MONETARIO ECONÓMICO

CURRENCY UNION AND REAL EXCHANGE RATE BEHAVIOR

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Abstract

In this paper we study the behavior of the real exchange rate of three American currencies relative to the U.S. dollar: the Canadian dollar, the Mexican peso and the Panamanian balboa. Our principal objective in doing so is to investigate the effects of alternative exchange-rate regimes, including currency union, on real exchange rate behavior. In each of these three cases we find at least some evidence supporting the purchasing power parity hypothesis in the data that we examine. Our second set of conclusions concerns the criticisms recently directed at the empirical exchange-rate literature. An important criterion underlying our choice of countries was diversity of experience with regard to the exchange-rate regime. The objective was to design an experiment in which meaningful comparisons of behavior across regimes would be possible.

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In this paper we study the behavior of the real exchange rate of three North currencies *vis-a-vis* the U.S. dollar: the Canadian dollar, the Mexican peso, and the Panamanian balboa. Our principal objetive in doing so is to investigate the effects of alternative exchange-rate regimes, including currency union, on real exchange rate behavior. Our choice of countries here is purposeful. Panama has been linked via a one-to-one exchange rate to the United States since it received its independence in the early part of the last century. Its currency, the Balboa, is for all practical purposes simply a unit of account. Panama therefore serves as a good example of a currency union. Canada and Mexico in contrast have independent currencies, but share common borders with and have strong real side linkages to the United States via both goods and labor markets. They therefore provide useful benchmarks for assessing the Panamanian experience.

In the next section of the paper we deal with theoretical considerations and review the relevant literature. In the third section, we present an historical overview of the four countries' exchange-rate experience during the varying periods for which we have data. We then go on to present empirical evidence on the short- and long-run behavior of the three real exchange rates. The methods that we use here range from simple graphical analysis, to unit root tests and Chow-type tests of temporal and spatial stability. The last section presents conclusions and outlines further research.

The key theoretical concept underlying our analysis of regime effects and of real exchange rate behavior more generally is purchasing power parity. In its simplest formulation, purchasing power parity posits equality between the price level in one country and the exchange-rate adjusted price level in the other. It therefore treats the real exchange rate –the nominal exchange rate divided by the ratio of the two countries' price levels– as a constant. This constancy, moreover, is posited to exist across exchange-rate regimes. The regime therefore is viewed as neutral.

How close this description is to actual experience depends importantly on how the real exchange rate behaves under different regimes, whether it tends toward some stable

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value over time under the different regimes and whether this pattern of movements is itself invariant to the regime. Studies of real exchange rate behavior over the past decade and a half have differed in their conclusions about these questions.[1] According to one line of reasoning, PPP and explanations of exchange-rate behavior that are based upon it lost their usefulness following the shift to floating exchange rates by the United States and other industrial countries in the early 1970s. Real exchange rates by this account became excessively variable and rather than tending to revert to stable equilibria behaved in a completely random fashion. Later findings have been much more supportive of PPP, but these in turn have been called into question. One objection centers on the possible adverse econometric effects of data heterogeneity, of combining data for varied exchange rate regimes, and of the applicability to the current float of results obtained with such data. Another centers on sample selection bias since the preponderance of evidence on real exchange rate behavior and PPP has been derived from industrial-country experience. A third objection focuses on problems inherent to the unit-root tests that have been the backbone of much of the recent econometric research. The empirical results presented in this paper speak to these issues.

Theoretical Considerations

To understand the relationship between nominal and real exchange rates and their relationship, in turn, to purchasing power parity, consider the following expression for the real exchange rate:

$$q_{i,t} \equiv e_{it} - p_{i,t} + p_{US,t}\,, \qquad [1]$$

where q_{it} is the log of the real exchange rate of country i relative to the United States, e_{it} is the log of the corresponding nominal exchange rate, the domestic currency price of a U.S. dollar, and $p_{i,t}$ and $p_{US,t\,t}$ are the logarithms of the ith country and the U.S. price levels respectively. If purchasing power parity holds perfectly, q_{it} will equal a constant, call it q_i. In this case, we can rewrite equation (1) as:

$$p_{i,t} - e_{it} = p_{US,t} - q_i \qquad [2]$$

This formulation is of particular use in analysis of behavior under alternative regimes. Under fixed exchange rates, the nominal exchange rate e_{it} also is constant, and in the case of currency union, equal to unity. Under fixed exchange rates, equation (2) therefore links the two countries' price levels. It is therefore a macroeconomic version of the law of one price. Under floating exchange rates, in contrast, (2) is a relation among price levels and the nominal exchange rate, or alternatively between the exchange-rate adjusted price level in the country and the actual price level in the other.

We can thus think of equation (2) as defining a cointegrating relation between these two variables. To see this more clearly, consider the following stochastic analogue to (2):

$$pa_{it} = a + bp_{US,t} + u_t, \qquad [3]$$

where $pa_{it} = p_{i,t} - e_{it}$, the exchange-rate adjusted price level in country i, a and b are coefficients, and u_t is an error term.

Viewed from the perspective of (3), long-run PPP requires b to be unity and u_t to be stationary. If we impose the condition b=1, we can then apply a simple unit root test to the real exchange rate itself to test for cointegration. We do this below.

Previous Studies

In the early 1970s, an extreme version of the exchange-rate theory sketched above was the prevailing paradigm. As the 1980s drew to a close, however, even more mode-

[1] The literature alluded to immediately below is reviewed in the next section of this paper. For recent surveys of this literature see Edison, *et al.* [1997] and Taylor [1995].

rate versions stood in discredit. Then during the course of the 1990s the pendulum of professional opinion took another swing. Studies using both long-term times series data and multi-country panel data for recent decades both painted pictures that appeared more favorable to PPP than earlier studies.[2] These later studies pointed to mean-reverting behavior of one sort or another for a wide variety of real exchange rates over a wide variety of time periods. Deviations from PPP are persistent, but in the end seemed largely (though most likely not completely) to disappear.

That evidence, however, is now being questioned. Much of it comes from examination of long historical time series for the major industrial countries. Both aspects — the long periods spanned and the sample of countries investigated— are viewed by some commentators as potential problems.

The long data span has meant combining observations for fixed- and for floating-rate periods. This, it is claimed, is a source of aggregation bias. Plausible as this characterization may be, it has gone largely untested. One exception is [Lothian and Taylor, 1996] who use relationships estimated with data for long periods prior to the advent of the current U.S. float to forecast dollar-sterling and franc-sterling nominal exchange rates over that period. Their simple AR(1) models out-forecast the usual naive models in both instances, particularly at longer horizons. These AR(1) formulations, moreover, prove stable in Chow-type tests when data for the float and pre-float periods are combined. Further evidence is provided in an earlier paper of ours [Lothian and McCarthy, 2000] that tests the aggregation-bias hypotheses using data for Ireland. We find no evidence there to support that hypothesis.

The emphasis on industrial countries is also viewed as a source of problems. Because such countries have been at similar stages of economic development throughout most of the periods being studied, real variables it is claimed have had little scope in which to operate. This, it is claimed further, results in sample selection bias. Proponents of this view have presented no evidence to support it. The evidence that does exist, moreover, is unfavorable (see Lothian [1998b]).

A related objection has to do with the relative impacts of nominal and real variables in the samples under consideration and the alleged inability of conventional econometric techniques to separate the influences of the two. According to proponents of this view, the greater incidence and magnitude of nominal shocks in samples that include data for floating rate regimes make it difficult if not virtually impossible to detect real influences econometrically. Researchers, they claim, are therefore led to accept the hypothesis of real-exchange-rate stationarity erroneously.[3]

Our data allow us to explore all of these issues. The substantial differences over time and across countries in the regimes described below provide the necessary degrees of freedom for tests of the aggregation-bias hypothesis. The differences in the extent of economic development of the United States on the one hand and Mexico and Panama on the other allow us to investigate the sample-selection-bias question. The similarity in levels of development of Canada and the United States and the absence of sharp divergences in the monetary policies of the two countries allow us to address the issue of real-exchange rate non-stationarity in a more satisfactory manner.

Empirical Results

We begin with an historical overview of exchange-rate and associated economic and monetary experience in the four countries being studied. We then go on to present several bodies of empirical evidence on

[2] Studies using long time series include Diebold, et al. [1991], Lothian [1990], Johnson [1993], Lothian and Taylor, [1996], and Taylor [1996]. Panel-data studies in include Frankel and Rose [1996] and Lothian [1997].

[3] See Engel [2000]. A less sophisticated version of this objection is advanced in Cuddington and Liang [2000]. As Lothian and Taylor [2000] point out in their response to that study, the important question is not whether non-stationarity can be uncovered statistically but whether it is important economically.

exchange-rate behavior across the various monetary regimes that have existed for these countries over our sample period.

Historical Overview: Exchange-Rate Regimes

Panama for all intents and purposes is on a U.S. dollar standard. The dollar circulates freely and has been linked one-to-one with the Balboa since 1904. Mexico and Canada, in contrast, have had much more varied and otherwise quite different exchange-rate experience than Panama.

Over the sixty years that our data for Mexico cover, that country's exchange rate regime has alternated between periods in which the peso was allowed to float more or less freely relative to the U.S. dollar and periods in which it was rather rigidly pegged. These latter periods, in turn, have themselves varied considerably in the degree to which the peg worked and hence in the degree to which the exchange rate remained stable.

Over the entire sample period it was far from so. Depreciation of the peso relative to the U.S. dollar has been the rule rather than the exception. Since 1939, the peso has depreciated by slightly over 750 per cent, with close to nine tenths of that depreciation, in turn, coming during the course of the past two and a half decades.

In the fifteen years prior to 1939, the peso-dollar rate, though in several instances virtually constant for a number of years at time, more than doubled. Then during World War II and the years immediately following, stability ensued. That, however, did not last and between 1948 and 1954 the peso underwent a series of substantial devaluations.

Beginning in April 1954, the situation again changed and the peso entered its longest period of stability. The official rate was set at 12.50 (old) pesos per U.S. dollar and that rate was maintained for the next 22 years, albeit with some difficulty in the latter years of that period, due to much more expansive monetary policy in Mexico than in the United States in the early 1970s.

In September 1976 the peso was devalued and during the remainder of that year was left to float. It stabilized at 22.5 pesos per U.S. dollar and remained in that general range until 1982. From that point on the peso has depreciated continually via a series of abrupt step-like movements that by 1999 had brought it to a level of 9560 old pesos per U.S. dollar.

The Canadian dollar-U.S. dollar exchange rate, by comparison, has been much more nearly constant. Our data for Canada begin in 1870. At the time, Canada, like the United Kingdom, was on the gold standard. From then until the United States returned to gold in 1879, the Canadian dollar, therefore, floated relative to the U.S. dollar.

With Canada and the United States on gold from 1879 until World War I, a fixed exchange rate between the two countries' currencies prevailed. Fixed exchange rates, however, effectively broke down during the war and were not reestablished until 1925, when Canada, again like the United Kingdom, went back to gold. This second gold-standard period, however, proved to be of short duration. Canada left gold in 1931 in response to the Great Depression and during the remainder of the inter-war years, alternated between pegged rates relative to the U.S. dollar and a float. World War II brought pegged and heavily controlled exchange rates and the decade and a half thereafter pegged rates coupled with devaluations of the Canadian dollar (1948-1951). From 1952 to 1962, the Canadian dollar floated and then in 1962 a fixed exchange rate returned only to give way to floating rates once again in 1970. The Canadian dollar has floated since then and over the past decade depreciated substantially relative to the U.S. dollar.

A Summary of the Data

The price data that we use are consumer price indexes for Canada, Mexico, Panama and the United States for periods of varying length over the 1870 to 1999. Data for the last 50 years came from the International Monetary Fund's *International Financial Statistics*, both hard copy and CD ROM versions. Sources of earlier data are described in a separate appendix available from the

authors on request. Exchange rates are foreign currency vs. U.S. dollar rates.

Shown in Figures 1 through 3 are plots of the logs of the price levels in the three countries against the U.S. price level and of the corresponding log real exchange rates. The price series plotted in the charts for Canada and Mexico are CPIs that have been adjusted by exchange rates to put them on a U.S. dollar basis. For Panama, of course, no such adjustment is needed. Two features of the charts deserve comment. One is the substantial positive correlation between the four price series. All follow substantial and very similar upward trends over the periods for which data are available. The visual impression therefore is of tolerably stable relationships between domestic CPIs and the U.S. CPI in all three instances. The other feature of interest is the dramatic difference between the behavior of the price and real exchange rate series. In two cases –Canada and Mexico– the real exchange rates appear to be virtually without trend. In the third case –Panama– the real exchange rate appears to follow an upward trend, but it is exceedingly moderate and hence quite different from the trend followed by the CPIs. Both aspects of the data are consistent with the predictions of PPP.

Figure 1
Real exchange rate and US$ CPIs: Canada vs. US

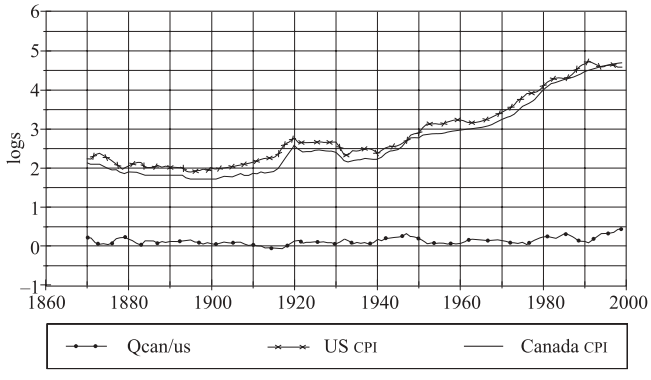


Figure 2
Real exchange rate and US$ CPIs: Mexico vs. US

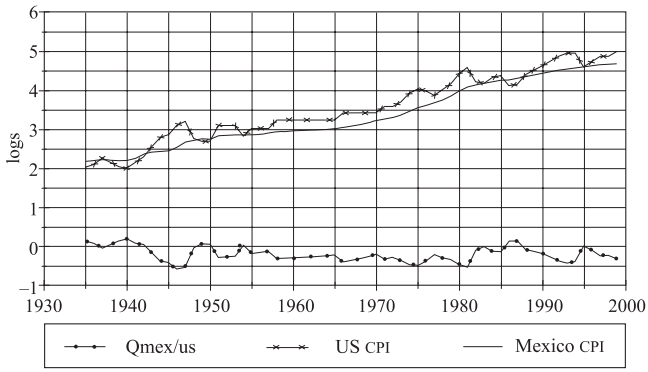
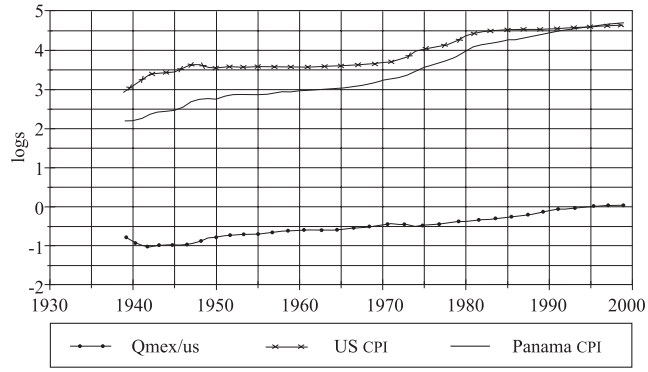


Figure 3
Real exchange rate and US$ CPIs: Panama vs. US



Short-term variability

Shown in Table 1 are means and standard deviations of the price series and the real exchange rates for both the full period and for various subperiods. For Canada and Mexico the subperiods were chosen to reflect temporal differences in the exchange rate regime; for Panama which maintained a currency union with the United States continuously, the subperiods reflect differences in the behavior of other economic variables that could conceivably affect real exchange rates.

Table 1a
Canada Means and Standard Deviations

		p_{US}	p_{CA}	q_{CA}
1871-1879	Mean	1.989	1.870	0.118
	St dev	0.093	0.151	0.079
1880-1913	Mean	1.795	1.718	0.077
	St dev	0.061	0.083	0.049
1914-1918	Mean	2.032	2.081	–0.048
	St dev	0.173	0.162	0.022
1919-1925	Mean	2.447	2.350	0.097
	St dev	0.060	0.046	0.029
1926-1931	Mean	2.401	2.317	0.084
	St dev	0.053	0.058	0.020
1932-1938	Mean	2.195	2.102	0.093
	St dev	0.034	0.066	0.045
1939-1947	Mean	2.403	2.208	0.195
	St dev	0.158	0.099	0.065
1948-1951	Mean	2.780	2.618	0.194
	St dev	0.039	0.059	0.049
1952-1962	Mean	2.917	2.843	0.074
	St dev	0.050	0.045	0.032
1963-1968	Mean	3.053	2.906	0.148
	St dev	0.048	0.059	0.011
1969-1971	Mean	3.233	3.101	0.132
	St dev	0.050	0.063	0.015
1972-1985	Mean	3.824	3.666	0.158
	St dev	0.328	0.255	0.083
1986-1999	Mean	4.514	4.264	0.251
	St dev	0.138	0.113	0.113

Note: p_{us} is log level CPI for the US. p_{ca} is the exchange-rate adjusted log level CPI and q_{ca} the log real exchange rate for Canada.

Table 1b
Mexico Means and Standard Deviations

		p_{US}	p_{ME}	q_{ME}
1939-1947	Mean	2.403	0.712	1.691
	St dev	0.158	0.454	0.304
1948-1954	Mean	2.816	1.042	1.774
	St dev	0.053	0.194	0.157
1955-1976	Mean	3.130	1.550	1.579
	St dev	0.223	0.295	0.092
1977-1982	Mean	3.922	2.363	1.559
	St dev	0.185	0.262	0.159
1983-1994	Mean	4.383	2.662	1.721
	St dev	0.136	0.308	0.188
1994-1999	Mean	4.653	2.958	1.694
	St dev	0.034	0.150	0.117

Note: p_{us} is the log level CPI for the US, p_{ME} is the exchange-rate adjusted log level CPI and q_{ME} the log real exchange rate for Mexico.

Table 1c
Panama Means and Standard Deviations

		p_{US}	p_{PA}	q_{PA}
1939-1947	Mean	2.403	3.353	–0.950
	St dev	0.158	0.208	0.080
1948-1962	Mean	2.872	3.572	–0.699
	St dev	0.074	0.023	0.085
1962-1972	Mean	3.120	3.643	–0.524
	St dev	0.117	0.057	0.062
1973-1986	Mean	3.893	4.271	–0.378
	St dev	0.313	0.238	0.079
1987-1989	Mean	4.354	4.538	–0.184
	St dev	0.043	0.002	0.041
1990-1999	Mean	4.586	4.600	–0.014
	St dev	0.081	0.034	0.048

Note: p_{US} is the log level CPI for the US, p_{PA} is the log level CPI and q_{PA} the log real exchange rate for Panama.

The subperiod means exhibit time patterns similar to those of the plotted series - substantial increases in the means of the CPIs and little or no increases in the means of the real exchange rates. The standard deviations provide information on possible cross-regime differences in real exchange rate variability. For the most part we see no consistent differences. The one difference that is visible in these data is between the variability of the real U.S. dollar exchange rate of Panama and the variability of the real U.S. dollar exchange rates of Canada and Mexico. Currency union seems to matter but not fixed versus floating rates more generally.[4]

We investigate this issue further using both graphical analysis and dummy variable regressions. Let us turn to the graphical analysis first. Shown in Figures 4 through 6 are variance decompositions of the three log real exchange rates by subperiods. These are based on the well-known formula for the variance of a sum:

$$\text{Var}[q_i] = \text{Var}[e_i] + \text{Var}[p_i/p_{US}] - 2\,\text{Cov}[e_i, p_i/p_{US}] \quad [4]$$

where Var[x] and Cov[x,y] denote the variance of x and the covariance of x and y, respectively, and all other symbols are as defined earlier. Data for Canada are plotted in two charts: Figure 4a shows data for subperiods between 1870 and 1938; Figure 4b shows data for subperiods from 1939 to 1999. Figures 5 and 6 show data for Mexico and Panama, respectively. These data begin in 1939 and are for the same subperiods as for Canada. Since Panama in effect had an exchange rate of unity throughout the sample period, no variance decomposition is possible. We do however plot two measures of real exchange rate variability. One set of figures is for the standard deviation of the log real exchange rate the same measure used in the other three graphs. The other is for the standard deviations of the de-trended log real exchange rate. The vertical scales for the charts for Canada and Panama are one twentieth the scale for Mexico.

Figure 4a: Canada

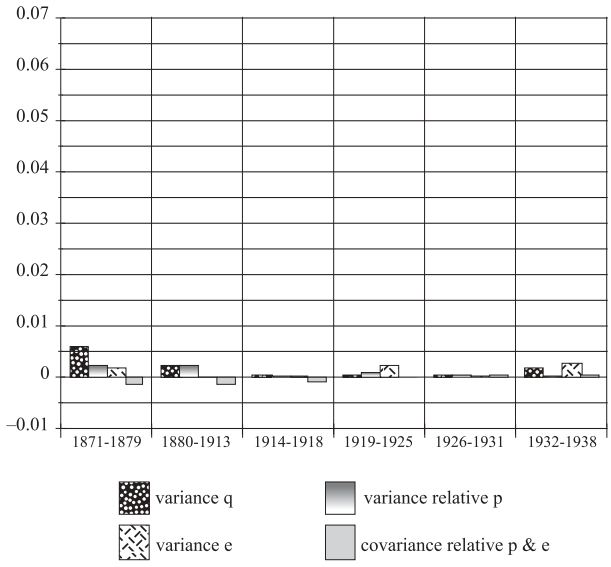
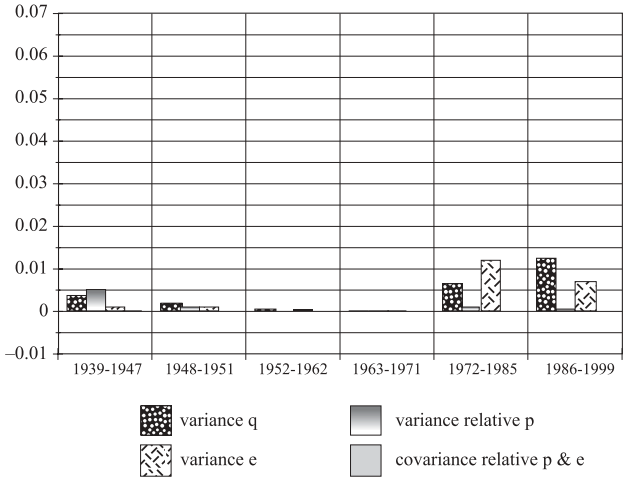


Figure 4b: Canada



[4] Mussa [1986] investigates regime effects using a wide variety of exchange-rate data. His results point to systematically higher variability of real exchange rates under floating rate regimes than under fixed. He explains this finding using a monetary model with exchange-rate overshooting. In such a model, the nominal exchange rate adjusts quickly and overshoots following a monetary shock, while the relative price level adjusts slowly. In the initial part of the process, variability of both nominal and real exchange rates increase; only later does the variability of the relative price level also increase.

Several aspects of these charts deserve comment. The first is the greater within-country variability of Canada's and Mexico's real exchange rates from 1972 on than before that date. This period in both instances is one of substantial nominal exchange rate variability - floating rate in the case of Canada and a mixture of floating rates and pegged but changing rates in the other. A second thing to notice is the sizable covariance terms for Mexico in the subperiods from 1972 on. These are periods in which variation in both nominal exchange rates and relative price levels increases markedly. The increase in the covariance between the two is exactly what one would expect to see under purchasing power parity. The final thing to notice in these graphs is the lower variability of Panama's real exchange rate throughout the sample period than the other two countries' real exchange rates.

This difference between Panama on the one hand and Canada and Mexico on the other is highlighted further in the regressions shown in Table 2. The dependent variables in these regressions were the subperiod standard deviations shown in Table 1. The independent variables were two regime dummies and a dummy to control for World War II. The first regime dummy was

Figure 5: Mexico

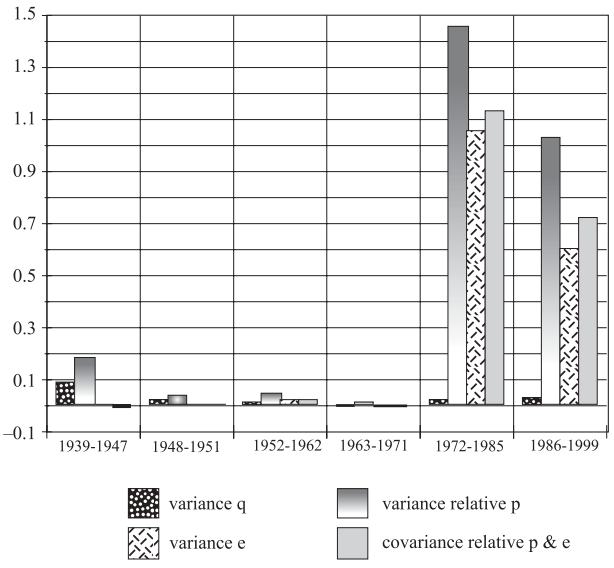


Figure 6: Panama

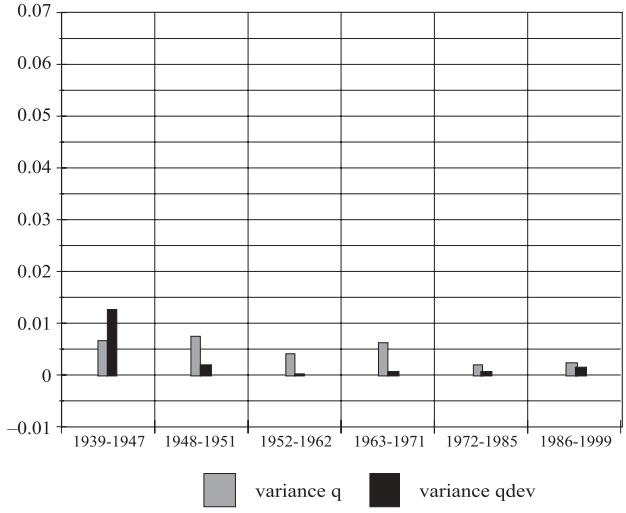


Table 2
Regressions to test for differences in variability across nominal exchange rate regimes

Constant	*DUNION*	*DWWII*	*DFIXED*	*R²/SEE*
0.070	–0.065	0.100	0.012	0.348
3.815	–1.955	2.501	0.401	0.060
0.075	–0.058	0.105		0.343
5.236	–2.066	2.848		0.060

Note: The dependent variable is the pooled series of standard deviations of the real exchange rate for the periods listed in Table 1. DFIXED is a dummy for all fixed-rate periods *including* the period of currency union between Panama and US. DUNION is a dummy for the period of currency union alone; and DWWII is a dummy for World War II. Figures below the coefficients are t values.

for all fixed-rate observations including those for currency union; the second for currency union alone. Only the second matters. It is significantly different from zero and negative.

Unit Root Tests and Long-run Behavior

Table 3 presents econometric evidence on long-run behavior. The question that it addresses is the stationarity of the real exchange rates and hence the nature of the long-term relation linking the nominal exchange rates and the foreign-country and U.S. price

levels. The test results shown there are for augmented Dickey-Fuller tests and Phillips-Perron tests for the three log real exchange rates and their log price-level and, where appropriate, log nominal-rate components. These were run both for levels and first differences of the variables. The components in almost all instances are non-stationary in levels but stationary in first differences. The results for real exchange rates, which are the principal concern here, are somewhat mixed.

Table 3

Unit root tests

Series	*Canada 1871-1999*	*Mexico 1939-1999*	*Panama 1939-1999*
Domestic Prices			
Log Levels			
ADF	1.977	0.745	–0.589
P-P	1.597	1.780	–1.388
First Differences			
ADF	–6.274	–3.398	–2.427
P-P	–6.434	–3.247	–3.868
US Prices			
Log Levels			
ADF	1.199	–0.615	–0.615
P-P	2.188	–0.101	–0.101
First Differences			
ADF	–5.155	–2.858	–2.858
P-P	–4.994	–3.623	–3.623
Nominal Exchange Rate			
Log Levels			
ADF	–1.164	0.492	
PP	–0.722	1.380	
First Differences			
ADF	–9.133	–3.763	
PP	–9.005	–3.654	
Real Exchange Rate			
Log Levels			
ADF	–2.311	–4.823	–4.567
P-P	–2.073	–3.760	–4.458
First Difference			
ADF	–9.314	–5.737	–6.246
P-P	–9.260	–7.005	–6.451

Note: ADF is Augmented Dickey Fuller unit root test with the appropriate number of lagged differences determined by the BIC criterion. P-P is the Phillips-Perron unit root test with the window width set at 3 or 4. The critical values for .01, .05 and .10 significance levels are: 1871-1999: –3.48, –2.88 and –2.58 1939-1999: –3.54, –2.91 and –2.59 The critical values for .01,.05 and .10 significance levels in regressions with a trend are: 1939-1999: –4.12, –3.49 and -3.17.

In terms of level of statistical significance, the results are strongest for Mexico. Using both test variants we reject the unit-root null for the log levels at well below the 1% level. For Canada, in contrast, we cannot reject even at the 10% level, while for Panama we can reject at 1%, but only after allowance for a deterministic trend.[5]

At first glance, these findings seem to suggest an inverse relation between the degree to which PPP holds and to the variability of nominal exchange rates.[6] This is clearly quite counterintuitive. If anything, one would expect PPP to hold more closely under a common currency than in a situation, such as that of Mexico, in which nominal exchange rates had changed substantially. Yet the two appear to be about the same while Canada with much more stable nominal exchange rates than Mexico appears to perform worst.

We are, however, somewhat hesitant to embrace such a ranking for several reasons. One is the possibility that the Canadian results are simply a statistical fluke. When we truncated the Canadian sample and ended anywhere from the early to the mid-1990s, rather than 1999, we consistently rejected the unit root null. Only when we added the data for the last five years did that become impossible. The obvious question that arises is whether these recent observations are just outliers or are indicative of some permanent behavioral change.[7]

A second reason to be circumspect about these results is that unit-root tests, however useful they may be in many instances, are hardly the sole criterion by which to

[5] We can reject a unit root for the Canadian-US real exchange rate at the 5% if the Wholesale Price Index is used instead of the Consumer Price Index.

[6] Other researchers have concluded much the same thing in studies in which the behavior of real exchange rates internationally and intra-nationally are being compared. It has generally been possible to reject the unit root null with the international data but not with the intra-national data. See, e.g., Engle and Rogers [1995], Bayoumi and Macdonald [1998], and Culver and David Papell [1999]. Chen and Devereux [1999], however, dispute this interpretation.

[7] Evidence from Johnson [1993] supports the rejection of a unit root for the Canadian-US real exchange rate for the period 1920 to 1991. However, he also finds that this conclusion was sensitive to both sample length and the choice of price index.

judge long-run real exchange rate behavior. A simple alternative metric, nominal exchange rate predictability, in fact gives a quite different ranking. By this criterion Mexico ranks third, Canada second and, if we allow for the trend, Panama first. The standard deviations of the log real exchange rates of the first two countries are .182 and .093, respectively, while the standard error of estimate in a regression of the log real exchange rate of Panama on time is .061.

Behavior Across Regime

Table 4 presents estimates of AR(1) models for the three countries' real rates and reports the results of Chow-type tests that we used to assess the stability of the relationships across regimes. Included in these regressions are dummy variables to allow both slopes and intercepts to vary across regimes and across countries. Since heteroskedasticity is liable to pose a problem we use heteroskedastic-consistent standard errors throughout. In no instance, are either the regime slope or intercept dummy significant. This is true for Canada and Mexico individually as well three countries taken as a group. The country dummies are, however, significant. At first glance these differences might seem to be regime connected given the currency union between the United States and Panama. On closer inspection, this does not seem to be the case at all. Canada is the reference point in these regressions. The significant country dummies in the pooled regression imply significant differences between Mexico and Panama on the one hand and Canada on the other, but not significant differences between Mexico and Panama of the sort that would exist if the country dummies were picking up regime-related effects. The difference between the estimated slope coefficients for the latter two countries is non-zero but nevertheless well within the range of error in the equations. The allegation that the regime matters and that aggregation bias is therefore a problem in time series tests of PPP remains unproven.

Table 4
Regressions to test differences across regimes

Variable	*Coefficient*	*S.E.*	*t-Statistic*
Canada			
Intercept	0.015	0.007	1.993
q_{t-1}	0.919	0.050	18.386
DFIXED	–0.014	0.012	–1.178
$DFIXEDHq_{t-1}$	0.064	0.092	0.696
R^2	0.806		
SEE	0.040		
Mexico			
Intercept	0.630	0.398	1.581
q_{t-1}	0.627	0.224	2.804
DFIXED	–0.008	0.471	–0.017
$DFIXEDHq_{t-1}$	–0.013	0.270	–0.049
R^2	0.407		
SEE	0.136		
Panama			
Intercept	–9.612	3.331	–2.886
q_{t-1}	0.739	0.092	8.055
Time	0.005	0.002	2.891
R^2	0.992		
SEE	0.027		
Pooled			
Intercept	0.012	0.007	1.748
q_{t-1}	0.937	0.044	21.435
DFIXED	–0.006	0.008	–0.704
$DFIXEDHq_{t-1}$	–0.014	0.024	–0.570
DMEX	0.613	0.218	2.810
$DMEXHq_{t-1}$	–0.307	0.131	–2.350
DPAN	–9.556	3.230	–2.959
$DPANHq_{t-1}$	–0.184	0.103	–1.809
DPANHtime	0.005	0.002	2.963
DWWII	–0.002	0.023	–0.086
R^2	0.992		
SEE	0.073		

DFIXED is a dummy for fixed exchange rates, DMEX and DPAN are dummies for Mexico and Panama. Standard errors are White's heteroskedasticity-consistent standard errors.

Conclusions

We reach two sets of conclusions. The first has to do with the overall performance of purchasing power parity in the data that we examined. In each of the three cases we find at least some evidence supporting the hypothesis. For both Mexico and Panama we find evidence of real exchange rate stationarity, absolute stationarity in the case of Mexico and trend stationarity in the case of Panama. In the case of Canada the real exchange rate appears to have been stationary over most of the period but a shift may have occurred during the past decade. In any event, errors in predicting nominal exchange rates on the basis of PPP are quite small for Canada, as also is the case for Panama once a trend is taken into account.

Our second set of conclusions concerns the criticisms recently directed at the empirical exchange-rate literature. An important criterion underlying our choice of countries was diversity of experience with regard to the exchange-rate regime. The object was to design an experiment in which meaningful comparisons of behavior across regimes would be possible. In the main we were unable to find any. The allegation of problems created due to aggregating data across regimes therefore receives no support at all in these data. A second criterion for choosing the countries in our sample was differences in level of economic development. The object here was to provide ample leeway for real variables to operate. For Mexico such factors do not appear to matter. For Panama they might be of some importance, but a modified form of PPP nevertheless continues to perform well.

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