EXCHANGE RATE DETERMINATION IN JAMAICA: A MARKET MICROSTRUCTURES AND MACROECONOMIC FUNDAMENTALS APPROACH

by

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ABSTRACT

This paper uses hybrid models that combine economic fundamentals and micro-market variables to investigate the behaviour of US/Jamaica exchange rate. The co-integration analysis applied to post-2000 monthly data indicates, in contrast to previous studies done on Jamaica that these models give a better fit, produce parameter estimates with sensible signs and sizes and allow for long-run relationships which are not present when the micro-based variables are excluded.

Keywords: Exchange Rates, Microstructure, Co-integration
JEL No: F3, F4, C22

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Introduction

Arguably, the exchange rate is the most important price in an open economy. It has both direct and indirect effects on other macroeconomic variables such as imports, exports, wages and inflation. For instance, the exchange rate can influence inflation through increases in import prices of final goods (the direct channel), and through the price of imported intermediate inputs (the indirect channel). It is therefore surprising, that Meese and Rogoff (1983a, b) found that traditional macroeconomic theories have failed to explain exchange rate behaviour. Frankel and Rose (1995) put it this way in their survey in the *Handbook of International Economics*: 'There is remarkably little evidence that macroeconomic variables have consistent strong effects on floating exchange rates except during extraordinary circumstances such as hyperinflations. Such negative findings have led the profession to a certain degree of pessimism vis-à-vis exchange rate research [and] the Meese and Rogoff analysis at short horizons has never been convincingly overturned or explained. It continues to exert a pessimistic effect on the field of empirical exchange rate modelling in particular and international finance in general. Such results indicate that no model based on such standard fundamentals like money supplies, real income, interest rates, inflation rates, and current account balances will ever succeed in explaining or predicting a high percentage of the variation in the exchange rate, at least at short- or medium-term frequencies.'

Similar to the observations of Meese (1983) and Meese and Rogoff (1983a, b) for the United States (US) currency and the various currencies of other developed countries, Walker (2002), in exploring the relationship between volumes, volatility and spreads, and Seerattan (2004), in examining the efficiency of central bank intervention, questioned the applicability of traditional macroeconomic exchange rate theories to the economy of Jamaica. Walker (2002), in particular, suggested that these models do not work because they are based on assumptions, for instance, identical agents, perfect information, as well as costless transactions which are inconsistent with the reality of the market. Citing Frankel, Galli and Giovannini (1996) she pointed out that these models have not only failed to explain short-run exchange rate movements but have also been incapable of forecasting future movements in exchange rates. Seerattan (2004), on the other hand, argued that the microstructure approach provides a superior platform to conduct his analysis since such a framework allows for the examination of variables such as order flow, information flow, trading procedures, and liquidity on exchange rate determination. Consequently, both researchers used alternative theories from market microstructure finance to model the US/Jamaica exchange rate. They found that these latter theories explained the Jamaican/US rate reasonably well. The main purpose of this paper is to empirically test a hybrid model of the Jamaican/US$ exchange rate, along the lines of Evans and Lyons (2002) who amplified the traditional macroeconomic analysis by inserting a variable from market microstructure finance. This article differs from the previous studies undertaken for Jamaica in several ways. One, instead of only employing the traditional macroeconomic exchange rate theories or the micro-based theories, it applies a combination of the two. Two, the paper focuses on the more recent period of 2000-2008 in contrast to the 1990s used by earlier writers. Three, to accommodate the aggregative macro data, monthly frequency is utilised relative to daily series[2] employed by previous micro-researchers. Four, and along the lines of Chen (2004), four structural exchange rate models usually

[2] The unavailability of the series in daily monetary aggregates is a possible weakness of this article.

employed in the literature are considered, these include the purchasing power parity (PPP) model, and three variants of the canonical monetary model. Furthermore, these models are augmented with micro-based variables and are assessed using co-integration modelling, with the estimates of the long run relationships derived from the efficient dynamic Ordinary Least Squares (OLS) procedure of Stock and Watson (1993). As it relates to the other supplementary information presented in this paper, section 2 illustrates four canonical structural exchange rate models which are augmented with micro-market variables in Section 3. This section also provides a brief review of the empirical evidence in select developing countries, particularly Caribbean territories, in addition to assessing the Jamaican exchange market. In Section 4 the co-integration methodology, data and empirical results are discussed and section 5 concludes the paper.

2. Theoretical Background and Previous Empirical Evidence

The literature suggests various types of models on theories of exchange rates determination: the flexible price, the sticky price, the portfolio balance, and the monetary interest-rate differential models. As a number of surveys exists that deal with these extant theories and models (see Isard, 1995; Taylor, 1995), it is unnecessary to discuss them in detail here. Exchange rate theories can be adequately subsumed into three broad categories, namely partial equilibrium models which address both the relative and absolute PPP for the good market, as well as covered and uncovered interest rate for the asset market and the balance of payments; the general equilibrium framework which includes the Mundel-Flemming, the Balassa- Samuelson, the Redux and the pricing-to-market type models; and finally the disequilibrium or the so called hybrid structures which are usually derived by bringing together a monetary model that incorporates adjustments in price and output to achieve a long-run equilibrium. The purchasing power parity (PPP) model and three variants of the monetary model of exchange rate determination are outlined below.

The absolute PPP model tests how exchange rates relate to their relative consumer price index (CPI). The formula given below is based on the absolute PPP model that allows for transport costs, risk premia, and other factors:

$$s_t = \propto + p_t^* - p_t + \varepsilon_t \qquad (1)$$

All variables are in logarithms. s_t is the foreign currency price of a unit of home currency which implies that a larger number relates to an appreciation of the home currency. p_t and p_t^* are home and foreign CPI respectively, and ε_t represents a stationary disturbance term.

Now consider two variants of the flexible price monetary model, the latter based on PPP plus additional structural restrictions. One such constraint is the money market equilibrium, which states that the log of real money demand (m_t) depends linearly on the log of real income and the nominal interest rate:

$$m_t - p_t = \beta_y y_t - \beta_i i_t + \varepsilon_t$$

Assuming a similar money equation for the foreign country and manipulating the resultant expression, the exchange rate becomes a positive function of the relative money stocks and the nominal interest differentials between the two countries, and a negative function of their relative real income and relative prices (see Bilson (1978), Frenkel (1976), MacDonald and Taylor (1994) and Flood and Rose (1995)).

$$s_t = \propto + \beta_m(m_t^* - m_t) - \beta_p(p_t^* - p_t) - \beta_y(y_t^* - y_t) + \beta_i(i_t^* - i_t) + \varepsilon_t \quad (2)$$

The second monetary model presented here posits that the international capital market equilibrium is driven by the uncovered interest parity (UIP) condition:

$$i_t^* - i_t = E_t(s_{t+1} - s_t)$$

Incorporating the UIP into the flexible price monetary model above, the exchange rate can be expressed as the expected present-value of relative money stock, relative prices and relative real income, and positing that these three sets of fundamentals follow a drift less random walk, the following reduced-form equation can be derived (Mark (1995), Kilian (1999)):

$$s_t = \propto + \beta_m(m_t^* - m_t) - \beta_p(p_t^* - p_t) - \beta_y(y_t^* - y_t) + \varepsilon_t \quad (3)$$

The final monetary model discussed in this paper includes short-term price rigidities, following the work of Dornbusch (1976) and Frankel (1979). With short-run price stickiness, the PPP condition is violated temporarily, and the short-term liquidity effects of monetary policy would have to be captured by a relation between interest rates and the exchange rate. To incorporate the latter relationship, Frankel (1979) used a real interest rate variable defined as nominal interest rate differential term and an inflation expectation component to give the following reduced form equation:

$$s_t = a + (m_t^* - m_t) - \beta_p(p_t^* - p_t) - \beta_y(y_t^* - y_t) - \beta_i(i_t^* - i_t) + \beta_\pi(\pi_t^* - \pi_t) + \varepsilon_t \quad (4)$$

Note that in this model, the interest differentials enter the exchange equation with the opposite sign to that of the flexible price model presented above.

The four models outlined above along with their variants have all been tested extensively without much empirical success. In this paper, the focus is on the following four specifications that relate exchange rates (s_t) linearly to a set of fundamentals:

Relative PPP Model:

$$s_t = \propto + \beta_p (p_t^* - p_t) + \varepsilon_t \tag{5}$$

Asset Approach Flexible Price Monetary Model:

$$s_t = \propto + \beta_m (m_t^* - m_t) - \beta_p (p_t^* - p_t) - \beta_y (y_t^* - y_t) + \varepsilon_t \tag{6}$$

Flexible Price Monetary Model:

$$s_t = \propto + \beta_m (m_t^* - m_t) - \beta_p (p_t^* - p_t) - \beta_y (y_t^* - y_t) - \beta_i (i_t^* - i_t) + \varepsilon_t \tag{7}$$

Sticky Price Monetary Model:

$$s_t = \propto + \beta_m (m_t^* - m_t) - \beta_p (p_t^* - p_t) - \beta_y (y_t^* - y_t) - \beta_i (i_t^* - i_t) + \beta_\pi (\pi_t^* - \pi_t) + \varepsilon_t \tag{8}$$

The regression coefficients have the following interpretations and theoretical values: β_p, the coefficient on the relative CPIs, and β_m, the elasticity with respect to money stock, should be unity. β_y represents the income elasticity of money demand, and β_i and β_π the interest and expected inflation semi-elasticity. Note what appears as four models are in fact one (similar remarks apply to Equations *(11*) and *(14)*: the 'sticky price model' imbeds the other models. A general-to-specific type approach could be applied directly to the sticky price model. However, to compare this study with that of Chen (2004), the four equations are estimated instead of one.

As a result of attempts to solve the empirical difficulties of the traditional models, Evans and Lyons (2002) propose a framework based on portfolio shifts that incorporate elements from the market microstructure finance. The latter emphasises that some information relevant to exchange rates is not publicly available, that market participants and trading mechanisms differ in ways that affect prices (see Lyons (2001)). In this situation, variables like order flow (transaction volume that is signed) and the bid-ask spread become important to exchange rate determination.

The Evans and Lyons (2002) model can be expressed by:

$$DP_t = D_m - lDx_t \quad (9)$$

where *DP* is the exchange rate change, D_m are innovations concerning macroeconomic information (e.g., interest rate changes), *l* is a positive constant, D_x is the order flow, and the subscript *t* refers to time. The variable *x* is the accumulated order flow. This hybrid model gave better results, both in terms of the significance, size and signs of coefficients, as well as R^2, than the macro-based models. de Medeiros (2005) made two modifications to Equation (5) for estimation purposes. Firstly, he defined the public information increment D_m as the change in the interest rate differential i.e. $D_m = D(i - i^*)$, plus a white-noise random term. Secondly, he replaced the dependent variable by the change in the log of the spot exchange rate, D_p. With these adjustments, the specification becomes comparable to the standard macroeconomic models, taking the form:

$$Dp_t = a + bD(i_t - i_t^*) - lDx_t + e_t \tag{10}$$

where *Dp* is the change in the log of the spot exchange rate, *D(i – i*)* is the change in the interest rate differential, *Dx* is the order flow, *a* and *b* are regression parameters, and *e* ~ N(0, s^2) is the error term. This model was applied to the Brazilian foreign exchange market (R$/US$) using OLS and significant and correctly signed coefficients, and high R^2s were obtained, suggesting a tentatively adequate specification. Estimation by a GARCH process further improved the OLS results.

Exchange Rate Modelling in the Caribbean

Exchange rate modelling in the Caribbean has followed the international literature, with the focus on estimating macro-based theories. Coppin (1994) and Howard and Mamingi (2002), in studies for Barbados, found that there was evidence of the monetary approach to the balance of payments (MABP) which Dornbusch (1976) states relates changes in the balance of payments and exchange rate to variations in the supply and demand of money. Leon (1988), who examined Jamaican data, also indicated that the MABP's predictions were not rejected. More recently, Ghartey (1994) also concluded that the monetary approach to exchange rate determination holds in both Barbados and Jamaica, with stronger results for the latter country. Wint (2002), like Ghartey (1994), also argues that macroeconomic fundamentals are the causal factor driving the exchange rate for the period up to 1999 in Jamaica. However, after 1999 Wint's data do not support the usefulness of macroeconomic fundamentals as an empirical model of exchange rate and neither Ghartey nor Wint used microstructures in determining Jamaica's exchange rate.

Watson (1990), in a study where he modelled Trinidad and Tobago's balance of payments for the period 1965–1985, reported that it was not in accord with what the MABP predicted. More recently, Ghartey (2000) also found that there was no causal relationship between money supply and exchange rate, and that the external influence of oil revenues could have been the main contributor to this result.

Within the context of measuring the effectiveness of central bank intervention in the foreign exchange markets of Jamaica and Trinidad and Tobago, Seerattan (2004) and Walker (2002) found support for the micro-based approach to exchange rate determination. Seerattan and Spagnolo (2009) further realised that looking at the microstructures impact on the exchange rate without considering the volatility of the exchange rate, limited the usefulness of the exchange rate analysis to policy makers especially in an environment where exchange rate volatility was heavily influencing the dynamics within the market. As a result these authors modelled volatility of exchange rate movements within selected Caribbean countries using a multivariate GARCH model. This attempt by Seerattan and Spagnolo (2009) to capture the volatility was an extension of the work of Kim and Sheen (2006) that utilised a bivarate GARCH process as well as Kearns and Rigobon (2005) who employed simulated generalised method of moments (GMM).

Longmore and Robinson (2004) supported Meese and Rogoff's (1983) observation and question the ability of macroeconomic fundamentals in determining the rate of exchange, especially within the short run. They concluded that Jamaica's exchange rate was influenced by factors other than macroeconomic fundamentals and incorporated market microstructures variables in their model. Longmore and Robinson (2004) agreed with Wollmershaeuser (2003) that microstructures are concerned with the details of the mechanics of foreign exchange trading, while macroeconomics typically view this as largely unimportant.

Jamaica Exchange Market

Through the establishment of exchange rate stability and prudent monetary supply management, the Jamaican authorities (Bank of Jamaica) have attempted to maintain annual inflation to keep prices stable. Jamaica's exchange rate is therefore implemented to preserve the anti-inflationary policy of the Bank of Jamaica (BOJ) and not designed or used for external equilibrium in the balance of payments as reported by the IDB (2003).

The country's exchange rate is formally determined using a floating exchange rate regime in theory, but in practice the Bank of Jamaica intervenes strongly in the foreign exchange market, so as not to allow currency movements that could jeopardize stability in prices.

According to an IDB (2003) report, Jamaica has liberalized its foreign exchange market with the removal of exchange controls in 1991/92. The report further stated that in 1992 the Exchange Control Act was repealed and guidelines were established including the licensing of foreign exchange dealers and transactions regulations. Three main groups are included in the institutional framework of the Jamaican foreign exchange market. These are the authorized foreign exchange dealers (commercial banks, merchant banks and trust companies associated with merchant banks) whose duties include buying and selling foreign exchange, as well as taking deposits and making loans; cambios who are permitted only to buy and sell foreign exchange and bureaux de change who are limited to a maximum of US$10,000 or its equivalent for individual transactions. Bureaux de change are institutions created to facilitate transactions in the hotel sector, their primary trading activity being to exchange currency for hotel guests.

Authorized dealers and cambios are currently required to sell 5% of their daily gross purchases to the BOJ , while the bureaux de change have to sell 10% of their daily purchases to the BOJ, according to the IDB report. Any intervention by the BOJ takes place through authorized dealers and cambios, thereby directly impacting liquidity and the exchange rate.

The work of Longmore and Robinson (2004) showed that there is a need for market microstructures along with macroeconomics variables in determining the equilibrium of the Jamaican short-run exchange rate. This paper therefore developed the following empirical models incorporating these two types of variables.

3. Empirical Models

Along with Equations (5) to (8) the following empirical models, based on a combination of macro and microstructure variables, are estimated:

$$s_t = \propto + \beta_p(p_t^* - p_t) + c\,IS + d\,VS + f\,VB + g\,SP + \varepsilon_t \qquad (11)$$

$$s_t = \propto + \beta_m(m_t^* - m_t) + c\,IS + d\,VS + f\,VB + gSP + \varepsilon_t \qquad (12)$$

$$s_t = \propto + \beta_m(m_t^* - m_t) + \beta_i(i_t^* - i_t) + c\,IS + d\,VS + f\,VB + g\,SP + \varepsilon_t \qquad (13)$$

$$s_t = \propto + \beta_m(m_t^* - m_t) + \beta_i(i_t^* - i_t) + \beta_\pi(\pi_t^* - \pi_t) + c\,IS + d\,VS + f\,VB + g\,SP + \varepsilon_t \qquad (14)$$

where IS represents sales of foreign US dollars by the central bank for intervention purposes, VS is the volume of sales of US dollars in the market, VB is the volume of US dollars purchased in the market and SP is the bid-ask spread on US dollars in the market. These variables are similar to those utilised by Seerattan (2004). Note the ideal case would have been to include order flow since purchases and sales volumes are only rough indications of selling and buying pressures in the market because of double counting and other aggregation problems (Lyons, 2001). In terms of *a priori* signs, greater sales of US dollars are expected to be associated with a declining exchange rate (appreciation $d< 0$), while higher purchases of US dollars are likely to be related to an increasing exchange rate (depreciation $f > 0$). Rising spreads reflect market power in these markets, which is used to keep the selling rate relatively fixed but vary the buying rate to maintain or augment the spread. Thus, higher spreads are expected to be linked to a declining (appreciating $g < 0$) and/or relatively stable exchange rate (Seerattan, 2004). Of course, intervention by the central bank via the sale of US dollars is anticipated to be negatively related to the exchange rate ($c < 0$), that is, the sale of US dollars by the central bank in the market is likely to strengthen the exchange rate. Note that intervention purchases by the central bank in Jamaica are extremely rare.

4 Methodology, Data and Results

To establish the validity and importance of the respective models presented above co-integration analysis is used. First, unit root tests are conducted using the methods of Dickey and Fuller (1979) and Kwiatkowski, Phillips, Schmidt, and Shin (1992). Next, two tests that check for co-integration relations are undertaken, that is, the two-stage Engle-Granger (1987) Augmented Dickey-Fuller (ADF) procedure and the multivariate co-integration method of Johansen (1988). Finally, the dynamic OLS of Stock and Watson (1993) is used to estimate the co-integrating vectors. This approach has certain advantages over both the OLS and the maximum likelihood procedures. With respect to OLS, it improves on it by coping with small sample and dynamic sources of bias. It is also ideally suited for dealing with series integrated of different orders such as I(0) and I(1), an advantage suited to the dynamics of the different macro- and micro-variables used in the paper. The Johansen method, being a full information technique, is exposed to the problem that parameter estimates in one equation are affected by misspecification in other equations. The Stock Watson method is, by contrast, a robust single equation approach which compensates for regressor endogeneity by incorporating leads and lags of first differences of the explanatory variables, and for serially correlated errors by applying a generalised least squares (GLS) procedure. In addition, it has the same asymptotic optimality properties as the Johansen distribution.

In terms of the data, monthly observations over the period 2000 to 2008 are utilised. Following most of the literature, the money variable used is M1, as the exchange rate is primarily affected by currency in circulation and reserves at the central bank. The price variable is the Consumer Price Index (CPI), and the interest rate is the rate of returns on three-month Treasury bill. The exchange rate is the end of period monthly nominal Jamaican/US exchange rate. Real output is unavailable on a monthly basis for both the US and Jamaica. An attempt to utilise industrial production also failed due to a lack of data for Jamaica. Consequently, this variable is omitted from the relevant equations above. The information set also includes series from central bank intervention in the US dollar market (both the buying and selling operations), total volume selling, total volume buying and the bid-ask rate, which is a spread computed as the difference between the weighted average selling and the weighted average buying rate. All data are taken from the Bank of Jamaica data files.

Table 1 presents the descriptive statistics for the variables which display a mixture of normal and non-normal distributions. All computations were done in EVIEWS 6.1.

Table 1.Descriptive Statistics

	EXR	LRP	RM1	RRIR	LIDVUS	SPREADJUS	USDS	USDP
Mean	4.065833	-0.276487	0.445709	-3.105349	16.36659	0.249762	17.35567	17.32784
Median	4.117081	-0.264131	0.452200	-2.801666	16.38501	0.245000	17.35706	17.29011
Maximum	4.267737	-0.019103	0.729871	-1.586604	17.22428	0.450000	18.37478	18.03500
Minimum	3.821442	-0.575565	0.094429	-5.465803	15.28430	0.060000	16.64375	16.57770
Std. Dev.	0.143473	0.162290	0.132777	1.145857	0.412233	0.087688	0.324553	0.343157
Skewness	-0.560084	0.023495	-0.190350	-0.420100	-0.257005	0.257747	0.137460	0.066841
Kurtosis	1.855811	1.582955	2.812659	1.813251	2.657475	2.703104	3.104353	2.368689
Jarque-Bera	8.973801	7.035782	0.630103	7.400079	1.335353	1.238583	0.302648	1.457486
Probability	0.011255	0.029662	0.729751	0.024723	0.512899	0.538326	0.859569	0.482515

A quick glance at Figure A1 suggests that there may be a combination of trending and stationary variables, raising concern about spurious regressions. As a result, tests for the order of integration of the series are undertaken and then checks are made on the above models to see if the variables form co-integrating or long-run equilibrium relationships in the Engle and Granger (1987) sense. Establishing co-integration provides a criterion for choosing a model that only employs macroeconomic fundamentals as regressors to exchange rate determination or a model with both macroeconomic fundamentals and micro-market variables. As mentioned above, the unit root tests are conducted with the procedures of Dickey and Fuller (1979), and Kwiatkowski, Phillips, Schmidt, and Shin (1992). The former test takes a null hypothesis of non-stationarity while the null for the latter is stationarity. The results derived (see Table A1) are dependent on the particular test chosen. There is conclusive evidence that all the macro variables are I(1) and the bid ask spread is I(0). However, for the other micro-based variables, the findings from the two tests are in conflict, with the ADF test indicating I(0) and the KPSS statistic suggesting I(1). To resolve this conflict the more powerful Elliot, Rothenberg, and Stock (1996) ADF-GLS test is applied and the results reveal that all the variables are I(1) except the bid-ask spread.

The next step is to check for the existence co-integration relationships. In this respect, the two-stage Engle-Granger Augmented Dickey-Fuller (ADF) procedure which applies the ADF tests to the OLS residuals from the exchange rate-fundamentals regressions is used. The Johansen (1988) technique is also employed, not only to detect if any linear combination of the variables in the models is stationary, but also to determine the number of long-run relationships. These tests have low power, especially in small samples. As a result, the DOLS method is utilised to estimate the co-integrating vector. These results are reported in Table B2.

Both the Engle Granger and Johansen tests indicate that there is no co-integration among the variables in Models 5 to 8, that is, in the exchange rates-fundamentals regressions, but for the hybrid models (Models 11 to 14) there is evidence of co-integration (see Table B2). The Johansen technique reveals that there is one co-integration vector for all the hybrid specifications. For the DOLS estimation, four lags and leads are included in the respective models, then the insignificant ones are dropped until the models pass the classical least squares assumptions of serially uncorrelated, homoscedastic and normal errors, and constant parameters. Four variables are consistently significant and have the correct *a priori* sign in all of the models estimated. These are relative prices, relative money, intervention variable and US dollar purchases in the market. The inclusion of the micro-based variables improves the fit of all the models, produces coefficient estimates with *a priori* signs (see the interest rate variable in Model 10) and turn otherwise non-stationary residuals from OLS regressions to one supporting co-integration. In addition, these findings suggest that micro-market variables are important factors in explaining US/Jamaica exchange rate movements, and that their omission may explain some of the earlier failures of these empirical exchange rate equations.

Conclusions

Similar to international studies, standard macro fundamentals-based models of exchange rate determination have offered little empirical value in explaining exchange rate behaviour in Jamaica post 2000. This paper presents results that show that a hybrid model incorporating micro-based variables with these economic fundamentals can provide a better fit, produce parameter estimates with sensible signs and sizes as well as allow for co-integration or long-run relationships to be established using monthly data variables. The findings suggest that micro-market variables are important factors in determining US/Jamaica exchange rate movements, and that their omission may explain some of the earlier failures of these empirical exchange rate equations. These results can be used by policy makers to better explain movements in the Jamaican exchange rate, and the impact of the microstructure and macro variables.

References

Bilson, J. 1978. "Rational Expectations and the Exchange Rate". IMF Staff Papers

Coppin, A. 1994. "The Determinants of International Reserves in Barbados: A Test of the Monetarist Approach". *Social and Economic Studies.* Vol.43, 75-90.

Chen, Y. 2004. "Exchange Rates and Fundamentals: Evidence from Commodity Economies" University of Washington. Mimeographed Report.

Dickey, D.A. and W.A. Fuller. 1979. "Distribution of Estimators for Time Series Regressions with a Unit Root". *Journal of the American Statistical Association.* Vol.74, 427-431.

Elliot, G., T.J. Rothenberg and J.H.S tock. 1996. "Efficient Tests for an Autoregressive Unit Root". Technical Working Paper No. 130. National Bureau of Economic Research.

Evans, M.D.D. and R.K. Lyons. 2002. "Order Flow and Exchange Rate Dynamics". *Journal of Political Economy*, Vol. 110, No.1, 170-180.

de Medeiros, O. 2005. "Exchange Rate and Market Microstructure in Brazil". *Academic Open Internet Journal,* Vol.14.

Dornbusch, R. 1976. "Expectations and Exchange Rate Dynamics". *Journal of Political Economy*, Vol. 84, 1161-1176.

Engle, R.F. and C.W.J. Granger. 1987. "Co-integration and Error Correction: Representation, Estimation, and Testing". *Econometrica,* Vol. 55, 251–276.

Flood, R. and A. Rose. 1995. "Fixing Exchange Rates: a Virtual Quest for Fundamentals". *Journal of Monetary Economics*, Vol. 36, No. 1, 3-38.

Frenkel, J. 1976. "A Monetary Approach to the Exchange Rate: Doctrinal Aspects and Empirical Evidence". *Scandinavian Journal of Economics*, Vol. 78, No. 2, 200-224.

Frankel, J. 1979. "On the Mark: a Theory of Floating Exchange Rates Based on Real Interest Differentials". *American Economic Review*, Vol. 69, 610-622.

Frankel, J., and A. Rose. 1995. "Empirical Research on Nominal Exchange Rates" in *Handbook of International Economics* Vol. 3, edited by Gene Grossman and Kenneth Rogoff . Amsterdam: Elsevier Science.

Frankel, J., G. Galli and A. Giovannini. 1996. "The Microstructure of Foreign Exchange Markets". *National Bureau of Economic Research* HG205.M53.

Ghartey, E. 1994. "Seasonal Integration and Cointegration Exchange Rate and Monetary Policy Dynamics in a Caribbean Environment". Working Papers, Caribbean Centre for Money and Finance.

Ghartey, E. 2000. "Macroeconomic Instability and Inflationary Financing in Ghana", *Economic Modelling*, Vol. 18, No. 3, 415-433.

Howard, M. and N. Mamingi. 2002. "The Monetary Approach to the Balance of Payments: An Application to Barbados". *The Singapore Economic Review*, Vol. 47, No. 2, 213–228.

Inter-American Development Bank. Annual Report 2003. http://www.iadb.org/exr/ar99/ar2003/ar2003_eng.pdf

Isard, P. 1995. *Exchange Rate Economics*. Cambridge, UK: Cambridge University Press.

Johansen, S. 1988. "Statistical Analysis of Co-integrating Vectors". *Journal of Economic Dynamics and Control,* Vol.12, 231-254.

Kearns, J. and R. Rigobon. 2005. "Identifying the Efficacy of Central Bank Intervention: Evidence from Australia and Japan". *Journal of International Economics*, Vol.66, 31-48

Kilian, L. 1999. "Exchange Rates and Monetary Fundamentals: What do we Learn from Long Horizon

Regressions?" *Journal of Applied Econometrics,* Vol. 14, 491-510.

Kim, S., and J. Sheen. 2006. "Interventions in the Yen-Dollar Spot Market: A Story of Price, Volatility and Volume". *Journal of Banking and Finance*, Vol. 30, 3191-3214.

Kwiatkowski, D., P.C.B. Phillips, P. Schmidt and Y, Shin. 1992. "Testing the Null Hypothesis of Stationarity Against the Alternative of a Unit Root: How Sure are we that Economic Time Series have a Unit Root?" *Journal of Econometrics*, Vol. 54, 159-178.

Leon, H. 1988. "A Monetary Approach to the Balance Of Payments: A Simple Test of Jamaican Data". *Social and Economic Studies*, Vol. 37, No. 4, 1–37.

Longmore, R. and W. Robinson. 2004. "Modelling and Forecasting Exchange Rate Dynamics in Jamaica: An Application of Asymmetric Volatility Models". Bank of Jamaica, Mimeographed Report.

Lyons, R.K. 2001. *The Microstructure Approach to Exchange Rates.* Cambridge, MA: MIT Press.

MacDonald, R. and M. Taylor. 1994. "The Monetary Model of the Exchange Rate: Long-run Relationships, Short-run Dynamics and how to Beat a Random Walk". *Journal of International Money and Finance*, Vol. 13, 276-90.

Mark, N., 1995. "Exchange Rates and Fundamentals: Evidence on Long-horizon Prediction". *American Economic Review,* Vol. 85, 201-218.

Meese, R. and K. Rogoff. 1983a. "Empirical Exchange Rate Models of the Seventies: Do they Fit out of Sample?" *Journal of International Economics*, Vol. 14, 3-24.

Meese, R. and K. Rogoff. 1983b. "The Out-of-Sample Failure of Empirical Exchange Rate Models" in: *Exchange Rate and International Macroeconomics*, edited by J. Frenkel, Chicago: University of Chicago Press.

Seerattan, D. 2004. "The Effectiveness of Central Bank Intervention in The Foreign Exchange Markets in Select Flexible Exchange Rate Countries in the Caribbean. Mimeographed Report.

Seerattan, D. and N. Spagnolo. 2009. "Intervention in the Foreign Exchange Market, Market Turnover and the Impact on Exchange and Interest Rate Dynamics in the Caribbean". Mimeographed Report.

Stock, J. and M. Watson. 1993. "A Simple Estimator of Co-integrating Vectors in Higher Order Integrated Systems". *Econometrica,* Vol. 61, No. 4, 783-820.

Taylor, M. 1995. "The Economics of Exchange Rates". *Journal of Economic Literature,* Vol. 33, 13-47.

Walker, A. 2002. "The Microstructure of the Jamaican Foreign Exchange Market: Volumes, Volatility and Spreads". Bank of Jamaica, Mimeographed Report

Watson, P.K. 1990. "Modelling the Balance Of Payments of Trinidad And Tobago, 1965–1985". *Social and Economic Studies*, Vol. 39, No. 1, 51–70.

Wint, A. 2002. "Competitiveness in Small Developing Economies: Insights from the Caribbean". University of the West Indies.

Wollmershaeuser, V.T. 2003. "A Theory of Managed Floating". University of Wurzburg, PhD Dissertation.

Appendix A

Figure A1 : Plots of Variables

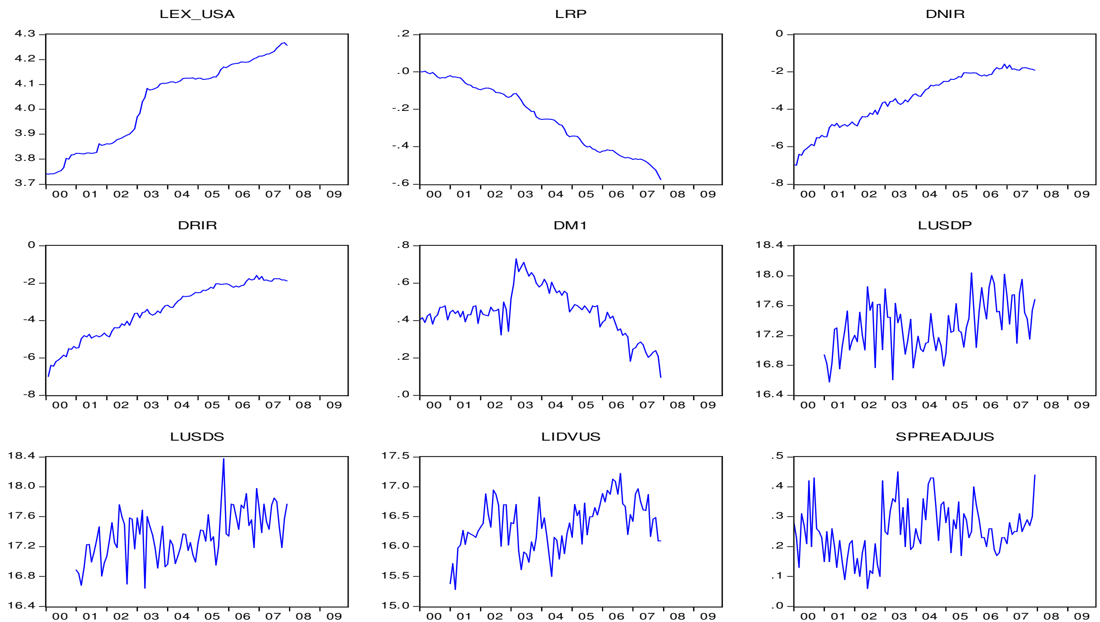

Table A1. Representative Unit Root Test Statistics

A. In Levels

	ADF	KPSS	DF-GLS
Log(Nominal ExRate)	-1.437	1.253***	
Log(Relative CPI)	-0.835	1.302***	
Log(Relative M1)	-0.447	0.463*	
Log(Relative RIR)	-2.203	0.285***	
Log(Intervention)	-3.187**	0.500**	-2.421
Log(USDPurchases)	-6.301***	0.780***	-1.498
Log(USDSales)	-6.080***	0.956***	-0.712
Bid-Ask (Spread)	-3.467**	0.300	

Table B1: First Differences

	ADF	KPSS	DF-GLS
ΔLog(Nominal ExRate)	-3.933***	0.146	
ΔLog(Relative CPI)	-5.751***	0.236	
ΔLog(Relative M1)	-12.399***	0.393	
ΔLog(Relative RIR)	-13.309***	0.094	
ΔLog(Intervention)		0.225	-13.085***
ΔLog(USDPurchases)		0.106	-10.483***
ΔLog(USDSales)		0.089	-10.528***

*Notes:*** indicates rejection of the null at 1% significance level; ** at 5% and * at 10%.*

Table B2. Estimation of Cointegration Vectors Under DOLS Dependent Variable: Log(Nominal ExRate)

	PPP Model		Asset Approach Flexible Price Monetary Model		Flexible Price Monetary Model		Sticky Price Monetary Model	
	Macro	Hybrid	Macro	Hybrid	Macro	Hybrid	Macro	Hybrid
Log(Relative CPI)	-0.868*** (0.029)	-0.852 (0.041)	-0.991*** (0.019)	-0.993*** (0.026)	-0.719*** (0.080)	-1.040*** (0.057)	-0.746*** (0.087)	-1.040*** (0.057)
Log(Relative M1)			0.368*** (0.032)	0.344*** (0.026)	0.337*** (0.032)	0.304*** (0.021)	0.388*** (0.034)	0.307*** (0.020)
Log(Relative NIR)					0.032*** (0.009)	-0.010 (0.007)		
Log(Relative RIR)						-0.010 (0.008)	0.028*** (0.010)	-0.010 (0.008)

Table B2 (*Continued*). Estimation of Cointegration Vectors Under DOLS Dependent Variable: Log(Nominal ExRate) *Cont'd*

	PPP Model		Asset Approach Flexible Price Monetary Model		Flexible Price Monetary Model		Sticky Price Monetary Model	
	Macro	Hybrid	Macro	Hybrid	Macro	Hybrid	Macro	Hybrid
Log(Intervention)		-0.164*** (0.031)		- 0.100*** (0.015)		-0.175*** (0.012)		- 0.175*** (0.012)
Log(USDPurchases)		-0.089 (0.059)		0.060*** (0.021)		0.139*** (0.026)		0.141*** (0.026)
Log(USDSales)		0.241*** (0.079)		0.017 (0.019)		0.045 (0.029)		0.043 (0.043)

Table B2 *(Continued)*. **Estimation of Cointegration Vectors Under DOLS Dependent Variable: Log(Nominal ExRate)** ***cont'd***

	PPP Model		Asset Approach Flexible Price Monetary Model		Flexible Price Monetary Model		Sticky Price Monetary Model	
	Macro	Hybrid	Macro	Hybrid	Macro	Hybrid	Macro	Hybrid
Bid-Ask (Spread)		0.168** (0.064)		0.030 (0.039)		0.041 (0.026)		0.038 (0.026)
Engle-Granger Co-integration	NO	YES	NO	YES	NO	YES	NO	YES
Johansen Co-integration [Rank)	NO	YES [1]	NO [1]	YES	NO	YES [1]	NO	YES [1]
Adjusted R^2		0.926		0.973		0.977		0.976
Number .of Observations		88		88		88	87	

*Notes:*** indicates rejection of the null at 1% significance level; ** at 5% and * at 10%.*

Note it is possible that seasonality of order flows (purchases and sales) arising from tourism receipts may affect the exchange rate. To account for this the US$ purchases and sales were deseasonalised and included in models 7 to 10. These results, shown in Table B3, revealed similar findings as the models that were not deseasonalised.

Table B3. Estimation of Cointegration Vectors Under DOLS
Dependent Variable: Log(Nominal ExRate)

	PPP Model		Asset Approach Flexible Price Monetary Model		Flexible Price Monetary Model		Sticky Price Monetary Model	
	Hybrid	D/S. Hybrid	Hybrid	D/S. Hybrid	Hybrid	D/S. Hybrid	Hybrid	D/S. Hybrid
Log(Relative CPI)	-0.852*** (0.041)	-0.213*** (0.09)	-0.993*** (0.026)	-0.309*** (0.076)	-1.040*** (0.057)	-0.915*** (0.090)	-1.040*** (0.057)	-(0.915)*** (0.092)
Log(Relative M1)			0.344*** (0.026)	0.347*** (0.037)	0.304*** (0.021)	(0.387)*** (0.001)	0.307*** (0.020)	(0.387)*** (0.001)
Log(Relative NIR)					-0.010 (0.007)	-0.004** (0.0015)		
Log(Relative RIR)					-0.010 (0.008)	-0.004*** (0.0001)	-0.010 (0.008)	-0.0037*** (0.0000)
Log(Intervention)	-0.164*** (0.031)	-0.1562*** (0.021)	-0.100*** (0.015)	-0.1702*** (0.0217)	-0.175*** (0.012)	-0.1717*** (0.0209)	-0.175*** (0.012)	-0.1720*** (0.019)

Table B3 *(Continued)* Estimation of Cointegration Vectors Under DOLS Dependent Variable: Log(Nominal ExRate) *Cont'd*

	PPP Model		Asset Approach Flexible Price Monetary Model		Flexible Price Monetary Model		Sticky Price Monetary Model	
	Hybrid	D/S. Hybrid	Hybrid	D/S. Hybrid	Hybrid	D/S. Hybrid	Hybrid	D/S. Hybrid
Log(USDPurchases)	-0.089 (0.059)	-0.0905*** (0.0103)	0.060*** (0.021)	0.072*** (0.008)	0.139*** (0.026)	0.056*** (0.006)	0.141*** (0.026)	0.056*** (0.005)
Log(USDSales)	(0.241)*** (0.079)	0.148* * (0.050)	0.017 (0.019)	0.180*** (0.019)	0.045 (0.029)	0.192*** (0.016)	0.043 (0.043)	0.190*** (0.015)

Table B3*(Continued)*. Estimation of Cointegration Vectors Under DOLS Dependent Variable: Log(Nominal ExRate) *Cont'd*

	PPP Model		Asset Approach Flexible Price Monetary Model		Flexible Price Monetary Model		Sticky Price Monetary Model	
	Hybrid	D/S. Hybrid	Hybrid	D/S. Hybrid	Hybrid	D/S. Hybrid	Hybrid	D/S. Hybrid
Bid-Ask (Spread)	0.168** (0.064)	0.1810*** (0.0248)	0.030 (0.039)	0.169*** (0.034)	0.041 (0.026)	0.172*** (0.020)	0.038 (0.026)	0.170*** (0.021)
Engle-Granger Co-integration	YES	YES	YES	YES	YES	YES	YES	YES
Johansen Co-integration [Rank)	YES [1]	YES[1]	YES [1]	YES[1}	YES [1]	YES[1]	YES [1]	YES[1]
Adjusted R^2	0.926	0.907	0.973	0.956	0.977	0.984	0.976	0.983
Number .of Observations	88	88	88	88	88	88	87	88

*Notes:*** indicates rejection of the null at 1% significance level; ** at 5% and * at 10%.*