Re-Examination of Exchange Rate Determinants using Non-Parity Factors

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Abstract

This paper reports new findings on exchange rate dynamics on how *non-parity* fundamental factors affect exchange rates in addition to the well-known yet controversial effects from two parity factors. The tests were done on two groups of trade-linked developed and emerging countries: G-10 and Latin America. Also, by systematically retesting the model with high and low frequency data sets, this study revealed both short and long run behaviour. Finally we use newer econometric methods including pooled time series panel regression to obtain robust results. The resulting evidence is: non-parity factors are significantly correlated with exchange rates after controlling for parity factor effects. This appears to suggest that future research should include powerful non-parity factors along with parity factors controlling intervalling and trade intensity effects.

Keywords: Exchange Rates, Parity Theorems, Productivity, Trade and Capital Flows, Sovereign Debt, Reserves, Growth, Monetary and Fiscal Policy.

JEL classification: F31, F32, C32, C33, C43

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1.0 Introduction

The motivation of this paper is to present findings on exchange rate behavior by including *new* factors suggested by careful search of economic theories to investigate exchange rate determination within *trade-linked* multi-country groups. Prior studies examining exchange rate behaviour between pairs of countries pay no attention to whether there exist any intensive trade-linkages among them. Intensity of trade conditions how the supply of and demand for a given currency translate as exchange rate changes, hence one should control trade intensity before testing for exchange rate behavior. G-10 and Latin American countries were selected on the basis of trade linkages to form two trade-related test groups. By testing the model across two contrasting groups, our tests provide good understanding of different behavior of the model in (i) developed and (ii) emerging economies. The results we report in this paper are new and should greatly amplify our current knowledge of exchange rate dynamics.

Interest in currency behavior has been rekindled in recent years because of the incompleteness of knowledge on exchange rate determination in the face of recurrent currency crises. This paper is thus motivated to address the concerns of leading researchers expressing increasing frustration over their failures to explain exchange rate movements (Dornbusch, 1987a; MacDonald and Taylor, 1992; Ho and Ariff, 2011). With rapid growth in trade and capital flows across national boundaries, newer key economic factors do exert dominant influences on foreign currency behavior (Harvey, 2001) but are not yet tested systematically. These factors are many, and include current account deterioration, excessive sovereign debt accumulation, capital flows, foreign currency reserves and fiscal imbalances: which have yet been systematically applied *together in one single study* while controlling for trade intensity. Additional factors that are viewed as affecting exchange rate include the following: economic growth; exchange rate regimes; and uncontrolled monetary expansion.

Findings reported here leads to a better understanding of long-run exchange rate. With better understanding of the workings of exchange rates, multinationals and government policies could be geared towards how non-parity fundamentals do significantly change a country's exchange rates because these factors work over long periods of time. Productivity or sovereign debt does affect exchange rates significantly as reported here. These findings have policy relevance.

The rest of the paper is divided into four sections. A brief overview of a judicious selection of a large literature is given in the next section. Section three is meant to provide description of the complex methodology and data set up. The findings are discussed in section four. This paper ends with a conclusion in section five.

2.0 Literature on Exchange Rate Determinants

The currency exchange market is the world's largest market with daily trade reported to be approximately US$4.0 trillion compared to US$3.3 trillion a year ago, which is much more than even the world's combined bond or stock markets.[1] Spot currency transactions account for 37 per cent (US$1.5 trillion) of total foreign exchange market turnover, yet models of parity conditions explain very little of the exchange rate variations in this spot market. Hence, the importance of such a market cannot be underestimated especially when one needs to know as to what factors *jointly* contribute to exchange rate changes. All we know is that exchange rates are determined in the long run by the two parity factors: price differences in traded goods and interest rate differences. There are many non-parity factors (for example productivity in Rogoff, 1999; MacDonald and Wojcik, 2003) which have yet been systematically tested jointly in a single study to reveal the effects of these factors.

2.1 Parity Theorems

The two parity theorems of exchange rates include the Purchasing Power Parity (PPP: Cassel, 1918) as well as the Interest Rate Parity (IRP: Fisher, 1930). The relative version of PPP suggests that, if a country's inflation rate is relatively higher than its trading partner country, that country will find its currency value falling in proportion to its relative price level increases, in the *long run*. The change in exchange rate E is a function of price differences, where j represents country, t represents time period, P represents prices, d domestic and f foreign as stated below:

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

PPP has been observed by researchers as a basis for international comparison of income and expenditures; as an efficient arbitrage condition in goods; and as a theory of exchange rate determination, although it explains little of the variation. The underlying theory is based on a simple goods market arbitrage argument but it ignores tariffs, transportation costs, and assumes common goods consumed to ensure identical prices across countries, under the *law of one price*. While this notion appears simple enough, specifying comparative prices between two countries in the short run is difficult. This has led to a majority of empirical literature failing to verify that PPP holds.[2]

[1] BIS report including Triennial Central Bank Survey of Foreign Exchange and OTC Derivative Market Activity in April 2010.

[2] Empirical work that has led to conflicting empirical findings on PPP includes MacDonald (1993), Rogoff (1996), Bayoumi and MacDonald (1999), Parsley (2007) and Cheng (1999). They have all found no clear evidence or at best, very weak relationship between inflation and exchange rates. Ho and Ariff (2010) using an appropriate GDP-weighted measure of exchange rate found evidence that price parity holds when controlled for trade intensity.

This theorem has been extensively tested by scholars. With the clear lack of evidence to support short run equilibrium and the observed high exchange rate volatility, it seems that the theory has failed to garner support in the 1970s and 1980s.[3] The obvious lack of evidence under the floating regimes since 1973 is perhaps a motivating force that led to the development of the sticky price idea by Dornbusch (1976). Methodologies applied in the last two decades, given the low power of unit root tests, researchers have often failed to reject the null hypothesis of random walk. Froot and Rogoff (1994), in a survey article, concluded that the theory is not a short run relationship and that prices do not offset exchange rate swings on a monthly or even annual basis. Frankel and Rose (1996a) examined it using a panel of 150 countries with data over 45 years and confirmed that the theory holds and their estimate implied a half-life of PPP deviations of four years: this suggests a long run relationship between prices and exchange rates. Similarly, Bahmani-Oskooee, Kutan and Zhou (2009) and Ho and Ariff (2008) also found significant relationship for group of countries in the long run.[4]

The law of one price in the asset market for securities is detailed by interest rate parity (IRP).[5] In theory, the foreign exchange market is in equilibrium if deposits of all currencies offer the same rate of return. A rise in interest rates, then, will attract more monetary investment flows via carry-trade into the country resulting in an appreciation of the currency in the short run and exchange rates should fall in the long run to restore equilibrium. According to the uncovered interest rate parity, the ratio of changes in exchange rate *E*, within a time period *t*, is a function of domestic interest rate i^d, and foreign interest rate i^f.

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

International Fisher Effect (IFE) implies that relative interest rate differences will give rise to exchange rate changes. The ability of exchange rate markets to anticipate interest differences is supported by several empirical studies that indicated a long run tendency for these differences to offset exchange rate changes.[6] How about *non-parity* factors, the focus of this research, and exchange rates?

[3] Henry and Olekaln's (2002) study on Australia found little evidence for long run equilibrium between exchange rate and prices: a surprising result. In a similar view, Adler and Lehman (1983) found that the deviations from PPP follow a random walk without reverting back to PPP-consistent values in 43 countries.

[4] Kuo and Mikkola (2001), Lothian and Taylor (2000), Mark and Sul (2001), Schnabl and Baur (2002) found considerable evidence for long run relation and concluded that fundamentals play a significant role in determining exchange rates. Such evidence have been reported in time-to-equilibrium studies cited in the paper.

[5] The interest rate theory was first developed by Keynes (1923) and Fisher (1930) through the introduction of Fisher effect for domestic interest rate theory.

[6] Studies providing evidence include Mark (1995) and, Hoffman and MacDonald (2003). These studies reported measures of long run expected changes in exchange rates as highly correlated with interest rate differentials.

2.2 Non-Parity Variables

The two parity theories reviewed so far with their strong assumptions of equal country risk and zero transaction costs, as well as no other factors entering the equilibrium, have long been maintained as the two premier theories on exchange rate determination. Some researchers pointed out, over the last two decades, that there are other variables which are correlated with exchange rate movements.[7] Inclusion of these variables could shed new light, and also may assist in identifying potential other-than-parity-factor explanations to understanding exchange rate behavior. Despite the fact that parity explanations have gained centre stage up until about the 1980s in exchange rate behavior research, recent years have witnessed interests in other explanations, given the conflicting empirical evidence on parity theories.

2.2.1 Current and Capital Account Deterioration

Exchange rate determination has been linked only to parity conditions as in Cassel (1918), Keynes (1923) and Fisher (1930), or trends in productivity as in Balassa (1964) and Samuelson (1964): so productivity is an important non-parity factor. Studies of financial crises in Latin America and East Asia have been motivated by an interest in the roles of banking, and balance of payments. The trade and capital balances are known to be most sensitive to exchange rate changes. For currencies affected by the 1997/8 Asian financial crisis, the reversal of capital flows, and the resulting current account deficits (along with pre-existing high sovereign debt) have been shown as common non-parity factors in that crisis. Therefore these variables should have tremendous impacts on exchange rates.[8]

Karfakis and Kim (1995) using Australian exchange rate data found that unexpected current account deficit is associated with exchange rate depreciation, and a rise in interest rates. Evidence is found that current account deficits diminishes domestic wealth, and may lead to overshooting of exchange rates. A fall in the real value of currency was also reported by Obstfeld and Rogoff (1995), Engel and Flood (1985), and Dornbusch and Fisher (1980). There has also been a surge and collapse in international capital flows into developing countries in the recent decades.[9] Sudden outflow of capital is another major concern when it can drastically affect exchange rates as were witnessed during several financial crises of Brazil, East Asia, and

[7] Frankel and Rose (1996b) on current account and government budget deficits; Calvo, Leiderman and Reinhart (1994) on capital flows, inflation and current account deficits; and Aizenman and Marion (2002) on reserve and credibility; recently papers on fundamentals effect on exchange rates include Ho and Ariff (2009a), Ehrmann and Fratzscher (2005), and many others.

[8] It is documented that the currency crises in recent decades were due to vast changes in these variables: see Kim (2000).

[9] Gross foreign direct investment as a percentage of GDP increased more than 100 percent for Korea, the Philippines and Indonesia during 1990-2001. Net private capital flows into six developing regions in the world totalled US$167.976 million in 2001. Source: *2003 World Development Indicators*, database, World Bank, 13 April 2003.

Mexico. These capital outflows affect domestic output, real exchange rates, capital and current account balances for years after the crises.[10]

Portfolio investments have increased in recent years due to greater access to capital markets via newer more open regulations, reduced capital controls and the overall globalization of financial services.[11] Calvo, Izquierdo and Talvi (2003) blamed the fall of Argentina's currency on the country's vulnerability to sudden stops in capital flows. A study by Kim (2000) on four countries that faced currency crises found that reversal of capital flows as well as current account deficits are significantly related to currency crises in those countries. Rivera-Batiz and Rivera-Batiz (2001) concluded that explosion of capital flows resulted in higher interest rates and depreciation of exchange rates in the long run.

2.2.2 Loss of International Reserves and Excessive Foreign Currency Debt

The amount of international reserves held by the central authority is another factor affecting exchange rate determination.[12] Due to the usage of reserves as a means to defend a country's currency (so it creates imbalances in world economies) it provides credibility to the value of the currency. This suggests that reserves and the type of currency exchange regime (managed float) are likely to affect exchange rates. Changes in reserves and foreign currency debt indirectly affect the public's perception of the value of a country's currency[13].

Marini and Piersanti's (2003) study covering Asian countries found that a rise in current and expected future budget deficits generated appreciation in exchange rates and a decumulation of external assets, resulting in a currency crisis when foreign reserves fell to a critical level. Calvo, Leiderman and Reinhart (1994) showed that increase in capital inflows increase total reserves and real exchange rates of Lain American countries. Hsiao and Hsiao (2001) found a unidirectional causality from short-term external debt/international reserves ratio to exchange rates in Korea. Similar to Martinez (1999) on Mexico, Frankel and Rose (1996b) studied a large group of developing countries and found that the level of debt, foreign direct investment, foreign interest rates, foreign reserves and growth rates affect exchange rates significantly.

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[10] Studies on capital flows using output, exchange rates and balance of payments include Kim (2000) and Calvo and Reinhart (2002).

[11] Portfolio investment inflows have increased from RM19,346 (US$7,620) millions in 1991 to a peak of RM238,454 (US$93,880) millions in 1994 in Malaysia. Source: Bank Negara Malaysia and Department of Statistics, Malaysia. Portfolio investment across the world averaged US$102 billion in 1995-96 and US$26 billion during 1997-2000 according to World Economic Outlook, 2003, IMF.

[12] Korea's usable reserve fell from US$28 billion to a mere US$6 billion when their currency went on a free fall in December 1997: Aizerman and Marion (2002). Brazil's reserves fell from US$75 billion to less than half of that before the currency collapsed in 1998: Dornbusch and Fisher (2003).

[13] Total external debt for six developing regions in the world according to World Bank classification amounted to US$2,332,621 millions in 2001. Source: *2003 World Development Indicators*, World Bank.

2.2.3 Trade Openness, Growth, Fiscal Imbalances, Excessive Monetary Expansion and Exchange Rate Regime

Globalization has resulted in domestic financial markets being more integrated with international markets. Open economy's domestic interest rates tend to reflect not only domestic conditions but also international conditions such as prevailing world interest rate, after allowing for currency risk: see Edward and Khan (1985) and Ariff (1996). Open economies facing capital flows, competitive interest rates and trade competition from others lead to a defined relationship between openness and the rate of growth in some countries,[14] Karras (1999), Papell and Theodoridis (1998) studied openness, exchange rates and prices: they found stronger evidence to support PPP in countries with less exchange rate volatility and shorter distance from other countries. Greater openness is a negative factor currency stability, according to them.

Among the many models found in the literature to explain long-term deviations from theory, the most popular one is from Balassa (1964) and Samuelson (1964). Both agued that technological progress has historically been faster in the traded goods sector than in non-traded goods sector and therefore traded goods productivity bias is more obvious in higher income countries. Froot and Rogoff (1994) and Rogoff (1999) further showed that faster growing countries would tend to experience exchange rate appreciation (example Brazil, India and China in the 2000s) relative to their slower growing partners when technological changes happen more often in trading goods sector as a result of intense international competition.

Using a panel of OECD countries, Canzoneri, Cumby and Diba (1999) found that when relative productivity of traded goods grew more rapidly in Italy and Japan than in Germany, both lira and yen appreciated in real terms against Deutschemark. Other studies that provided support for productivity explanation for long-run real exchange rate movements includes Ho and Ariff (2009b), Chinn (2000) and Cheung, Chinn and Pascual (2003) who found that productivity model works well for the mark-yen exchange rates but the same conclusion cannot be applied to all others.

MacDonald and Wojcik's (2003) study on EU accession countries found that productivity, as well as private and government consumption significantly affect exchange rate behaviour. In contrast with Edwards and Savastano (1999), Bailey, Millard and Wells (2001) found that increased labour productivity in the US resulted in current account deficits that are financed by large capital inflows, which appreciated the dollar exchange rates.

Since the breakdown of the fixed Bretton Woods monetary system, exchange volatility has drastically increased to levels that are beyond the explanation of parity factors and possibly also

[14] Karras and Song (1996) investigated 24 OECD countries with data over thirty years and found positive relationship between output volatility, economy's trade openness and exchange rate flexibility.

other factors.[15] Grilli and Kaminsky (1991) concluded that real exchange rate changes substantially across historical periods but not necessarily across exchange rate regimes. Calvo and Reinhart (2002) examined thirty-nine countries and found that moderate to large exchange rate fluctuations are very rare in managed float systems. Other studies that found similar results include Moosa and Al-Loughani (2003) and Edwards (2002) who explained that super-fixed regimes were highly inflexible and inhibited adjustment process.

3.0 Data, Methodology and Summary Statistics

3.1 Data

The exchange rate data are the US dollar rate against the other G-10 and Latin American countries (IFS line rf) as the foreign unit as observed at the end of observation periods. This study includes countries in two trade-related regions: nine countries in the G-10 region with data over 25 years and seven countries in the Latin America region, data over 15 years. The *International Financial Statistics* (IFS) CD-ROM is the major source for these data. Price variables include CPI (IFS line 64) of individual countries; T-Bill and Money market rates (IFS line 60) are used to arrive at the interest differentials between countries. Changes in exchange rates, prices and interest differentials are calculated using natural logarithm.

Parity Variables: Consumer Price Index (CPI) measures prices of a basket of goods available in each country. Wholesale Price Index (WPI) measures the wholesale price of a basket of the country's goods. It is believed that the latter is a better proxy when countries do engage in market intervention to gain advantage in trade. The proxy used to test *interest* parity is the domestic short-term money market interest rate, depending on the availability of data from each country, all of which closely reflect interest rate movements. US short term Treasury-bill rate is the foreign interest rate for measuring interest differentials between countries.

Non-Parity Variables: The non-parity current and capital flow variables include: trade balance (Trade) from imports and exports of goods, current account balance (Cur), balance of payments (BOP) from overall balance, capital flows include both inflows and outflows of foreign direct investment (FDI) and portfolio investments (Pt), total reserves (TRes) as well as foreign debt (FD). Monetary expansion data is broader money (M2) which includes both money and quasi-

[15] Reviewing the US experience with flexible exchange rates, Dornbusch (1987b) found that changes in exchange rates during a fifteen-year period are *in*consistent with any explanations in theory and may not be related to fundamentals.

money. Growth rate (Prodty) is measured by change in Gross Domestic Product (GDP) per capita. The set of dummy variables includes exchange regimes which are grouped into three categories: free-float, exchange band/managed, and fixed regime. Trade openness is measured by total trade (TTrade), that is, the sum of total imports and exports, as a proportion of GDP. Complete data are sourced from DataStream, World Bank as well as individual country's Central Banks and Statistical Departments. The independent variables are categorised into parity and non-parity variables. A summary of variable definitions and their expected signs are found in Table 1.

Table 1: Variable Specification, Definitions and Expected Signs

No.	Variable	Definition	Expected Sign
1.	LnER	Log difference of Exchange Rate over time periods	
2.	LnP	Log difference of Prices over time periods	+
3.	LnI	Log difference of Interest Rate over time periods	+
4.	Trade/GDP	Trade Balance / Gross Domestic Product (GDP)	-
5.	Cur/GDP	Current balance / GDP	-
6.	BOP/GDP	Balance of Payment / GDP	-
7.	TRes/M	Total Reserve / Total Import	-
8.	FD/GDP	Foreign Debt / GDP	+
9.	InFDI/GDP	Inflows of Foreign Direct Investment / GDP	-
10.	OutFDI/GDP	Outflows of Foreign Direct Investment / GDP	-
11.	InPt/GDP	Inflows of Portfolio Investment / GDP	-
12.	OutPt/GDP	Outflows of Portfolio Investment / GDP	-
13.	Bdgt/GDP	Budget Deficit or Surplus /GDP	-
14.	TMy/GDP	Total Money (M2) / GDP	+
15.	Prodty	Gross Domestic Product / Total Population	-
16.	TTrade/GDP	Total Exports and Imports / GDP	-
17.	Regime	Exchange Regime	+ or -

The sample in this study includes nine countries in the G-10 region: Canada, France, Germany, Italy, Japan, Netherlands, Sweden, Switzerland, the U.K. and seven countries in the Latin American region: Argentina, Chile, Colombia, Ecuador, Mexico, Peru and Venezuela shown in Table 2. The reasons behind the choice countries are the high level of inter-trade between countries in the similar geographical region and the availability of information with these nations.

Table 2: Data Length for the Regions of Countries

Region	G-10	Latin America
No. of countries	9	7
Quarterly	1974:1 – 1998:4	1991:1 – 2006:1
Yearly	1974 – 1998	1991 - 2005

3.2 Methodology

Pooled Data Panel Model: Seemingly unrelated regression (SUR) and fixed effect (FE) pooled data model are used to investigate exchange rate behavior. SUR allows cross-sectional variations in the data set, and thus yields robust estimates of the test statistics according (Zellner, 1962). As a system of equations, this method can be applied rather than estimating the equation in one cross section, which would be wasteful as it would leave out information in the data set besides also introducing errors via the error term. SUR is estimated using generalised least squares algorithm. Since SUR technique utilizes information on the correlation between the error terms, the resulting estimates are more precise than estimates from least squares: it also yields lower standard errors and higher R^2.

More recent studies have also concentrated on longitudinal data set. These panel data sets are more oriented toward cross-sectional analyses. Panel data provides a richer environment for the development of estimation techniques with robust test results. It allows the use of time-series cross-sectional data to overcome deficiencies that could not be handled in either cross-section or time-series setting alone. By allowing cross-sectional variation or heterogeneity to affect parameter estimation, the resulting estimates are robust. We use the fixed effect approach here because it permits the constant term to be the country-specific variations in the regression as stated in Greene (2003). This is referred to as the least squares dummy variable (LSDV) model. The random effect model is not appropriate for our tests. We also assume that the issue of ambiguous relationship may be minimised through the use of instrumental-variables (IV) regression. The Hausman (1978) test statistics proposed by Davidson and MacKinnon (1993) for endogeneity is applied.

In summary, the analysis of the determinants of exchange rates is carried out by estimating the pooled regression parameters in the model that follows:

$$\begin{aligned}\ln ER_{jt} = {} & a'_{0}D_j + a'_{1j}\ln\left(\frac{P}{P*}\right)_{jt} + b'_{1j}\ln\left(\frac{I}{I*}\right)_{jt} + c'_{1j}\left(\Delta Trade/GDP\right)_{jt} + c'_{2j}\left(\Delta Cur/GDP\right)_{jt} + \\ & c'_{3j}\left(\Delta BOP/GDP\right)_{jt} + c'_{4j}\left(\Delta InFDI/GDP\right) + c'_{5j}\left(\Delta OtFDI/GDP\right) + c'_{6j}\left(\Delta InPt/GDP\right)_{jt} + \\ & c'_{7j}\left(\Delta OtPt/GDP\right)_{jt} + c'_{8j}\left(\Delta FD/GDP\right) + c'_{9j}\left(\Delta T\,\mathrm{Re}s/GDP\right) + c'_{10j}\left(\Delta \mathrm{Pr}odty\right)_{jt} + \\ & c'_{11j}\left(\Delta Bdgt/GDP\right)_{jt} + c'_{12j}\left(\Delta TTrade/GDP\right)_{jt} + c'_{13j}\left(\Delta TMy/GDP\right)_{jt} + c'_{14j}(\mathrm{Re}gime)_{jt} + v'_{ij}\end{aligned} \tag{3}$$

The subscript *j* represents a country in the sample, while *t* denotes the number of time periods (quarterly, yearly, two yearly and so on respectively). The fixed effect approach allows the constant term to vary from one cross-section unit to another (the LSDV model). This helps to control for unobserved components of country heterogeneity (through having country-specific constant terms) that may in fact drive both exchange rates and other country characteristics included in the regressions.

Table 3: Non-Parity Variables VIF and Tolerance Measure

Variables	G-10		Latin America	
	VIF	Tolerance	VIF	Tolerance
LNP	1.849	0.541	1.302	0.768
LNI	1.253	0.798	1.280	0.781
Trade/GDP	3.351	0.298	6.691	0.149
Cur/GDP	3.319	0.301	7.730	0.129
BOP/GDP	1.536	0.651	7.275	0.158
InFDI/GDP	1.629	0.614	1.088	0.919
OutFDI/GDP	1.660	0.603	1.097	0.911
InPt/GDP	1.154	0.867	5.838	0.163
OtPt/GDP	1.099	0.910	1.249	0.800
TRes/IM	1.570	0.637	1.245	0.803
Bgt/GDP	1.157	0.864	1.271	0.787
TMy/GDP	1.344	0.744	1.448	0.691
PROD	2.178	0.459	1.091	0.916
FD/GDP	1.230	0.813	1.197	0.836
TTrade/GDP	1.838	0.544	1.481	0.675
Regime	1.649	0.606	1.184	0.845

* VIF values of more than 10 shows significant multicollinearity.

Table 4: Unit Root Tests for Parity and Non-Parity Variables for G-10 and Latin America Countries

Variables	G-10			Latin America		
	ADF Test		ADF Test	ADF Test		ADF Test
	t-stats	t-stats	t-stats	t-stats	Model (lag)	KPSS statistic
lnER	-14.71***	-16.49***	-16.49***	-16.49***	C(0)	0.772***
lnP	-3.53***	-2.99**	-2.99**	-2.99**	None	0.119
lnI	-6.50***	-10.73***	-10.73***	-10.73***	C(0)	0.111
Trade/GDP	-8.98***	-9.70***	-9.70***	-9.70***	C(19)	0.494**
Cur/GDP	-14.68***	-9.67***	-9.67***	-9.67***	C(15)	0.259
BOP/GDP	-22.25***	-9.62***	-9.62***	-9.62***	C(2)	0.122
InFDI/GDP	-4.76***	-11.49***	-11.49***	-11.49***	C(10)	0.102
OutFDI/GDP	-20.70***	-6.33***	-6.33***	-6.33***	C(19)	0.038
InPt/GDP	-20.73***	-9.62***	-9.62***	-9.62***	C(20)	0.029
OutPt/GDP	-4.13***	-7.91***	-7.91***	-7.91***	C(18)	0.015
TRes/IM	-8.47***	-9.44***	-9.44***	-9.44***	C(0)	0.214
Bdgt/GDP	-14.88***	-21.20***	-21.20***	-21.20***	C(7)	0.087
TMy/GDP	-10.57***	-5.84***	-5.84***	-5.84***	C(0)	0.069
Prodty	-3.83***	-5.61***	-5.61***	-5.61***	C(11)	0.082
FD/GDP	-12.99***	-8.40***	-8.40***	-8.40***	C(3)	0.098
TTrade/GDP	-10.14***	-8.02***	-8.02***	-8.02***	C(11)	0.069

Critical values for ADF tests at 10,5 and 1% levels of significance are respectively, -2.59, -2.90 and –3.53 with a constant and –3.17, -3.48 and –4.09 with a constant and a deterministic trend. Critical values for KPSS tests at 10, 5 and 1% levels of significance are respectively, 0.35, 0.46 and 0.74 with a constant and 0.12, 0.15 and 0.22 with a constant and a linear trend.

Note: For the ADF tests, the unit root null is rejected if the value of the ADF t-statistics is less than the critical value. For the KPSS tests, the null of stationarity is rejected if the value of the KPSS statistic is greater than the critical value. *, ** and *** denote statistical significance at 10, 5 and 1% level. The critical values for the ADF tests are from MacKinnon (1991).

Common problems faced in cross-sectional and time series analysis are non-normality of variables, nonstationarity of time series data, multicollinearity among criterion factors,

autocorrelation and heteroscedasticity. Multicollinearity reduces any single independent variable's predictive power by the extent to which it is associated with the other independent variables. It can be detected using Variance Inflation Factor (VIF) that shows how the variance of an estimator is inflated by the presence of multicollinearity in Table 3 (Hair *et al.*, 1998). Variables with larger VIF values or low tolerance level are excluded: alternatively highly collinear variables may be joined in some transformation of the series.

The normality of all the variables will be tested to ensure multivariate normality and this is further ensured by specifying the variables in natural logarithms while stationarity of the series is tested and confirmed by Augmented Dickey-Fuller (ADF) unit root test and the Kwiatkowski, Philips, Schmidt and Shin (KPSS) Test reported in Table 4. The presence of heteroscedasticity is detected by White's test using Eviews software. To ensure that the assumption of constant variance is not violated, the heteroscedasticity and autocorrelation problems are tested and corrected.

4.0 Are Non-Parity Factors Correlated with Exchange Rate Changes?

4.1 G-10 Developed Countries

The results from SUR and fixed effect models for the G-10 developed countries are summarized in Table 5. There is no significant evidence of price parity even up to three-year intervals: even the sign of the results are inconsistent with theory. It can be attributed to exchange rates adjustments to price changes which are slow (sticky) and that the adjustment period is out of the range of this study. Interest parity is holding at three-year intervals when interest rate difference is negatively related as predicted with domestic exchange rates. The effect is statistically significant at the 10 per cent level in SUR and marginally significant too for the fixed effect model.

With the longer term of two and three-year intervals, fixed effect and SUR models shed more light in explaining exchange rate behaviour. Those non-parity fundamental factors, which are significant in the short term (quarterly intervals), include accumulation of reserves, accumulation of foreign debt, growth rate and monetary expansion. Growth rate is a significant driver of exchange rates for developed country group as it is statistically significant not only in the shorter period (t-statistic of -7.76 in one-year interval) but also in the longer period (t-statistic of -3.78 in four-year interval). An increase in GDP almost always leads to improvement in the domestic currency value, a result consistent with theoretical beliefs, which statistics is statistically significant throughout the different time intervals.

Total reserve is another significant determinant of changes in exchange rates, where increase in reserves improves the credibility of the domestic currency.

Table 5: SUR and Fixed Effects Results for G-10 Developed Countries

Developed Countries		Quarterly SUR♣♦	Fixed effects♠#	Yearly SUR♣♦	Fixed effects♠#	2 Yearly SUR♣♦	Fixed effects♠#	3 Yearly SUR♣♦	Fixed effects♠#
Observation		222	222	175	175	86	86	72	72
Intercept		.013	.016	.049	.036	.114	.124	.180	.067
		(3.14)*	(5.69)*	(5.76)*	(1.58)	(5.52)*	(2.03)**	(5.31)*	(1.02)
Parity	Price	-.029	-.026	-.078	-.096	-.122	-.160	-.207	-.247
		(-2.75)*	(-1.52)	(-5.59)*	(-4.04)*	(-3.76)*	(-3.27)*	(-4.70)*	(-5.08)*
	Interest	-.093	-.155	.023	-.113	.070	-.192	.671	.761
		(-1.49)	(-2.14)**	(0.18)	(-0.61)	(0.22)	(-0.40)	(1.67)***	(1.49)
Non-Parity	Trade/GDP	.099	.164	-.204	.536	.547	.745	-.265	-.560
		(0.47)	(0.75)	(-0.50)	(0.90)	(0.72)	(0.66)	(-0.27)	(-0.61)
	BOP/GDP	.117	.126	-.274	-.226	-.389	.477	1.098	1.098
		(1.46)	(1.28)	(-1.15)	(-0.89)	(-0.86)	(0.81)	(1.32)	(1.49)
	Cur/GDP	-.060	-.099	-.193	-.669	-1.109	-1.387	.305	.260
		(-0.38)	(-0.56)	(-0.57)	(-1.23)	(-1.68)***	(-1.15)	(0.31)	(0.25)
	InFDI/GDP	.123	.136	.072	.223	-.514	-1.002	1.044	.106
		(1.24)	(1.60)	(0.24)	(0.75)	(-0.81)	(-1.83)***	(0.72)	(0.09)
	OutFDI/GDP	-.062	-.065	-.098	-.028	-.923	-.793	-.497	-.895
		(-0.69)	(-0.80)	(-0.33)	(-0.08)	(-1.93)***	(-1.06)	(-0.36)	(-0.83)
	InPt/GDP	-.002	-.008	-.142	-.196	-.289	-.815	.575	.620
		(-0.06)	(-0.31)	(-0.95)	(-1.34)	(-0.90)	(-2.06)**	(1.15)	(1.42)
	OutPt/GDP	.002	.006	.160	.312	.213	.603	1.195	1.249
		(0.06)	(0.34)	(1.12)	(1.85)***	(0.65)	(1.59)	(1.57)	(1.75)***
	TRes/Im	-.109	-.118	-.201	-.263	-.314	-.455	-.231	-.275
		(-4.12)*	(-3.18)*	(-2.40)**	(-2.56)*	(-2.51)**	(-1.75)***	(-1.51)	(-1.88)***
	ForDt/GDP	.105	.096	-.115	-.168	.163	.960	-	-
		(1.80)***	(1.20)	(-0.76)	(-0.63)	(0.43)	(1.25)		
	Prodty	-188.214	-188.614	-34.213	-37.049	-39.347	-41.486	-34.091	-32.357
		(-19.86)*	(-15.86)*	(-14.56)*	(-7.76)*	(-8.81)*	(-4.45)*	(-5.69)*	(-3.78)*
	Bdgt/GDP	-.019	-.027	.249	.358	.312	.447	.171	.263
		(-0.52)	(-0.75)	(1.69)***	(1.35)	(1.05)	(1.19)	(0.39)	(0.57)
	TMy/GDP	-.025	-.032	-.209	-.252	-.126	-.163	-.120	-.105
		(-2.41)**	(-2.10)**	(-3.87)*	(-3.58)*	(-1.68)***	(-1.82)***	(-1.01)	(-1.26)
	Regime	-.001	-.002	-.001	.014	-.002	.009	-.008	.070
		(-0.40)	(-0.61)	(-0.09)	(0.87)	(-0.18)	(0.20)	(-0.36)	(1.42)
	TTrade/GDP	-.014	-.026	-.158	-.203	-.341	-.357	-.591	-.630
		(-0.34)	(-0.57)	(-2.33)**	(-1.74)***	(-3.26)*	(-2.37)**	(-4.47)*	(-6.12)*
	Adj R^2	0.792	0.811	0.792	0.811	0.802	0.804	0.797	0.779
	F-prob	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

♣Pooled General Least Squares with Cross-section SUR that estimates a feasible GLS specification correcting for both cross-section heteroscedasticity and contemporaneous correlation. ♠Fixed effects Pooled GLS with cross section weights where Eviews estimates a feasible GLS specification assuming the presence of cross-section heteroscedasticity. #With White's cross-section standard errors & covariance correction by treating pooled regression as a multivariate regression with an equation for each cross section and computing White-type robust standard errors for the system of equations. ♦With cross-section SUR (PCSE) using Panel Correlated Standard Error methodology standard errors & covariance correction. Numbers in parentheses are t-statistics. *, **, *** represent 1%, 5%, 10% significance level respectively. F-prob represents F-probability values and Adj R^2 represents adjusted R-squared values.

Even after taking into consideration different country effects in the fixed effects model, it is still statistically significant for the group for all interval time periods in the study

The findings from SUR and fixed effect models show significance of trade openness in the longer term (t-ratios of -4.47 and -6.12 for SUR and fixed effects respectively at four-year intervals) confirming that openness to trade brings positive long run benefits to this group of developed countries by strengthening their currencies. As these countries are more open to international trade, their exchange value also improves, which is directly opposite to the results for developing countries which are far more dependent on imports of capital goods.

Monetary expansion has positive effect on exchange rates which is not in line with the monetarists' belief. In the shorter period of quarterly to one-year intervals, increases in money supply actually lead to significant improvements in currency values. This is however not as significant as the time period lengthens: so it is a short run factor. Thus positive monetary effects on exchange rates may only be felt in shorter term, and not necessary in the longer period, perhaps providing evidence of good monetary targeting by regulators.

In the longer term for this region of developed G-10 countries, growth rate, accumulation of reserves and trade openness are non-parity factors, which continue to be statistically significant in determining exchange rates. Findings from both models also include capital flows and current account balance, which are significant in two-year intervals. The coefficient for foreign debt accumulation is only significant at quarterly interval (t-statistic of 1.80) in the very short run and not in other time periods.

The adjusted R-squared values for the models are all above 78 per cent indicating that more than seventy-eight per cent of the changes in exchange rates can be explained by these models, a notable improvement over reported studies using parity theories. Moreover, the probabilities for F-ratio of these results are generally very low and this also indicates that there is good overall model fit. In summary, non-parity factors, namely growth rates, accumulation of reserves, monetary expansion, trade openness, capital flows and current account balance are significant drivers that are correlated with the changes in exchange rates for this group of developed countries.

4.2 Latin America

From the results of quarterly, and one to three-year intervals for the Latin American region of countries summarised in Table 6, the coefficient for price parity coefficient is statistically significant and of the expected sign for quarterly and one-year interval: price parity holds in short run, a result that is consistent with the short time to equilibrium in a less sticky trade regimes. After taking into account individual country effects in the fixed effect model, price parity holds in this region even in short period. This shows that price changes are more closely monitored and exchange rates are very responsive to price changes in these countries which

faced exceptionally high inflation. Interest parity is also holding in this region of countries and it may be due to the vulnerability of these countries to large fluctuations in prices and interest, and therefore exchange rates adjust quickly to changes in both.

The role of non-parity fundamentals cannot be ignored both in the short as well as in the longer term. The set of non-parity factors, which are driving exchange rates in the shorter term includes growth rates, monetary expansion and trade openness. Findings from SUR and fixed effect models identify: foreign direct investment outflows; and regime shifts (quarterly intervals) which are inversely related to changes in domestic exchange rates. Increase in outflow of capital reduces the domestic currency value and when exchange rate regimes become more flexible, the domestic currency value falls. This indicates turbulent times when exchange rates generally slide downwards. This is consistent with the theoretical understanding that, when these countries allow exchange rate to be determined through much more open market mechanism, it is also the time when authorities are not able to defend them any more resulting in the currency crisis in the region.

In the longer run, trade and portfolio flows, accumulation of reserves, government foreign borrowings and exchange rate regime emerge as significant determinants of exchange rates. It is not surprising to find that. For developing countries depend heavily on international trade, so we find the coefficient for trade is statistically significant (t-statistic of -4.48 at two-year intervals) and also have the expected signs. Improvement in trade balance actually improves currency value. Portfolio investment inflow is positively related to changes in domestic currency value and is statistically significant for two-year intervals (t-ratio of -4.63).

Accumulation of reserves strengthens credibility of a currency and so it is statistically significant at two-year intervals (t-statistic of -2.26). Excessive foreign borrowing by government is inversely related to changes in domestic exchange rates: the coefficient is statistically significant at two-year intervals. The coefficient for exchange regime is statistically significant (t-ratio of 4.64) at two-year intervals, again signalling the eventual inability of governments to defend their exchange rates under crisis situation thus allowing currencies to float to determine their own values.

The other non-parity fundamentals include trade openness, and monetary expansion. Surprisingly growth rates are not significant determinants of exchange rates in the longer term for this group of developing countries. The adjusted R-squared values for the models are almost all above 70 per cent indicating that more than seventy per cent of changes in exchange rates can be explained by these models. The F-ratio of these results are relatively low indicating good overall model fit.

In summary, parity fundamentals are more important determinants of exchange rates in this region of developing countries in Latin America. Moreover, non-parity fundamentals including

Table 6: SUR and Fixed Effects Results for Latin America

Latin America		Quarterly		Yearly		2 Yearly		3 Yearly	
		SUR♣♦	Fixed effects♠#	SUR♣♦	Fixed effects♠#	SUR♣♦	Fixed effects♠#	SUR♣♦	Fixed effects♠#
Observation		142	142	40	40	27	27	21	21
Intercept		.010	-.005	-.230	-.174	.261	-.231	.738	-.568
		(2.46)**	(-0.25)	(-1.63)	(-1.40)	(0.55)	(-0.97)	(0.61)	(-0.66)
Parity	Price	.016	.012	.087	.135	-.757	-.956	.038	-.125
		(2.95)*	(1.69)***	(1.67)	(2.23)**	(-2.53)**	(-4.29)*	(0.07)	(-0.18)
	Interest	.036	.074	3.357	3.564	1.000	-3.818	10.812	11.570
		(0.86)	(1.21)	(9.04)*	(7.31)*	(0.41)	(-1.75)	(2.52)*	(1.26)
Non-Parity	Trade/GDP	-.033	.038	8.454	9.006	-22.519	-36.881	-36.431	-90.325
		(-0.08)	(0.09)	(1.98)***	(1.54)	(-1.75)	(-4.48)*	(-2.19)***	(-3.30)
	BOP/GDP	-.060	-.084	.213	1.635	12.544	15.629	14.390	36.043
		(-0.92)	(-1.50)	(0.14)	(0.92)	(2.19)**	(5.89)*	(1.91)***	(3.34)
	Cur/GDP	.670	.550	-8.047	-9.544	15.337	29.072	37.857	77.016
		(1.84)***	(1.39)	(-1.88)***	(-1.59)	(1.09)	(5.57)*	(2.35)**	(3.38)
	InFDI/GDP	.115	.074	-.576	-.435	5.282	4.537	1.554	31.834
		(0.87)	(0.55)	(-0.41)	(-0.26)	(0.56)	(1.31)	(0.17)	(3.30)
	OutFDI/GDP	-1.186	-1.015	-.636	10.457	-	-	-	-
		(-1.91)***	(-1.31)	(-0.11)	(1.80)***				
	InPt/GDP	.062	.081	.861	-1.214	-20.216	-25.397	3.975	-4.480
		(1.02)	(1.56)	(0.65)	(-1.56)	(-2.29)**	(-4.63)*	(0.39)	(-1.18)
	OutPt/GDP	-.037	-.144	-.939	-.445	-4.200	4.436	-	-
		(-0.15)	(-0.43)	(-0.55)	(-0.23)	(-0.44)	(0.41)		
	TRes/Im	.008	.016	-.412	.391	-1.420	-2.391	2.784	-3.681
		(0.52)	(0.94)	(-0.89)	(1.15)	(-0.98)	(-2.26)***	(0.70)	(-1.35)
	ForDt/GDP	-.127	-.155	-7.467	-6.382	21.656	50.566	-	-
		(-0.63)	(-0.63)	(-1.96)***	(-1.04)	(1.50)	(4.31)*		
	Prodty	-28.103	-28.846	-54.710	-463.922	207.573	80.602	187.853	1011.020
		(-12.48)*	(-7.25)*	(-0.47)	(-2.19)**	(1.04)	(0.27)	(0.41)	(2.11)
	Bdgt/GDP	-.018	-.044	3.086	1.730	1.922	-3.682	4.130	40.802
		(-0.16)	(-0.38)	(1.68)	(1.73)***	(0.25)	(-1.24)	(0.21)	(4.99)
	TMy/GDP	-.660	-.730	-.934	-.346	1.168	11.709	-10.328	-14.303
		(-9.45)*	(-8.06)*	(-0.67)	(-0.12)	(0.21)	(1.72)	(-1.83)	(-3.86)
	Regime	.016	.028	.051	-.015	.200	.721	-.620	-.048
		(3.49)*	(2.81)*	(0.64)	(-0.16)	(0.83)	(4.64)*	(-0.77)	(-0.17)
	TTrade/GDP	.370	.250	.065	-.004	-2.378	-.581	-1.872	3.206
		(2.19)**	(1.50)	(0.09)	(-0.01)	(-1.26)	(-0.24)	(-0.50)	(1.01)
	Adj R^2	0.703	0.747	0.866	0.922	0.574	0.865	0.842	0.926
	F-prob	0.000	0.000	0.000	0.000	0.025	0.005	0.003	0.206

♣Pooled General Least Squares with Cross-section SUR that estimates a feasible GLS specification correcting for both cross-section heteroscedasticity and contemporaneous correlation. ♠Fixed effects Pooled GLS with cross section weights where Eviews estimates a feasible GLS specification assuming the presence of cross-section heteroscedasticity. # With White's cross-section standard errors & covariance correction by treating pooled regression as a multivariate regression with an equation for each cross section and computing White-type robust standard errors for the system of equations. ♦With cross-section SUR (PCSE) using Panel Correlated Standard Error methodology standard errors & covariance correction. Numbers in parentheses are t-statistics. *, **, *** represent 1%, 5%, 10% significance level respectively. F-prob represents F-probability values and Adj R^2 represents adjusted R-squared values.

trade and capital flows, accumulation of reserves, government foreign borrowing and exchange rate regime are also significant drivers of exchange rate in the long term.

5.0 Conclusion

The findings reported in this paper make a modest contribution to extend our understanding of exchange rate behavior in two *trade-linked* regions, one developed and another emerging economies. Specifically, this paper considers the extent to which parity *and* non-parity factors are correlated systematically with movements of exchange rates. We also use the latest statistical methods and tests to derive robust test results.

We find that, for the region of G-10 countries, in the long run, in addition to parity factors, non-parity fundamentals such as (1) growth rate, (2) accumulation of reserves, (3) portfolio outflow and (4) trade openness provide high-degree of explanation for exchange rate changes. For the region of Latin American emerging countries, non-parity fundamentals such as (1) accumulation of reserves, (2) trade balance, (3) sovereign debt and (4) capital flows are significant drivers of exchange rates.

We believe the improved test methodology in this study led to improved results helped to identify new fundamental factors that are related to exchange rates while the puzzle of the short term versus long term behavior is made obvious by different data frequencies from quarterly to several years: the longer the intervalling period the higher is the fit of the model as judged by explained variation parameter. Most variables thus have long-run impact on exchange rate changes. Nevertheless, exchange rate is known to overshoot perhaps because traders made very quick adjustments to predicted or rumoured changes in fundamental factors leading to exchange rates overshooting in the short run. In summary, it is in the interests of a large community of currency traders to over-react to a multitude of news resulting in overshooting of exchange rates despite the factors having a longer-run relationship in most cases, and not a short run impact.

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