richmond *Economic Review*.

Vaubel R. (1978), “Real Exchange Rate Changes in the European Community: A New Approach to Optimum Currency Areas”, *Journal of International Economics*, 8:319–339.

Wei, S-J and D. Parsley (1996), “Purchasing Power Disparity During the Recent Floating Rate Period”, *Quarterly Journal of Economics*,

Williamson, J. (1987), “Exchange Rate Management: The Role of Target Zones”, *American Economic Review*, (Papers and Proceedings) 77(2) 200–4.