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Fundamentals of Exchange Rate Determination: Malaysia and the ASEAN Emerging Countries

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Abstract: This paper reports new findings on exchange rate dynamics concerning non parity fundamentals and parity factors effects on exchange rates within a group of closely trading emerging countries: non parity fundamental factors suggested by economic theories have yet been systematically related to exchange rates. We use a high- and low-frequency multi-country pooled time series panel data approach. The evidence that emerges from this paper is that non parity factors, which we included, are significant contributors to exchange rates. These new findings on other-than-parity fundamentals add to a richer understanding of exchange rate behaviour as well as clarify why existing findings are mixed.

Keywords: Exchange rates, foreign debt, growth, monetary and fiscal policy, parity theorems, reserves, trade and capital flows

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

1. Introduction

An unresolved issue in international finance of the recent decades is the role of capital flows in the determination of exchange rates, and in examining traditional factors employed to study exchange rates of small to medium-sized economies. After much effort at studying bilateral exchange rate determination, a new approach using multi-country framework and improved research design is needed to understand exchange rates. The motivation of this paper is to present findings on exchange rate behaviour by including new theory-cum-empirically-verified factors as well as other theory-suggested ones to investigate exchange rate determination in a trade-related multi-country context. We have built a test model to incorporate both parity and non parity variables in an attempt to build a more complete model of equilibrium.

Researchers have expressed increasing frustration over their failure to explain exchange rate movements fully (Dornbusch 1987a; MacDonald and Taylor 1992) using parity variables. With rapid growth in trade and capital flows across national boundaries, newer key factors are becoming dominant in affecting the value of foreign currency (Harvey 2001). These

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factors are many and include current account deterioration, excessive foreign debt accumulation, capital flows, foreign currency reserves and fiscal imbalances. Additional factors that are viewed as affecting exchange rate include economic growth, exchange rate regimes, and uncontrolled monetary expansion, all of which are non parity factors.

This study extends the literature by looking at the contributions of non parity variables after extracting the impact of parity variables. The resulting findings can provide an improved understanding of the dynamics of how exchange rates are determined in a trade-related multi-country context by factors beyond the traditional parity conditions. With a better understanding of the workings of exchange rates, multinationals and government policies can be geared towards preventing huge losses from financial and currency crises such as those experienced by many corporations and countries in the recent decade.

From the findings for Malaysia, economic growth rate is the major determinant of exchange rate movements; accumulation of international reserves, trade openness and the domestic monetary stance are also important non parity factors. For the emerging country region as a whole, growth rate, budget balance and trade openness exert significant influences on exchange rates in the shorter period but not in the longer term. Interest rate parity holds very well in the longer term and this study concludes that increases in nominal interest rates lead to downward movements in exchange rates. In addition, foreign debt and accumulation of reserves are significant drivers in the longer term, and monetary expansions are positively related to the domestic exchange rates and this might be a reflection of faster growth rates driving monetary expansion.

The remainder of this paper is divided into four sections. The next section contains a brief overview of the current literature which assisted in identifying fundamentals relevant to this study. Section 3 illustrates the methodology involved, followed by report on significant findings and robustness testing in Section 4. This paper ends with a conclusion in Section 5.

2. Literature on Exchange Rate Determination

The currency exchange market is the world's largest market in terms of daily trading volume, in excess of USD2.3 trillion; no comparison to even the world's combined bond or stock markets.[1] The imports and exports of goods and services, coupled with international capital flows could account for only part of these currency transactions. The primary function of the foreign exchange market is to facilitate international trade and investment as well as to permit transfers of purchasing power denominated in one currency to another.

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). These theorems have been extensively tested by renowned scholars all over the world. Interest in currency behaviour is rekindled because of the incompleteness of our knowledge on exchange rate determination in the face of periodic currency crises, and by the availability of newer statistical tools, as well as the accumulation of data over lengthy periods.

[1] BIS report including Triennial Central Bank Survey of Foreign Exchange and Derivative Market Activity April 2007.

2.1 Parity Theorems

PPP has been observed by researchers as a basis for international comparison of income and expenditures; and efficient arbitrage condition in goods as a theory of exchange rate determination. The underlying theory is based on a simple goods market arbitrage argument: ignoring tariffs, transportation costs, and assuming common goods consumed should 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]

The relative version of PPP, as is commonly used in prior studies, suggests that if a country's inflation rate is relatively higher than its trading partner's, that country will find its currency value falling in proportion to its relative price level increases. The change in exchange rate E is a function of price differentials, where j represents country, t represents time period, P represents prices, d domestic and f foreign as stated below:

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

With the clear failure of short run PPP and years of high exchange rate volatility, it seems that the theory of PPP had failed to hold during the 1970s and 1980s.[3] The obvious lack of evidence on PPP under the current floating regimes acted as a motivating force that led to the development of the sticky price, which is an over-shooting exchange rate model of Dornbusch (1976). In the last two decades, given the low power problem of unit root tests for PPP, researchers often failed to reject the null hypothesis of the random walk.[4] In their survey of PPP literature, Froot and Rogoff (1994) concluded that PPP 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 PPP using a panel of 150 countries for forty-five years and confirmed that PPP holds and their estimate implied a half-life of PPP deviations of four years.

The law of one price in the asset market for securities is interest rate parity (IRP).[5] In theory, the foreign exchange market is in equilibrium when deposits of all currencies offer the same rate of return. A rise in interest rates will attract more investment 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

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[2] Empirical work that has led to conflicting empirical findings for PPP includes MacDonald (1993), Rogoff (1996), Bayoumi and MacDonald (1999) and Cheng (1999). They have all found no clear evidence or at best, very weak relationship between inflation and exchange rates.

[3] Henry and Olekalns' (2002) study on Australia found little evidence for long-run equilibrium between exchange rate and prices. In a similar view, Adler and Lehman (1983) found that the deviations from PPP followed a random walk without reverting to PPP for 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 relations and concluded that fundamentals play a significant role in determining exchange rates.

[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.

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.

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

International Fisher Effect (IFE), a relative specification found in the literature, implies that relative interest rate differentials will give rise to similar final results in exchange rates; similar to PPP which implies that exchange rates will adjust to changes in inflation differentials. The ability of exchange rate markets to anticipate interest differentials is supported by several empirical studies that indicate a long run tendency for these differentials to offset exchange rate changes.[6]

2.2 Non Parity Variables

The two parity theories 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 point 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 assist in identifying potential from other-than-parity explanations for understanding exchange rate behaviour. Despite the fact that parity explanations have gained centre stage up until about the 1980s for exchange rate behaviour research, recent years have witnessed interest in other explanations, given the conflicting empirical evidence on parity theories. Hence, we searched the literature to identify a few such variables for inclusion in an expanded model.

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). 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 countries affected by the 1997/8 Asian financial crisis, the reversal of capital flows, and current account deficits (together with high foreign debt) have been nominated as common factors surrounding that crisis. Therefore these variables should have tremendous impacts on exchange rates.[8]

Karfakis and Kim (1995) using Australian exchange rates found that an unexpected current account deficit is associated with a depreciation of exchange rates and a rise in interest rates. Evidence that current account deficits diminish domestic wealth and may lead to overshooting of the exchange rates, thus a fall in the real value of the currency, has

[6] Studies that provided evidence include Mark (1995) and, Hoffman and MacDonald (2003) which found measures of long run expected changes in exchange rates highly correlated with interest rate differentials.

[7] Frankel and Rose (1996b) on current account and government budget deficits; Calvo *et al.* (1994) on capital flows, inflation and current account deficits; and Aizenman and Marion (2002) on reserve and credibility; and many others.

[8] It is documented, including the study of Kim (2000),that the recent currency crises were due to vast changes in these variables.

been provided by Obstfeld and Rogoff (1995a), Engel and Flood (1985), and Dornbusch and Fisher (1980). There has also been a surge in international capital flows into developing countries in the recent decades.[9] A sudden outflow of capital is another major concern when it can drastically affect exchange rates as was seen during the financial crises of Brazil, East Asia, and Mexico. These capital flows affect domestic output, real exchange rates, capital and current account balances for years thereafter.[10]

Portfolio investments have also increased in recent years due to greater access to capital markets via newer regulations, reduced capital controls and the overall globalisation of financial services.[11] Calvo *et al.* (2003) blamed the fall of Argentina's currency programme on their country's vulnerability to sudden stops in capital flows. A recent 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 these countries.[12] 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.[13] Reserves are used as a means to defend a country's currency as it provides credibility to the value of the currency; this suggests that reserves and the type of currency exchange regime in this case (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 and this study aims to provide significant results in this area.[14]

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 *et al.* (1994) showed that an increase in capital inflows increased total reserves and real exchange rates of Lain American countries. Hsiao and Hsiao (2001) found

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[9] Gross foreign direct investment as a percentage of GDP increased more than 100 per cent for Korea, the Philippines and Indonesia for the period 1990-2001. Net private capital flows into six developing regions in the world totalled USD167.976 million in 2001. *Source*: *2003 World Development Indicators*, database, World Bank, 13 April 2003.

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

[11] Portfolio investment inflows increased from RM19,346 millions in 1991 to a peak of RM238,454 millions in 1994 for Malaysia. *Source*: Bank Negara Malaysia and Department of Statistics, Malaysia. Portfolio investment averaged USD102 billion for 1995-96 and USD26 billion for 1997-2000 according to World Economic Outlook, 2003, IMF.

[12] Using annual data for 21 OECD countries, Krol (1996) found that capital flows have a significant effect on current accounts as well as exchange rates and this is reinforced by Kim (2000).

[13] Korea's usable reserve fell from USD28 billion to a mere USD6 billion when their currency went on a free fall in December 1997(Aizerman and Marion 2002). Brazil's reserves fell from USD75 billion to less than half of that before the currency collapsed in 1998(Dornbusch and Fisher 2003).

[14] Total external debt for six developing regions in the world according to World Bank classification amounted to USD2,332,621 millions for 2001. Source: *2003 World Development Indicators*, World Bank.

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.

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

Globalisation has resulted in domestic financial markets being more integrated with international financial markets. An open economy's domestic interest rates tend to reflect not only domestic conditions but also international conditions namely the prevailing world interest rate, after allowing for currency risk (Edward and Khan 1985; Ariff 1996). Open economies facing capital flows, competitive interest rates and trade competition from others must lead to a defined relationship between openness and the rate of growth in some countries.[15] Similar to Karras (1999), Papell and Theodoridis's (1998) study on openness, exchange rates and prices found stronger evidence of PPP for countries with less exchange rate volatility, and shorter distance from other countries but not for countries with greater openness to trade.

Among the many models found in the literature to explain long-term deviations in PPP, the most popular one is from Balassa (1964) and Samuelson (1964). Both argued 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 relative to their slower growing partners when technological changes happen more often in the rading goods sector as a result of intense international competition.

Using a panel of OECD countries, Canzoneri *et al.* (1999) found that when relative productivity of traded goods grew more rapidly in Italy and Japan than in Germany, both the lira and yen appreciated in real terms against the Deutschemark. Other studies that provided support for productivity explanation for long-run real exchange rate movements includes those of Chinn (2000) and Cheung *et al.* (2003) who found that the 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 to Edwards and Savastano (1999), Bailey *et al.* (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.

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

[16] Reviewing the US experience with flexible exchange rates, Dornbusch (1987b) found that changes in exchange rates in the last fifteen years are inconsistent with any explanations in theory and may not be related to fundamentals.

Since the breakdown of the fixed Bretton Woods system, exchange volatility has drastically increased to levels that are beyond the explanation of fundamentals.[16] Grilli and Kaminsky (1991) concluded that real exchange rate behaviour changes substantially across historical periods but not necessarily across exchange rate regimes. Calvo and Reinhart (2002) examined thirty-nine countries around the world and found that moderate to large exchange rate fluctuations are very rare in managed float systems. Other studies that found similar results include those of Moosa and Al-Loughani (2003) and Edwards (2002) who explain that super-fixed regimes are highly inflexible and inhibit adjustment process. These non parity variables, as separately identified in several studies, may be included to identify how these are systematically correlated with exchange rates.

3. Data, Methodology and Summary Statistics

3.1 Data

The data on exchange rates between individual countries, and the United States (US) dollar (IFS line rf) as the foreign unit as observed at the end of observation periods. Quarterly bilateral exchange rates for Malaysia as well as five emerging ASEAN countries are from 1978:1 to 2005:1. The *International Financial Statistics* (IFS) CD-ROM is the major source for these data. Price variables include CPI (IFS line 64) and PPI (IFS line 63) 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.

The non parity current and capital flow variables include: trade balance (trade) from imports and exports of goods, and 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); and total reserves (TR) as well as foreign debt (FD). Monetary expansion data is broader money[17] (M2) which includes both money and quasi-money. Growth rate (PROD) 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.[18] Trade openness is measured by total trade (TTrade), that is, the sum of total imports and exports, as a proportion of GDP. Incomplete data are sourced from *Datastream*, World Bank as well as individual country's Central Banks and Statistics 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.

The sample in this study includes Malaysia as an individual country and a selection of five ASEAN countries: Indonesia, Malaysia, the Philippines, Singapore and Thailand. The reason behind the choice of these five countries is the high level of inter-trade between them within the same geographical region.

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[17] IFS defined money as the sum of currency outside deposit money banks and demand deposits, and quasi money as the sum of time, savings and foreign currency deposits of the resident sector.

[18] Exchange regimes are according to Reinhart and Rogoff (2002).

Table 1. Summary of variables and definitions

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	+/-

3.2 Methodology

The regression analysis tests the price and interest parity theorems and then includes other non parity fundamentals with appropriate tests to check the robustness and validity of results for Malaysia. The one-step ordinary least squares model has its limitations and hence a two-step regression is used to explain the unexplained effects captured in the residuals from the first regression using parity variables. This overcomes the problem of estimating the parity relations which have significant pairwise correlations with non parity variables. A parsimonious regression approach then allows an examination of each independent variable's contribution to the model, which will be useful in selecting a narrower set of variables.

Investigating both price and interest parities should yield results that could explain the extent to which parity hypotheses may explain changes in exchange rates. Exchange rates are also dependent on changes in non parity variables especially in the short run. This section describes the tests aimed at estimating the individual effect such variables have on exchange rates. These variables will also be tested together, first in a general model, and subsequently eliminating uncorrelated variables by using the Akaike Information Criterion (AIC) that will result in a stepwise approach as is widely used to identify relevant variables in prior studies.

Step 1:

$$\text{Parity: } \ln(ER)_{jt} = \alpha'_{0j} + \alpha'_{1j} \ln(P)_{jt} + \beta'_{1j} \ln(I)_{jt} + \gamma_{jt} \quad (3)$$

Step 2:

$$\text{Non Parity: } \gamma_{jt} = a'_{0j} + \sum b'_j Z_{jt} + v'_{jt} \quad (4)$$

where, the dependent variable takes the residual value from the first regression. The first regression includes the effect of the parity relations, and the residual as the dependent variable for the second regression contains the potential effects from non parity relations. Thus, this two-step regression may be applied to investigate the parity and non parity relations both in time series and cross-sectional tests.

Common problems faced in cross-sectional and time series analysis are non normality of variables, non stationarity of time series data, multicollinearity among criterion factors, autocorrelation and heteroscedasticity. The impact of multi-collinearity is to reduce 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 (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 will be tested and confirmed by Augmented Dickey-Fuller (ADF) unit root test and the Kwiatkowski, Philips, Schmidt and Shin (KPSS) Test. All the variables are stationary in the first difference and ratio forms as stated in Tables 3 and 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.

3.3 Pooled Series Panel Model

Seemingly unrelated regression (SUR) and fixed effect (FE) pooled data models are employed to investigate exchange rate behaviour. SUR allows cross-sectional variations in the data

Table 2. Non parity variables VIF and tolerance measure

	Malaysia		ASEAN	
Variables	Tolerance	VIF	Tolerance	VIF
LNP	0.524	1.910	1.019	0.983
LNI	0.425	2.351	1.064	0.939
Trade/GDP	0.712	1.404	2.995	0.334
InFDI/GDP	0.763	1.311	3.080	0.323
OutFDI/GDP	0.755	1.324	1.649	0.608
InPt/GDP	0.162	6.169	1.102	0.909
OtPt/GDP	0.135	7.385	1.142	0.877
TRes/IM	0.565	1.770	0.328	0.754
Bgt/GDP	0.734	1.363	1.144	0.875
TMy/GDP	0.224	4.458	1.474	0.677
PROD	0.169	5.912	1.095	0.915
FD/GDP	0.592	1.688	3.342	0.299
TTrade/GDP	0.316	3.163	3.222	0.312
Regime	0.283	3.528	1.207	0.832

* VIF values of more than 10 show significant multicollinearity.

Table 3. Unit root tests for parity and non parity variables for Malaysia

	Malaysia		
Variables	ADF Test		KPSS Test
	t-stats	Model(lag)	KPSS statistic
lnER	-8.87***	C(0)	0.104
lnP	-2.35	C(1)	0.290
lnI	-2.61*	C(3)	0.551**
Trade/GDP	-12.26***	C(0)	0.077
Cur/GDP	-4.54***	C(0)	0.232
BOP/GDP	-3.79**	C(0)	0.500**
InFDI/GDP	-7.32***	C(1)	0.325
OutFDI/GDP	-8.48***	C(1)	0.152
InPt/GDP	-6.02***	C(0)	0.188
OtPt/GDP	-5.06***	C(0)	0.190
TRes/IM	-7.33***	C(0)	0.056
Bdgt/GDP	-2.88*	C(7)	0.063
TMy/GDP	-7.93***	C(0)	0.075
Prodty	-8.07***	C(0)	0.059
FD/GDP	-2.22	C(3)	0.351*
TTrade/GDP	-10.22	C(0)	0.101

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).

set, and thus yields robust estimates of the test statistics according to Zellner (1962). As a system of equations, this method can be applied here rather than estimating the equation in one cross-section, which would be wasteful as it would leave out information in the data set. SUR is estimated using generalised least squares algorithm. Since the SUR technique utilises 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 examine issues that could not be studied in either cross-section or time-series settings alone. By allowing cross-sectional variation or heterogeneity to affect estimations, the resulting estimates are robust. We use the fixed effect approach here because it permits the constant term to be the country-specific variations

Table 4. Unit root tests for parity and non parity variables for ASEAN

	ASEAN		
Variables	ADF Test		KPSS Test
	t-stats	Model(lag)	KPSS statistic
lnER	-19.16***	C(0)	0.480**
lnP	-2.81*	C(0)	0.280
lnI	-5.95***	C(3)	0.310
Trade/GDP	-4.48***	C(11)	0.299
Cur/GDP	-10.05***	C(3)	0.060
BOP/GDP	-16.75***	C(2)	0.050
InFDI/GDP	-10.28***	C(5)	0.040
OutFDI/GDP	-12.95***	C(3)	0.200
InPt/GDP	-13.15***	C(10)	0.060
OutPt/GDP	-7.90***	C(13)	0.050
TRes/IM	-18.05***	C(0)	0.092
Bdgt/GDP	-15.50***	C(3)	0.050
TMy/GDP	-19.70***	C(0)	0.360*
Prodty	-6.25***	C(4)	0.350*
FD/GDP	-4.60***	C(3)	0.192
TTrade/GDP	-6.00***	C(7)	0.275

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).

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 data regressions as follows:

$$\ln ER_{jt} = a_0' D_j + a_{1j}' \ln(P)_{jt} + b_{1j}' \ln(I)_{jt} + c_{1j}' (Trade/GDP)_{jt} + c_{2j}' (Cur/GDP)_{jt} +$$
$$c_{3j}' (BOP/GDP)_{jt} + c_{4j}' (InFDI/GDP) + c_{5j}' (OtFDI/GDP) + c_{6j}' (InPt/GDP)_{jt} +$$
$$c_{7j}' (OtPt/GDP)_{jt} + c_{8j}' (FD/GDP) + c_{9j}' (T\,\mathrm{Re}\,s/GDP) + c_{10j}' (\mathrm{Pr}\,odty)_{jt} +$$
$$c_{11j}' (Bdgt/GDP)_{jt} + c_{12j}' (TTrade/GDP)_{jt} + c_{13j}' (TMy/GDP)_{jt} + c_{14j}' (\mathrm{Re}\,gime)_{jt} + v_{ij}' \quad (5)$$

In the above equation, 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.

4. Findings

This section reports the quarterly as well as other interval results on Malaysia and the panel results for ASEAN emerging countries as a region. Since the exchange rate used in this model is against the foreign currency, a negative coefficient corresponds to an increase in the value of domestic currency and a positive coefficient indicates otherwise.

4.1 Malaysia

4.2.1 Short Term

From the quarterly results (meaning the regressions used observations over quarterly time periods, thus identifying the short-run relationship) in Table 5, it is important to note that higher growth rate stands out clearly as the major determinant of exchange rates in Malaysia. This study however cannot find any verification of the purchasing power and interest parity holding in the short term which is consistent with a summary of current empirical literature. The other shorter term significant variables include accumulation of reserves, monetary expansion and trade openness of this country. Although statistically insignificant in the short term, the coefficient for foreign debt is in the right direction where increase in debt leads to depreciation of the domestic currency. Capital and portfolio flows on the other hand are insignificant. The *F*-probability of 0.000 shows that the model is highly statistically significant and that growth rate is the major driving force behind exchange rate movements. The adjusted R-squared of 0.798 also indicates that about 80 per cent of the movements in exchange rates can be explained by this model.

Total reserves have a significant coefficient (*t*-stats of -2.55) consistent with theoretical expectation that an increase in reserves raises the confidence level others have on its currency value. The government' fiscal budget is marginally significant (*t*-stats of -1.76) but of the correct sign. This reflects that fiscal budget condition does not drive the value of the Malaysian ringgit. Monetary policy of the government is another significant factor (*t*-stats of 2.68) where excessive monetary expansion leads to deterioration of currency value. Moreover, the total trade or trade openness coefficient is significant and the relationship is negative. This reflects that openness to trade resulted in huge imports that send the currency value falling.

The parsimonious model in Table 6 indicates similar findings for the country. The coefficient for growth rate (*t*-stats of -13.28) is still the most significant fundamental driving exchange rates in Malaysia. Other similar significant variables include fiscal budget and external trade in the shorter term. The parsimonious model that has fewer variables has a value of about 77 per cent as explained variation.

Table 5. Quarterly one and two-step results – Malaysia

		Without investment flows		With investment flows	
			2 Step		2 Step
Intercept		0.017	0.006	0.001	0.005
		(3.48)***	(1.33)	(0.06)	(1.28)
Parity	lnP	-0.045	-0.011	-0.060	-0.026
		(-1.08)	(-0.23)	(-0.36)	(-0.37)
	lnI	-0.016	0.088	0.022	0.061
		(-0.22)	(0.67)	(0.11)	(0.44)
Non parity	Trade/GDP	-0.069	-0.127	0.047	0.042
		(-1.30)	(-1.10)	(0.53)	(0.51)
	InFDI/GDP			0.172	0.172
				(0.56)	(0.58)
	OtFDI/GDP			-0.106	-0.112
				(-0.39)	(-0.42)
	InPt/GDP			-0.059	-0.060
				(-1.36)	(-1.43)
	OtPt/GDP			0.105	0.105
				(2.03)	(2.10)
	TRes/Im	0.005	0.001	-0.051	-0.053
		(0.33)	(0.06)	(-2.32)**	(-2.55)**
	ForDt/GDP	-0.034	-0.044	0.177	0.175
		(-0.60)	(1.14)	(1.20)	(1.29)
	Prodty	-207.442	-210.558	-0.786	-0.781
		(-2.29)**	(-2.02)**	(-10.94)***	(-11.91)***
	Bdgt/GDP	-0.042	-0.047	-0.073	-0.073
		(-2.25)**	(-3.26)***	(-1.71)	(-1.76)
	TMy/GDP	-0.179	-0.178	0.107	0.110
		(-8.22)***	(-6.62)***	(2.44)**	(2.68)***
	Regime	0.006	0.004	0.003	0.001
		(1.19)	(0.77)	(0.28)	(0.148)
	TTrade/GDP	-0.022	-0.019	0.167	0.165
		(0.72)	(-0.53)	(4.59)***	(4.69)***
	Adj R^2	0.770	0.767	0.790	0.798
	F-prob	0.000	0.000	0.000	0.000

*, ** and *** denote statistical significance at 1, 5 and 10% levels, *t*-statistics are in parentheses. The results were corrected for heteroscedasticity and autocorrelation using Newey-West HAC matrix.

Table 6. Quarterly one and two-step parsimonious results – Malaysia

Variables:	1 Step	2 Step
Bdgt/GDP	-0.123 (-3.07)***	-0.123(-3.07)***
TTrade/GDP	0.191 (5.50)***	0.190(5.50)***
Prodty	-0.835 (-13.29)***	-0.833(-13.28)***
Adjusted R^2	0.775	0.775
F-Probability	0.000	0.000

*, ** and *** denote statistical significance at 1, 5 and 10% levels. *t*-statistics are in parentheses.

4.2.1 Longer Term

The longer term results are shown in Table 7 as a comparison from short to a longer period of time. Parity theorems are not achieved and both price and interest coefficients are not significant in determining exchange rates. Sample period may be too short to allow reliable use of parity fundamentals to predict changes in exchange rates, even when these fundamentals do determine exchange rates. A further study with longer time series in the future would be able to obtain more significant results.

There is no doubt that growth rate is the major determinant of exchange rates in Malaysia from the results obtained here for quarterly as well as all subsequent time periods. The adjusted R-squared for all period intervals are close to 80 percent and this shows that the models can explain a large portion of exchange rate movements. Monetary expansion is also an important longer term variable and according to theory, an increase in money supply is indirectly related to exchange rates and statistically significant in both three and four yearly intervals (meaning the observations are made over 3- and 4-year intervals to capture long-run behaviour). It is important to note that exchange rate depreciation of a certain magnitude always become more worrisome if coupled with excessive monetary expansion. It is evident that as the time interval of observations is increased to long term, the coefficient of variation increased to 95 per cent (see numbers in the last column).

The coefficients for total reserve are significant (*t*-stats -2.32 and -3.23 respectively) and of the correct direction for quarterly, and one-year intervals. This shows that in the shorter-term, persistent accumulation of reserves increases the value of the currency when others gain confidence in the credibility of the country's currency. Moreover, trade openness is also significant only in the shorter term and it is negatively related to exchange rates. This shows that an increase in trade variable, that is, more imports and exports, actually leads to a fall in the value of currency. This may be explained by the huge amount of imported capital goods that is needed to drive expansion and growth of the economy. Moreover, when income and wealth increase, more imports are absorbed into the country.

Non parity variables which are marginally significant in affecting exchange rates in the shorter time period also include outflow of foreign direct and portfolio investments. Outflow of foreign direct investment is negatively related to domestic exchange rates and this may be due to better opportunities in relatively cheaper countries. On the other hand, outflow of portfolio investments are positively related to exchange rates and higher value of domestic currency allows investors to receive more foreign currency investments. In summary, the

Table 7. Results from quarter and one- to four- yearly intervals – Malaysia

		Quarterly	Yearly	Two yearly	Three yearly	Four yearly
Intercept		0.001	0.001	0.034	0.031	-0.386
		(0.06)	(0.04)	(0.57)	(1.06)	(-6.57)*
Parity	lnP	-0.060	-0.371	-0.318	-0.073	-3.101
		(-0.36)	(-2.68)**	(-1.13)	(-0.65)	(-5.37)
	lnI	0.022	-0.494	-0.009	0.018	-0.116
		(0.11)	(-1.56)	(-0.17)	(1.23)	(-4.02)
Non Parity	Trade/GDP	0.047	0.230	0.386		
		(0.53)	(1.64)	(1.02)		
	BOP/GDP		0.105			
			(0.83)			
	InFDI/GDP	0.172	-0.348	-0.392		
		(0.56)	(-0.75)	(-0.38)		
	OtFDI/GDP	-0.106	2.263			
		(-0.39)	(2.20)**			
	InPt/GDP	-0.059	0.069	1.016	3.680	
		(-1.36)	(0.28)	(0.91)	(5.90)*	
	OtPt/GDP	0.105	-11.480		1.733	
		(2.03)**	(-3.13)***		(1.73)	
	TRes/Im	-0.051	-0.385	-0.198	0.020	
		(-2.32)**	(-3.23)***	(-0.97)	(0.25)	
	ForDt/GDP	0.177	0.023	-0.166		1.865
		(1.20)	(0.10)	(-0.40)		(5.68)
	Prodty	-0.786	-0.216	-0.193	-0.280	-0.208
		(-10.94)***	(-14.20)***	(-2.51)*	(-17.30)**	(-15.58)**
	Bdgt/GDP	-0.073	-0.052	0.032	2.281	
		(-1.71)*	(-2.09)*	(0.04)	(5.24)	
	TMy/GDP	0.107	0.836	0.566	0.821	1.750
		(2.44)**	(5.94)***	(1.12)	(6.08)*	(13.72)**
	Regime	0.003	0.001			
		(0.28)	(0.14)			
	TTrade/ GDP	0.167	0.108			
		(4.59)***	(1.05)			
	Adj R^2	0.790	0.927	0.796	0.984	0.951
	F-prob	0.000	0.000	0.043	0.093	0.152

*, ** and *** denote statistical significance at 1, 5 and 10% levels. *t*-statistics are in parentheses. The results were corrected for heteroscedasticity and autocorrelation using Newey-West HAC matrix.

Table 8. Yearly parsimonious results – Malaysia

Variables	Yearly	2 yearly	3 yearly	4 yearly
Prodty	-0.206	-0.217	-0.180	-0.254
	(-13.04)***	(-6.32)***	(-4.09)***	(-5.27)***
TMy/GDP	0.643	0.689		1.167
	(5.28)***	(2.36)**		(2.79)**
TRes/Im	-0.278			
	(-3.05)***			
Adjusted R^2	0.902	0.743	0.636	0.813
F-Probability	0.000	0.000	0.003	0.016

*, ** and *** denote statistical significance at 1, 5 and 10% levels, *t*-statistics are in parentheses.

key driving forces behind the Malaysian ringgit are growth rates, budget balance, accumulation of foreign reserves and monetary expansion in the domestic economy.

The results from a parsimonious model given in Table 8 clearly show that growth rate and monetary expansion are the major determinants of exchange rates in Malaysia. It is interesting to note that accumulation of reserves is also a significant determinant for one yearly interval.

4.2 ASEAN

The results from SUR and fixed effect models for the five ASEAN emerging countries are summarised in Table 9. The coefficient on price changes is not statistically significant and does not have the predicted sign in tests for all time periods in this study. This indicates that even up to three-year intervals, price parity is still not holding for this region of rapidly developing countries. With lengthier data span and longer time intervals, future studies might reveal different results. The coefficient for interest changes is however statistically significant and is according to IRP for the longer term of one to three-year intervals.

In the quarterly period findings, growth rate appears as the most influential fundamental variable for the determination of exchange rates. Growth rate is positively related to exchange rate implying that higher economic growth rates strengthen the domestic currency value. Similar to growth rate, fiscal budget balance is also statistically significant. It is directly related to exchange rates. Improvement in budget balance also enhances the domestic currency value.

Other significant non-parity variables in the short term quarterly findings are monetary expansion, exchange regime and trade openness. Monetary expansion and exchange regime are positively related to exchange rates. Increase in money supply improves the value of domestic currency, contrary to monetarists' theory. Then again, for most developing countries, this is the case. Monetary expansion is perhaps needed to accommodate economic growth in these countries, and the effect is positive through the growth rate variable as found repeatedly. For this region of rapidly developing countries, monetary expansion continues to be a significant factor even in the longer term. Exchange regime, which is more flexible in this region, corresponds to an improvement in domestic exchange rates where

Table 9. SUR and fixed effects results for ASEAN countries

	Quarterly		Yearly		2 yearly		3 yearly	
	SUR[a2]	Fixed effects[13]	SUR[a2]	Fixed effects[13]	SUR[a2]	Fixed effects[13]	SUR[a2]	Fixed effects[13]
Intercept	.022 (8.48)*	.025 (4.60)*	.087 (5.60)*	.079 (5.20)*	.056 (0.95)	.042 (0.58)	-.098 (-0.70)	-.112 (-0.50)
lnP	-.010 (-1.54)	-.003 (-0.32)	.001 (0.09)	-.020 (-1.44)	-.041 (-1.13)	-.024 (-0.45)	-.010 (-0.24)	-.036 (-0.44)
lnI	.010 (0.20)	.001 (0.05)	.500 (4.20)*	.696 (3.05)*	1.562 (6.70)*	1.685 (3.90)*	2.455 (5.80)*	3.255 (2.70)*
Trade/GDP	.120 (1.10)	.115 (0.90)	.182 (0.90)	.060 (0.49)	-.160 (0.60)	-.250 (-0.90)	.046 (0.09)	-.426 (-0.80)
BOP/GDP	.014 (0.40)	.032 (0.80)	-.130 (-1.10)	-.180 (-1.30)	.010 (0.04)	-.080 (-0.40)	.229 (0.30)	.065 (0.10)
Cur/GDP	.048 (0.50)	.060 (0.60)	-.240 (-1.25)	-.230 (-1.48)	.240 (0.90)	.150 (0.60)	-.090 (-0.20)	.094 (0.20)
InFDI/GDP	-.008 (-0.07)	.021 (0.17)	.332 (1.24)	.174 (0.52)	-.232 (-0.42)	-.151 (-0.23)	.843 (0.84)	1.105 (0.63)
OtFDI/GDP	.082 (0.20)	.09 (0.29)	9.752 (1.71)***	.836 (1.98)**	1.233 (1.60)	0.937 (0.85)	.332 (0.15)	-.212 (-0.06)
InPt/GDP	.047 (0.82)	.044 (0.60)	-.069 (-0.30)	.031 (0.12)	-.517 (-0.79)	-.290 (-0.50)	-1.468 (-1.20)	-.769 (-0.51)
OtPt/GDP	.154 (1.37)	.16 (1.32)	1.028 (0.10)	-.065 (-0.36)	-.113 (-0.16)	-.263 (-0.31)	-1.048 (-0.85)	-1.095 (-0.43)
TRes/Im	-.004 (-0.19)	-.014 (-0.79)	-.028 (-0.22)	.020 (0.10)	-.369 (-2.10)**	-.341 (-2.05)**	-.258 (-0.87)	-.276 (-0.86)

continued on next page

Table 9. Continued

FD/GDP	-.066	-.068	-.099	-.099	.130	.094	.947	.865
	(-1.27)	(-1.79)***	(-0.49)	(-0.33)	(0.43)	(0.24)	(2.50)**	(1.19)
Prodty	-319.990	-361.340	-20.019	-25.370	5.320	-1.030	3.760	4.172
	(-3.12)*	(-3.27)*	(-2.86)*	(-2.98)*	(0.43)	(-0.05)	(0.15)	(0.09)
Bdgt/GDP	-.080	-.089	-.178	-.117	-.153	.037	-1.025	-1.096
	(-2.26)**	(-2.50)*	(-0.83)	(-0.65)	(-0.49)	(0.10)	(-1.25)	(-1.20)
TMy/GDP	-.203	-.203	-.870	-.850	-.500	-.490	-.460	-.538
	(-12.40)*	(-11.20)*	(-13.50)*	(-12.10)*	(-4.00)*	(-3.40)*	(-1.75)***	(-2.30)**
Regime	-.004	-.006	-.010	-.002	.048	.068	.200	.240
	(-2.20)**	(-2.10)**	(-0.94)	(-0.25)	(1.31)	(1.45)	(2.24)**	(1.62)
TTrade/GDP	.070	0.080	.060	.050	.018	-.010	-.003	-.060
	(2.26)**	(2.12)**	(2.04)**	(1.45)	(0.40)	(-0.20)	(-0.04)	(-0.50)
Adj R^2	0.810	0.810	0.836	0.840	0.849	0.780	0.860	0.760
F-prob	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

[a]Pooled general least squares with cross-section SUR that estimates a feasible GLS specification correcting for both cross-section heteroscedasticity and contemporaneous correlation. [1]Fixed effects Pooled GLS with cross section weights where Eviews estimates a feasible GLS specification assuming the presence of cross-section heteroscedasticity. [3]With White's cross-section standard errors and 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. [2]With cross-section SUR (PCSE) using Panel Correlated Standard Error methodology standard errors and covariance correction. *, **, *** represent 1, 5, 10% significance respectively.

government which are more confident of their currency value allowed them to decide their own values in the market thus resulting in more credibility in its value.

It is interesting to note that trade openness is another short term phenomenon where an increase in the degree of openness to trade leads to a fall in currency value. When developing countries open their market to international trade, their currency value is negatively related to the degree of openness. In contrast, when developed countries open themselves up to international trade, it affects them positively. Thus, the impact observed for developing countries is picked up as the impact of capital imports on devaluing the currency in these countries. Developed countries, conversely, do have more open trade and are the producers of capital goods. Further studies ought to be carried out in order to fully understand this difference between developed and developing countries.

In the longer term of one to three-yearly intervals, interest rates and monetary expansion continue to be significant drivers of exchange rates in the one- to three-year intervals. It is interesting that in the longer term, accumulation of reserves and foreign debt become more significant variables in influencing exchange rates in this region. Accumulation of reserves becomes statistically significant at two-year intervals where an increase in reserves improves the domestic currency values. Foreign debt, however, has a negative relationship with exchange rates where accumulation of more foreign borrowings actually reduces the credibility of currency at the three-year intervals. The other non parity fundamentals not significant in affecting exchange rates are balance of payments, current account balance, capital flows, fiscal budget and trade openness. Also, growth rates of these five countries are not a long-term phenomenon in driving exchange rates, as is the case with other regions.

In summary, for these five countries, (1) monetary expansion, interest rate (2) accumulation of reserve, and (3) excessive government foreign debt are long term drivers of exchange rates. Growth rate, budget balance and trade openness exert significant influences on exchange rates in the shorter period but not in the longer term.

5. Conclusion

The findings presented in this paper provide a modest contribution to extend the literature on exchange rate behaviour of Malaysia and five ASEAN emerging countries by considering the extent to which parity and non parity variables influence the movements of exchange rates systematically. We find that of the non parity variables for Malaysia, four have extensive explanatory power in the models investigated: growth rates, accumulation of reserves, trade openness and monetary expansion. Collectively, these variables explain about 80 per cent of the changes in exchange rates in Malaysia. The parity variables, on the other hand, are generally statistically insignificant. Another non parity variable which is marginally significant includes fiscal balance of the government.

For the group of trade-related ASEAN emerging countries, the results are robust as these are obtained from pooled panel data. We find that, in the long run, non parity fundamentals such as (1) monetary expansion, (2) accumulation of reserves, and (3) foreign borrowings provide explanation for movements in exchange rates. Interest parity is also found to be holding in the longer term: the method of SUR and fixed effects models both appear to yield robust results. PPP does not hold in the short run, which is consistent with prior empirical findings. Other non parity variables that drive exchange rates in the shorter term include fiscal budget balance, growth rate and trade openness. It is important to note

that different countries face a different set of parity and non parity variables which are significant in driving their exchange rates. We believe the tests developed in this study led to improved results, helped to identify new fundamentals that are related to exchange rates while the puzzle of the short-term versus long-term behaviour was made obvious by applying different data frequencies from quarterly to several years.

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