EXCHANGE RATES, MARKET EFFICIENCY AND PURCHASING POWER PARITY: LONG-RUN TESTS FOR THE LATIN AMERICAN CURRENCIES*

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Abstract

In efficient markets current prices reflect all available information. Past prices do not contain any useful information for predicting future prices or for realizing extraordinary gains. This principle, known as the weak hypothesis of informational market efficiency, has been incorporated into Purchasing Power Parity (PPP) theory to overcome its limitations in the intertemporal analysis of exchange rate adjustments to inflationary trends. Overall, recent studies dealing with exchange rates from developed countries validate their efficiency. Research for the case of developing economies is rather limited. The present study analyzes empirically the efficiency of the exchange rates markets from 15 Latin American Countries for the period 1970-2000. Based on the enhanced PPP model, two regression analyses and a unit root test are applied.

Key words: exchange rates, efficient markets, purchasing power parity, Latin America.

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Resumen

En mercados eficientes, los precios corrientes reflejan toda la información disponible. Los precios pasados no contienen ninguna información útil para predecir precios futuros y realizar ganancias extraordinarias. Este principio, hipótesis débil de la eficiencia informativa de los mercados, ha sido incorporado a la teoría de la paridad del poder adquisitivo (PPA), a fin de sobreponer sus limitaciones en el análisis intertemporal del ajuste de los tipos de cambio a las tendencias inflacionarias. En general, estudios de mercados de divisas de los países desarrollados validan su eficiencia; sin embargo, la investigación para el caso de los países en vías de desarrollo es limitada. En este trabajo se analiza la eficiencia de los mercados de divisas de 15 países latinoamericanos para el periodo 1970-2000. Basándose en el modelo ampliado de PPA, se aplican dos modelos de análisis de regresión y uno de raíz unitaria.

Résumé

Dans des marchés efficients, les prix courants reflètent toute l'information disponible. Les prix du passé ne contiennent aucune information utile pour prédire les futurs prix ni pour obtenir des bénéfices extraordinaires. Ce principe, hypothèse faible de l'efficience informationnelle des marchés, a été incorporé à la théorie de la parité du pouvoir d'achat (PPA), afin de surmonter ses limitations dans l'analyse inter-temporelle de l'ajustement des taux de change aux tendances inflationnistes. En général, les études sur les marchés de devises des pays développés valident son efficience. L'investigation en ce qui concerne les nations en voie de développement est limitée. Dans ce travail, on analyse l'efficience des marchés de devises dans 15 pays latino-américains pour la période 1970-2000. Se basant sur le modèle amplifié de PPA, on applique deux modèles d'analyse de régression et un modèle de racine unitaire.

Mots clés: taux de change, marchés efficients, parité du pouvoir d'achat, Amérique Latine.

Resumo

Nos mercados eficientes, os preços correntes refletem tuda a informação disponível. Os preços do passado não comtêm nenhuma informação útil para predizer preços futuros e obter lucros extraordinários. Este princípio, hipótese fraca da eficiência informacional dos mercados, foi incorporado à teoria da paridade do poder aquisitivo (PPA) a fim de sobrepôr suas limitações no análise inter-temporal do ajuste dos tipos de câmbio às tendências inflacionárias. Em geral, estudos sobre os mercados de divisas dos paises desenvolvidos validam a sua eficiência. A pesquisa para o caso dos paises em desenvolvimento é limitada Neste trabalho analiza-se a eficiencia dos mercados de divisas em 15 paises da América Latina para o período 1970-2000. Baseando-se no modelo ampliado de PPA, aplicam-se dois modelos de análise de regressão e um de raiz unitária.

Palavras chave: tipos de câmbio, mercados eficientes, paridade do poder aquisitivo, América Latina.

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, studies 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 study is to investigate whether EPPP holds for the case of the Latin American currencies. Exchange rate and inflation rate data gathered from the International Monetary Fund's International Financial Statistics 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 hypotheses to be tested derived from the efficient purchasing power parity propositions. Section III presents the empirical results. Two regression tests and a unit root test are performed; the first regression aims at determining whether or not past exchange rates, adjusted for inflation rates, contain any information to predict future spot rates. The second regression tests whether real exchange rates follow a martingale process, which is then complemented with unit root test to determine whether the series are stationary. Prior 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.

Ppurchasing power parity and efficient exchange markets

For the international investor, risk in international capital and money markets is closely 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 mainly to avoid overvaluation of the domestic currency, followed by drastic devaluation adjustments. Purchasing Power Parity (PPP) is the first well-developed, but very controversial theory of exchange rate determination in international finance (Taylor and Taylor, 2004). 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 indices. In other words, the variation in the exchange rates for two currencies should be 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. It is also an important guideline for policy makers from central banks; their adjustments to exchange rates should respond promptly to inflation differentials with their main trade partners to avoid extended overvaluations or under-valuations that undermine their currencies and lead to large delayed adjustments that become the root of financial crises. Although PPP is supposed to hold in the long run, short term deviations from PPP induce cross-border transfers of commodities and capital. Most models of exchange rate determination are based largely on the long-run validity of the PPP proposition (Dornbusch, 1976; Mussa, 1982; Abuaf and Jorion, 1990; and Cuddingham, 1998; Sarno and Taylor, 2002; Coakley et al, 2005, among others). The adoption of flexible exchange rates since the early 1970's induced theoretical and empirical research, refining existing models about exchange rate determination. PPP provides an easy and inexpensive way of making medium-to-long-run predictions about exchange rate movements. Sustained deviations of the current real exchange rate from its long-run equilibrium level create economic exposure for the firm, excessive exchange rate risk for international investors, and great macroeconomic fragility towards external shocks, which might end in severe currency and financial crises. There is no practical reason why the equilibrium real exchange rate should not vary through time as sustained by PPP. 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). 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 (1976, 1981), Hakkio (1982), Krugman (1978), Dornbusch (1980; 1985), Broadberry (1987), Edison (1987), Murray and Papell (2002), and Taylor (2002) all confirm this result.[1] Considering the fact that many studies asserted that real exchange rates behave like a random-walk, Roll (1979) argued that a problem of most tests on PPP is an inadequate specification of PPP as a dynamic intertemporal theory. He formulated a superior theory of PPP from an efficient markets perspective based on

[1] An assessment of PPP studies can be found in Breuer (1994), Pippenger (1986) and Taylor and Taylor (2002).

international commodity arbitrage, *i.e.* the efficient markets PPP (EPPP).[2] Later, Adler and Lehmann (1983) developed another version of the efficient markets PPP based on financial arbitrage in bonds. Empirical evidence for EPPP can be found in the works of Roll (1979), Darby (1980), Adler and Lehmann (1983), Koveos and Seifert (1985), Pippenger (1986), Huang (1987), Witt, Jr. (1992), Taylor, 2002 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 for PPP using a first-order auto-regression model in a multivariate setting. They show that long run PPP might indeed hold, even when there are substantial short term deviations from the parity condition. Examining the Australian case, Olekalns and Wilkins (1998), estimating a fractionally 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 especially to industrial countries.[3] The purpose of this paper is to investigate whether EPPP, as identified by Roll (1979),[4] holds for the case of the Latin American currencies, during the period

[2] An important contribution from modern financial economics is the study of market efficiency from an informational point of view. Essentially, it means that current prices from financial assets fully reflect all available information. Three hypotheses have been advanced in this respect: the weak hypothesis, semi-strong hypothesis, and strong hypothesis. The weak hypothesis, or return predictability hypothesis, indicates that in efficient markets, information from historical prices is fully reflected in current prices. Past prices do not provide information to predict current prices and obtain extraordinary gains. The semi-strong hypothesis maintains that all publicly available information, including fundamentals about the economy, is fully reflected in financial asset prices. The strong hypothesis maintains that all information, whether public or private, is fully reflected in financial asset prices. These hypotheses therefore indicate different degrees of informational efficiency implying, in turn; efficiency in the allocation of resources. Numerous econometric tests can be used to test these hypotheses. Most frequently these tests have been used in the context of Modern Portfolio Theory (MPT), as the lack of efficiency means prices and returns can be predicted to obtain extraordinary gains. Important extensions of these hypotheses include the analysis of price and return patterns from financial assets to determine disequilibria whether caused by market forces, or weak policy-making due to economic or political causes. Thus, efficiency tests on capital markets, derivatives markets, interest rates and exchange rates have also become powerful evidence for analyses carried out by policy —and normative-oriented economists, political economists and economic historians. For an excellent review of informational market efficiency see Elton, *et al.* (2003).

[3] 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 EPPP for the Latin American black market currencies during the period April 1973-March 1983. The work by Mkenda (2001) applied a panel data approach for selected African countries using annual data for the period 1965-1996.

[4] Financial arbitrage is not included in our tests because emerging capital markets are only recently integrating themselves into global financial activity. Furthermore, there is no available long-run data for emerging markets' international transactions in bonds. We must also point out that recent research on efficiency depart from Roll's EPPP, stressing co-integration analysis (with key variables

January 1970-December 2000. During the last three decades of the 20th Century the Latin American countries underwent recurrent crises characterized, among other things, by severe exchange rate imbalances followed by drastic government-determined adjustments, complemented by market adjustments. Moreover, during the period under analysis, exchange rate authorities from the area adopted several exchange rate regimes attempting to cope with recurrent balances in their economies, as well as to respond to the challenges derived from opening up their economies. Towards the end of the century freer market exchange rate activity was promoted by their policy makers. In the long run, exchange rates in Latin America should have adjusted taking into account their inflation rates' differential with their main commercial and financial partner, the United States of America.

Efficient purchasing power parity models and data

EPPP is based on the constraint that, in efficient markets, the real return to an investor from intertemporal speculation in 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. Lagged prices contain no information useful in predicting future prices or obtaining extraordinary gains; that is, from a dynamic perspective, predictability based on past information means a departure from equilibrium conditions. The first testable version of EPPP can be expressed in a regression format as follows:

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

where X_t is the natural logarithm of the spot exchange rate adjusted for the inter-country 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} is the 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 being equal to unity and the other coefficients being zero.

Second, 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:

such as futures rates) and unit root tests, but mostly for recent time periods due to data availability from developing countries. (For recent PPP unit root and co-integration analysis see: Cheng, 1999; Engel, 2000; Fleissig and Strauss, 2000; Parikh and Wakerley, 2000; Choi, 2001; Diamandis 2002; Apte, et al, 2004; Wu, 2004; Kargbo, 2005). These econometric models are powerful tests for long run equilibrium analysis, but leave aside intertemporal analysis like the regression analyses proposed by Roll and applied in this study. Nevertheless, because this work also deals with a long-run assessment we complement our empirical work with unit root tests.

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

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

The random walk hypothesis implies that the b_i (i = 1,...,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, updating EPPP, if the time series of changes in the exchange rate follow a martingale process, it should therefore be characterized by a random walk process; the time series should be a non-stationary 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):

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

The null and alternative hypotheses are: H_0: .$\lambda = 0$; H_1: $\lambda < 1$; acceptance of the null hypothesis implies non-stationarity. To control for higher-order correlation in a series the ADF approach adds lagged differenced terms on 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 λ coefficient of the AR(1) regression to account for the serial correlation on ε. Unit root tests have become useful due to their increased testing power. Important long-term tests 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 bilateral real rates of exchange. The evidence by Cuddington and Liang contradicts those findings; using a two hundred-year series for dollar-sterling real rates they find that, choice in the lag length might influence the results,[5] or else deterministic trends and structural breaks may give rise to non-stationarity. 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).[6]

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

[5] On this issue see: Ng and Perron (2001).

[6] Related to this study, it is worth noting that employing the martingale process and the definition of rational expectations, Ghartey (2004) proves that the pure random-walk spot exchange rate is an adequate means to universally test foreign exchange market efficiency.

the U.S. dollar and end-of-month consumer price indices. The exchange rate data used in testing the efficient markets hypotheses cover the period January-1970-December 2000.[7] Data was gathered for 15 countries: Argentina, Bolivia, Brazil, Colombia, Costa Rica, Chile, Ecuador, El Salvador, Guatemala, Honduras, Mexico, Paraguay, Peru, Uruguay, and Venezuela.[8] Exchange rate series were adjusted for changes in the numeraire taking place during the period under analysis. The original January 1970 price of the domestic currency for the dollar was maintained as a point of reference to evaluate and compare changes throughout time. Inflation rate series were adjusted to a uniform January 1970 base.

Empirical results

Basic Statistics

Tables 1 to 3 summarize the main stochastic characteristics of the Latin American currencies on a long-term basis.[9] Statistics are shown for the bilateral local currency in relation to the U.S. dollar. Table 1 shows the basic statistics for the local currency price of dollars in nominal terms. Table 2 shows those statistics in real terms. Table 3 shows the basic statistics for the series of changes (returns) in the real exchange rates from the Latin American countries 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. Two meaningful situations can be identified: *a)* exceedingly high changes in the price of the dollar from January 1970 to December 2000 coupled with large volatilities; and, *b)* lack of normality.

Moreover, the evidence shows that the largest Latin American countries, Argentina Brazil, 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 3.50 pesos (minimum for the period), ending with an unbelievable maximum price of 100 000 000 000 (old) pesos per dollar; the average for the period was 33 956 905 017, and the standard deviation amounted to 46 359 116 966 points. These facts, as a lesson from the past, show the unsustainability of the one peso per dollar followed during the decade of the 1990s. The case of Brazil 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

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7 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 of changes in the exchange rate for all years during the period under analysis.

8 Countries from the Region not included in the sample due to the lack of continuity in the series available, as a result of their political problems, are: Dominican Republic, Nicaragua and Haiti. In addition, Cuba is not a member of the International Monetary Fund and the U.S. dollar is the means of exchange in Panama.

9 All tables presented in this study are original, presenting results from the econometric tests carried out by the authors with the econometric software E-Views.

Table 1
Basic Statistics for Latin America Monthly Nominal Exchange Rate

	Argentina	*Bolivia*	*Brazil*	*Colombia*	*Costa Rica*
Mean	33956905017	2001727	415736595660	450.13	86.97
Median	8005000	375000	6210.00	145.35	50.60
Maximum	100000000000	6390000	2963974397190	2211.94	318.02
Minimum	3.50	11.88	4.42	18.01	6.65
Std. Dev.	46359116966	2242460	810563628758	561.46	91.23
Skewness	0.678	0.515	1.70	1.41	1.05
Kurtosis	1.50	1.66	4.49	4.19	2.90
Jarque-Bera	63.06	44.32	214.02	145.15	68.38
Probability	0	0	0	0	0
Observations	372	372	372	372	372
	Chile	*Ecuador*	*El Salvador*	*Guatemala*	*Honduras*
Mean	197145	1992.29	4.89	2.93	4.60
Median	165895	67.18	2.50	1.00	2.0
Maximum	572680	25000	9.30	7.91	15.14
Minimum	11.68	18.18	2.50	1.00	2.00
Std. Dev.	183291.81	4902.17	2.76	2.38	4.37
Skewness	0.39	3.75	0.50	0.68	1.34
Kurtosis	1.62	16.99	1.44	1.82	3.17
Jarque-Bera	38.65	3904.28	52.82	50.16	112.38
Probability	0	0	0	0	0
Observations	372	372	372	372	372
	Mexico	*Paraguay*	*Peru*	*Uruguay*	*Venezuela*
Mean	2368.31	902.18	76758095	2414680	112.99
Median	254.36	240.00	11827	99375	7.50
Maximum	10174.50	3543.90	353100000	12515000	699.75
Minimum	12.49	126.00	38.70	250.00	4.29
Std. Dev.	3210.26	1016.57	118968812	3851380	201.17
Skewness	1.23	1.07	1.16	1.43	1.82
Kurtosis	3.10	2.95	2.70	3.55	4.74
Jarque-Bera	93.57	71.49	84.28	131.91	252.63
Probability	0	0	0	0	0
Observations	372	372	372	372	372

(old) cruzeiros per dollar.[10] The average was 415 736 595 660 and the standard deviation was situated at 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 average was 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 average amounted to 76 758 095 soles per dollar and the standard deviation was 118 968 812 points. Finally, it is worth noting that the smaller Latin American countries presented less severe changes. Furthermore, those from Central America experienced rather mild changes. The case of El Salvador best exemplifies 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 average was 4.89 and the standard deviation was 2.76 points. However, the small South American countries, rather resembled the patterns present in the large Latin American economies. In particular, 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 average amounted to 197 144.68 pesos per dollar and the standard deviation was 183 291.81 points.

The exchange rate series for the Latin American currencies are also characterized by a lack of normality. As shown in Table 1, in all cases the Jarque-Bera statistics confirm the absence of normality. In this respect, the fact stands out that seven countries —Brazil, Colombia, Ecuador, Honduras, Mexico, Uruguay, and Venezuela— have leptokurtic curves, while the remaining 8 countries —Argentina, Bolivia, Costa Rica. Chile, El Salvador, Guatemala, Paraguay and Peru— have platykurtic curves. Finally, all the 15 countries in the sample have curves skewed to the right.

Similar statistical behavior is present in the case of real exchange rates and changes in real prices. Apparently, in the long run, exchange rate maladjustments to inflationary trends appear to be small for all Latin American currencies. Comparing the nominal rate with the adjusted (real) inflation rate differentials, slight overvaluations can be discerned for the cases of Argentina, Bolivia, Chile, Mexico and Peru; minimal cases of undervaluation are present in the cases of Brazil, Ecuador, El Salvador and Uruguay. Colombia, Costa Rica, Guatemala, Honduras, Paraguay and Venezuela had real rates on target with inflationary changes. Highlighting the case of Brazil, measured in old cruzeiros, in real terms the dollar should have appreciated from 4.34 units to 2 939 778 687 830 cruzeiros

[10] The cruzeiro changed its denomination several times during the period under analysis. Currently the Real is the official Brazilian currency. We maintained the cruzeiro denomination in this section only for analytic purposes.

Table 2
Basic Statistics for Latin America Monthly Real Exchange Rate

	Argentina	*Bolivia*	*Brazil*	*Colombia*	*Costa Rica*
Mean	33509508176	1982648	407069896551	444.94	86.21
Median	6560600	364492	5580	144.83	51.04
Maximum	104194693258	6518643	2939778687830	2218.39	315.85
Minimum	3.45	11.70	4.34	18.21	6.60
Std. Dev.	46161048312	2232381	802427700143	557.10	90.56
Skewness	0.70	0.53	1.74	1.43	1.06
Kurtosis	1.53	1.68	4.64	4.28	2.92
Jarque-Bera	63.83	44.33	229.46	152.70	69.41
Probability	0	0	0	0	0
Observations	372	372	372	372	372
	Chile	*Ecuador*	*El Salvador*	*Guatemala*	*Honduras*
Mean	195784	1920	4.86	2.91	4.56
Median	162375	66.54	2.52	1.02	2.00
Maximum	572943	24667	9.13	7.89	15.06
Minimum	10.92	18.13	2.40	0.88	1.86
Std. Dev.	182738	4677	2.74	2.36	4.31
Skewness	0.40	3.72	0.50	0.68	1.35
Kurtosis	1.64	16.83	1.45	1.84	3.20
Jarque-Bera	38.51	3824	52.91	50.11	113.887
Probability	0	0	0	0	0
Observations	372	372	372	372	372
	Mexico	*Paraguay*	*Peru*	*Uruguay*	*Venezuela*
Mean	2402.71	894.77	76062444	2381038	110.40
Median	261.42	236.23	10748	95125	7.45
Maximum	10404.06	3544.52	353159259	12408000	699.13
Minimum	12.11	112.07	37.17	250.00	4.17
Std. Dev.	3246.21	1010.46	118412996	3817425	197.40
Skewness	1.22	1.08	1.17	1.45	1.84
Kurtosis	3.07	2.98	2.75	3.60	4.86
Jarque-Bera	92.29	72.82	86.18	135.31	265.41
Probability	0	0	0	0	0
Observations	372	372	372	372	372

Table 3
Basic Statistics for Latin America Monthly Real Exchange Rate Changes

	Argentina	*Bolivia*	*Brazil*	*Colombia*	*Costa Rica*
Mean	-0.021	0.932	-0.070	0.093	0.294
Median	-0.471	-0.020	0.009	0.161	-0.017
Maximum	118.32	217.56	49.045	7.691	43.885
Minimum	-60.91	-52.097	-39.59	-15.377	-24.513
Std. Dev.	14.365	19.95	5.729	2.039	4.465
Skewness	3.232	6.732	1.407	-0.968	5.540
Kurtosis	26.05	61.80	37.083	12.402	53.184
Jarque-Bera	8882	56399	18129	1428	40939
Probability	0	0	0	0	0
Observations	372	372	372	372	372
	Chile	*Ecuador*	*El Salvador*	*Guatemala*	*Honduras*
Mean	0.270	0.266	-0.196	0.086	0.094
Median	-0.220	-0.470	-0.309	-0.084	-0.150
Maximum	179.494	39.549	66.811	92.181	96.527
Minimum	-34.249	-15.574	-6.266	-12.342	-6.841
Std. Dev.	10.593	5.442	4.427	5.450	5.234
Skewness	13.024	3.898	12.471	13.220	16.875
Kurtosis	222.25	23.325	174.680	221.463	311.381
Jarque-Bera	755611	7345	466491	750593	1491684
Probability	0	0	0	0	0
Observations	372	372	372	372	372
	Mexico	*Paraguay*	*Peru*	*Uruguay*	*Venezuela*
Mean	-0.043	0.132	1.380	-0.104	0.003
Median	-0.459	-0.272	-0.178	-0.189	-0.383
Maximum	65.018	62.975	199.686	48.797	74.703
Minimum	-44.607	-11.715	-22.393	-39.150	-21.527
Std. Dev.	6.536	5.956	13.040	5.339	7.346
Skewness	4.654	7.960	10.200	2.629	7.090
Kurtosis	52.431	78.257	147.357	38.559	62.373
Jarque-Bera	39217	91715	329453	20027	57757
Probability	0	0	0	0	0
Observations	372	372	372	372	372

per dollar, which is slightly below 0.82 percent, the (overvalued) nominal value reported earlier. Finally, examining the series of changes in the exchange rates (returns for the foreign exchange investor), the large volatilities in the Latin American foreign exchange markets are confirmed. In real terms the standard deviation for monthly variations of exchange rates varied between 2.039 points in the case of Colombia to a maximum of 14.365 points in the case of Argentina.

Efficient PPP *Tests*

The estimated coefficients and the results of the hypothesis tests pertinent to equation (1) are presented in Table 4. The null hypothesis, formulated in accordance with EPPP, is that the coefficient of the previous period's spot exchange rate (*t-1*) is equal to one and that the coefficients of other 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 $b_i = 0\ (i > 1)$.

These 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.*, $b_l = 1$), and apparently statistically significant, only for the cases of five countries: Brazil (1.0127), Ecuador (0.9967), Mexico (1.0449), Paraguay (1.0568), and Uruguay (0.9644). Only in the case of Ecuador are all remaining coefficients, b_2 to b_7, fairly close to zero, near to 0.05 in six cases and near to 0.07 in one case. However those coefficients are not statistically significant. For the cases of Brazil, Mexico, Paraguay and Uruguay there are some coefficients, b_2 to b_7, that are significantly distant from zero. For example, in the case of Brazil $b_2 = 0.1701$, $b_3 = -0.3728$, and $b_4 = 0.1679$. In the case of Mexico, $b_2 = 0.2146$ and $b_5 = 0.2008$. Most of these coefficients are statistically significant. Moreover, the high *R* square and insignificant t-tests for the remaining *bi* coefficients signal multi-colinearity. Therefore, we can convincingly reject the hypothesis that $b_2 = b_3$, --- $b_7 = 0$. This is confirmed by the Wald test. As shown in Table 4 the F and Chi-square statistics decisively reject the null hypothesis at a one percent significance level. Thus, on a long-term basis, past spot rates adjusted for inflation from previous months seem to contain some information about current spot exchange adjusted for inflation. This reflects the fact that authorities from Latin American central banks have tended to control foreign exchange markets and have also adjusted exchange rates with significant delays. Similarly, adjustments based on market activity, or on the application of different exchange rate regimes have often been unable to keep pace with inflation and overall economic conditions. Thus, past exchange rates contain valuable information to predict current spot rates. This would clearly be the case with pegged exchange rates and various forms of sliding currency adjustments. Indeed, especially before the debt crisis, Latin American countries that *pegged* their currency to the dollar, themselves later adopted different exchange rate regimes, from a tight, dirty

Table 4
Efficient Market Test of Purchasing Power Parity for Latin American Currencies

Argentina	b_0	b_1	b_2	b_3	b_4	b_5	b_6	b_7
Coefficients	0.0124	1.1704	-0.5101	0.3723	0.0546	-0.1044	-0.0261	0.0429
t-Statistics	0.8568	11.9656	-4.0965	6.1872	0.8279	-1.6573	-0.4357	0.9644
Probability	0.3921	0	0.0001	0	0.4083	0.0983	0.6633	0.3355
R^2	F-statistics	Durbin-Watson				Statistic		Probability
0.9998	247356		1.9886	F-Test		10.0732		0
				Chi-Square		60.4391		0
Bolivia	b_0	b_1	b_2	b_3	b_4	b_5	b_6	b_7
Coefficients	0.0132	0.8715	0.1395	-0.2137	0.3970	-0.2760	0.3884	-0.3076
t-Statistics	0.6989	6.8211	1.0128	-3.1000	6.1116	-4.1921	5.7857	-6.5116
Probability	0.0000	0.0000	0.3118	0.0021	0.0000	0.0000	0.0000	0.0000
R^2	F-statistics	Durbin-Watson				Statistic		Probability
0.9990	52025		2.0474	F-Test		10.3522		0
				Chi-Square		72.4651		0
Brazil	b_0	b_1	b_2	b_3	b_4	b_5	b_6	b_7
Coefficients	0.0060	1.0127	0.1701	-0.3728	0.1679	-0.0391	0.0713	-0.0104
t-Statistics	1.2490	17.6854	2.2336	-5.7810	2.5929	-0.5971	1.1042	-0.2680
Probability	0.2125	0.0000	0.0261	0.0000	0.0099	0.5508	0.2702	0.7889
R^2	F-statistics	Durbin-Watson				Statistic		Probability
0.9999	1858504		1.9890	F-Test		5.7056		0
				Chi-Square		39.9397		0
Colombia	b_0	b_1	b_2	b_3	b_4	b_5	b_6	b_7
Coefficients	-0.0003	0.6382	0.5566	-0.0500	-0.0527	-0.0900	0.0215	-0.0236
t-Statistics	-0.0944	8.1807	7.0108	-0.7016	-0.7427	-1.2633	0.3002	-0.4830
Probability	0.9249	0.0000	0.0000	0.4834	0.4581	0.2073	0.7642	0.6294
R^2	F-statistics	Durbin-Watson				Statistic		Probability
0.9999	357705		1.9565	F-Test		11.5074		0
				Chi-Square		80.5518		0
Costa Rica	b_0	b_1	b_2	b_3	b_4	b_5	b_6	b_7
Coefficients	0.0110	1.2270	-0.0675	-0.1249	-0.1092	-0.0776	0.2265	-0.0772
t-Statistics	1.6139	11.5804	-0.6600	-1.9301	-1.7408	-1.2210	3.6300	-1.7098
Probability	0.1074	0.0000	0.5096	0.0544	0.0826	0.2229	0.0003	0.0882
R^2	F-statistics	Durbin-Watson				Statistic		Probability
0.9989	48608		1.9139	F-Test		5.1437		0
				Chi-Square		30.8621		0
Chile	b_0	b_1	b_2	b_3	b_4	b_5	b_6	b_7
Coefficients	0.0009	1.3136	-0.3375	-0.0063	-0.0936	0.1678	-0.1107	0.0668
t-Statistics	0.0392	7.8850	-1.6098	-0.0717	-1.1888	2.1082	-1.3548	1.3840
Probability	0.9687	0.0000	0.1083	0.9428	0.2353	0.0357	0.1763	0.1672
R^2	F-statistics	Durbin-Watson				Statistic		Probability
0.9989	46867		2.0821	F-Test		2.2419		0.0388
				Chi-Square		13.4517		0.0364
Ecuador	b_0	b_1	b_2	b_3	b_4	b_5	b_6	b_7
Coefficients	0.0012	0.9967	-0.0423	-0.0576	0.0686	0.0564	-0.0433	0.0224
t-Statistics	0.1611	6.1711	-0.2576	-0.8012	0.9975	0.8245	-0.6335	0.4343
Probability	0.8721	0.0000	0.7969	0.4236	0.3192	0.4102	0.5268	0.6643
R^2	F-statistics	Durbin-Watson				Statistic		Probability
0.9995	94433		1.9392	F-Test		0.9427		0.4643
				Chi-Square		5.6562		0.4628
El Salvador	b_0	b_1	b_2	b_3	b_4	b_5	b_6	b_7
Coefficients	0.0009	1.1099	-0.1624	0.0078	0.0406	-0.0269	0.0147	0.0141
t-Statistics	0.1337	5.6123	-0.8057	0.1122	0.5868	-0.3882	0.2117	0.2776
Probability	0.8937	0.0000	0.4210	0.9108	0.5577	0.6981	0.8324	0.7815
R^2	F-statistics	Durbin-Watson				Statistic		Probability
0.9938	8143		1.9882	F-Test		0.3285		0.9408
				Chi-Square		2.2992		0.9414

Continuation

Guatemala	b_0	b_1	b_2	b_3	b_4	b_5	b_6	b_7
Coefficients	0.0021	1.0874	-0.1038	-0.0172	0.0127	0.0485	-0.0226	-0.0069
t-Statistics	0.5434	6.9067	-0.6922	-0.2544	0.1916	0.7342	-0.3431	-0.1395
Probability	0.5872	0.0000	0.4893	0.7993	0.8482	0.4633	0.7317	0.8891
R^2	F-statistics	Durbin-Watson			Statistic		Probability	
0.9957	11781		1.9958	F-Test		0.2539		0.9707
				Chi-Square		1.7773		0.9711

Honduras	b_0	b_1	b_2	b_3	b_4	b_5	b_6	b_7
Coefficients	0.0041	1.1833	-0.1658	-0.0349	0.0572	-0.0677	0.0431	-0.0187
t-Statistics	0.7945	5.7520	-0.8177	-0.4942	0.8158	-0.9654	0.6133	-0.3682
Probability	0.4274	0.0000	0.4141	0.6215	0.4152	0.3350	0.5400	0.7129
R^2	F-statistics	Durbin-Watson			Statistic		Probability	
0.9953	10777		2.0150	F-Test		0.3902		0.9080
				Chi-Square		2.7313		0.9087
				0.3902	0.9080	0.3902	0.9080	0.3902

Mexico	b_0	b_1	b_2	b_3	b_4	b_5	b_6	b_7
Coefficients	0.0089	1.0449	-0.2146	0.0417	0.0147	0.2008	-0.0719	-0.0165
t-Statistics	1.0655	5.0062	-0.9170	0.5981	0.2135	2.9119	-1.0354	-0.3006
Probability	0.2873	0.0000	0.3598	0.5501	0.8311			
R^2	F-statistics	Durbin-Watson			Statistic		Probability	
0.9994	85205		2.0268	F-Test		3.9526		0.0008

Paraguay	b_0	b_1	b_2	b_3	b_4	b_5	b_6	b_7
Coefficients	0.0011	1.0568	0.0341	-0.1097	0.0035	-0.0318	0.0370	0.0101
t-Statistics	0.0744	6.2950	0.2079	-1.5121	0.0483	-0.4450	0.5167	0.2005
Probability	0.9407	0.0000	0.8354	0.1314	0.9615	0.6566	0.6057	0.8412
R^2	F-statistics	Durbin-Watson			Statistic		Probability	
0.9978	23578		2.0012	F-Test		0.5955		0.7596
				Chi-Square		4.1685		0.7601

Peru	b_0	b_1	b_2	b_3	b_4	b_5	b_6	b_7
Coefficients	0.0049	0.5139	0.5165	0.3016	-0.3656	0.0995	0.0533	-0.1192
t-Statistics	0.3577	3.3179	3.2133	4.0661	-4.8354	1.3143	0.7207	-2.2890
Probability	0.7208	0.0010	0.0014	0.0001	0	0.1896	0.4715	0.0227
R^2	F-statistics	Durbin-Watson			Statistic		Probability	
0.9997	148609		1.9832	F-Test		9.8476		0
				Chi-Square		68.9332		0

Uruguay	b_0	b_1	b_2	b_3	b_4	b_5	b_6	b_7
Coefficients	0.0095	0.9644	-0.0737	0.1255	0.0904	-0.1571	-0.0367	0.0866
t-Statistics	0.8500	8.4773	-0.6575	1.9117	1.4515	-2.4870	-0.5998	1.7968
Probability	0.3959	0.0000	0.5113	0.0567	0.1475	0.0133	0.5490	0.0732
R^2	F-statistics	Durbin-Watson			Statistic		Probability	
0.9998	226674		2.1045	F-Test		2.0367		0.0498
				Chi-Square		14.2568		0.0468

Venezuela	b_0	b_1	b_2	b_3	b_4	b_5	b_6	b_7
Coefficients	0.0078	1.1145	-0.2131	0.0006	0.0195	0.1523	-0.1212	0.0454
t-Statistics	1.0454	4.7382	-0.8258	0.0084	0.2730	2.1315	-1.6921	0.8818
Probability	0.2965	0.0000	0.4095	0.9933	0.7850	0.0337	0.0915	0.3785
R^2	F-statistics	Durbin-Watson			Statistic		Probability	
0.9984	32724		2.0170	F-Test		1.7827		0.0895
				Chi-Square		14.4800		0.0858

float to programmed sliding rates. By the 1990's many economies tended to promote free exchange markets, or else to adopt some currency convertibility schemes, namely currency boards as in the case of Argentina.[11]

Finally, it is worth noting that for the cases of Argentina, Costa Rica, Chile, El Salvador, Guatemala, Honduras, and Venezuela, the coefficient b1 is significantly higher than one; and for the cases of Bolivia, Colombia and Peru, this 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 the 15 Latin American countries under study, the first efficient purchasing power hypothesis must be rejected. Their markets are inefficient and past (monthly) exchange rates do contain some valuable information about the current spot rate.

Table 5 summarizes the results of the tests of equation (2). The null hypothesis that the real exchange rates differentials follow a martingale process is not supported for the Latin American case, on a long term basis. Indeed, 11 countries in the sample show several b_1 to b_6 coefficients greater than zero. This is the case of Argentina, Bolivia, Brazil, 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, Brazil 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_6 are near to zero, but are not statistically significant. For Brazil 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_2, b_3 and b_6, and their t-statistic is greater than two; the remaining two coefficients, b_4 and b_5, are close to zero but are not statistically significant. Countries for which all coefficients b_1 to b_6 are close to zero are El Salvador, Guatemala, Honduras and Paraguay. Nevertheless in none of these cases is the t-statistic 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, considering a six-month reference horizon for traders in the exchange markets. 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 a 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 6, for all fifteen Latin American currencies in the sample, the real price series have a unit root. The t-

[11] See: Johnston and others (1999), and Ishii (2003) and others, from this International Monetary Fund publication, for a fine assessment of exchange rate arrangements and foreign exchange markets during the last two decades.

Table 5
Test of Martingala Process for Latin American Currencies

Argentina	b_0	b_1	b_2	b_3	b_4	b_5	b_6
Coefficients	-0.0006	-0.3226	0.1462	0.1186	-0.0670	-0.1396	-0.0216
t-Statistics	-0.0844	-6.1141	2.6609	2.1460	-1.2111	-2.5448	-0.4103
Probability	0.9328	0.0000	0.0081	0.0325	0.2267	0.0114	0.6818
R^2	F-statistics		Durbin-Watson			Statistic	Probability
0.1519	10.7131		2.0056	F-Test		10.7131	0
				Chi-Square		64.2783	0
Bolivia	b_0	b_1	b_2	b_3	b_4	b_5	b_6
Coefficients	0.0084	-0.1137	-0.2173	0.1644	-0.0859	0.2397	-0.1305
t-Statistics	0.8759	-2.1736	-4.2503	3.1484	-1.6453	4.6884	-2.4944
Probability	0.3817	0.0304	0	0.0018	0.1008	0	0.0131
R^2	F-statistics		Durbin-Watson			Statistic	Probability
0.16453	11.7832		1.9966	F-Test		11.7830	0
				Chi-Square		70.6992	0
Brazil	b_0	b_1	b_2	b_3	b_4	b_5	b_6
Coefficients	-0.0622	0.1983	-0.2333	0.0474	0.0160	0.0192	0.0627
t-Statistics	-0.2130	3.7653	-4.3439	0.8605	0.2903	0.3572	1.1890
Probability	0.8314	0.0002	0	0.3901	0.7718	0.7211	0.2352
R^2	F-statistics		Durbin-Watson			Statistic	Probability
0.0802	5.2136		2.0005	F-Test		5.2136	0
				Chi-Square		31.2815	0
Colombia	b_0	b_1	b_2	b_3	b_4	b_5	b_6
Coefficients	0.0007	0.3676	0.0330	-0.0230	-0.0382	-0.0200	-0.1143
t-Statistics	0.6782	7.0126	0.5899	-0.4110	-0.6819	-0.3562	-2.1767
Probability	0.4981	0.0000	0.5556	0.6813	0.4957	0.7219	0.0302
R^2	F-statistics		Durbin-Watson			Statistic	Probability
0.1718	12.4079		1.9766	F-Test		12.4079	0
				Chi-Square		74.4445	0
Costa Rica	b_0	b_1	b_2	b_3	b_4	b_5	b_6
Coefficients	0.0022	0.1558	0.0153	-0.0375	-0.1881	0.1454	0.1615
t-Statistics	0.9790	2.9906	0.2929	-0.7312	-3.6715	2.7866	3.1003
Probability	0.3283	0.0030	0.7697	0.4652	0.0003	0.0056	0.0021
R^2	F-statistics		Durbin-Watson			Statistic	Probability
0.1123	7.5707		1.9850	F-Test		7.5707	0
				Chi-Square		45.4243	0
Chile	b_0	b_1	b_2	b_3	b_4	b_5	b_6
Coefficients	0.0043	-0.0046	-0.0566	-0.1772	0.0069	-0.0761	-0.0467
t-Statistics	0.7768	-0.0877	-1.0739	-3.3590	0.1305	-1.4459	-0.8849
Probability	0.4378	0.9302	0.2836	0.0009	0.8962	0.1491	0.3768
R^2	F-statistics		Durbin-Watson			Statistic	Probability
0.0373	2.3182		1.9947	F-Test		2.3182	0.0329
				Chi-Square		13.9094	0.0307
Ecuador	b_0	b_1	b_2	b_3	b_4	b_5	b_6
Coefficients	0.0023	-0.0116	-0.0996	-0.0256	0.0180	-0.0580	-0.0797
t-Statistics	0.8554	-0.2206	-1.8955	-0.4835	0.3404	-1.1018	-1.5106
Probability	0.3929	0.8255	0.0588	0.6291	0.7337	0.2713	0.1318
R^2	F-statistics		Durbin-Watson			Statistic	Probability
0.0212	1.2932		2.0027	F-Test		1.2932	0.2594
				Chi-Square		7.7594	0.2563
El Salvador	b_0	b_1	b_2	b_3	b_4	b_5	b_6
Coefficients	-0.0023	-0.0510	-0.0253	-0.0032	-0.0364	-0.0259	-0.0320
t-Statistics	-0.9916	-0.9678	-0.4786	-0.0598	-0.6904	-0.4914	-0.6060
Probability	0.3220	0.3338	0.6325	0.9524	0.4904	0.6234	0.5449
R^2	F-statistics		Durbin-Watson			Statistic	Probability
0.0057	0.3405		2.0020	F-Test		0.3405	0.9152
				Chi-Square		2.04298	0.9152

Continuation

Guatemala	b_0	b_1	b_2	b_3	b_4	b_5	b_6
Coefficients	0.0010	-0.0252	-0.0278	-0.0148	0.0091	-0.0146	-0.0247
t-Statistics	0.3397	-0.4779	-0.5278	-0.2805	0.1729	-0.2769	-0.4689
Probability	0.7343	0.6330	0.5979	0.7793	0.8629	0.7820	0.6394
R^2	F-statistics	Durbin-Watson				Statistic	Probability
0.0025	0.1480		2.0002	F-Test		0.1480	0.9894
				Chi-Square		0.8882	0.9895

Honduras	b_0	b_1	b_2	b_3	b_4	b_5	b_6
Coefficients	0.0011	0.0006	-0.0157	0.0181	-0.0314	0.0014	-0.0208
t-Statistics	0.3789	0.0114	-0.2973	0.3431	-0.5963	0.0263	-0.3939
Probability	0.7050	0.9909	0.7664	0.7317	0.5514	0.9790	0.6939
R^2	F-statistics	Durbin-Watson				Statistic	Probability
0.0019	0.1156		2.0012	F-Test		0.1156	0.9946
				Chi-Square		0.6936	0.9946

Mexico	b_0	b_1	b_2	b_3	b_4	b_5	b_6
Coefficients	-0.0005	-0.1688	-0.1532	-0.1180	0.0846	0.0200	0.2099
t-Statistics	-0.1610	-3.2705	-2.9252	-2.2350	1.6029	0.3816	4.0597
Probability	0.8722	0.0012	0.0037	0.0260	0.1098	0.7030	0.0001
R^2	F-statistics	Durbin-Watson				Statistic	Probability
0.1042	6.9574		1.9655	F-Test		6.9574	0
				Chi-Square		41.7443	0

Paraguay	b_0	b_1	b_2	b_3	b_4	b_5	b_6
Coefficients	0.0013	0.0865	-0.0337	-0.0094	-0.0576	0.0143	-0.0053
t-Statistics	0.3992	1.6386	-0.6364	-0.1767	-1.0879	0.2696	-0.0996
Probability	0.6900	0.1022	0.5249	0.8598	0.2774	0.7876	0.9207
R^2	F-statistics	Durbin-Watson				Statistic	Probability
0.0117	0.7100		2.0001	F-Test		0.7100	0.6417
				Chi-Square		4.2601	0.6415

Peru	b_0	b_1	b_2	b_3	b_4	b_5	b_6
Coefficients	0.0091	0.0925	0.3382	-0.0707	0.0103	0.0390	-0.0607
t-Statistics	1.3832	1.7551	6.3976	-1.2669	0.1839	0.7379	-1.1520
Probability	0.1675	0.0801	0.0000	0.2060	0.8542	0.4611	0.2501
R^2	F-statistics	Durbin-Watson				Statistic	Probability
0.1266	8.6720		1.9981	F-Test		8.6720	0
				Chi-Square		52.0322	0

Uruguay	b_0	b_1	b_2	b_3	b_4	b_5	b_6
Coefficients	-0.0008	-0.1469	0.0118	0.1096	-0.0555	-0.0197	0.0085
t-Statistics	-0.3533	-2.7842	0.2221	2.0590	-1.0421	-0.3703	0.1621
Probability	0.7241	0.0056	0.8244	0.0402	0.2981	0.7114	0.8713
R^2	F-statistics	Durbin-Watson				Statistic	Probability
0.0400	2.4923		1.9997	F-Test		2.4924	0.0224
				Chi-Square		14.95409	0.02061

Venezuela	b_0	b_1	b_2	b_3	b_4	b_5	b_6
Coefficients	-0.00005	-0.0993	-0.0999	-0.0936	0.0499	-0.0541	-0.0579
t-Statistics	-0.0123	-1.8854	-1.8897	-1.7648	0.9402	-1.0241	-1.0984
Probability	0.9902	0.0602	0.0596	0.0785	0.3478	0.3065	0.2728
R^2	F-statistics	Durbin-Watson				Statistic	Probability
0.0341	2.1127		2.0037	F-Test		2.1127	0.0512
				Chi-Square		12.6760	0.0485

statistic for both the ADF and Phillips-Perron test are smaller than the critical value needed to reject the null hypothesis at either one percent, five percent or 10 percent levels of significance. These series therefore follow a random walk process and are therefore non-stationary, However, the series of changes in exchange rates (Table 7), 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.

Furthermore, the existence of stationarity in the real exchange rate 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 behavior of the Latin American currencies, considering the recurrent crises and stop-go patterns of growth characterizing their economies during the last three decades of the 20th Century. It is worth mentioning that applying a Chow break point test, five countries (Argentina, Bolivia, Costa Rica, El Salvador, and Peru) show a rupture in their series of real exchange rates in the 1980's. Meanwhile, for the remaining 10 countries the rupture in that series took place during the last decade of the last century. Table 8 shows these results. Thus, although there are some regional similarities in the long-run behavior of exchange rates in the Latin American countries, particularly evident in Tables 1-3, results from Tables 4-8 underlie the heterogeneity of the region.[12] 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 non-stationarity, and the behavior of the real exchange rate was stable, not constant.[13]

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, pegging, excessive control over the their exchange rates, and delayed adjustment of the exchange rate *vis-à-vis* the U.S. dollar, exchange markets in the region have been made inefficient. Past prices and past changes in the exchange rate seem to contain some useful information about the present levels of Latin American exchange rates. Furthermore, the empirical evidence is in disagreement with the results for Latin American black market exchange rates, as reported by Koveos and Selfert (1985) and by Diamandis (2003) for parallel markets. 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

[12] The structural breaks present in Table 8 also underscore the singularity of each country, as well as stressing the importance of historical analysis and policy-oriented studies, as pointed out above, note 2.

[13] These two facts suggest the need for further studies on EPPP for the Latin American currencies, with full identification of optimal breakpoints. Because the breakpoints for the real exchange rates indicate short analysis periods, for the last decade, this study does not include further research on the EPPP. On the issues concerning unit root test and structural breakpoints see: Perron and Vogeslang (1992), Perron (1997), and Baum, Barkoulas and Caglayan (2000).

Table 6
Unit Root Test for Real Exchange Rates

Country	*ADF*	*pp*	*Unit Root*
Argentina	-0.6246***	-0.0653***	Yes
Bolivia	-1.4240***	-0.8817***	Yes
Brazil	-1.9988***	-2.2086***	Yes
Colombia	-1.8263***	-2.0564***	Yes
Costa Rica	-1.9270***	-1.8795***	Yes
Chile	-1.7224***	-1.4130***	Yes
Ecuador	-0.8959***	-0.8776***	Yes
El Salvador	-2.0335***	-2.1158***	Yes
Guatemala	-1.8812***	-1.9478***	Yes
Honduras	-1.2608***	-1.2654***	Yes
Mexico	-1.4416***	-1.4087***	Yes
Paraguay	-2.0384***	-2.0367***	Yes
Peru	-1.7486***	-1.5973***	Yes
Uruguay	-0.0755***	0.0893***	Yes
Venezuela	-1.7762***	-1.7384***	Yes

McKinnon Critical values for Augmented Dickey-Fuller and Phillips-Perron test without trend and intercept at 1%, 5% and 10% levels of significance are –3.99, –3.42 and –3.13 respectively.
* Denote significance at the 10% level.
** Denote significance at the 5% level.
*** Denote significance at the 1% level.

Table 7
Unit Root Test for Real Exchange Rates Changes

Country	*ADF*	*pp*	*Unit Root*
Argentina	-8.6424	-26.6354	No
Bolivia	-8.2872	-21.5979	No
Brazil	-7.1944	-16.2268	No
Colombia	-8.8623	-12.7280	No
Costa Rica	-6.4411	-16.0807	No
Chile	-9.3657	-19.2227	No
Ecuador	-9.1445	-19.6737	No
El Salvador	-8.4502	-20.1776	No
Guatemala	-8.1199	-19.6568	No
Honduras	-8.0119	-19.1868	No
Mexico	-9.5815	-17.5976	No
Paraguay	-8.0213	-17.5976	No
Peru	-7.0250	-17.8470	No
Uruguay	-7.8049	-22.2458	No
Venezuela	-8.9173	-21.2823	No

McKinnon Critical values for Augmented Dickey-Fuller and Phillips-Perron test without trend and intercept at 1%, 5% and 10% levels of significance are –3.99, –3.42 and –3.13 respectively.
* Denote significance at the 10% level.
** Denote significance at the 5% level.
*** Denote significance at the 1% level.

Table 8
Chow's Breakpoint Tests for the Latin American Real Exchange Rates

Country	*Breakpoint*	*F-statistic*	*Probability*	*Log Likehood Ratio*	*Probability*
Argentina	12/31/1989	64.91	0	112.36	0
Bolivia	12/31/1984	7.70	0	15.26	0
Brazil	12/31/1998	73.64	0	125.19	0
Colombia	12/31/1996	6.86	0	13.62	0
Costa Rica	12/31/1981	4.37	0.01	8.74	0.01
Chile	12/31/1996	5.37	0	10.70	0
Ecuador	12/31/1999	156.94	0	229.28	0
El Salvador	12/31/1989	8.85	0	17.48	0
Guatemala	12/31/1985	10.96	0	21.54	0
Honduras	12/31/1990	16.83	0	32.56	0
Mexico	12/31/1994	51.96	0	92.50	0
Paraguay	12/31/1997	12.65	0	24.74	0
Peru	12/31/1989	37.35	0	68.74	0
Uruguay	12/31/1995	57.21	0	100.68	0
Venezuela	12/31/1995	46.43	0	83.69	0

appropriate framework for many currencies in Latin America; exchange rate markets in the region are inefficient. Seemingly, by the year 2000, exchange rates have practically adjusted to past inflationary trends, as shown by the evidence from Tables 1 and 2. However, the financial literature gives ample evidence of rather delayed, drastic, crisis-generating exchange adjustments traditionally being implemented by exchange rate authorities from the region. Only during the past decade has the market become an important mechanism to adjust exchange rates in line with inflation differentials in the rest of the world.

Conclusion

This paper has investigated whether the efficient markets version of Purchasing Power Parity theory holds for Latin American currencies for the 1970-2000 period. Two tests of the EPPP with seemingly unrelated regressions were used and, in addition, two unit root tests were applied. In general, the empirical evidence obtained does not favor the EPPP. Results suggest inefficient foreign exchange markets in the region, resulting both from weak exchange rate policies and weak foreign exchange market development. Concerning exchange rate policies, the evidence also suggests that the various exchange rate regimes adopted by governments from the region, ranging from tightly controlled markets, to managed sliding mechanisms, and fully or nearly fully free markets, were insufficient and inappropriate to deal with the extraordinary changes that the Latin American economies underwent during the last three decades of the 20th Century. Furthermore, contrary to prior evidence that the efficient markets version of PPP generally holds, this conclusion cannot be generalized for the Latin American case, for the period under study. Finally, although the evidence from the econometric tests also suggests some regional similarities in long run exchange rate behavior, the results obtained also underscore the heterogeneity of the region; patterns of maladjustment in exchange rates differ from country to country and the structural breaks that can be related to such processes are also different. The evidence also implies the need to strengthen foreign exchange market activity as a means to maintain more stable exchange rates and avoid cyclical economic crises which in Latin America have consistently been triggered by currency crises. In this respect, since markets might be inefficient in themselves, exchange rate authorities should also complement market activity by implementing timely, dynamic adjustments based on close monitoring of inflation rate differentials with their main trade partners. These policies should be complemented by the creation of exchange rate derivatives to overcome the limitations of the incomplete markets which still characterize many Latin American countries. Since the region's currencies have been subject to tight government controls, but have been moving towards freer markets in response to their recurrent economic crises and to the challenges of globalization, further research will be necessary in the near future (with more accumulated data) to test PPP for these economies in the long run, particularly determining optimal structural breaks to examine and compare PPP market adjustments from recent periods *vis-à-vis* PPP adjustments resulting from previous exchange rate regimes.

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