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The Long-Run Behavior of the Real Exchange Rate: A Reconsideration

THIS PAPER PRESENTS THE RESULTS OF A NEW TEST of whether or not the real exchange rate is a random walk. The behavior of the real exchange rate is intimately related to the behavior of deviations from purchasing-power parity (PPP). There is widespread agreement that substantial deviations from PPP have occurred during the current period of flexible exchange rates, but the permanence of those deviations remains at issue.

Richard Roll (1979) provides a finance-based theory of exchange-rate movements that implies that the real exchange rate should follow a random walk. He argues that his theory is consistent with PPP, but in one key respect his analysis is the antithesis of PPP:[1] if the real exchange rate is a random walk, then there is no long-term equilibrium value to which the real exchange rate tends to return. Changes in the real exchange rate are expected to be permanent, and deviations from PPP can be expected to become unbounded as the forecast horizon gets longer.

In empirical tests, a number of authors find support for the random walk hypothesis about real exchange rates. Roll (1979), Frenkel (1981), Adler and Lehmann (1983), and others fail to reject the random walk hypothesis. Similarly, Hakkio (1984, 1986) is unable to reject the hypothesis, but he also demonstrates that standard tests have low power against the alternative hypothesis that the real exchange

The author thanks Will Roberds for many helpful discussions, and Karen Johnson, Jeffrey Rosensweig, Charles Whiteman, and two anonymous referees for useful comments. The views expressed are those of the author and do not necessarily reflect those of the Federal Reserve Bank of Atlanta or the Federal Reserve System.

[1]Adler and Lehmann (1983) and Pippenger (1986) support Roll's contention, though Frankel (1985, pp. 39–40) argues persuasively that Roll's approach has little basis in theory.

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Journal of Money, Credit, and Banking, Vol. 24, No. 1 (February 1992)

rate has a sizable autocorrelation coefficient in the stationary range (that is, below 1). By contrast, Cumby and Obstfeld (1984), Frankel (1985), Huizinga (1987), Kaminsky (1987), and Abuaf and Jorion (1990) are able to reject the random walk hypothesis in some instances.

In a more general context, Sims (1988) argues that classical statistical tests for the presence of unit roots, such as the Dickey-Fuller (1979) tests used in some of the empirical work on the real exchange rate, are fundamentally flawed. As an alternative, he proposes a test based on Bayesian posterior odds ratios that is designed to discriminate between a unit root and a large but stationary autocorrelation coefficient.

This paper applies the Sims test to real exchange rate data. The results favor the presence of a large autocorrelation coefficient, but *not* a unit root. This suggests that deviations from PPP persist for a number of years, but they are not permanent.

The remainder of the paper is organized as follows. In section 1, Sims's test and its differences with classical tests are discussed. Both the Sims and Dickey-Fuller tests for the presence of a unit root are implemented empirically using two data sets: with monthly data from the current period of flexible exchange rates in section 2, and with annual data covering both the Bretton Woods era and the period of flexible exchange rates in section 3. The conclusions are summarized in section 4.

1. SIMS'S TEST FOR THE PRESENCE OF A UNIT ROOT

Consider the following autoregressive model of the real exchange rate:

$$(y_t - \mu) = \rho\,(y_{t-1} - \mu) + e_t \tag{1}$$

where y_t is the real exchange rate at time t, μ is the "long-run" value of the real exchange rate, and $e_t \sim N(0, \sigma^2)$ is the error term and is independent of past values of y.

In this model, the long-run behavior of the real exchange rate is critically dependent on the value of the autoregressive coefficient ρ. If $0 < \rho < 1$, the system is stable in the sense that y_t tends to move smoothly toward its long-run value, μ. In this case, μ can be interpreted as the value of the real exchange rate consistent with PPP, and $(y_t - \mu)$ is the deviation from PPP in period t. In the absence of future shocks, the deviation $(y_t - \mu)$ would shrink in subsequent periods when $0 < \rho < 1$.

In contrast, if there is a unit root ($\rho = 1$), the behavior of the real exchange rate is quite different. In this case, there is no tendency for $(y_t - \mu)$ to shrink; instead, the real exchange rate is a random walk.

Accordingly, the problem for empirical work is to make statistical inferences about the value of ρ. Using a classical approach, Dickey and Fuller (1979) provide a test of the null hypothesis that $\rho = 1$, using statistics generated by an OLS regression of y onto its own lagged value. The standard t-test is not appropriate because under this null hypothesis the variance of the real exchange rate is infinite.

Sims (1988) and Sims and Uhlig (1988) argue that classical tests such as the one proposed by Dickey and Fuller provide a misleading picture of the plausibility of unit roots. Using Bayesian methods, they show that the prior implicit in the classical tests not only gives excessive (in their view) weight to the unit root null, but also gives substantial and disproportionate weight to values of ρ above one (Sims and Uhlig 1988, p. 8).

As an alternative to the classical analysis, Sims (1988) proposes a Bayesian test based on a suggestion in Leamer (1978, pp. 100–108). Leamer argues that when testing a point-null hypothesis against a composite alternative, using the Bayesian posterior odds ratio is a more sensible approach than using a likelihood ratio test or the sampling theory approach. The posterior odds ratio can be interpreted as a weighted average of the likelihood function over all points consistent with the null hypothesis, divided by a similar weighted average of the likelihood function over all points in the alternative. The weights are derived from the prior distribution of the parameters. By contrast, the likelihood ratio test uses only the maximum values of the likelihood function for each alternative.

To apply Leamer's suggestion to equation (1), Sims proposes a prior distribution for ρ which spreads probability α, $0 < \alpha < 1$, uniformly on the interval $(0,1)$, and gives the unit root ($\rho = 1$) probability $(1 - \alpha)$. This specification gives a clear but limited advantage to the unit root hypothesis, because any individual point between zero and one has essentially zero prior probability, while the point where $\rho = 1$ has probability $(1 - \alpha)$. By contrast, as demonstrated by Sims and Uhlig (1988), the prior implicit in classical unit root tests is not at all flat; in the case of an OLS-estimated $\hat{\rho}$ equal to 0.95, the implicit prior treats values of ρ around 1 as being two or three times more likely than values around 0.90, even though the likelihood function is symmetric around 0.95. More disturbingly, the prior implicit in classical tests gives even more weight to values of ρ above 1 than to values around 1, and the weight given to the region above 1 increases as $\hat{\rho}$ approaches 1 from below.

Using the Leamer-inspired prior for $\hat{\rho}$ plus a standard prior about the variance parameter, Sims (1988) is able to derive the approximate likelihood function. Define $T \equiv (1 - \hat{\rho}/\sigma_\rho$, where $\sigma_\rho \equiv \sqrt{[\sigma^2/\Sigma y_{t-1}^2]}$, to be the conventional t statistic for testing $\rho = 1$, $\Phi(x)$ to be the cumulative distribution function for the standard normal distribution evaluated at x, and $\phi(x)$ to be its probability density function. Then Sims shows that in large samples the posterior odds ratio favors the null hypothesis ($\rho = 1$) if[2]

$$\frac{(1 - \alpha)\ \phi(T)}{\sigma_\rho\ [\alpha\ \Phi(T)]} > 1 \ . \tag{2}$$

This criterion is different from classical hypothesis tests, not only because of the role of the prior distribution, but also because of the presence of σ_ρ in the de-

[2]In a full Bayesian analysis, the constant on the right-hand side of expression (2) might be a number other than one, depending on the loss function applying to the two hypotheses. However, this extension is not pursued here.

nominator. If the null hypothesis ($\rho = 1$) is true, σ_ρ should shrink much faster as sample size rises than when the alternative is true. This criterion tends to favor the null hypothesis when σ_ρ is small (for given values of α and T). By contrast, likelihood ratio tests fail to use all the information in σ_ρ.

In actual applications, Sims suggests that for annual economic data the alternative hypothesis can reasonably be limited to values of ρ between 1/2 and 1. For more frequent data, the interval associated with this alternative hypothesis has a lower bound closer to 1. In the case of quarterly data, the interval is approximately (0.84,1) because 0.84 to the fourth power is equal to the lower bound for annual data; the interval is (0.94,1) for monthly data.

Therefore, Sims proposes the following revised criterion: the null hypothesis ($\rho = 1$) is favored if

$$\gamma > 0 \tag{3}$$

where $\gamma \equiv 2\log\left(\frac{1-\alpha}{\alpha}\right) - \log(\sigma_\rho^2) + 2\log(1 - 2^{-1/s}) - 2\log[\Phi(T)] - \log(2\pi) - T^2$ and s is the number of periods per year (for example, twelve for monthly data).[3]

In typical examples, $\sigma_\rho < 1$, implying that $-\log(\sigma_\rho^2)$ is positive. Smaller values of σ_ρ induce larger values of $-\log(\sigma_\rho^2)$, thereby favoring the unit root hypothesis. However, larger values of $T \equiv (1 - \hat{\rho})/\sigma_\rho$ favor the alternative hypothesis.

2. TESTS USING MONTHLY DATA FROM THE CURRENT PERIOD OF FLEXIBLE EXCHANGE RATES

A number of authors have used monthly data from the current period of flexible exchange rates to test the hypothesis that the real exchange rate is a random walk. Roll (1979), Frenkel (1981), Adler and Lehmann (1983), Darby (1983), and Mishkin (1984) report that they cannot reject the random walk hypothesis. In related papers, Mark (1986), Mecagni and Pauly (1987), and Corbae and Ouliaris (1988) report that nominal exchange rates are not cointegrated with price indexes. Enders (1988) reports mixed results; parameter estimates are consistent with slow reversion to PPP, but standard errors are sufficiently large that it is not possible to reject the random walk hypothesis.

By contrast, Cumby and Obstfeld (1984), Huizinga (1987), Pippenger (1986), and Kaminsky (1987) provide some evidence against the random walk hypothesis, though none of their tests rejects it strongly.[4] Hakkio (1986) provides Monte Carlo evidence that standard statistical tests have very low power when the true autocorrelation coefficient is fairly close to 1. Even using a sample size of 250 (somewhat

[3]Sims suggests ignoring the term $-2\log(\Phi(T))$ because it is likely to be small when $\hat{\rho} < 1$ and is asymptotically negligible; he also leaves out the term $-\log(2\pi)$.

[4]Buiter (1987) argues that Huizinga's results actually favor the random walk hypothesis.

larger than is now provided by monthly data from the current period of flexible exchange rates), Hakkio shows that the power of these tests is often below 20 percent. Abuaf and Jorion (1990) increase statistical power by using a multivariate generalized least squares version of the Dickey-Fuller test. To further increase power, they impose the restriction that the value of $\hat{\rho}$ be the same for all real exchange rates in the sample (ten countries in their work); however, they do not provide a theoretical justification for this restriction. With this caveat, their results lead to rejection of the random walk hypothesis.[5]

Accordingly, the existing empirical literature suggests either that the real exchange rate is a random walk, or that it has a sizable autocorrelation coefficient that is statistically very difficult to distinguish from a unit root, given the amount of data currently available and the low power of the statistical tests that have been used.

As discussed earlier, the test proposed by Sims differs from the classical tests that have been used in previous studies of exchange rates and is arguably a better test. To perform the Sims test, the log of the real exchange rate was regressed onto a constant and its own lagged value. Using the United States as the base country, monthly data on the real exchange rate for five countries were used: the United Kingdom, France, Germany, Switzerland, and Japan. For each country, two real exchange rates were calculated; one using consumer prices, and one using wholesale prices.[6] The sample period began in June 1973, several months after the breakdown of the fixed exchange rate regime, and ended in December 1989, thereby providing 199 observations.[7]

As expected on the basis of previous empirical work on this issue, the regressions using monthly data produced estimates of the autoregressive coefficient $\hat{\rho}$ rather close to 1; for these five countries, $\hat{\rho}$ was in all cases in the interval between 0.96 and 1. However, estimates of the annualized value of $\hat{\rho}$, which were obtained by raising the monthly estimates to the twelfth power, were considerably further below one, falling in the range between 0.65 and 0.85. The estimates of the annualized value of $\hat{\rho}$ and statistics for testing the null hypothesis ($\rho = 1$) are presented in Table 1.

For comparison purposes, the second column in Table 1 presents the Dickey-Fuller test statistic, $T_{\mu} \equiv (\hat{\rho} - 1)/\sigma_{\rho}$.[8] To reject the null hypothesis at the 95 percent significance level would require that T_{μ} be less than -2.88; clearly, none of the

[5]In recent papers, Glen (1988, 1989) also succeeds in rejecting the unit root hypothesis about real exchange rates by using adjustments for heteroskedasticity that shrink key standard errors.

[6]The choice of price index in tests of PPP is somewhat controversial. Some authors favor a broad index such as the consumer price index, while others favor a narrower index with heavy weight on tradables, such as the wholesale price index. See the survey in Frenkel (1976).

[7]Monthly data on consumer prices, wholesale prices, and end-of-period exchange rates were all obtained from *International Financial Statistics*. Previous work on this topic has used either monthly average or end-of-period exchange rates; results using monthly averages were similar to those reported here. Because of lack of data availability, the sample period for France when the WPI is used ends in December 1985.

[8]Dickey and Fuller have constructed several different test statistics; on the basis of power considerations against a variety of alternatives, this particular one is recommended in Dickey, Bell, and Miller (1986), p. 18.

TABLE 1

TESTS FOR A UNIT ROOT IN THE REAL EXCHANGE RATE: SAMPLE PERIOD: JUNE 1973 TO DECEMBER 1989

	Price Index	Annualized $\hat{\rho}$	Dickey-Fuller T_{μ}	Sims γ	Sims $1-\alpha^*$
United Kingdom	CPI	0.71	−1.66	−4.88	0.7413
	WPI	0.73	−1.56	−4.50	0.7038
France	CPI	0.80	−1.35	−3.44	0.5822
	WPI	0.84	−1.10	−2.64	0.4838
Germany	CPI	0.80	−1.36	−3.44	0.5826
	WPI	0.75	−1.48	−4.17	0.6679
Switzerland	CPI	0.70	−1.73	−5.10	0.7624
	WPI	0.68	−1.76	−5.37	0.7859
Japan	CPI	0.83	−1.19	−2.78	0.5009
	WPI	0.72	−1.57	−4.56	0.7101

NOTE: For both tests, the null hypothesis is ($\rho = 1$). For the Dickey-Fuller test, the critical region is $T_{\mu} < -2.88$; for the Sims test, the critical region is $\gamma < 0$. Because of data availability the sample period for France when the WPI is used ends in December, 1985.

countries in this sample comes close to rejecting the unit root on the basis of this classical test.

What about the Sims test? Recall that the Sims test favors the null hypothesis ($\rho = 1$) if the test statistic γ is positive. In order to calculate γ it is necessary to specify the prior distribution for ρ, which in this case includes choosing the parameter α. Sims suggests using $\alpha = 0.8$, which implies that the prior probability of a unit root is $(1 - \alpha)$ or 0.2. This prior still gives some advantage to the unit root hypothesis, because in terms of annual data the point null hypothesis ($\rho = 1$) has the same prior probability as the infinite number of points in various intervals that are consistent with the alternative hypothesis, for example ($0.875 < \rho < 1$).

The third column of Table 1 reports the values of the test statistic γ for these real exchange rates, calculated using $\alpha = 0.8$. For all five countries, regardless of whether consumer or wholesale prices are used in constructing the real exchange rate, γ is negative, implying that the alternative hypothesis is favored. Accordingly, contrary to the Dickey-Fuller results, the Sims test indicates that we can reject the hypothesis that the real exchange rate is a random walk.

The last column of the table provides a measure of how strong the rejection of the null hypothesis is. On an ex post basis, it is possible to calculate the minimum prior probability on the null hypothesis, $(1 - \alpha^*)$, that would be necessary in order to force the Sims criterion to favor the null hypothesis, given the sample information. The larger the value of $(1 - \alpha^*)$, the stronger is the data's rejection of the unit root hypothesis. As the table indicates, in all five countries the unit root is solidly rejected, because the prior probability of the null hypothesis would have to be much higher than the 0.2 suggested by Sims before this test would favor the unit root hypothesis. The strongest rejections are for Switzerland and the United Kingdom, which would require a prior weight of more than 0.7 on the unit-root null before the Sims criterion would favor a random walk.

3. TESTS USING ANNUAL DATA NOT LIMITED TO THE POST-BRETTON WOODS PERIOD

Another approach has been to examine the behavior of the real exchange rate over the long run, using data sets that extend back as far as the period of the gold standard, decades before the current period of flexible exchange rates. This approach greatly increases the time span covered by the data, thereby possibly increasing the power of statistical tests for random walk behavior (see Shiller and Perron 1985). However, it also may increase the likelihood that structural breaks are included in the sample. Gailliot (1970) and Officer (1980) report that PPP holds fairly well in the very long run. However, Edison (1987) claims that significant deviations from PPP occur even in the long run, and Adler and Lehmann (1983) report that even annual data on the real exchange rate are consistent with martingale behavior.[9]

Frankel (1985) tests for a unit root in the real exchange rate between the United States and the United Kingdom, using the Dickey-Fuller test on annual data. He is unable to reject the random walk hypothesis when the sample period is limited to the current flexible rate regime (1973–84), or to the postwar period (1945–84). However, when he uses his full sample (1869–1984), he is able to reject the random walk hypothesis, and finds that the real exchange rate tends to regress to PPP at a rate of about 14 percent per year. Abuaf and Jorion (1990) are also able to reject the unit root hypothesis using annual data from 1901 to 1972 on eight countries. For several countries unrestricted single equation tests reject a random walk, and their multivariate restricted approach leads to a strong rejection as well. They conclude that real exchange rates tend to regress to PPP at a rate of about 19 percent per year.

Table 2 presents the results of performing the test proposed by Sims using annual data from the period since World War II for the same five countries as in Table 1, plus Australia.[10] As before, the United States was used as the base country. In most cases the sample period includes both the Bretton Woods period and the period of flexible exchange rates.[11]

The first column of Table 2 gives the estimates of $\hat{\rho}$, the autocorrelation coefficient. In all cases except for the Japanese CPI results, $\hat{\rho}$ was in the stable range (smaller than one). Nonetheless, the Dickey-Fuller test statistic (given in the second column) is able to reject the unit root hypothesis at the 95 percent significance level in only one case, the French CPI results. By contrast, the Sims test indicates that the data solidly reject the unit root hypothesis for four of these countries: the United Kingdom, France, Germany, and Australia.[12] The values of $1 - \alpha^*$ show that the

[9]The variance-ratio test in Glen (1989) also fails to reject the unit root hypothesis with annual data.

[10]Australia was excluded from Table 1 because monthly data were missing. Annual average data were obtained from *International Financial Statistics*.

[11]The sample period in the results using consumer prices is either 1949 or 1950 to 1989 in all cases. In the results using wholesale prices, the sample period is either 1949 or 1950 to 1989 for the United Kingdom, Switzerland, Germany, and Japan. Because of lack of data availability, the wholesale price sample period is 1950 to 1985 for France, and 1970 to 1989 for Australia.

[12]The prior distribution for the autocorrelation coefficient is the same as was used for the monthly results, namely a probability of 0.8 for the interval between 1/2 and 1 (in terms of annual data) and a probability of 0.2 for the unit root.

TABLE 2

TESTS FOR A UNIT ROOT IN THE REAL EXCHANGE RATE USING ANNUAL DATA SINCE WORLD WAR II

	Price Index	$\hat{\rho}$	Dickey-Fuller T_{μ}	Sims γ	Sims $1 - \alpha^*$
United Kingdom	CPI	0.81	−1.93	−4.97	0.7504
	WPI	0.81	−1.77	−4.55	0.7084
France	CPI	0.51	−4.25	−19.72	0.9998
	WPI	0.90	−0.97	−2.00	0.4045
Germany	CPI	0.89	−1.49	−2.84	0.5080
	WPI	0.89	−1.43	−2.77	0.5001
Switzerland	CPI	0.96	−0.72	−0.06	0.2050
	WPI	0.89	−1.38	−2.68	0.4878
Japan	CPI	1.01	—	—	—
	WPI	0.92	−1.00	−1.60	0.3574
Australia	CPI	0.87	−1.74	−3.68	0.6118
	WPI	0.71	−1.75	−5.38	0.7867

NOTE: For both tests, the null hypothesis is ($\rho = 1$). For the Dickey-Fuller test, the critical region is $T_{\mu} < -3.00$; for the Sims test, the critical region is $\gamma < 0$. Because the estimated $\hat{\rho}$ for the Japanese CPI was outside the stable range, the test statistics were not computed in this case.

rejection is especially strong for the United Kingdom and Australia; in these countries, the prior distribution would have to give the unit root hypothesis a probability over 0.6 before the posterior odds would favor a random walk. On the other hand, the results for Switzerland and Japan are inconsistent. Using the CPI, the Japanese results favor the unit root, and the Swiss results just barely favor stationarity. Using the WPI, both the Japanese and Swiss results reject the unit root by a comfortable margin.

The results in Tables 1 and 2 are based on the model in equation (1), which assumes that the "long-run" value of the real exchange rate is a constant term, μ. However, Balassa (1964) argues that, because of a productivity bias in favor of tradable goods, the equilibrium value of the real exchange rate may change over time, especially when one country is growing more rapidly than another. In particular, the real exchange rate of the high-growth country should appear to appreciate. The greater is the weight of nontradable goods in the price index being used, the larger is this effect; therefore, the results using the CPI should be affected more than the results using the WPI. In order to adjust for such structural shifts, some of Frankel's (1985) Dickey-Fuller tests model the long-run equilibrium value of the real exchange rate with a linear time trend, rather than a constant term. Despite this adjustment, Frankel is still unable to reject the unit root hypothesis when only postwar data are used. What about the Sims test?

Table 3 presents results using annual data, adjusting for a linear time trend in the long-run equilibrium real exchange rate.[13] The parameters of the time trend were estimated in a single equation along with $\hat{\rho}$. The first column of Table 3 gives the estimates of $\hat{\rho}$; they are all in the stable range, well below one. However, the Dickey-Fuller test statistics continue to indicate that except for the French results

[13]The data used for Table 3 are identical to those in Table 2.

TABLE 3

TESTS FOR A UNIT ROOT IN THE REAL EXCHANGE RATE USING ANNUAL DATA AND INCLUDING A TIME TREND

	Price Index	$\hat{\rho}$	Dickey-Fuller T_t	Sims γ	Sims $1 - \alpha^*$
United Kingdom	CPI	0.65	−3.22	−11.90	0.9897
	WPI	0.64	−2.87	−10.05	0.9744
France	CPI	0.48	−4.58	−22.62	0.9999
	WPI	0.82	−1.72	−4.30	0.6821
Germany	CPI	0.76	−2.74	−8.65	0.9496
	WPI	0.77	−2.19	−6.25	0.8504
Switzerland	CPI	0.82	−2.12	−5.56	0.8008
	WPI	0.78	−2.29	−6.54	0.8678
Japan	CPI	0.69	−3.48	−13.29	0.9948
	WPI	0.77	−2.06	−5.81	0.8201
Australia	CPI	0.83	−1.88	−4.68	0.7215
	WPI	0.69	−1.77	−5.56	0.8008

NOTE: For both tests, the null hypothesis is ($\rho = 1$). For the Dickey-Fuller test, the critical region is $T_t < -3.60$; for the Sims test, the critical region is $\gamma < 0$.

using the CPI, the unit root hypothesis cannot be rejected at the 95 percent significance level.

The last two columns of Table 3 give the results for the Sims test. With the time trend included, the unit root hypothesis can be rejected consistently for all six countries, as shown by the negative values of γ.[14] Regardless of which price index is used, all of the values of $(1 - \alpha^*)$ are well above one-half. The rejections are strong even for Switzerland and Japan, countries where the results were marginal or ambiguous in Table 2.

If the unit root hypothesis is rejected, then $(1 - \hat{\rho})$ is the speed of adjustment, the fraction of a deviation from the long-run equilibrium that is closed per year. The results using the CPI in Table 3 imply that the speed of adjustment ranges from 17 percent per year for Australia to 52 percent for France. The average for these six countries is about 29 percent per year. Accordingly, the return to equilibrium is clearly a multiyear process.

4. CONCLUSION

This paper applies a new statistical test to evaluate the random walk hypothesis about real exchange rates. If true, this hypothesis would imply that deviations from purchasing-power parity have no tendency to fade away in the long run. The test is applied to monthly data from the period of flexible exchange rates alone, as well as annual data spanning the Bretton Woods and flexible exchange rate periods. When wholesale prices, which give heavy weight to tradable goods, are used in calculating

[14]In a recent paper using classical statistical tests and a much longer data sample extending back to the early 1900s, Kim (1990) is able to reject the random walk hypothesis for five WPI-based real exchange rates; however, the random walk is not rejected for three out of five CPI-based real exchange rates, even when a trend is included in the equation.

the real exchange rate, the results using the new test consistently favor stationarity, not the random walk hypothesis. When consumer prices are used, as is more common in the literature, the results again favor stationarity, though for some countries it is important to adjust for a trend in the real exchange rate when long time spans are involved. The results using consumer prices corroborate those of Abuaf and Jorion (1990) but are contrary to some previous results in the literature.

In sum, this paper provides evidence that real exchange rates do not follow a random walk, though they clearly have a sizable autoregressive component that makes the return to equilibrium a multiyear process.

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