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Ariff, Mohamed; Zarei, Alireza

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PARITY THEOREMS REVISITED: AN ARDL BOUND TEST WITH NON-PARITY FACTORS

Mohamed Ariff[1,2*] and Alireza Zarei[2]

[1]*Bond University, Qld 4229, Australia*
[2]*Universiti Putra Malaysia, Serdang, Selangor, Malaysia*

[*]Corresponding author: mariff@bond.edu.au

ABSTRACT

The research question addressed in this paper is, do inflation and interest rate differences across two major economies fully drive the long-run exchange rate changes if controls for non-parity factors are embedded? Exchange rate behaviour research is once again an interesting topic given the availability of powerful econometric approaches to resolve unsolved issues. We re-examine the exchange rate behaviour of the US economy, applying a more appropriate econometric model using 55 years of quarterly data. The model explains 96% of variation in exchange rates, which testifies to the model's appropriateness. The error correction estimate indicates a time-to-equilibrium of 0.139 per quarter; that is, full adjustment takes seven quarters. Tests indicate evidence of a long-run relationship among the exchange rate, prices, and interest rates. The coefficients on both parity factors (prices and interest rates) are statistically significant with correct theory-suggested signs. These findings constitute strong evidence in support of parity and non-parity theorems while confirming that the US currency behaviour over 1960–2014 is consistent with parity and non-parity theories.

Keywords: ARDL, bound test, exchange rate, prices, interest rates, speed of adjustment, non-parity factors

INTRODUCTION

This research report provides new evidence that the United States (US) exchange rate is significantly influenced by the factors that have a role in the parity theorems. That is, both relative prices and relative interest rates have significant effects on the nominal US exchange rates over a period slightly longer than half a century. We use a very long time series covering 212 quarters. The novel idea tested in our report is to incorporate recently suggested non-parity factors (Ho & Ariff, 2012) as control variables in the widely used traditional parity models using inflation and interest rate differences as well as developing a robust time series model for research on this topic with more countries than used in this study. Several theories from the international finance literature predict how exchange rates are determined; however, to date, there is a lack of clear support in many studies for the prediction that inflation (relative prices) has a significant effect on the exchange rate. Some writers have termed the lack of evidence a 'puzzle' (Bergin, Glick, & Taylor, 2006). The theorem that relative interest rates affect exchange rate has been strongly repudiated in recent decades. Thus, an appropriate econometric approach is adopted in this research paper–ARDL and Bound Testing–to re-examine US exchange rate behaviour using more up-to-date data and an appropriate methodology. This paper explains this new approach, the appropriate model and the resulting findings.

Purchasing Power Parity (Cassel, 1918) or PPP for inflation and the International Fisher Effect (Fisher, 1930) or IFE for interest rates are two cornerstones of monetary theory regarding exchange rate behaviour. Despite the efforts of a long list of scholars, there is still a lack of full support for the theory-predicted results. The theory predictions, however, are viewed as routine with regard to practical policy decisions at the macro and micro levels in a variety of contexts in real-world economic decision making. (i) Does the PPP factor affect the exchange rate? (ii) Does the interest rate (IFE) affect the exchange rate? (iii) Do the PPP and IFE hold together if controls for the recently supported non-parity factors are embedded in our tests? The model developed in this study combines the two parity theorems as well as three non-parity factors that are widely demonstrated as being correlated with exchange rates in several closely linked trading groups.

We proceed to explain the theories and the empirical literature on parity theorems before explaining the research process to be followed in this research. The findings are then discussed.

EXCHANGE RATE THEORIES

There is renewed interest in exchange rate determination in both the theoretical and empirical literature. The existing literature and the respected financial press reports suggest large volatility in several currency exchange rates under the free-floating system, which started in earnest in 1973 after the breakdown of the 1946 Bretton Woods Agreement. Aside from this, the lack of evidence for PPP continues to be a puzzle. After the 2008–2009 Global Financial Crisis (GFC), currency trading volume increased by nearly 60% to US$ 5.3 trillion per day. Thus, a re-examination of exchange rate behaviour is warranted in the much changed present context of changing dynamics of exchange rate behaviour using the traditional parity theoretic framework by also incorporating newly suggested non-parity factors into the tests. Garratt, Lee, Hashem Pesaran and Shin (2003) develop a system-of-equations approach to build a macroeconomic model of the UK economy, also incorporating parity factors; our research has a limited scope and only searches for a simple innovation in line with the long tradition of connecting the exchange rate to parity factors using time series dynamics rather than building a system of equations. An additional notable study identifies a structural approach to study the transmission dynamics of parity factors, addressing how two close-trading nations (China and Malaysia) have price and interest rate factors as relevant factors (Chan & Hooy, 2012). Traditionally, under the monetarist approach of exchange rate determination, the PPP (Cassel, 1918) and IFE (Fisher, 1930) are assumed to fully explain how currency exchange rates are determined. Recent researchers have added few non-parity factors, as explained previously, to the parity factors from the monetary theories.

No evidence is available that the PPP holds in the short run, although, using a novel approach, one study (Manzur & Ariff, 1995) provides support for a long-run equilibrium. There is some support for the IFE in the early literature on the exchange rate (Edison & Melick, 1999); however, later studies have repudiated many of the early findings. Hence, the literature that is relevant to this study is on inflation and interest rate differences as well as the known non-parity factors that are also likely to be relevant for exchange rate research. Our research is limited in scope and does not embed the exchange rate behaviour within the broader macroeconomic theories as in some of the above-cited articles.

Purchasing Power Parity

Purchasing Power Parity (PPP) suggests that the exchange rate is influenced by relative price differences in traded goods/services across countries (Cassel, 1918). PPP is often said to have originated from the earlier Spanish literature on how the money supply under the gold standard in that era led to inflation during the periods of gold importation by Spain from the New World. PPP examines this relationship between exchange rates across different countries, and many classic studies used time series regressions to verify this theory. PPP asserts that inflation, measured as the relative prices across any two countries, should be offset by changes in the exchange rate; it does not specify the time to equilibrium for this change to occur, although later ideas such as the Sticky Price Hypothesis (Dornbusch, 1976) suggest a lengthy time to equilibrium. Hence, any two identical goods produced in any two countries are said to have a similar base price under the *law of one price* or LOOP for the same basket of goods/services traded with different currencies.

Scholars researching macroeconomic and international finance topics have found that PPP is potentially applicable to a wide range of policy decisions in the post Bretton Woods era. International comparison of income and expenditure is facilitated via the equilibrium conditions among the factors, given an efficient arbitrage in goods and services trade. It is a theory for short-run (for which there is little evidence) as well as long-run exchange rate determination, whereby the authorities set or steer a nominal exchange rate that satisfies international competition at any time.

The PPP states that a country's currency will adjust rapidly in the market by the ratio of the rate of inflation and the trading partner's inflation rate. There is a possibility for the relative PPP to hold in the long run but not in the very short run, given price stickiness. This study uses the relative version of PPP as:

$$\ln E_{jt} = a_j + b_j ln\left(\frac{P_t^d}{P_t^f}\right)_{jt} + \mu_{jt} \tag{1}$$

where E is the exchange rate of country j over time period t, P^d is the domestic price, and P^f is foreign price.

International Fisher Effect

A link between the interest rate and inflation is postulated by Fisher (1930), which predicts that the nominal exchange rate will adjust by the ratio of relative interest rates of the two countries via a change in currency value: This is the IFE. This prediction is based on the effect of domestic inflation increases devaluing the currency by the amount of domestic inflation as suggested by the Domestic Fisher Effect hypothesis; that is, the exchange rate will decline. The relationship between interest rates and inflation is one to one, assuming a world of perfect capital mobility with no transaction costs; this effect is normally considered to be instantaneous. This idea plays a crucial role, given that the nominal interest rate will not be fully adjusted after a change in the expected inflation (according to Levich, 2011). A large number of studies have been conducted on the IFE theory. The early studies date back to the 1980s. However, there is evidence of mixed findings concerning the IFE, although, unlike the PPP, this theory has modest support in the earlier empirical literature.

Any change in a country's interest rate, perhaps arising from monetary policy actions or perhaps from actual inflation rates, will create disequilibrium in currency value requiring long-term adjustments of the country's exchange rate to restore a new equilibrium. In other words, the ratio of changes in exchange rates is determined by the ratio of domestic (superscript *d*) to foreign interest rate (relative interest rate, superscript *f*) as:

$$\frac{E_{t+1}}{Et} = \left(\frac{1 + i_t^d}{1 + i_t^f} \right) \tag{2}$$

The IFE suggests the exchange rate is moving to equalise the interest rate difference across countries under the assumption that this is the unbiased predictor of future changes in the nominal spot exchange rates. Test results from this theorem suggest that the interest rate differences are correlated significantly with exchange rate changes, although many tests indicate that, due to under-specification of this relationship, the explained variation in such tests is very low as indicated by the low R-squared values reported (including those in this paper for our preliminary models). This is due to the variable specification issue, which has to be addressed carefully. It is also likely that the usual definition of the relative interest rate in nominal terms would introduce a correlation with inflation; thus, any joint test is likely to be biased given the correlation between the inflation and nominal interest rate. To correct this, one needs to re-specify the interest rates.

Non-Parity Factors

There have been several important studies exploring whether one or more non-parity factors are also relevant for exchange rate movements; given the lack of explanatory power of the monetary theorems, there are just two parity conditions for equilibrium. Frankel and Rose (1996) suggest trade balances and Canzoneri, Cumby and Diba (1999) suggest productivity changes. These and other factors are tested in an additional study (see Ho & Ariff, 2012) identifying five relevant non-parity factors for theory-building on exchange rates. In this study, we take cognisance of these new factors, which are perhaps also simultaneously likely to improve the explanatory power of the parity theorems. One needs to control the impacts of these factors in a test model of parity conditions.

Thus, we believe that the introduction of a more fully specified model will lead to robust results for our exchange rate research compared to the existing US studies that are limited to using parity factors only. Clearly, the differences in the behaviour of the US exchange rate may well be due to changes in the underlying non-parity factors. Hence, our findings may provide fresh insights into the very old issue of parity factors.

EMPIRICAL EVIDENCE ON PARITY THEORIES

Purchasing Power Parity

Because the nominal prices are unstable or may also be sticky (meaning prices take time to change (Dornbusch, 1976) and the nominal exchange rates are subject to wide fluctuations as the result of volatilities in flows of capital, goods and services, the short-run equilibrium is often viewed as not likely to hold. For example, if interest rates, subjected to other effects, are also affecting the exchange rate in the short run, why is there lack of evidence for a similar behaviour for inflation? This could be attributed to the model(s) used for exchange rate studies or perhaps also to the sources of disturbances to the real exchange rate from non-parity factors. In this regard, the structural models of Garratt et al. (2003) and Chan and Hooy (2012) may be superior to the simpler time series models.

A large number of studies conducted in the late 1970s failed to validate the PPP relationship, mainly due to non-stationarity conditions of the residuals, as we have come to discover since the 1980s from the advances in econometrics leading to the non-stationarity problem in levels data that introduces bias in parameter estimates and test statistics. While some studies failed to confirm the presence of unit root or stationarity conditions, the relationship between the respective variables (nominal exchange rates and relative prices) was incorrectly computed, resulting in spurious results. The empirical research on PPP before the 1980s applied the absolute version of the PPP, which resulted in the rejection of the PPP. The most influential study of this type (Frenkel, 1976) obtained estimates of the respective coefficients that should not reject the PPP even considering the fact that the sampled countries in the study were among the high-inflation economies.

Accordingly, in the early 1980s, researchers began to test for stationarity using newly developed unit root tests (Dickey-Fuller's ADF test). The ADF test, despite its resolution of the problem, still failed to strongly support the PPP in nearly all studies of unit root tests using cross-country data for the free floating period after 1973. There were some exceptions; a few studies verified a long-run PPP behaviour, given that the real exchange rate deviations from its mean value are only temporary in nature. Such a failure was basically attributed to the limited power of the tests employed, especially in the small samples using the simulation exercises (Levin & Lin, 1992).

In the late 1980s, researchers, noting the low power of the tests, switched to using long time series to take advantage of the long horizon data. Using an error-correction model (Edison, 1987), researchers analysed the US Dollar-UK

Pound Sterling data over the period 1890–1978 and found a slightly higher degree of significance for the PPP. A large number of other studies in the early 1990s attempted to test for the PPP condition over longer time horizons (something we also do in this study) while also using a number of recently developed new and sophisticated methods such as cointegration (Garratt et al., 2003), fractional integration and error correction models. The results of these studies favoured the PPP predictions: These also supported a real exchange rate mean-reverting behaviour (Rogoff, 1996). Mollick (1999), using data from Brazil, analysed long time period data for the years 1885 to 1990. The results, however, were mixed: The presence of the unit root (non-stationarity) was not rejected by the formal unit root tests, while the time series trends favoured a stationarity of the variables. Autoregressive processes used in the model yielded robust and satisfactory estimation of the real exchange rate compared with regression methods.

Consistently, Lothian and Taylor (1996) applied the annual real exchange rate data of Franc-Sterling and Dollar-Sterling over two centuries. The results for such a long time period were satisfactory, rejecting the null hypothesis of the unit root for PPP using both the ADF and Phillips-Perron (PP) test (Phillips & Perron, 1988). Additionally, in a separate study, Lothian and Taylor (2000) produced evidence to support their belief about the PPP reliability over the long run and used a method for faster estimation of the mean reversion speed for the real exchange rate. Andersson and Lyhagen (1999) applied a panel unit root test, through which the null hypothesis of no co-integrating relationship between the domestic and foreign price levels was rejected for some of the sampled countries. Using a relatively similar small sample as the one applied by Andersson and Lyhagen (1999) but with long time horizon data for the real exchange rate of 21 countries, Shively (2001) found evidence of a consistent PPP relationship to add an additional satisfactory result for longer time periods. Concerning the results obtained supporting the PPP, after three decades of floating exchange rates, there is still evidence from various studies that the strong prediction of PPP is not borne out in tests for either the short or long run. Failure to support the PPP's predictive power has been termed the "PPP Puzzle" in a recent paper by Bahmani-Oskooee, Kutan and Zhou (2009).

International Fisher Effect

The relationship between real interest and real exchange rates (that is, after the inflationary effect is removed) is highlighted in several studies using post-Bretton Woods data. One primary and well-known model of the exchange rate is the sticky price model of Dornbusch (1976), which suggests that under a flexible exchange rate framework, prices of goods in a country are subject to slower (stickier) adjustments than those of capital assets, thus initiating arbitrage opportunities in the short run, as suggested by the IFE (see Manzur and Ariff, 1995, which identifies the time periods for stickiness).

There is evidence from several important studies on the correlations of real interest and exchange rates, with several different assumptions. Mishkin (1984) views the real interest rates across a sample of major economies as similar. Similarly, Mark (1985) tests for the conditions of high capital mobility and equality of short-term *ex ante* real interest rates and net of tax real rates among flexible and specific market-linked exchange rates. The results from the latter study are consistent with Mishkin in that the IFE hypothesis of parity conditions is rejected considering its joint relationship with the *ex-ante* PPP.

Critics of parity theorems made the obvious conclusion that there is still a lack of support for some of the theories. One suggestion is that the cointegration of real returns is not tested in Mark and Mishkin's studies. Other studies introduced control factors and cointegration tests. Notably, the two-step method of Engle-Granger cointegration was applied in several studies to examine how real exchange rates are cointegrated with real interest rates. Examples include Meese and Rogoff (1988), Edison and Pauls (1993), and Throop (1993); these studies failed to support a significant co-integrating relationship (possibly in the long run) between the respective variables. After applying the maximum likelihood estimation method for the Johansen co-integration test, the results became somewhat more favourable to the theory (Johansen & Juselius, 1992; Edison & Melick, 1999). This suggests that the choice of methods is a crucial factor in obtaining reliable results.

Similar to the PPP, there is some evidence in the empirical studies that a long-run relationship between exchange rate and interest rate differences appears to hold well (Hill, 2004). On the other hand, in the short run, the IFE has not been proven to hold (Cumby & Obstfeld, 1981). Such mixed evidence is a motivation for revisiting the research on the IFE hypothesis as much as the research on the PPP hypothesis.

Non-parity Factors

While these theories are generally treated as general equilibrium conditions — known as parity theorems in the monetary economics framework — researchers have recently identified, as mentioned earlier, a number of other-than parity factors as influencing exchange rates significantly. Given the lack of strong evidence for the full explanatory power of the parity factors for exchange rate behaviour, these so-called "non-parity" factors have gained significant popularity in recent years in exchange rate studies.

The level of international reserves of a country is a determinant of exchange rates (Frankel & Rose, 1996); this idea is from the Philip's Curve effect, long observed in international economics studies. A country's currency value is subject to movements as a result of unexpected changes in foreign reserves held by the central authority to service the trade bills arising from international trade and also from the use of reserves to defend the currency during crisis periods. There is a direct relationship between the currency value and any unexpected changes in the country's reserves on the back of productivity increases or even the level of foreign currency debt. The relationship between the level of international reserves and the value of the currency is the subject of a study (Martínez, 1999; Marini & Piersanti, 2003) that indicates support for the variable as a non-parity factor.

Capital flows play a crucial role in determining the behaviour of exchange rates. The accessibility to cash from capital markets has become easier because of new rules and de-regulations, in addition to the general reduction in capital controls in many countries, which has led to improved inter-country cash flows. There are several studies with evidence suggesting a significant relationship between capital flows and exchange rate changes. Examples are Kim (2000), Calvo, Izquierdo and Talvi (2003), and Rivera-Batiz and Rivera-Batiz (2001).

RESEARCH DESIGN, VARIABLES, HYPOTHESES AND MODELLING

This research addresses the presumed relationship between exchange rates and parity variables, with and without controls for non-parity variables specified in a more appropriate new test model to be developed and applied to the US currency data against the UK pound sterling. The data series (exchange rate; inflation; interest rate differences; non-parity factors) are obtained from data sources for the US and the UK economies. We use a long time series for the pre-floating era from the year 1960 to the post-floating era including the year 2014, a 55-year data set. "What are the factors that had significant influences on the US$ rate" is the research question. During the test periods, both the US dollar and the British pound (GBP) played significant roles as international currencies.

The test model to be developed in this section specifies inflation and interest rate differences across the US and the UK as parity factors on the right-hand side, and then the test is repeated introducing control variables, which are non-parity factors. In such a full model, a single regression would be appropriate for the tests while also re-estimating the effects from parity and non-parity factors. We believe that this approach yielded new insights on how (i) exchange rates behave differently, and (ii) introducing the validity of non-parity factors for the US$ exchange rate.

Data, Variable Transformation and Test Models

The data employed are the Nominal Exchange Rate (NER), Consumer Price Index (CPI), short-term Risk-Free (Treasury) interest Rates, Total Reserve, Population, Total Value of Imports, Current Account Balance, GDP, and Total Value of Exports. The GDP data are used to standardise other variables. Data on the above three other-than non-parity variables are only available on a yearly basis, so these could not be included in the quarterly data set. The series are quarterly from 1960 to 2014. Table 1 provides a summary of the variables, with their expected signs for the tests.

Table 1
Variable specification, definitions and expected signs

No.	Variables	Definition	Expected Sign
1.	LNER	Log of Nominal Exchange Rate over time periods	Dep. Variable[a]
2.	LCPI	Log of Prices over time periods	–
3.	IFE	(1+ Short-term Domestic Interest Rate) / (1+Short-term Foreign Interest rate)	+
4.	CA/GDP	Current Account Balance / GDP	+
5.	TTrade/GDP	Total Exports and Imports / GDP	+
6.	Productivity	GDP / Population	+

Note: [a]Dep. Variable stands for Dependent Variable.

IFE is measured using short-term risk free interest rates (Treasury bills) for the US by dividing the interest rate in the UK as a measure for the relative interest rate. The major sources of data are *The International Financial Statistics* (IFS) CD-ROM, *Thomson Reuters DataStream,* and the *Capital IQ* database. The Consumer Price Index (CPI) is used as a proxy for measuring the purchasing power parity. The CPI measures the prices of a basket of goods available in the US and the UK.

Hypotheses

The main hypothesis is that the parity variables should hold because the model to be developed would have the appropriate refinements to measure these effects correctly, provided that (a) the data series are sufficiently long with the appropriate specifications, (b) the parameter estimation is performed with robust test methods, (c) and non-parity factors are embedded in the tests.

H_1: The null hypothesis: The price differences across the UK and the US are not likely to significantly impact the US currency nominal exchange rate against the UK pound. We expect to reject this null hypothesis to seek support for the PPP theory.

H_2: The null hypothesis: The real interest rate differences across the US and the UK are not likely to significantly impact the US currency exchange rate with the UK. The rejection of the null hypothesis will support the IFE prediction.

H_3: The null hypothesis: The three non-parity factors recently found to have an impact on exchange rates are not significantly correlated with the US nominal exchange rates with the UK pound. We expect to reject this hypothesis and to find significant impacts of these factors on the US currency exchange rate against the UK pound.

These three testable hypotheses are to be verified by t-tests on the parameters estimated by the test models. There are other tests for which we will report the preparation of the data series are transformed to assure the assumptions of the tests are complied with. We believe that using time series data for multiple countries can be more reliable if the procedure for proper model selection is appropriate and is carefully performed.

Choice of Appropriate Models

We approach the construction of a research model by combining the received theories in international economics. First, there is the PPP theorem, which suggests the following parity relationship: EX = f($INFL^{-}$), meaning that the relative changes in inflation for any two trading countries are positively related to increasing exchange rate changes. The IFE predicts a positive relation between the relative interest rate (the ratio of the interest rate of one country and that of the other country) and the nominal exchange rates: EX = f($RINT^{+}$). The non-parity variables we chose on a quarterly basis are total trade (TTRADE), current account (CA) and productivity (PRODVTY). The theory-suggested relationship is EX = f($TTRADE^{+}$; CA^{+}; $PRODVTY^{+}$). The dependent variable EX is the exchange rate, which, to comply with the econometric properties of the variables, will be specified as the nominal exchange rate over any two time periods, in our case, a quarter. Similarly, the dependent variable is also transformed to avoid violating the assumptions of the model specified in this section.

By combining these separate theorems, we establish the idea that the exchange rate is a function of all five criterion variables: EX = f(INFL; RINT; TTRADE; CA; PRODVTY: Residuals). If these five factors together could fully explain the variation in the exchange rates, it is possible to view this model as fully specified; the residuals enable this model to be considered non-deterministic because there is no claim that the model is fixed. In the continuing discussion in this section, we will explain how the assumptions of the test models are tested to ensure robust estimation. To compare how these individual theorems perform, we will use the two parity theorems as a simple relationship, with price followed by a simple relationship with interest rates. These results will provide the base estimates without econometric refinements to be compared with the full model to observe how the results would have improved.

The final model based on a single equation, which includes the two parity factors and three non-parity factors, is specified below. The following equation indicates the basic relationship among the variables. We use this to obtain what we claim to be robust estimates, which will hopefully provide support for the parity theorems and indicate if the explained variations are 100%. In addition, we will also test for the error correction (speed of adjustment) factor, which will indicate the important time-to-equilibrium measure.

$$ln\left(\frac{NER_t^d}{NER_t^f}\right)_t = \gamma_1\left(\frac{1+i_t^d}{1+i_t^f}\right)_t + \gamma_2 ln\left(\frac{CPI_t^d}{CPI_t^f}\right)_t + \gamma_3\left(\frac{TTrade}{GDP}\right)_t + \gamma_4\left(\frac{CA}{GDP}\right)_t + \gamma_5 Prodvty_t + \varepsilon_t \quad (3)$$

where NER represents the Nominal Exchange Rate, i^d denotes the Domestic Interest Rate, i^f is the Foreign interest rate, as in Equation (2), CPI stands for the Consumer Price Index, as in Equation (1), $\frac{TTrade}{GDP}$ represents the total trade as a proxy of total trade (export and import) over Gross Domestic Product (GDP), $\frac{CA}{GDP}$ is the ratio of the current account balance over GDP, and *Prodvty* is Productivity measured as GDP over the total population over time t.

Some tests are required to verify that the specifications of variables conform to the assumptions of the model. As a general rule, the validity of the co-integrating series is determined by investigating the order of integration of the variables, which, by definition, should be similar. One may note that an equilibrium long-run relationship exists between variables (for example, the exchange rate and parity conditions) if the variables are integrated of the same order. Thus, two series are said to be co-integrated if they move in one direction over the long run and the linear combination is stationary. One popular approach for this purpose is the Auto Regressive Distributed Lag (ARDL) with a bound test to examine the long-run and the short-run relationships among variables (Pesaran & Shin, 1997; Pesaran, Shin, & Smith, 2001). We needed to test this condition strictly to determine that the ARDL is the most appropriate model. This test establishes the long-run and short-run dynamics, so the short-run relationship is also tested.

Prior to estimating a model using the ARDL approach, we need to validate the presence of the long-run relationship (cointegration) by employing the Pesaran et al. (2001) critical values and comparing the calculated F-statistics from the pre-determined lower- and upper-bound measures as evidence of a long-run relationship. By this means, two simultaneous models are proposed as being very appropriate for testing for long-run and short-run dynamics under a conditional ARDL-ECM framework. The correct stationarity conditions—the series do not all have the same order of stationarity—would permit us to apply the ARDL model as the most appropriate model and then compute the ECM estimation for the time-to-equilibrium for the exchange rate to fully adjust to the impacts of the five independent variables. Two outputs will be provided; one is the long-run relationship between the variables and the other is the Error Correction Mechanism (ECM). The ECM estimate would indicate the short-run dynamics while also implying the existence of a long-run relationship with an additional Error Correction Term (ECT) as the independent variable. The coefficient of this variable (i.e., ECT) is used to measure the speed of adjustment of the independent variables to equilibrium. For identification of the short-run and long-run relationship, ECM is the most appropriate, so we apply this approach.

If the variables in levels are not stationary of the same order, a number of econometric methods are ruled out, among which are the standard cointegration (Engle-Granger and Johansen-Juselius) and VAR approaches. For example, the choice of VAR requires all variables to be of the same order. Even if the first difference is to be used in a VAR model, all variables are to be integrated of order 1. This process rules out the use of VAR or an equivalent approach, such as the VAR-type causality, variance decomposition or impulse response function. The decision, therefore (as will be verified in the results section in Table 3), given that only two of the variables are stationary at levels, is for the ARDL approach and not the other cointegration approaches. Note that the aim of this search is to improve the time series regressions usually applied to study the parity relationship.

Diagnostic Statistics on Assumptions and Descriptive Statistics

Table 2 is a summary of the descriptive statistics on the variables used in this study.

Table 2
Descriptive statistics of the variables in the tests

Quarterly Data Series	Mean[a]	SD[b]	Skew[c]	Kurt[d]	JB[e]
NER (Dependent)	0.6478	0.2312	0.3822	1.9122	15.6884
CPI	0.1812	0.2822	0.8585	1.9942	35.1404
RIFE	–0.0011	0.0112	1.7257	11.7569	786.2976
TTRADE	0.0351	0.0126	–0.0495	2.1574	6.3870
CAGDP	–0.0145	0.0180	–0.3762	1.8236	17.3051
Productivity	21,922.4	15,803.3	0.4275	1.8331	18.5710

Basic descriptive statistics of the variables are provided in this table. [a] 'Mean' represents the average or the mean value; [b]SD represents standard deviation; [c]Skew represents skewness; [d]Kurt denotes kurtosis; [e]JB stands for Jarque-Bera test.

These statistics suggest that the means of the variable are very close to zero in many cases because of data transformation, with the exception of the variable Productivity, which is a large value. The first two variables (Exchange rates: LNER) and the inflation (LCPI) are *ln* of the variables. The relative real interest rate is the ratio of the two-country interest rates expressed as previously explained. The non-parity variables are after standardisation by GDP.

The statistics on stationarity testing are summarised in Table 3. These statistics in Panel A for tests on levels indicate that all variables are generally non-stationary. This means that all the series are not integrated of the same order; a property that indicates that ARDL is the most appropriate method. The statistics in Panel B are on first difference. To confirm the order of integration of the time series, we conducted two unit root tests using the augmented Dickey-Fuller ADF (Dickey & Fuller, 1979; 1981) and the Phillips and Perron (1988) (henceforth PP) tests. The ADF model can be very useful in identifying higher order serial correlation in conjunction with higher order lags. The Phillips and Perron (1988) test allows for relatively weak assumptions regarding the distribution of the residuals in the equation.

The results reported in Table 3 suggest that some of the series are integrated of order one, and the degree of integration of all of the series are not identical. The ADF and PP tests both confirm that of the six variables, four variables are not stationarity at level (NER, PPP, CAGDP, PRODTY), which means that they are integrated of order one. The two other variables are, however, stationary at level (RIFE, TTRADE), which means they are integrated of order zero. Because the tests are going to be performed with ARDL, this condition does not violate the use of ARDL for reliable test results.

Table 3
Results on data transformation (unit root tests)

This table reports the statistics on stationarity of data series. The statistics suggest that most of the data are stationary at first difference, which is judged by the respective ADF and PP tests of unit root.

	Augmented Dickey Fuller (ADF)		Phillips Perron (PP)	
Panel A	Level			
Variable	Constant Without Trend	Constant With Trend	Constant Without Trend	Constant With Trend
NER	–1.87	–2.26	–1.892	–2.45
	(14)	(14)	[3]	[4]
RIFE	–3.34**	–3.56**	–13.29***	–13.43***
	(14)	(14)	[10]	[10]
PPP	–1.96	–0.88	–2.20	–0.60
	(14)	(14)	[10]	[10]
TTRADE	–0.65	–4.09***	–0.58	–3.25*
	(14)	(14)	[8]	[6]
CAGDP	–1.36	–2.24	–1.40	–2.44
	(14)	(14)	[2]	[3]
Prodvty	2.11	2.35	3.23	–2.47
	(14)	(14)	[9]	[8]
Panel B	First Difference			
NER	–11.39***	–11.38***	–12.68***	–12.65***
	(14)	(14)	[1]	[0]
RIFE	–10.84***	–10.82***	–43.85***	–43.72***
	(14)	(14)	[7]	[7]
PPP	–4.06***	–4.44***	–13.21***	–13.33***
	(14)	(14)	[11]	[10]
TTRADE	–9.26	–9.24	–10.05***	–10.23***
	(14)	(14)	[14]	[14]
CAGDP	–13.39***	–13.36***	–13.39***	–13.36***
	(1)	(1)	[1]	[1]
Prodvty	–5.13***	–5.85***	–7.87***	–98.79***
	(14)	(14)	[7]	[6]

Note: *** and ** denotes significant at 1%, and 5% significance level, respectively. The figure in parenthesis (…) represents optimum lag length selected based on Akaike Info Criterion. The figure in bracket […] represents the Bandwidth used in the KPSS test selected based on Newey-West Bandwidth criterion.

FINDINGS

We present the results in this section and discuss why these results are significantly different from those in published studies. First to be discussed are the estimates using the OLS procedures with data transformed as explained in the previous section; that is, the results pertain to Equations (1) and (2). The test results using Equation (3) and the component results from bound testing are presented after the initial results. The central research question remains: Do relative prices *and* relative interest rates have significant coefficients as suggested by the theories, and is the explained variation in the model close to 100 per cent? In this manner, the appropriate time series model is demonstrated to be superior to the simple OLS approaches traditionally used in many of the prior studies.

Basic OLS Tests on Parity Models

Table 4 reports the statistical significance of the two parity theories, i.e., the PPP and IFE run separately using bivariate equations. The variables are transformed data series that satisfy the assumptions of the ARDL model. Panel A is a summary of the test statistics for the PPP theorem as in Equation (1); Panel B provides the statistics on the IFE theorem as in Equation (2). Running the test model as a bivariate relationship ignores that the exchange rate is affected not just by inflation but also by the interest rate and three other non-parity factors. These bivariate results are therefore from an under-specified model. PPP predicts that inflation should fully explain the changes in the exchange rate, so it predicts a coefficient that is equal to 1.00.

The statistics in Panel A reveal that the coefficient for inflation is 0.737, which is significant (t-value of 30.06), and the explained variation of this regression is 0.80. Thus, the PPP appears to hold. However, the model is underspecified as noted earlier, and the predicted coefficient is not equal to 1.00, nor is the explained variation close to 100%. There are also violations in the OLS test assumptions; for example, the DW statistic is 0.217, which suggests that there is serial correlation; hence, the parameters are biased. Given these deficiencies, the OLS test results need to be improved.

Table 4
Tests on price and interest rate parity based on bivariate modelling

This table reports statistics on the test of two parity theorems, namely Purchasing Power Parity and International Fisher effect using two bivariate regression equations. Results are still in support of theorems, while concerning the improper specification of models, a very tiny standard errors followed by large t-statistics are reported.

Panel A: $NER_t = \alpha_t + PPP_t + \varepsilon_t$						
Ordinary Least Square	Intercept	PPP	Obs.	Adj. R-sq.	F-statistics	Prob. (F-statistics)
Overall Sample Quarterly 1960–2014 DW = 0.217	0.514 (62.59)***	0.737 (30.06)***	212	0.80	904.13	0.000
Panel B: $NER_t = \alpha_t + RIFE_t + \varepsilon_t$						
Ordinary Least Square	Intercept	RIFE	Obs.	Adj. R-sq.	F-statistics	Prob. (F-statistics)
Overall Sample Quarterly 1960–2014 DW = 0.140	0.653 (42.20)***	4.96 (3.62)***	212	0.05	13.14	0.000

Note: Obs. stands for observation; Adj. R-Sq. represents Adjusted R-Square and Prob. denotes probability.

The results in Panel B on IFE also have limitations: serial correlation; explained variations; coefficient size, etc. The model is underspecified, as is evident from the strong significance of the intercept (t-value of 42.20), while the very large coefficient on the RIFE could be due to errors from violations of the assumptions of the OLS regression. The explained variation is too low (0.05), and the DW statistic of 0.140 is far from the required value of approximately 2.00. Importantly, the coefficient has the wrong positive sign, which suggests that the currency would depreciate with a higher interest rate difference.

While both factors appear in the two panels to be supported by their statistical significance, there are other serious reasons not to accept these results as reliable when the theorems are run as bivariate regressions and the non-parity factors are removed. Furthermore, both tests render very large t-statistics (PPP = 30.06; IFE = 42.20), which indicates errors in the estimation of standard errors. Given both equations, this may indicate that using the theories in isolation cannot produce robust results compared to the results from applying Equation (3).

OLS Test Results Using Equation 3

As an intermediate step, we proceeded to apply the OLS regression on Equation (3) before running the ARDL regression and bound tests. The results on the OLS are summarised in Table 5. It is to be noted that the OLS model is not fully appropriate because it does not take into account the distributed lag effects, and additionally, the long-run effect can only be captured by cointegration approaches (Engle-Granger, etc.) or ARDL. The OLS approach does not permit the estimation of error correction for the long-run relationship to exist. The statistics in Table 5 are an improvement of the results from the bivariate regressions discussed in the previous section.

Table 5
Ordinary least square results on parity and non-parity factors

This table is a summary of statistics from running Equation (3) as an OLS regression. The intercept is not significant, indicating that the inclusion of all factors in the model makes this model fully specified. The inflation (PPP) is significant with a very small coefficient of 0.127; interest rate (RFE) is –0.607, which has the theory-consistent negative sign; and the non-parity factors have incorrect signs on two factors.

Ordinary Least Square Dependent Variables = NER		Overall Sample 1960–2014
Intercept	0.009	(0.31)
PPP	0.127	(3.27)***
RIFE	–0.607	(–1.89)*
TTRADE	1.864	(1.77)*
CAGDP	–0.327	(–0.84)
PRODVTY	–0.000001	(–1.55)
Observations	212	Adjusted R-squared 0.96
DW Statistics	1.65	F-statistics 847.33***

Note: Figures in parentheses represent the *t*-statistics. *** represents null hypothesis rejection at 1%; ** represents null hypothesis rejection at 5%, and * represents null hypothesis rejection at 10% degree of significance.

The explained variation as suggested by the adjusted R-squared value of 0.96 would have us believe that the five factors together fully explain the changes in the exchange rate. Second, the model fit is significant as judged by the F-ratio. The DW statistic of 1.65 suggests that there is no serial dependence in the residuals. The intercept is not significant, suggesting that the model is unlikely to be under-specified. The parity factors have the correct sign, although the size of the coefficient for inflation is not equal to 1.00, and of the three non-parity factors, one is significant (total trade, TTRADE) at the 0.10 acceptance level. The coefficients for the current account have the incorrect sign.

ARDL and Error Correction Tests Using Equation 3

We now provide a summary of test results from the ARDL first to reveal if the coefficients for the five factors are significant and then to observe whether there is a long-run relationship between the exchange rate and the five independent factors: (see Table 6).

Table 6
Results of bound tests

In this table, *k* is the number of variables; the maximum lag identified is 2; the tests identified the upper and lower bounds at three levels of significance as shown in the table.

NER = f (PPP, IFE, TTRADE, CAGDP, PRODVTY)		F-statistic (6,186) = 3.9359**	
		k = 5, n = 55	Lag = 2
Pesaran et al. (2001)	Critical Value	Lower bound I(0)	Upper bound I(1)
	99% Level	3.41	4.68
	95% Level	2.62	3.79
	90% Level	2.26	3.35
Lagrange multiplier statistic		23.6585***	
Likelihood ratio statistic		25.1006***	

The computed F-value, the likelihood ratio and Lagrange multiplier are used for testing the long-run relationship. Pesaran et al. 2001 provides critical values for the bound tests. If the calculated F-statistics; F(6,186) = 3.94 are greater than the upper bound value at the 5% and 10% degree of significance and if the ECM is negative, we have support for the theories in the model.

These procedures satisfy (long-run) co-integrating relationship between the variables under consideration. The other estimated parameters also affirm that the model is relevant for a long-run relationship to exist between the five independent variables for the exchange rate. The LM of 23.6585 and the LR statistics equal to 25.1006 are significant at the 0.01 or better probability levels. The F-statistic is 3.9359, which suggests that the model holds well. Table 7 is a summary of the results from the ARDL tests.

Table 7
Long run relationship and diagnostics tests

This table reports the statistics on the long-run relationship between the variables. As shown in the table, only the two parity theories are statistically significant over long-run. This is in support of the studies conducted by parity factors. The diagnostics related to the model are shown at the bottom of the table.

NER	PPP	RIFE	TTRADE	CAGDP	PRODVTY	Intercept
DepVar	–0.893	4.586	–7.792	–0.160	0.000003	–0.270
	(–5.23)***	(1.95)*	(–1.09)	(–0.05)	(0.69)	(1.38)

Test	LM version	*p*-value	*F*-version	*p*-value
Serial Correlation	CHSQ(4) = 10.501	0.033**	(4, 197) = 2.5925	0.038**
Functionality	CHSQ(1) = 0.0009	0.976	(1, 200) = 0.0008	0.977
Normality	CHSQ(2) = 9.0478	0.011**		
Heteroskedasticity	CHSQ(1) = 3.4088	0.065**	(1, 208) = 3.4320	0.065**
	R-Squared = 0.9638		DW-Statistic = 2.02	

The model indicates that the R-squared value is very high (96.38%), indicating the extent to which the five factors explain the variation in the US–UK exchange rate. Both parity factors are significant, and one of the three non-parity factors is significant, while the other two are not significant. Compared to the results from the OLS regressions, the ARDL results display the correct signs for the two parity factors as well as the non-parity factors.

We find that the two parity variables (inflation from PPP and the relative interest rate from IFE) are strongly significant. Note that the PPP coefficient is close to –1 (–0.89), indicating a depreciation in the exchange rate, and the effect of the real interest rate in the IFE predicts an appreciating currency with a parameter equal to 4.59. These are excellent estimates, consistent with the higher impact of the IFE and the lower impact of the PPP on the nominal exchange rate.

In addition, note that, unlike in prior studies, we use the real interest rate by subtracting inflation from the interest rate in these tests. This is the only means of removing the confounding effect of using the nominal exchange rate as the IFE variable, as is common in some research. Specifying the nominal interest rate introduces the multicollinearity problem between inflation and the interest rate factors; hence, the test results would be biased. There is no serial correlation problem as indicated by the DW statistic of 2.02. The non-parity factors are all not significant, and the signs do not mean anything under this condition. In the long run, therefore, the control variables appear to be insignificant.

Thus, with the necessary data transformation and applying the appropriate modelling, we obtain *full support for parity theorems* (PPP and IFE). These results make sense and are also consistent with the results reported in a few carefully executed studies that support a long-run relationship largely for the IFE and PPP. The diagnostic tests and data specification in the correct manner are needed to obtain these results. The ARDL framework has been demonstrated to be robust against any symptom of serial correlation among the residuals. Thus, it can be noted that the presence of serial correlation does *not* impact the estimators as long as our concern is the ARDL (Laurenceson & Chai, 2003). The functionality test or the stability test is supported by its critical value. The heteroskedasticity and non-normality are natural under the ARDL approach, given that a combination of different orders of integration of variables is used.

Further results using the error correction version of the model are presented here to test if there is a long-run integration; for the time-to-equilibrium for the tested currency, see Table 8. This test is meant to identify the speed of adjustment for the variables on the exchange rate: The coefficient (lamda = λ on ECM) should be negative and significant for a long-run relationship to exist.

Table 8
Error correction representation for the US currency using ARDL model

dNER	dNER1	dPPP	dIFE	dTTrade	dCAGDP	dPRODTY	Intercept	ECM(-1)
–1.00	0.171	0.124	–0.639	8.801	0.022	–0.000053	0.037	–0.139
	(2.49)**	(3.13)***	(–2.05)**	(3.87)***	(0.05)	(–0.69)	(1.31)	(–3.83)***
	R-Squared = 0.168				DW-Statistics = 2.02			

The empirical results can be based on the re-parameterisation of the estimated ARDL (2, 0, 0, 1, 0, 0) model. According to these numbers, the lagged error-correction term (ECM) has the expected negative sign and is statistically significant at the 0.01% level. Kremers, Ericsson and Dolado (1992) report a significant error-correction term is rather efficient in establishing cointegration between variables. The lagged differences in the model are used to capture the short-term dynamics among the variables. The ECM of –0.139 is negative and significant and would suggest a speed of adjustment of more than one quarter of 13.9%. This would mean that the time-to-equilibrium for the US currency is approximately less than two years or seven quarters. The lag variables except two non-parity variables are significant at 0.05 or better probability levels. This supports a short-run dependence on past values. Now, we summarise the dynamics of the long-run relations in Figure 1.

This figure shows two plots of cumulative sum and cumulative sum of squared values of recursive residuals of the long-run relationship. The plots are within the bounds showing there is significant relationship in our tests.

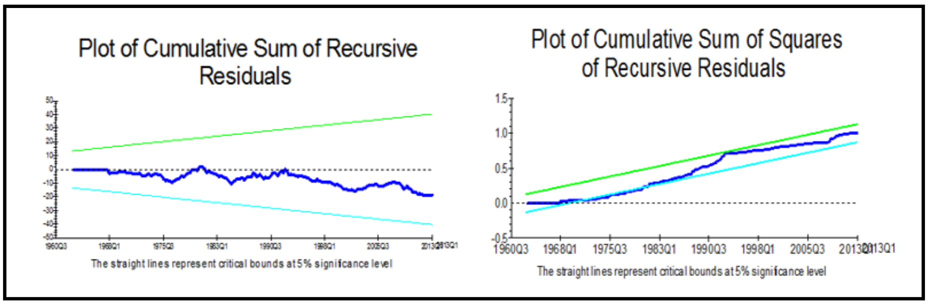

Figure 1. Plots of CUSUM and CUSUM-SQUARES values

The long-run relationship between the exchange rate and its determinants is further verified using the CUSUM and CUSUM-squared tests (Brown et al., 1975). We apply this test on the residuals of the model. The aim of the tests is to check for the consistency of long-run parameters. The outcome of each test is in terms of plots indicating the cumulative sum of recursive residuals and recursive squared residuals as a set of n observations. As a condition for the stability of the estimates, the CUSUM and CUSUM-squared should range within the 5% level of significance.

The data as indicated in the two figures fall within the specified range of acceptance (critical bounds), which is a requirement for this relationship to exist. Therefore, the plots reveal evidence to support a significant cointegrating relationship between exchange rates on the one side and the parity as well as the non-parity variables. This therefore confirms the existence of strong evidence in favour of the monetarist theorems on prices and interest rates, in our view, for the first time in a test using the ARDL approach.

CONCLUSION

In this paper, we explain how we proceeded to conceive a novel way to re-state the often-tested parity theorems, which form a part of the widely tested monetary economics theories. There are creative innovations in this paper. The reasons for this attempt are that there is only weak support to date for these theorems despite a great deal of studies and that the literature suggests that a more appropriate econometric approach is needed to reveal the underlying behaviour to resolve this puzzle. Our maintained hypotheses are that the relative prices (inflation) and relative interest rates of two trading economies are significant factors only if controls for non-parity factors are embedded in a properly specified full model with long-length time series. The US and UK data were used because long-length data are readily available for these economies. The methods used range from simple OLS and multiple regressions to the ARDL and bound testing, which, in our view, satisfy the search to reveal the long-length equilibrium.

The results reveal that both the PPP and IFE theorems are strongly supported, which is, in our view, a new finding that is clearly in support of the parity theorems for the SS currency against the UK pound sterling. Non-parity factors as hypothesised also significantly affect the US exchange rate, at least in some of the tests. The econometric tests to ensure compliance with the strict assumptions of the test model in this study, in our view, make these results reliable and robust. Perhaps the research process followed in this study is a new approach. This approach to exchange rate study may be useful for studying other economies to reveal whether there is clear evidence to support the relevance of parity theorems to economies other than that of the United States of America.

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REFERENCES

Andersson, J., & Lyhagen, J. (1999). A long memory panel unit root test: PPP revisited. *Stockholm School of Economics Working Paper*, 303.

Bahmani-Oskooee, M., Kutan, A. M., & Zhou, S. (2009). Towards solving the PPP puzzle: Evidence from 113 countries. *Applied Economics, 41*(24), 3057–3066.

Bergin, P., Glick, R., & Taylor, A. M. (2006). Productivity, tradability, and the long-run price puzzle. *Journal of Monetary Economics*, *53*(8), 2041–2066.

Brown, R. L., Durbin, J., & Evans, J. M. (1975). Techniques for testing the constancy of regression relationships over time. *Journal of the Royal Statistical Society. Series B* (Methodological), 149–192.

Calvo, G. A., Izquierdo, A., & Talvi, E. (2003). Sudden stops, the real exchange rate, and fiscal sustainability: Argentina's lessons (*Working paper no. 9828*). National Bureau of Economic Research. Retrieved from http://www.nber.org/papers/w9828

Canzoneri, M. B., Cumby, R. E., & Diba, B. (1999). Relative labor productivity and the real exchange rate in the long run: evidence for a panel of OECD countries. *Journal of International Economics, 47*(2), 245–266.

Cassel, G. (1918). Abnormal deviations in international exchanges. *The Economic Journal, 28*(112), 413–415.

Chan, T.-H., & Hooy, C.W. (2012). Malaysia–China in the liberalization era: Structural modelling of international parity conditions and transmission mechanism. *Global Economic Review, 41*(3), 259–277.

Cumby, R. E., & Obstfeld, M. (1981). A note on exchange-rate expectations and nominal interest differentials: A test of the Fisher hypothesis. *The Journal of Finance, 36*(3), 697–703.

Dickey, D. A., & Fuller, W. A. (1979). Distribution of the estimators for autoregressive time series with a unit root. *Journal of the American statistical Association, 74*(366), 427–431.

Dickey, D. A., & Fuller, W. A. (1981). Likelihood ratio statistics for autoregressive time series with a unit root. *Econometrica: Journal of the Econometric Society*, *49*(4), 1057–1072.

Dornbusch, R. (1976). Expectations and exchange rate dynamics. *Journal of Political Economy, 84*(6), 1161–1176.

Edison, H. J. (1987). Purchasing power parity in the long run: A test of the dollar/pound exchange rate (1890–1978). *Journal of Money, Credit and Banking, 19*(3), 376–387.

Edison, H. J., & Melick, W. R. (1999). Alternative approaches to real exchange rates and real interest rates: three up and three down. *International Journal of Finance & Economics, 4*(2), 93–111.

Edison, H. J., & Pauls, B. D. (1993). A re-assessment of the relationship between real exchange rates and real interest rates: 1974–1990. *Journal of Monetary Economics, 31*(2), 165–187.

Fisher, I. (1930). *The theory of interest*. New York: Macmillan.

Frankel, J. A., & Rose, A. K. (1996). Currency crashes in emerging markets: An empirical treatment. *Journal of International Economics, 41*(3), 351–366.

Frankel, J. A., & Rose, A. K. (1996). A panel project on purchasing power parity: Mean reversion within and between countries. *Journal of International Economics, 40*(1), 209–224.

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

Garratt, A., Lee, K., Hashem Pesaran, M., & Shin, Y. (2003). A long run structural macroeconometric model of the UK. *The Economic Journal, 113*(487), 412–455.

Hill, C. H. (Ed.). (2004). *International business: Competing in the global marketplace* (5th ed.). New York: McGraw-Hill.

Ho, C. S. F., & Ariff, M. (2012). Time to equilibrium in exchange rates: G-10 and Eastern European economies. *Global Finance Journal, 23*(2), 94–107.

Johansen, S., & Juselius, K. (1992). Testing structural hypotheses in a multivariate cointegration analysis of the PPP and the UIP for UK. *Journal of Econometrics, 53*(1–3), 211–244.

Kim, Y. (2000). Causes of capital flows in developing countries. *Journal of International Money and Finance, 19*(2), 235–253.

Kremers, J. J., Ericsson, N. R., & Dolado, J. J. (1992). The power of cointegration tests. *Oxford Bulletin of Economics and Statistics, 54*(3), 325–348.

Laurenceson, J., & Chai, C. (2003) *Financial reform and economic development in China*. Cheltenham, UK: Edward Elgar Publishing.

Levich, R. M. (2011). *Evidence on financial globalization and crises: Interest rate parity*. Finance Working Papers, New York University.

Levin, A. T., & Lin, C.-F. (1992). *Unit root tests in panel data: asymptotic and finite-sample properties.* Economics Working Paper Series, University of California at San Diego.

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

Lothian, J. R., & Taylor, M. P. (2000). Purchasing power parity over two centuries: Strengthening the case for real exchange rate stability: A reply to Cuddington and Liang. *Journal of International Money and Finance, 19*(5), 759–764.

Manzur, M., & Ariff, M. (1995). Purchasing power parity: New methods and extensions. *Applied Financial Economics, 5*(1), 19–26.

Marini, G., & Piersanti, G. (2003). *Fiscal deficits and currency crises.* CEIS Tor Vergata-Research Paper Series(15).

Mark, N. C. (1985). Some evidence on the international inequality of real interest rates. *Journal of International Money and Finance, 4*(2), 189–208.

Martínez, J. (1999). Mexico's balance of payments and exchange rates: a cointegration analysis. *The North American Journal of Economics and Finance, 10*(2), 401–421.

Meese, R., & Rogoff, K. (1988). Was it real? The exchange rate-interest differential relation over the modern floating-rate period. *The Journal of Finance, 43*(4), 933–948.

Mishkin, F. S. (1984). Are real interest rates equal across countries? An empirical investigation of international parity conditions. *The Journal of Finance, 39*(5), 1345–1357.

Mollick, A. V. (1999). The real exchange rate in Brazil Mean reversion or random walk in the long run? *International Review of Economics & Finance, 8*(1), 115–126.

Pesaran, M. H., & Shin, Y. (1997). An autoregressive distributed-lag modelling approach to cointegration analysis. *Econometric Society Monographs, 31*, 371–413.

Pesaran, M. H., Shin, Y., & Smith, R. J. (2001). Bounds testing approaches to the analysis of level relationships. *Journal of Applied Econometrics, 16*(3), 289–326.

Phillips, P. C., & Perron, P. (1988). Testing for a unit root in time series regression. *Biometrika, 75*(2), 335–346.

Rivera-Batiz, F. L., & Rivera-Batiz, L. A. (2001). International financial liberalization, capital flows, and exchange rate regimes: An introduction. *Review of International Economics, 9*(4), 573–584.

Rogoff, K. (1996). The purchasing power parity puzzle. *Journal of Economic literature, 34*(2), 647–668.
Shively, P. A. (2001). A test of long-run purchasing power parity. *Economics Letters, 73*(2), 201–205.
Throop, A. W. (1993). A generalized uncovered interest parity model of exchange rates. *Economic Review* (Vol. 2, pp. 3–16). San Francisco: Federal Reserve Bank of San Francisco.