

**Exchange Market Efficiency and Purchasing Power Parity:  
Long Run Behavior of Latin American Currencies**

**Alejandra Cabello  
Universidad Nacional Autónoma de México**

**Robert Johnson  
University of San Diego**

**Edgar Ortiz  
Universidad Nacional Autónoma de México**

**Luc Soenen  
California State Polytechnic University**

**Inaugural International Conference on  
Business, Banking and Finance  
University of West Indies, St. Augustine  
Trinidad & Tobago  
April 27-29**

**Contact author:  
Edgar Ortiz  
Apartado 21-244  
Col Coyoacán  
Del Coyoacán  
04000 México, D.F.  
Tel: (5255) 56 58 19 49  
Fax: (5255) 56 58 19 49  
e-mail: [edgaro@servidor.unam.mx](mailto:edgaro@servidor.unam.mx)**

**EFFICIENCY AND PURCHASING POWER PARITY:**

# LONG RUN TESTS FOR THE LATIN AMERICAN CURRENCIES

**Alejandra Cabello\***  
**Universidad Nacional Autonoma de México**

**Robert Johnson**  
**School of Business, University of San Diego**

**Edgar Ortiz**  
**Universidad Nacional Autonoma de Mexico**

**Luc Soenen**  
**California Tec University**

## Introduction

Empirical evidence demonstrates the failure of Purchasing Power Parity theory (PPP) to hold in the short run. While evidence in the long run has been mixed. A problem of many tests was an inadequate specification of PPP as a dynamic intertemporal theory. Roll's extension of this theory (1979) based on efficient markets (EPPP), overcomes that shortcoming. With few exceptions, research carried out for the cases of the developed countries support the efficient markets view of PPP. No studies have been carried out for the case of developing countries. The purpose of this paper is to investigate whether EPPP holds for the case of the Latin American currencies. Exchange rate and inflation rates data gathered for a sample of 15 Latin american currencies from **International Financial Statistics** from the International Monetary Fund covers the period January 1970 to December 2000. The paper is organized as follows. Section I reviews the issues concerning PPP and the empirical evidence related to efficient purchasing power parity tests. Section II presents the model and the data, underlying the hypothesis to be tested derived from the efficient purchasing power parity propositions. Section II presents the empirical results. Two regression tests and a unit root test are performed; the first regression aims to determine whether or not past exchange rates, adjusted for inflation rates, contain any information to predict future spot rates. The second regression tests if real exchange rates follow a martingale process, which is then complemented with unit root test to determine if the series are stationary. Previous to these tests, the basic stochastic characteristics of the exchange rates series are examined. The conclusions, in Section IV, offer some suggestions for policy making.

---

\* The authors wish to acknowledge and thank valuable comments received from Vincent Dropsy. California State University, Fullerton. Graduate assistance was provided by Raul de Jesus, Universidad Nacional Autonoma de Mexico.

## **I. PURCHASING POWER PARITY AND EFFICIENT EXCHANGE MARKETS**

For the international investor, risk at capital and money international markets is highly associated with exchange rates. For corporations operating internationally, transactions and economic risk are also determined by exchange rates; finally, macroeconomic performance depends on exchange rate stability and timely adjustments to avoid mainly overvaluation of the domestic currency. Purchasing Power Parity (PPP) is one of the oldest and most controversial doctrines in international finance. According to the traditional PPP theory, as originally defined by Cassel (1916; 1921), in perfect goods and financial markets identical goods must have the same real price everywhere. Otherwise commodity arbitrage will take place (Law of One Price). Assuming that every country consumes the same basket of goods, this theorem also applies to the national price indexes. In other words, the variation in the exchange rate for two currencies is equal to the inflation differential in the two countries over a period of time, equal in magnitude but opposite in sign (relative version of PPP).

PPP is a fundamental concept in international economics and also has important implications both for the financial manager of international portfolios as well as for the financial corporate manager. Although PPP is supposed to hold in the long run, short term deviations from PPP give rise to cross-border transfers of commodities and capital. Most models of exchange rate determination (e.g. Dornbusch, 1976 and Mussa, 1982) are largely based on long run validity of the PPP proposition. PPP provides an easy and inexpensive way to make medium to long run predictions about exchange rate movements. Sustained deviations of the actual real exchange rate from its long run equilibrium level create economic exposure for the firm, excessive exchange risk to international investors, and great macroeconomic fragility to external shocks, which might end in severe currency and financial crisis. There is no practical reason why the equilibrium real exchange rate should not vary through time as sustained by PPP. However, in addition to inflation and interest rates, the path of the real exchange rate compatible with the attainment of internal and external equilibrium is affected by changing world conditions, productivity improvements, adjustments to trade barriers, and changes in taxation, among other factors (Edwards, 1989). Additionally, globalization has led to an increased importance of capital flows, particularly foreign direct and portfolio investments as determinants of international reserves and exchange rate levels (Agénor and Hoffmaister, 1998; Bohn and Tesar, 1998; Goldberg and Klein, 1998; and Ortiz, 2000).

One of the most extensive reviews of the earlier tests of PPP was undertaken by Officer (1976). Since then evidence has been accumulating that demonstrates PPP's failure to hold in the short run. For instance, Frenkel (1981), Hakkio (1984), Krugman (1984), Dornbusch (1980; 1985), Broadberry (1987) and Edison (1987), Murray and Papell (2002), Taylor (2002) all confirm this result.<sup>1</sup> Roll (1979) argued that a problem of past tests of PPP is an inadequate specification of PPP as a dynamic intertemporal theory. He formulated a superior

---

<sup>1</sup> An assessment of PPP studies can be found in Breuer (1994).

theory of PPP from an efficient markets perspective based on international commodity arbitrage, i.e. the efficient markets PPP (EPPP). Later Adler and Lehmann (1983) developed another version of the efficient markets PPP based on financial arbitrage in bonds. Empirical evidence on EPPP can be found in the work of Roll (1979), Darby (1980), Adler and Lehmann (1983), Koveos and Seifert (1985), Huang (1987), Witt, Jr. (1993) and others. On the whole, the empirical evidence supports the efficient markets view of PPP for most industrialized countries. A notable exception is Huang (1987) who reports that expected nominal exchange rate changes appear to deviate systematically from expected inflation rate differentials supporting the presence of time-varying risk premia in foreign exchange markets. More recently, Abuaf and Jorion (1990) re-examined the evidence on PPP using a first order autoregression model in a multivariate setting. They show that long run PPP might indeed hold, although there are substantial short term deviations from the parity condition. Examining the Australian case, Olekalns and Wilkins (1998) estimating fractionally integrated integrated ARMA model find that PPP does have relevance for the long run behavior of the exchange rate.

Previous studies have by and large been restricted to early time periods and specially to industrial countries.<sup>2</sup> The purpose of this paper is to investigate whether the EPPP, as identified by Roll (1979),<sup>3</sup> holds for the case of the Latin American currencies, for the period January 1970-December 2000. During the last three decades of the XX Century the Latin American countries underwent recurrent crisis characterized, among other things, by severe exchange rate imbalances followed by drastic government determined adjustments, complemented with market adjustments; towards the end of the century freer market exchange rate activity was promoted by their policy makers. Thus, erratic exchange rate policy making and erroneous exchange rate regimes in the region led in the short run to severe exchange rate imbalances, becoming in turn important mechanisms to trigger the crisis in their countries (Wise and Roett, 2000).<sup>4</sup> At any rate, in the long run as a result of compelling adjustments and stimulated by freer exchange rate markets, exchange rates in Latin America should have adjusted taking into account their inflation differential rates with their main commercial and financial partner: the United States of America.

---

<sup>2</sup> An exception is Roll (1979) who examined 23 countries, including Argentina, Brazil, Chile, Mexico and Venezuela (1957-1976). Another notable exception is Koveos and Seifert (1985) who tested the EPPP for the Latin American black market currencies for the period April 1973-March 1983). The work by Mkend (2001) applied a panel data approach for selected African countries using annual data for the period 1965-1996.

<sup>3</sup> Financial arbitrage is not included in our tests because emerging capital markets are only recently integrating to global financial activity. Furthermore, there is no available long run data for emerging markets transactions in bonds.

<sup>4</sup> The work of Wise and Roett presents 7 papers dealing with exchange rate policy making in Latin American, emphasizing the cases of Argentina, Brazil, Mexico and Venezuela for the 1990's period. Their political and economic analysis are very illustrative concerning exchange rate policies and their relationship with macroeconomic policies and performance.

## II. THE MODEL AND DATA

EPPP is based on the constraint that, in efficient markets, the real return to an investor from intertemporal speculation on goods is anticipated to be zero. This paper investigates three testable implications of the efficient markets hypothesis, as suggested by Roll (1979). The EPPP hypothesis stipulates that all available information is utilized by the market participants such that the present spot exchange rate contains all the information to predict the future spot rate adjusted for the inflation differential. The first testable version of EPPP can be expressed in a regression format as follows:<sup>5</sup>

$$X_t = b_0 + b_1(\ln S_{t-1}) + b_2X_{t-1} + b_3X_{t-2} + b_4X_{t-3} + b_5X_{t-4} + b_6X_{t-5} + b_7X_{t-6} \quad (1)$$

where,  $X_t$  = the natural logarithm of the spot exchange rate adjusted for the intercountry inflation differential in period  $t$  (i.e.,  $X_t = \ln S_t - DI_t$ , where  $DI_t$  is the difference in the continuously compounded inflation rate between the home country and the foreign country.  $S_{t-1}$  = spot exchange rate in period  $t-1$ . The efficient markets version of PPP would be supported if equation (1) results in the  $b_1$  coefficient to be equal to unity and the other coefficients to be zero.

EPPP also implies that the real exchange rates follow a martingale process. Therefore deviations from PPP from one period to the next should be serially independent (Adler and Lehmann (1983)). Equation (2) can be used to test this hypothesis:

$$Y_t = b_0 + b_1Y_{t-1} + b_2Y_{t-2} + b_3Y_{t-3} + b_4Y_{t-4} + b_5Y_{t-5} + b_6Y_{t-6} \quad (2)$$

where  $Y_t$  = the difference between the rate of change in the spot exchange rate ( $\ln S_t - \ln S_{t-1}$ ) and the intercountry inflation differential ( $DI_t$ ) in period  $t$  (i.e.,  $Y_t = (\ln S_t - \ln S_{t-1}) - DI_t$ ).

The random walk hypothesis implies that the  $b_i$  ( $i = 1, \dots, 6$ ) coefficients should be zero for all  $i$ . Both equations, (1) and (2) are estimated to test the relevance of EPPP for the Latin American currencies.

Finally, if the time series of changes in the exchange rate follow a martingale process and should therefore be characterized by a random walk process; the time series should be nonstationary series. Thus, to support the EPPP we should be able to prove that the changes in real exchange rates have a unit root. The Augmented Dickey-Fuller Test (ADF) and the Phillip-Perron test are used to test this hypothesis. The two statistics test for a unit root in the univariate representation of a time series. For a series  $Y_t$  the ADF test (Dickey and Fuller, 1979) consist of a regression of the first difference of the series against the series lagged  $k$  times as shown in equation (3):

---

<sup>5</sup> Six lags have been chosen for this study based on the use of past information by financial analyst in Latin america, according to interviews taken among them, albeit it must be acknowledged that for annual assessments they also they to use past annual information.

$$\Delta y_t = \alpha + \lambda y_{t-1} + \sum_{s=1}^k \beta_s \Delta y_{t-s} + \varepsilon_t \quad (3)$$

The null and alternative hypothesis are:  $H_0: \lambda = 0$ ;  $H_1: \lambda < 1$ ; acceptance of the null hypothesis implies nonstationarity. To control for higher-order correlation in a series the ADF approach adds lagged differenced terms in the right side of the equation. Similarly, the Phillip-Perron test (1988) aims at controlling for higher-order serial correlation in a series making a correction to the t-statistic of the  $\gamma$  coefficient of the AR(1) regression to account for the serial correlation on  $\varepsilon$ . Unit root test have become useful due to their increased test power. Important long term test of PPP have been recently carried out by Lothian and Taylor (1996) and Cuddington and Liang (1998). The former conclude that PPP is valid in the long run for the bilateral real rates of exchange they considered. the finding of Cuddington and Liang contradict those findings; using a two hundred years series for the dollar-sterling real rates they find that, choice in the lag length might influence the results,<sup>6</sup> or else deterministic trends and structural breaks can give rise to nonstationarity. However, their findings are limited to real exchange rates. This study extends the unit root test to the series of changes in exchange rates to complement the martingale test proposed by equation (2).

The primary source of data for this study is the International Monetary Fund's **International Financial Statistics**, which includes end-of-month exchange rates relative to the U.S. dollar and end of month consumer price indexes.<sup>7</sup> The exchange rate data used in testing the efficient markets hypotheses cover the period January 1970-December 200.<sup>8</sup> Data was gathered for 15 countries: Argentina, Bolivia, Brasil, Colombia, Costa Rica, Chile, Ecuador, El Salvador, Guatemala, Honduras, México, Paraguay, Peru, Uruguay, and Venezuela.<sup>9</sup> Exchange rate series were adjusted for changes in the numeraire taking place during the period under análisis. The original January 1970 price domestic currency to the dollar was maintained as point of reference to evaluate and compare changes throughout time. Inflation rates series were adjusted to a uniform January 1970 base.

---

<sup>6</sup> On this issue see: Ng, S. and P. Perron (2001).

<sup>7</sup> Consumer price indexes are used in this study considering that consumer goods are the U.S. main imports from Latin America; similarly, consumer goods and intermediate goods (for consumer goods production) are the main Latin American imports from the U.S. In addition, exchange rate and portfolio investors use consumer price indexes more often than producer's price indexes to make their decisions. Finally, the differences in methodology in the construction of producers price indexes is greater than the differences in methodology used to derive consumer's price indexes.

<sup>8</sup> Actually the exchange series data includes December 1969, end of period, i.e., opening price for January 1970, to have a complete series of 12 months changes in exchange rate for all years for the period under analysis.

<sup>9</sup> Countries from the Region not included in the sample due to the lack of continuity in the series available derived from their political problems are: Dominican Republic, Nicaragua and Haiti. It is worth noting the lack of data for Nicaragua due to the Sandinist Revolution. In addition, Cuba is not a member of the International Monetary Fund and the U.S. dollar is the means of exchange in Panama.

### III. EMPIRICAL RESULTS

#### Basic Statistics

Tables 1 to 4 summarize the main stochastic characteristics of the Latin American currencies on a long term basis. Statistics are shown for the bilateral local currency in relation to the U.S. dollar; Table 1 shows the basic statics for the local currency price of dollars in nominal terms; Table 2 shows those statistics in real terms; and Tables 3 and 4 show the basic statistics for the series on changes (returns) in the nominal and real exchange rates from the Latin American countries in the sample. Figures 1 and 2 complement these analysis. Figure 1 illustrate skyrocketing evolution price of the dollar in terms of the local currencies; Figure 2 depicts the changes in real exchange rates, illustrating the large and time varying volatilities for the Latin American currencies in the sample. The data includes a total of 372 monthly observations. To apprehend fully the nature of the series, these statistics are shown in terms of the original price of the dollar in the local currency. Stressing the nominal exchange rates statistics two dramatic situations can be identified: a) Exceedingly high changes in the price of the dollar from January 1970 to December 2000 coupled with large volatilities; b) lack of normality.

Moreover, the evidence shows that the largest Latin American countries, Argentina Brasil, Mexico and to a lesser extend Colombia, Chile, Peru and Venezuela suffered the largest exchange rate changes. In nominal terms, in the case of Argentina, the price of the dollar was of 3.50 pesos (minimum for the 'period), ending with an unbelievable maximum price of 100,000,000,000 (old) pesos per dollar; the media for the period was 33,956,905,017, and the standard deviation amounted to 46,359,116,966 these facts, as a lesson from the past, show the unsustainability of the one peso per dollar followed during the 1990's decade. The case of Brasil is even more dramatic. As shown in Table 1, its currency varied from a minimum of 4.42 cruzeiros per dollar to a maximum of 2,963,974,397,190 (old) cruzeiros per dollar. The media was of 415,736,595,660 and the standard deviation situated in 810,563,628,758 points. Finally, Mexico was the least affected of the three large Latin American economies. In nominal terms the dollar price changed from a minimum of 12.49 to a maximum of 10,174.50 pesos per dollar. The media was of 2,368.31 pesos per dollar and the standard deviation amounted to 3,210.26 points. The medium sized Latin American economies (Colombia, Chile, Peru and Venezuela) followed similar, but somewhat less dramatic patterns of change in their exchange rates. The most severe changes took place in Peru. Its exchange rate in old nominal soles changed from a minimum of 38.70 to a maximum of 353,100,000 soles per dollar; the media amounted to 76,758,095 soles per dollar and the standard deviation was of 118,968,812 points. Finally, minimum and maximum exchange rates and volatility, it is worth noting that the smaller Latin American countries, presented less severe changes; furthermore, those from Central America presented rather mild changes. The case of El Salvador exemplifies best this case. In nominal terms, the price of the dollar in Colones changed only from a minimum of 2.50 to a maximum of 9.30; the media was of 4.89 and the standard deviation was of 2.76 points. However, the small South American countries, rather resembled the patterns present in the Large Latin American Economies. Particularly, in the case of Chile its exchange rate changed from a minimum of

11.68 pesos per dollar in January 1970 to a maximum of 572,680 (old) pesos per dollar by the end of the period. The media amounted to 197,144.68 pesos per dollar and the standard deviation at 183,291.81 points.<sup>10</sup>

The exchange series from the Latin American currencies are also characterized by the lack of normality. As shown in Table 1, in all cases the Jarque-Bera statistics shows a lack of normality. In this respect stands the fact that seven countries: Brasil Colombia, Ecuador, Uruguay, and less markedly Honduras and Venezuela present leptokurtic curves, while the remaining 8 countries, Argentina, Bolivia, Costa Rica, Chile, el Salvador, Guatemala Paraguay and Peru present a platykurtic curve. Finally, all the 15 countries in the sample present curves skewed to the right.

A similar situation is present for the case of real exchange rates, Table 2. Consistent with the case of nominal exchange rates. The series show great volatility and lack of normality. However, in spite of skyrocketing inflation rates the real prices series apparently show only slight misadjustments examining the maximum real prices. Moreover, for 10 of the 15 cases (Brasil, Colombia, Costa Rica, Chile, Ecuador, El Salvaor, Guatemala Honduras, Mexico and Urfuguy by the end of 2000 their currencies were slightly undervalued in relation to the dollar; Stressing the cases of Brasil and Mexico, the subvaluation of their currencies was of -0.82 percent and -1.34 percent, respectively. In the case of of Argentine, Bolivia, Paraguay, Peru and Venezuela a small overvaluation seemingly was present, 4.20% for the case of Argentina.

Large volatilities and lack of normality are also present in the series of changes in nominal exchange rates and changes in real prices (Tables 3 and 4). The most striking fact is the spread in their monthly volatility. Stressing the cases of Argentina, Brasil and Mexico for changes in nominal exchange rates, Table 3, the standard deviation for Argentina was 0.172 points, with a minimum of -0.31 and a maximum of 1.58 points; for the case of Brazil, the standard deviation of the changes was -0.102 points and a minimum of -0.18 and a maximum of 0.547 points; Mexico had a standard deviation of 0.070, and a minimum of -0.396 points and a maximum of 0.775 points. In teal terms (Table 4), for the same countries, the standard deviation for Argentina stood at 14.365 points with a minimum of -60.91 and a maximum of 118.32 points; the standard deviation of changes in real exchange rates for Brazil was of 5.729 points with a minimum of -39.59 points and a maximum of 49.045 points; in the case of Mexico, its standard deviation was 6.536 points with a minimum of -44.607 and a maximum spread of 65.018 points. Finally, it is worth noting that like in the case of nominal exchange rates examined before, The Central American countries show the smallest variations, and the smallest South American countries show volatilities smaller than those present in the largest Latin American Countries, Argentina, Brasil and Mexico, but greater than the volatilities shown by the Central American countries.

---

<sup>10</sup> The fact that the largest exchange rates and volatilities took place in the largest Latin American countries as well as in most South American economies, particularly the medium size one probably derived from their also large foreign debts and uncontrolled inflation rates.



## Efficient PPP Test

The estimated coefficients and the results of hypothesis tests pertinent to equation (1) are presented in Table 5. The null hypothesis, formulated in accordance with EPPP, is that the coefficient of the previous period's spot exchange rate is equal to one and that the coefficients of past exchange rates adjusted for inflation are equal to zero. The t-statistic can be used to test the significance level for each individual coefficient. An F statistic and Chi-square tests can be utilized to test the hypothesis that  $b_1 = 1$  and  $b_i = 0$  ( $i > 1$ ).

The results provide only weak support for the efficient markets version of PPP. The coefficient for the spot exchange rate in the previous period is close to unity (i.e.,  $b_1 = 1$ ), and apparently statistically significant, only for the cases of five countries: Brasil (1.0127), Ecuador (0.9967), Mexico (1.0449), Paraguay (1.0568), and Uruguay (0.9644). Only in the case of Ecuador all remaining coefficients,  $b_2$  to  $b_7$  are fairly close to zero near 0.05, nearing 0.07 in one case, but are not statistically significant. For the cases of Brasil, Mexico, Paraguay and Uruguay there are some coefficients  $b_2$  to  $b_7$  significantly far away from zero. For example in the case of Brasil  $b_2$  equals to 0.1701,  $b_3 = -0.3728$ , and  $b_4 = 0.1679$ . In the case of México,  $b_2 = 0.2146$  and  $b_5 = 0.2008$ . Most of these coefficients are statistically significant. Moreover, the high R square and insignificant t-tests for the remainder  $b_i$  coefficients signal multicollinearity. Therefore, we can convincingly reject the hypothesis that  $b_2 = b_3 = \dots = b_7 = 0$ . This is confirmed with the Wald test. As shown in Table 4 the F and Chi-square statistic decisively reject the null hypothesis at a one percent significance level. Thus in a long term basis, past spot rates adjusted for inflation from previous periods seem to contain some information about current spot exchange adjusted for inflation. This reflects the fact that during long periods authorities from Latin American Central banks "pegged" their currency to the dollar (earlier phase of the period under analysis) and maintained a tight dirty float during other periods, tending to freer markets during the last decade of the XX Century.

Finally, it is worth noting that for the cases of Argentina, Costa Rica, Chile, El Salvador, Guatemala, Honduras, and Venezuela, the coefficient  $b_1$  is significantly higher than one; and for the cases of Bolivia, Colombia and Peru, the coefficient is significantly lower than one. In addition, some other coefficients,  $b_2$  to  $b_7$ , for all these ten countries are significantly above zero, and most show high t-statistics. In short for these ten countries the first efficient purchasing power hypothesis must be rejected. Their markets are inefficient and past exchange rate contain some valuable information about current spot rate.

The rest of the coefficients are different from zero, particularly  $b_5$  (fourth lag) which is statistically significant. Moreover, the high R square and insignificant t-tests for the remainder  $b_i$  coefficients signal multicollinearity. Therefore, we can convincingly reject the hypothesis that  $b_2 = b_3 = \dots = b_7 = 0$ . This is confirmed with the Wald test. As shown in Table 5 the F and Chi-square statistic decisively reject the null hypothesis at a one percent significance level. Thus in a long term basis, past spot rate adjusted for inflation from previous

periods seem to contain some information about current spot exchange adjusted for inflation. This reflects the fact that during long periods authorities from Latin American Central Banks de Mexico "pegged" their currencies to the dollar and maintained a tight dirty float during other periods.

Table 6 summarizes the results of the tests of equation (2). The null hypothesis that the differentials in real exchange rates follow a martingale process is not supported for the Latin American case, in a long term basis. Indeed, 11 countries in the sample show several  $b_1$  to  $b_7$  coefficients greater than zero. This is the case of Argentina, Bolivia, Brasil, Colombia, Costa Rica, Chile, Ecuador, Mexico, Peru, Uruguay, and Venezuela. Similarly, most coefficients relatively close to zero are not statistically significant. It is worth noting the cases of Argentina, Brasil and Mexico. In the case of Argentina four coefficients depart significantly from zero ( $b_1$ ,  $b_2$ ,  $b_3$  and  $b_5$ ) and are statistically significant; the remaining coefficients  $b_4$  and  $b_7$  near zero but are not statistically significant. For Brasil two coefficients,  $b_1$  and  $b_2$ , are not close to zero and their t-statistic is significant; the remaining coefficients are relatively close to zero but are not statistically significant. Finally, in the case of Mexico four coefficients depart from zero,  $b_1$ ,  $b_2$ ,  $b_3$  and  $b_6$ , and their t-statistic is above two; the remaining two coefficients,  $b_4$  and  $b_5$ , are close to zero but are not statistically significant.

Countries that present all coefficients  $b_1$  to  $b_7$  close to zero are El Salvador, Guatemala, Honduras and Paraguay. Nevertheless in neither of these cases the t-statistic is significant. These results indicate that the difference between the rate of change in the spot exchange rate and the inter-country inflation differential is correlated for the Latin American currencies. The F-statistic and the Chi-square test from the Wald test confirm this result. According to this test, the hypothesis that all of the coefficients in equation (2) are equal to zero can be rejected at the 1% level of significance. However, it is worth noting that the R square statistic is very low in all cases.

The unit root tests confirm the previous results. As shown in Table 7 and 8, for all fifteen Latin American currencies in the sample, the real price series has a unit root. The t-statistic for both the ADF and Phillips-Perron test are smaller than the critical value needed to reject the null hypothesis at either the one percent, five percent and 10 percent levels of significance. These series therefore follow a random walk process and are therefore nonstationary. However, the series of changes in exchange rates, also analyzed in equation (2) are stationary; the series do not follow a random walk process, again for the case of all Latin American currencies (Tables 9 and 10).

Furthermore, the existence of stationarity in the real exchange series can be explained by the findings by Cuddingham and Liang (1998); in some cases, this is due to the presence of time trends and structural breaks. This possibility is consistent with the Latin American currencies, considering the recurrent crisis and stop and go patterns of growth characterizing their economies during the last three decades of the XX Century. It is worth noting that applying a Chow break point test, that five countries (Argentina, Bolivia, Costa Rica, El Salvador, and Peru) show a rupture in their series of real rates of exchange in the decade of the 1980's; while for the remaining 10 countries the rupture in that series took

place during the last decade of the last century. Table 11 shows these results. Finally, it must be pointed out that the unit root test for the Latin American currencies differs from that presented by Kahn and Parikh (1998) for the South African case. Despite drastic changes in exchange rate policy they found no evidence of unit root nonstationarity and the behaviour of real exchange rate was stable but not constant.<sup>11</sup>

In sum, the three tests applied to the Latin American currencies, for the period 1970-200, do not support the EPPP theory. In terms of efficiency; weak exchange rate policies (paralleling weak macroeconomic policies in general)<sup>12</sup> characterized by pegging, excessive control over their exchange rates, and delayed adjustment of the exchange rate vis a vis the U.S. dollar have led to inefficient exchange markets in the region; past prices, and past changes in the exchange rate seem to have some useful information about the present price of the Mexican exchange rate. Furthermore, the empirical evidence is in disagreement with the results for Latin American black market rates as reported by Koveos and Selfert (1985). Using market exchange rates reported for the case of 15 Latin American currencies the results are not favorable to their conclusion that the efficient markets version of PPP appears to be the appropriate framework for many currencies in Latin America.

#### **IV. CONCLUSION**

This paper has investigated whether the efficient markets version of Purchasing Power Parity holds for Latin American currencies for the 1970-200 period. To test the EPPP two seemingly unrelated regressions were used and in addition a unit root test was applied. In general, the empirical evidence obtained does not favor the EPPP. Results suggest inefficient exchange markets in the region resulting from weak exchange rate policies and weak exchange markets development. Contrary to prior evidence that the efficient markets version of PPP generally holds, the results show that this conclusion cannot be generalized for the Latin American case. Since the region's currencies have been subject to tight government controls, albeit moving towards freer markets derived from structural adjustments in response to their recurrent economic crisis and to the challenges of globalization, further research is necessary to test PPP for these economies, particularly determining optimal structural changes.

---

<sup>11</sup> These two facts suggest the need for further studies on PPP parity for the case of Mexico, including EPPP with the identification of optimal breakpoints. Because the breakpoint for the real exchange rate implies a shorter period for analysis, this study does not include further research on the EPPP for Latin American currencies. On the issues concerning unit root test and structural breakpoints see: Perron and Vogeslang (1992), Perron (1997) Baum, Barkoulas and Caglayan (200).

<sup>12</sup> For a good view of

## REFERENCES

Abuaf, N. and Ph. Jorion. (1990). Purchasing power parity in the long run. **Journal of Finance**, 45 (1), 157-154.

Adler, M. and B. Lehmann. (1983). Deviations from purchasing parity in the log run. **Journal of Finance**, 38 (4), 1471-1478.

Broadberry, S. N. (1987). Purchasing power parity and the Pound-dollar rate in the 1930's. **Econometrica**, 54 (February), 69-78.

Agénor, P-R. (1998). Capital flows and the real exchange rate: analytical framework and econometric evidence in Glick, Reuven (ed.), **Managing Capital Flows and Exchange Rates. Perspectives from the Pacific Basin**, Cambridge: Cambridge University Press, 100-140.

Baum, C., J.T. Barkoulas and M. Caglayan (2000). Long memory or structural breaks: can either explain nonstationary exchange rates under the current float?. **Working Paper**, Department of Economics, Boston College.

Bohn, H and L.L. Tesar. (1998). U.S. portfolio investment in Asian capital markets in Glick, Reuven (ed.), **Managing Capital Flows and Exchange Rates. Perspectives from the Pacific Basin**, Cambridge: Cambridge University Press, 43-72.

Breuer, J.B. (1994). An assessment of the evidence on purchasing power parity, in Williamson, J. (ed.), **Estimating equilibrium exchange rates**, Washington, D.C.: Institute for International Economics.

Cassel, G. (1916). The present situation of foreign exchanges, **Economic Journal** 26. 1916.

Cassel G. (1921). **The world's monetary problems**. London: constable & Co.

Cuddingham, J.T. and H. Liang. (1998). Re-examining the purchasing power parity hypothesis over two centuries, **Working Paper**, Department of Economics, Georgetown University.

Darby, M. R. (1980) does purchasing power parity work? **Working Paper No. 607**, National Bureau of Economic Research.

Dickey, D and W. Fuller. (1979). Distribution of the estimators for autoregressive time series with unit root. **Journal of the American Statistical Association**, 74, 427-431.

Dornbusch, R. (1976). Expectations and exchange rate dynamics. **Journal of Political Economy**, (84), 1161-1176.

Dornbusch, R. (1980). Exchange rate economics: where do we stand? **Brookings Papers on Economic Activity**, 1, 143-206.

Dornbusch, R. (1985). Purchasing power parity. **Working Paper** 1591, National Bureau of Economic Research.

Edison, H.J. (1987). Purchasing power parity in the long run: A test of the dollar/pound exchange rates (1890-1978). **Journal of Money, Credit and Banking**, 19 (August), 376-387.

Edwards, S. (1989). **Real exchange rates, devaluation, and adjustment**. Cambridge: MIT Press

Frenkel, J.A. (1976). A monetary approach to the exchange rate: Doctrinal aspects and empirical evidence. **Scandinavian Journal of Economics**, (78), 200-224.

Frenkel, J.A. (1981). Flexible exchange rates, prices and the role of news: lessons from the 1970s. **Journal of Political Economy**, 89 (August), 665-706.

Goldberg, L.S. and M. Klein. (1998). Foreign direct investment, trade and real exchange rate linkages in developing countries in Glick, Reuven (ed.), **Managing Capital Flows and Exchange Rates. Perspectives from the Pacific Basin**, Cambridge: Cambridge University Press, 73-100.

Hakkio, C.A. (1982) A re-examination of purchasing power parity: a multicountry and multi-period study. **Working Paper**, No. 865, National Bureau of Economic Research.

Huang, R. D. (1987). Expectations of exchange rates and differential inflation rates: further evidence of purchasing power parity in efficient markets. **Journal of Finance**, 42 (1), 69-79.

Kahn, B. and A. Parikh (1998). Does purchasing power parity survive political shocks in South Africa? **Weltwirtschaftliches Archiv**, 134 (1), 99-116.

Koveos, P. and B. Seifert (1985). Purchasing power parity and black markets. **Financial Management**, (Autumn), 40-46.

Krugman, P.R. (1978). Purchasing power parity and exchange rates: another look at the evidence. **Journal of International Economics**, 8 (August), 397-407.

Lothian, J.R. and M.P. Taylor. (1996). Real exchange rate behaviour: the recent float from the perspective of the past two centuries. **Journal of Political Economy**, 104 (3), 488-509.

Mkenda, B.K. (2001). An empirical test of purchasing power parity in selected African countries - A panel data approach. **Working Papers in Economics**, No. 39, Göteborg University.

Murray, C.J. and D.H. Papell (2002). The purchasing power parity persistence, **Journal of International Economics**, 56, 1-19.

Mussa,, M.L. (1982). A model of exchange rate dynamics. **Journal of Political Economy**, 90, 74-104.

Ng, S. and P. Perron. (2001). Lag length selection and the construction of unit roots tests with good size and power. **Econometrica**, 69, 1519-1554.

Officer, L. (1976). The purchasing power parity of exchange rates: a review article. **Intgernational Monetary Fund Papers**, 83 (May), 1-60.

Olekalns, N and N. Wilkins. (1998). Re-examining the evidence for long.run purchasing power parity. **The Economic Record**, 74 (224), 54-61.

Ortiz, E. "La Inversión extranjera de portafolios en los mercados de dinero y capital de México y su impacto en la crisis mexicana," Irma Manrique, coord., **Arquitectura de la Crisis Financiera**, México, D.F.: Miguel Angel Porrúa, 2000, pp. 191-220.

Perron, P. (1997). Further evidence on breaking trend functions in macroeconomic variables. **Journal of Econometrics**, 80, 355-385-

Perron, P. and T. Vogelsang. (1992). Nonstationarity and level shifts with application to purchasing power parity. **Journal of Business and Economic Statistics**, 10 (3), 301-320.

Phillips, P.C. and P.. Perron. (1988). Testing for a unit root in time series regression. **Biometrica**, 74, 335-346.

Roll, R. (1979). Violations of purchasing power parity and their implications for efficient international commodity markets, in Sarnat, M. and G. P. Szego (eds.), **International Finance and Trade**, Vol. I, Cambridge, MA: Ballinger Publishing Company, 133-176.

Taylor, A.M. (2002). A century of purchasing power parity. **The Review of Economics and Statistics**, (forthcoming).

Wise, C and R. Roetteds. (2000). **Exchange Rate Politics in Latin America**. Washington, D.C. Brookings Institution.