Working Paper

Estimating Jamaica's Fundamental Equilibrium Exchange Rate

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Abstract

The study sets out to enhance the Bank of Jamaica's portfolio of equilibrium exchange rate measures through the estimation of the Fundamental Equilibrium Exchange Rate for Jamaica. The FEER is a medium-term equilibrium exchange rate measure where equilibrium is defined as the level of the real effective exchange rate (REER) that is compatible with a country's internal and external balance. The FEER was estimated using the Autoregressive Distributed Lag (ARDL) approach. The study found that there were periods where Jamaica's REER was undervalued and periods where the REER was overvalued. Importantly, the study revealed that the depreciation observed since December 2011 has brought the REER in line with the equilibrium measure as at September 2013.

JEL Classification: F31, F32

[1] The views expressed in this paper do not necessarily reflect those of the Bank of Jamaica. The author is grateful to Mrs. Sharon Miller-Betty, Ms. Carey-Anne Williams and Ms. Karlia Jones for their assistance with the completion of this paper.

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1.0 Introduction

Equilibrium exchange rates are important primarily because of the relationship between the value of a country's currency and the sustainability of its balance of payments. This sustainability is influenced by the degree of competitiveness of the country's export industries and the domestic price of imports. In terms of the domestic economy, movements in the exchange rate will have an impact on inflation and investor confidence. An equilibrium measure can aid policy-makers in assessing the degree of adjustment which would be required of the nominal exchange rate in order to improve the country's price competitiveness and balance of payments (BOP).[2] Changes in the measures of equilibrium could also assist in highlighting the role which factors besides the exchange rate are playing in terms of a country's competitiveness, thereby preventing the targeting of a particular exchange rate adjustment when other structural weaknesses require more urgent attention.[3] The issue of an equilibrium exchange rate has become topical in the context of Jamaica's current Extended Fund Facility (EFF) with the International Monetary Fund (IMF) and comments by Fund staff about the currency's overvaluation.

Over the 15-year period FY1997/98 to FY2012/13, the Jamaica Dollar, vis-à-vis the US dollar, depreciated at an annual average rate of 6.1 per cent per year. This trend includes depreciation of 20.0 per cent in FY2008/09 during the onset of the global financial crisis and an appreciation of 4.4 per cent in FY2010/11, largely influenced by increased capital inflows following the signing of a Stand-By Arrangement (SBA) with the International Monetary Fund (IMF) in February 2010. The break-down of this arrangement and subsequent loss of investor confidence contributed to depreciation of 11.7 per cent in FY2012/13. Notwithstanding the depreciation over the 15-year period (FY1997/98 to FY2012/13), the Jamaica Dollar lost competitiveness at a rate of approximately 0.6 per cent per year, as measured by the real effective exchange rate (REER), resulting in a total loss of competitiveness of approximately 8.1 per cent. Since October 2012,

[2] Williamson (1983) distinguishes the market equilibrium exchange rate as the one which balances demand and supply of the currency in the absence of official intervention. Short-term equilibrium is defined as the exchange rate which will pertain if the market has full knowledge of the facts and reacts rationally. Medium-term equilibrium is achieved when the economy is at internal and external balance. Long-term equilibrium is defined as the point when equilibrium is achieved for all agents in the economy. This may take many years or decades to achieve (Williamson, 1983).

[3] In addition to price competitiveness, the World Bank (2011) listed the following as reasons for Jamaica's poor growth performance: frequent natural disasters, distortions from tax incentives, limited space for productive public spending due to high public debt, inadequate human capital, migration of skilled labour, crime and lapses in governance.

there has been a marked increase in the pace of exchange rate depreciation. This has resulted in some gain in competitiveness.

The issue of competitiveness is especially relevant in the context of the poor performance of Jamaica's external accounts over the past 15 years. Over the period from FY1997/98 to FY2012/13, Jamaica's current account deficit (CAD) averaged 9.5 per cent of Gross Domestic Product (GDP) and ranged from 5.0 per cent in FY2000/01 to 18.9 per cent in FY2008/09 (see **Graph 1, appendix**). Importantly, the deficit on the goods sub-account averaged 22.4 per cent of GDP, ranging from 13.0 per cent in FY1998/99 to 33.8 per cent in FY2008/09. The goods deficit has been the major driver of Jamaica's CAD over the period (see **Graph 2, appendix**). Jamaica's main imports have been fuel and consumer goods while the main exports have emanated from the mining sector (see **Graphs 3 and 4, appendix**).[4] Non-traditional exports such as mineral fuel and ethanol have been of growing significance over the past decade (see **Graph 4, appendix**). These high CADs have contributed to Jamaica's unsustainable International Investment Position (IIP) of -132.7 per cent of GDP (-US$19.1 billion) as at end-December 2012.

Other measures of competitiveness have produced varying results. Over the past decade, the ratio of tradables to non-tradables has declined marginally, indicating a loss in competitiveness.[5] Since 2007, the profitability of the manufacturing sector has increased as evidenced by the Unit Labour Cost (ULC) index.[6] The trend in the REER–ULC suggests that Jamaica has gained competitiveness since 2006.[7] This resulted from a downward trend in the ULC for Jamaica, relative to those of some OECD countries, namely USA, Canada, UK, Germany, Spain and Japan. This improvement may be attributed to a sharp decline in Jamaica's ULC of the manufacturing sector in 2007 largely reflecting a reduction in the labour compensation costs.

[4] Mining exports include bauxite and alumina

[5] Tradables were grouped as a sum of the components: agriculture export, mining and quarrying, manufacturing, mainly textiles and hotels & restaurants. Construction and services excluding hotels were considered non-tradable goods. In calculating the above indices, each sector was assigned a weight corresponding to its contribution to GDP. The base year used to create each price index was 1996. An increase in the measure suggests that investors would be more inclined to invest in the tradables sector.

[6] Improved competitiveness should allow domestic producers of tradable goods greater profits and hence increased production. An increase in the ratio suggests that the ULC is falling relative to the value-added. In this regard, an increase in the ratio suggests improved competitiveness.

[7] The REER-ULC is the REER deflated by ULC

Additionally, Jamaica's share of global exports has been declining, in large part due to Jamaica's exports of manufactured goods.

Regarding the responsiveness of imports and consequently, the current account, to changes in the REER, Henry and Longmore (2003) did not find a statistically significant relationship and indicated that their finding precludes a role for exchange rate and relative price adjustments in compressing import demand in a stabilization programme in Jamaica.[8] (See **Graphs 5 and 6, appendix**). Regarding the structural weaknesses of the Jamaican economy, Henry and Longmore (2003) pointed to trading arrangements, limited research and marketing support, crime and violence as well as the overall quality and work ethic of the labour force.

1.1 The Real Effective Exchange Rate

Driver and Westaway (2003) characterize the exchange rate in terms of a dynamic reduced form relationship which relates it to a set of explanatory variables such that:

$$e_t = \beta' Z_t + \theta' T_t + \varepsilon_t \qquad (1)$$

where e_t is the exchange rate in time t, Z is a vector of economic fundamentals that are expected to influence the exchange rate in the medium to long-run, T is a vector of transitory factors (including current and lagged variables as dynamic effects from the fundamentals, Z) which will have an impact on the exchange rate in the short-term. ε_t is a random disturbance and β and θ are vectors of coefficients. In the short-run, Andersen *et al* (2003) and Faust *et al* (2003) caution that the news component of macroeconomic announcements has an impact on the exchange rate in the immediate aftermath, measured in minutes, of the announcement. However, these movements only represent a small fraction of daily exchange rate volatility, making the impact of the announcements harder to detect at longer frequencies.

[8] An analysis of the elasticities by Henry and Longmore (2003) revealed that, in the long-term, the trade balance and consequently the current account will not improve with depreciation in the exchange rate as suggested by the Marshall-Lerner condition. A weighted summation of the elasticities of demand for imports and exports yielded a total of 0.4.

A real exchange rate (RER) can be expressed as the nominal exchange rate adjusted for any price differences between two or more countries. Depending on the prices being observed for the two countries, the measurement of the real exchange rate can take on very different values and direction of change and interpretation. The RER can be expressed in the manner shown in equation 2. A representation of the real effective exchange rate (REER) is derived from a composite weighting of the RER for a range of key trading partners. This is expressed in equation 3 below:

$$RER = S_{ijt}(\frac{P_{it}}{P_{jt}^{*}}) \quad (2)$$

$$REER = \left[S_{ijt}P_{it}/P_{jt}^{*}\right]^{\omega ij} \quad (3)$$

where RER and $REER$ is the real exchange rate and real effective exchange rate respectively, S_t is the nominal exchange rate between country i and j, P_{it} is the price level for the domestic country i and P_{jt}^{*} is the price level for the foreign country j. The RER is expressed as a geometric mean where $\omega_{ij}$is the weight of the foreign country j in the total trade of country i.

Eckstein and Friedman (2011) postulate that in a small open economy, the RER has an important impact on a country's growth trajectory and by extension, their economic stability. They added that RER misalignments could cause output loss and cyclical, inefficient allocation of resources, including low utilization of factors of production. Siregar and Rajan (2006) similarly argue that misalignment in the RER results in a country's loss of external competitiveness and growth reduction. In addition, they note that there is a possibility that sustained overvaluation could lead to a currency crisis and sustained undervaluation could lead to overheating of the economy. It is also argued that misalignment of the RER is responsible for global macroeconomic imbalances whereby countries with a grossly undervalued currency would automatically have an unfair competitive advantage.

1.2 Measures of Equilibrium Exchange Rates

The literature offers a number of different approaches to calculating the equilibrium exchange rate. These approaches include short-run (SR), medium-run (MR) and long-run (LR) measures of equilibrium. Among the SR measures are the capital enhanced equilibrium exchange rate

(CHEER) model and the behavioural equilibrium exchange rate (BEER). Examples of MR models are the fundamental equilibrium exchange rate (FEER) and the desired equilibrium exchange rate (DEER) while the LR measures include the natural real exchange rate (NATREX) and the atheoretical permanent equilibrium exchange rate (APEER) (Westaway and Driver, 2003).

Apart from the issue of the time period being assessed, these measures differ from the FEER in the theoretical construct. In particular, the BEER focuses on the Uncovered Interest Parity (UIP) condition where variables are expressed with respect to the country's main trading partners while the CHEER focuses on both the UIP and Purchasing Power Parity (PPP) conditions. In this context, the key factor underlying equilibrium in these SR measures would be the real interest rate differential and relative prices.[9] In contrast, the FEER focuses on the fundamentals that would allow the country to adjust to full employment and a sustainable current account level (see **Table 1, Appendix**). However, there is no consensus on the correct concept of equilibrium exchange rate and estimates can vary widely.

The Bank of Jamaica has calculated the BEER, CHEER and PEER (Robinson, 2010). Recent work has also been done on the NATREX (Wright, 2013).[10] This study seeks to enhance the

[9] Purchasing Power Parity (PPP) is based on the Law of One Price which implies that, in two countries that produce a similar good with minimal transportation costs and barriers to trade, the exchange rate should be such that the cost of a non-differentiable good remains the same throughout the world irrespective of the country in which it is produced (Mishkin, 2004). Uncovered Interest Parity (UIP) is based on the Theory of Asset Demand assuming currency transfers between territories are free of capital mobility restrictions rendering deposits in foreign currency to be a perfect substitute for deposits in domestic currency. On this basis the decision about whether to hold foreign or domestic currency, deposits will depend solely on the rate of interest offered on either domestic or foreign currency deposit accounts. Both domestic and foreign investors will shift deposits to the territory that offers a higher rate of interest on their respective currency deposits. The UIP condition therefore requires that the exchange rate be adjusted to correct any prevailing interest rate deviations between the observed territories i.e. arbitrage (Mishkin, 2004). The key difference between the two is that PPP is essentially a long-run (LR) condition due to stickiness of prices over time, while UIP is a short-run (SR) equilibrium condition due to the lower level of friction in capital market interest rates determination.

[10] Stein (1994) is the seminal contributor to the NATREX. This approach is conceptualized as the rate that would be actualized if unemployment was at its natural level and speculative and cyclical market factors were removed (Siregar and Rajan, 2006). In a later paper, Stein (2001) articulates that the ERER is a sustainable rate that satisfies a myriad of criteria. Among these criteria is the fact that at this rate, the economy is at full capacity, which implies that actual output is equal to potential output, unemployment is at its natural rate and inflationary adjustment is stable. Stein (2001) also posits that external balance must also be achieved. This assumes that investors are indifferent between holding domestic and foreign assets and there is neither upward nor downward pressure on the exchange rate. It also implies that interest rates between the two countries converge to a stable mean and the country's debt obligations stabilize to a sustainable level.

Bank's menu of equilibrium exchange rates through the addition of the FEER. This addition is particularly relevant in the context of the country's current borrowing relationship with the International Monetary Fund (IMF) and the attempts being made to restructure the Jamaican economy in an effort to foster macroeconomic stability, increase competitiveness and create a platform for economic growth.

The paper is structured as follows: Section two presents the literature review, section three presents the data and methodology, section four shows the results of the econometric estimation while section five provides the conclusion.

2.0 Literature Review

Various measures can be used to calculate a country's Equilibrium Real Effective Ecxhange Rate (EREER) with the selection of the appropriate measure based largely on the time-period being assessed. SR models largely consider capital market dynamics that reflect the actions of asset holders in response to available market information. The range of SR models include the Flexible Price Monetary Models (FPMM), Sticky Price Monetary Models (SPMM) proposed by Dornbusch (1976), the Portfolio Balance model presented by Chinn and Frankel (1993), MacDonald and Taylor (1992) and Taylor (1995), the CHEER model presented by MacDonald (2000) and the BEER model presented by Clark and MacDonald (1997 and 1999) (Robinson, 2010).

The FPMM proposed that prices are flexible and that purchasing power parity (PPP) holds continually (Frenkel, 1976) and (MacDonald and Taylor, 1992). Dornbusch (1976) introduced the concept of sticky prices, suggesting that prices take time to adjust, thereby causing nominal and real exchange rates to overshoot equilibrium levels. Shortcomings of the FPMM and SPMM models relate to the UIP assumption of no restrictions on the mobility of capital between territories. The CHEER model is based on the premise that, at any given point in time, the PPP condition may be in disequilibrium due to non-zero interest rate differentials in the SR. The CHEER model combines both components of the PPP and UIP conditions in determining equilibrium exchange rates (McDonald and Taylor, 1992).

The BEER model is also premised on the UIP condition which accounts for imperfect capital mobility with a risk premium (Driver and Westaway, 2003). In the empirical work, this risk premium is proxied using the ratio of outstanding domestic government debt to foreign government debt, both as a percentage of GDP. However, even with the addition of a risk premium, the UIP relationship is difficult to implement as an empirical model because of the absence of observed expectations of future levels of the RER. Clark and MacDonald (1997 and 1999) make the assumption that expected future exchange rates will be related to long-run fundamentals. The variables that Clark and MacDonald (1997 and 1999) use to represent long-run fundamentals are: the terms of trade (TOT) or the ratio of the unit value of exports to the unit value of imports; the relative price of traded to non-traded goods (TNT), proxied by the ratio of the Consumer Price Index (CPI) to the Producer Price Index (PPI); and Net Foreign Assets (NFA) as a ratio of Gross National Product (GNP). In each case, these variables are measured relative to their foreign counterparts.

An exchange rate is theoretically deemed to be at MR equilibrium when the internal and external economic affairs of a country are brought to a point where there is no natural tendency for change (Robinson, 2010). The internal balance relates to a position of full employment of resources while external balance relates to a sustainable current account position that is typically consistent with convergence to a LR steady state (Driver and Westaway, 2003). MR models include the FEER and DEER. These are both underlying balance models whereby the equilibrium is defined as the level of the RER that is compatible with internal and external balance but where asset stocks may still be changing over time (Driver and Westaway, 2003).

Among the LR models, Atheoretical Permanent Equilibrium Exchange Rate (APEER) aims to capture permanent changes in the RER using purely statistical techniques. Permanent Equilibrium Exchange Rates (PEERs) extend the BEER approach to use statistical methods to capture permanent movements in equilibrium exchange rates. Finally, the NATREX model aims to capture long-run exchange rate movements, where equilibrium is determined using the assumption that asset stocks will be constant (Driver and Westaway, 2003).

Wright (2013) calculated EREER's for select developing countries in the Western Hemisphere using the Macroeconomic Balance (MB) and NATREX approaches.[11] Wright (2013) found that the critical factors influencing the sustainable levels of the current account included a country's NFA to GDP ratio, relative productivity growth, labour force participation and fuel to GDP ratio. The world economic crisis was also found to significantly reduce the sustainable levels of the CAD, which can be explained by shocks to the flow of capital during these periods. Wright (2013) used an Autoregressive Distributive Lag (ARDL) error correction model which suggested that disequilibrium in the exchange rate is adjusted by 46.2 per cent each year and that the half-life deviation formula suggested that a half of the deviation in the exchange rate is corrected after 1.1 years for each country in the panel.[12]

Wright (2013) pointed out that the results from the NATREX and the MB approaches are not readily comparable because of the nature of the underlying assumptions of the two methodologies. The NATREX estimates a dynamic long-run equilibrium exchange rate that is consistent with macroeconomic fundamentals while the MB approach estimates the exchange rate misalignment over the medium-term that would ensure internal and external balance simultaneously. Additionally, while the NATREX is a direct approach to calculating the EREER, the MB approach utilizes an indirect methodology to calculate exchange rate misalignment.

Notwithstanding the differences, the two approaches were consistent in showing that there have been several intervals of misalignment and exchange rate adjustment over the sample period. Most of the factors which were found to significantly influence the current account norm were also found to have long-run relationships with the REER. The most consistent and important findings between the two approaches is that exchange rate misalignment is a stationary series which is largely self-corrective. This implies that, in the long-run, there should be no misalignment in the exchange rate since macroeconomic fundamentals will adjust to ensure that both exchange rate and current account gaps are closed. Finally, the resulting equilibrium

[11] The countries included the Dominican Republic, Jamaica, Peru and Uruguay

[12] The Half-Life Derivation formula as adopted from an IMF working paper by Zalduendo (2006) is as follows:
The cointegrating equation provides a means to assess the speed of adjustment; namely, the time in years, *t*, necessary to reduce the initial deviation from equilibrium can be calculated by estimating $(1-\gamma)t = (1-\delta)$, where γ is the estimated cointegrating coefficient and δ is the share of the catch-up being targeted (e.g., 0.5 for a half-life reduction). $T = [\text{Ln}\ (1-\delta)]/ [\text{Ln}\ (1-\gamma)]$

exchange rates were highly similar using the two approaches, with deviations occurring mainly between recessionary periods.

The results from the study also revealed that there have been a number of years over the sample period where the current account for the various countries was significantly misaligned. As a result, the MB approach revealed that the exchange rates for each of the countries in the study have had significant periods of misalignment from the ERER.[13] The required level of exchange rate adjustment was found to be a stationary series over the sample period which confirmed the assumption that, in the long-run, a current account misalignment and by extension an exchange rate misalignment from equilibrium positions, should be self-corrective.

2.1 The FEER

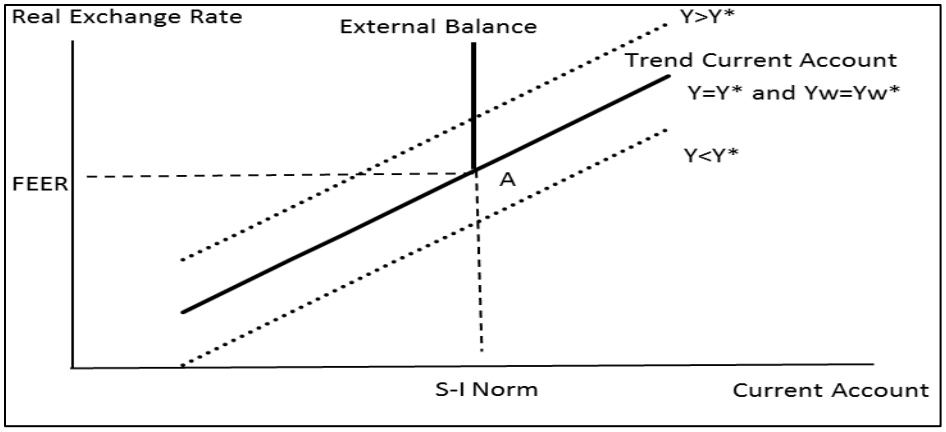
The FEER is particularly appropriate for assessing whether movements of the REER represent misalignments or whether the EREER itself has shifted as a result of changes in economic fundamentals (Roudet et. al., 2007). The FEER is an underlying balance model whereby the equilibrium is defined as the level of the RER that is compatible with internal and external balance (Driver and Westaway, 2003). Internal balance is reached when the domestic economy is at the full employment level of output (Y=Y*) at stable prices, while external balance is characterized as a balance of payments position sustainable over the MR (see **Graph 1**) (Driver and Westaway, 2003).

At the full employment level of output, there is an upward sloping relationship between the current account and the RER (see **Graph 1**). When Y=Y* and, for the world, Yw=Yw*, this can be thought of as the trend current account or savings minus investment (S-I) balance. External balance is given by the level of S-I which is sustainable in the medium to long-run. At point A, therefore, both internal and external balance will hold simultaneously and the RER will be at the FEER. For the given combination of S-I and Y* and Yw*, the FEER will be constant. However,

[13] The MB approach is similar to the FEER in terms of the assumptions which underlie both frameworks. However, for the MB approach, the sustainable current account is calculated and compared to the underlying (forecast) current account. The EREER is the exchange rate which would be required to close the current account gap, based on estimates of trade elasticities.

over time, the factors will shift relative to each other and these shifts will be reflected in changes in the FEER (Driver and Westaway, 2003).

Graph 1: Stylized Model of the FEER



(Driver and Westaway, 2003)

The FEER methodology uses indicators of internal and external balance to derive optimal exchange rate levels. The variables used to assess internal and external balance are those which are expected to influence the country's S-I balance. In this regard, the FEER reflects a RER that is sustainable. This exchange rate is expected to generate a current account surplus or deficit that matches the country's underlying capital flow over the cycle, assuming that the country is pursuing internal balance and that it is not restricting trade for balance-of-payments reasons (Cline and Williamson, 2011).

2.2 Calculating the FEER

The FEER is generally calculated by a two-step procedure: (1) identifying the components of the current account balance as a function of the REER; and (2) solving for the EREER by imposing macroeconomic balance. Based on the MR nature of the FEER approach, the assumption is made that the economy is operating at full employment or potential output and that the effects of past exchange rate changes have been fully realised (Isard, 2007). The variables that Clark and MacDonald (1997 and 1999) use to represent LR fundamentals are: the terms of trade (TOT) or the ratio of the unit value of exports to the unit value of imports; the relative price of traded to

non-traded goods (TNT), proxied by the ratio of CPI to PPI; net foreign assets as a ratio of GNP. Abdih and Tsangarides (2010) use the TOT, Government Spending, Degree of Trade Controls/Restrictions, Productivity and Investment.

Long-run determinants of the FEER are defined by select fundamentals that impact the S-I norm.[14] The FEER gives a path which defines movements in the RER in the medium to long-run. In other words, FEERs should move towards the real exchange rate, unless economies are permanently away from potential. The model of the FEER, however, is unable to describe the path by which the economy returns to equilibrium. It is a model of the real exchange rate based on the assumption that all variables have settled down to their steady-state growth paths and abstracts from the pricing considerations which will be important in the SR (Driver and Westaway, 2003).

Abdih and Tsangarides (2009) used a Vector Autoregression (VAR) framework to calculate the FEER for two CFA franc monetary unions.[15] The Johansen cointegration methodology was used to derive the equilibrium paths and associated misalignments for the period 1970 to 2005. They found that the REER was positively related to the terms-of-trade, government consumption and productivity while the REER was negatively related to investment and openness. In addition, they found that the value of the currencies of the two monetary unions was slightly more appreciated than their estimated LR equilibrium levels at end-2005. They noted that the misalignments were not statistically significant. The variables utilized in this study are similar to those used in Abdih and Tsangarides (2009). The methodology, however, differs due to the different orders of integration of the variables for Jamaica.

[14] The current account norm or sustainable current account is the current account balance which, if realized, would not lead to an increase in the country's indebtedness. The norm assumes that the growth rate of the economy must be higher than the interest rate on the country's liabilities, otherwise a trade surplus will be required to ensure that there is no increase in the country's debt ratio. The assumption is based on the following equation: $(x-m)_t - \left(\frac{i_t - g_t}{1+g_t}\right) b_{t-1} = 0$

[15] The two monetary unions were the Central African Economic and Monetary Community (CEMAC) and West Africa Economic and Monetary Union (WAEMU)

2.3 Contrasting Various Measures of EREER

The major advantage of the FEER and BEER over PPP framework is that they all relax the assumption of static equilibrium and allow the equilibrium exchange rate to change as economic fundamentals change (Driver and Westaway, 2003; McDonald, 2000; Siregar, 2011) (see **Table 1, Appendix**). However, an advantage of the CHEER modeling approach is that there is a higher estimated speed of convergence than that for simple PPP estimates. The approach has also been successful in forecasting movements in bilateral exchange rates.

Whereas the FEER is a special-purpose modeling approach that is designed to calculate the MR REER in order to assess the current value of the exchange rate, the BEER denotes a modeling strategy that attempts to explain the actual behavior of the exchange rate in terms of relevant economic variables. In the FEER approach, the notion of equilibrium that is considered relevant for assessing current exchange rates is that of macroeconomic balance, whereas this concept is absent from the BEER approach, where the relevant notion of equilibrium is the value given by an appropriate set of explanatory variables (Clark and McDonald, 1998) (see **Table 1, Appendix**).

A key policy question the FEER approach is designed to address concerns the degree to which the domestic currency is misaligned relative to its MR equilibrium value. However, it is not specified how the exchange rate moves from the current level to the MR equilibrium rate (Clark and McDonald, 1998; Driver and Westaway, 2003). Another limitation of the FEER approach results from its focus on the MR since the FEER approach removes speculative capital flows from the MR capital account, it is difficult to account for the impact of short-run changes in the interest parity condition on the dynamic path of adjustment toward the FEER. By its very nature, the FEER approach assumes that the interest rate remains at the MR equilibrium level, implying severe restrictions on how monetary policy can be modelled (see **Table 1, Appendix**).

Unlike the FEER, the BEER takes account of the impact of exchange rate changes over the adjustment path. The BEER attempts to capture the sources of changes in the capital account that may also affect the current account and the movement in the exchange rate itself. This may be especially important for countries that are experiencing substantial variation in SR fundamentals.

For relatively stable economies operating in the neighbourhood of internal and external balance, the BEER would converge toward the FEER. For this reason, policymakers in several developing countries have used the BEER to assess the appropriateness of exchange rate levels. As another drawback of the BEER, no theory guides the choice of fundamental variables in the BEER approach which is not the case for the FEER. LR determinants for the FEER are defined by select fundamentals that impact savings and investment.

The BEER approach relies critically on the assumption that the stable long-run relationship can be derived from historical data. This makes use of the BEER approach difficult for countries that have undergone substantial structural change or for which longer-term data are not available. The sensitivity of estimates to the choice of data is a common problem for all empirical equilibrium exchange rate models but this problem may be more serious for the BEER approach because it is an entirely empirical model in which no structure, such as long-run macroeconomic balance, is imposed. As a result, in the presence of sustained misalignment, time-series techniques may yield misleading results. One possible way to avoid this problem is to estimate equilibrium relationships within a cross-country panel framework, so as to incorporate a wider range of country experiences, though at the risk of making country-specific inferences more difficult (Clark and McDonald, 1998; Driver and Westaway, 2003).

3.0 Data and Methodology

The data and estimates ranged from December 1997 to September 2013 at a quarterly frequency. The REER and Terms of Trade (TOT) indices were based on the BOJ's estimates. A TOT shock is expected to induce an increase in domestic demand and hence an increase in the relative price of non-tradable goods, which leads to a REER appreciation. Net Foreign Liabilities (NFL) was calculated at a quarterly frequency by using the Bank's estimates for the IIP and interpolated based on the estimate for the CAD for each quarter where the IIP is assumed to deteriorate by the CAD. The CAD is based on the Bank's estimates. An increase in NFL requires a depreciation of the REER to increase competitiveness to restore equilibrium.

Trade Openness (OPEN) is proxied by the sum of exports and imports relative to GDP. For small, trade-dependent economies, greater openness is usually associated with external and

internal imbalance which requires a REER depreciation to facilitate a BOP correction. The extent of the response to this depreciation, however, depends on the trade elasticities. Productivity (PROD) was measured by Jamaica's per capita GDP relative to the per capita GDP of Jamaica's main trading partners. The influence of each trading partner was weighted based on its proportion of Jamaica's total trade. Through the Balassa-Samuelson effect, an increase in the productivity of tradables vs. non-tradables of one country, relative to a foreign country, raises relative wages. This increases the relative price of non-tradables to tradables and causes a REER appreciation.

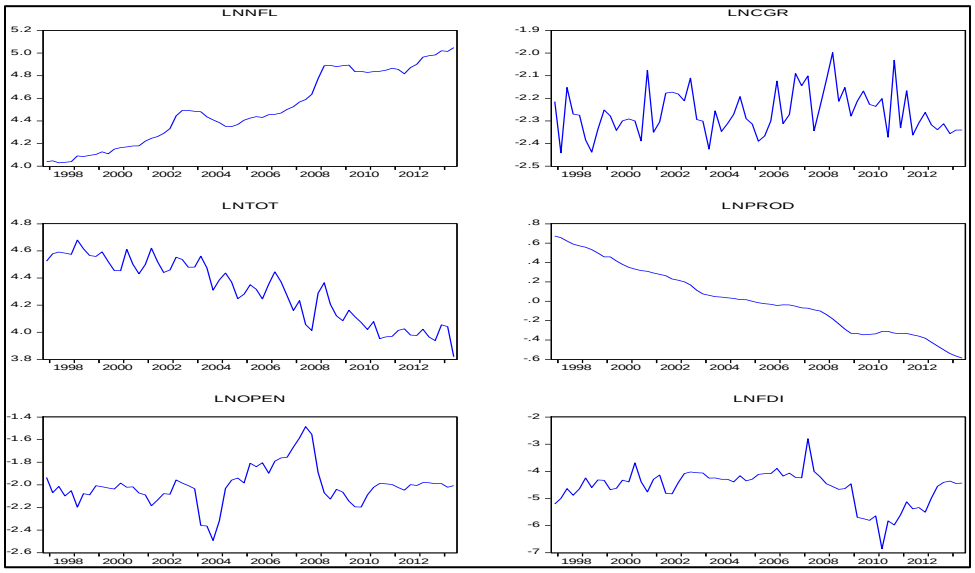
Real Government Spending (CGR) reflects the BOJ's estimates of Real Government Consumption with respect to GDP. The *a priori* expectation of the relationship of CGR to the REER is ambiguous and depends on whether the spending is directed to traded or non-traded goods. If the spending is directed to non-tradable goods then REER appreciation is to be expected.[16] Foreign Direct Investment (FDI) represents the BOJ's estimates of inflows into the economy with respect to GDP. The *a priori* expectation of the relationship between FDI and the REER is ambiguous since the sign will depend on the import content of the FDI.[17]

Since 1997, Jamaica's NFL has been climbing at a steady rate while CGR has displayed a stationary trend albeit with tempered rates of growth since 2012. Both the TOT index and PROD have been on a downward trend over the sample period. OPEN has been constant over the sample period with the exception of periods in 2004 and 2007 which saw sharp declines and increases, respectively. FDI also displayed a stationary trend over the sample period with the exception of a sharp decline between 2008 and 2010 due to the global recession (see **Graph 2**).

[16] The literature uses government spending since excess demand from the remaining public sector generally has to be met by the central government. It is also generally assumed that projects undertaken by entities have a reliable source of foreign financing and hence do not put undue pressure on the exchange rate

[17] This is particularly true for countries with a high import content in the production process

Graph 2



The FEER was estimated using the Autoregressive Distributed Lag (ARDL) approach. The series were input at a quarterly frequency. An ARDL model is a general dynamic specification, which uses the lags of the dependent variable and the lagged and contemporaneous values of the independent variables, through which the SR effects can be directly estimated and the LR equilibrium relationship can be indirectly estimated (Sultan, 2010). Previous studies used Vector Autoregressive (VAR) and Generalized Method of Moments (GMM) approaches which presuppose that the underlying regressors are all integrated of order one. In the presence of a mixture of stationary series and series containing a unit root, standard statistical inference based on conventional likelihood ratio tests is no longer valid and the Johansen procedure may lead to erroneous inferences (Pesaran and Shin, 1999). Pesaran and Shin (1999) developed the ARDL bounds testing approach for testing the existence of a cointegrating relationship. This approach is applicable irrespective of whether the underlying series are I(0), I(1).

Following Sultan (2010), an Unrestricted Error Correction Model (UECM) as depicted by equation 4 was estimated:

$$\Delta LogREER_t = \alpha + \sum_{i=0}^{m} B_i \, \Delta logP_{t-1} + \sum_{i=0}^{n} \gamma_i \Delta logY_{t-1} + \sum_{1=i}^{k} \emptyset_i \Delta logREER_{t-1} + \tau_1 logP_{t-1} + \tau_2 logY_{t-1} + \tau_3 logREER_{t-1} + \varepsilon_t \quad (4)$$

where Δ denotes the first difference operator, P_t and Y_t reflect the independent variables which affect the S-I balance, $REER$ reflects the Real Effective Exchange Rate and ε_t represents the error term.

Following Akinboade et al. (2008), the estimation utilized a parsimonious UECM by introducing a lag length of three for the differenced variables and then, following Hendry et al. (1984), variables which were non-significant were dropped. For the second step, bounds-testing was performed to identify the presence of a cointegrating relationship. This involved a joint significance test of lagged regressors using the F-statistic as represented by:

$$\tau_1 logP_{t-1} + \tau_2 logY_{t-1} + \tau_3 logREER_{t-1} = 0 \quad (5)$$

The bounds test methodology implies investigating the null hypothesis of non cointegration through a joint significance test of the lagged variables $logP_{t-1}$, $logY_{t-1}$, $\tau_3 logREER_{t-1}$ based on the Wald or F-statistics:

$$H_0: \tau_1 = \tau_2 = \tau_3 = 0 \quad (6)$$

$$H_1: \tau_1 \neq \tau_2 \neq \tau_3 \neq 0 \quad (7)$$

Two sets of critical F-*values* representing the upper and lower bound were taken from Pesaran and Shin (1999) for large samples. If the computed F-statistic for a chosen level of significance lies outside the critical bounds, a conclusive decision can be made regarding the cointegration of the regressors. If the statistic is higher than the upper bound, the null hypothesis of no cointegration can be rejected and the next step is to estimate the ARDL ECM where the short-run and long-run elasticities may be determined.

For the final step, the long-run equation which was a parsimonious selection of the variables in levels was then estimated.[18] The long-run equation provided the coefficients for the estimates of the EREER. A Hodrick-Prescott filter with a smoothing factor of 1600 was applied to eliminate

[18] The regression had 46 degrees of freedom

short-run fluctuations and derive a proxy for the long-run equilibrium of the explanatory variables.

4.0 Results

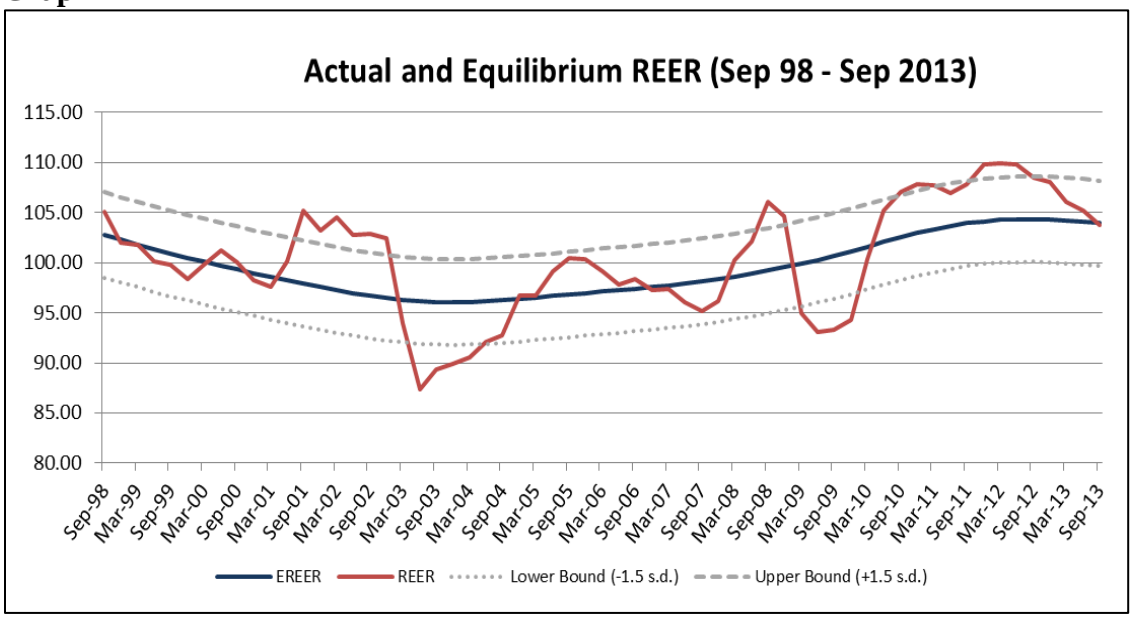
The results indicated that the variables NFL, TOT and PROD each had a unit root (see **Table 2, appendix**). Based on the bounds testing procedure, the null hypothesis of no cointegration was rejected since the F-statistic from the Wald test of the joint significance of the lagged regressors of the UECM was found to be outside the upper bound (see **Tables 3 and 4, appendix**). The long-run equation was then produced (see **Table 5, appendix**). The residual series from the long-run equation was found to be negative and significant when included in the error correction model, indicating the presence of a short-run mean reversion factor (see **Table 6, appendix**). In addition, the ECM term suggests that the REER would return to equilibrium in 1.3 quarters following a shock. The residuals of the ECM equation were found to be normally distributed (see **Graph 7, appendix**). Based on the long-run equation, the signs on all the variables met the *a priori* expectation with the exception of the TOT. The results indicate that the TOT is negatively related to the REER such that a decline in the index would cause an appreciation in the REER or loss in competitiveness (see **Table 5**).

Graph 2 shows the relationship between the EREER and the REER and includes bands representing 1.5 standard deviations above and below the FEER.[19] The results indicate periods of overvaluation and undervaluation. In particular, there was an overvaluation for the period September 2001 to December 2001 followed by a sharp reversal. In particular, there was an undervaluation between March 2003 and June 2004, associated with the depreciation and loss of confidence caused by Jamaica's rating downgrade by Standard & Poor's in the context of a deterioration in the country's fiscal accounts. The rate remained within the equilibrium bands until a brief period of overvaluation in the latter part of 2008 at the onset of the sub-prime crisis in the US. The depreciation which took place as the global recession deepened contributed to an undervaluation between March 2009 and March 2010. However, the confidence boost associated with the signing of an IMF programme and the successful Jamaica Debt Exchange (JDX) contributed to a period of overvaluation between December 2011 and September 2012.[20] The

[19] The standard deviation bands are calculated based on the FEER series
[20] The participation rate was over 95.0 per cent

depreciation since the June quarter of 2012, however, resulted in a correction of this overvaluation throughout the second half of 2012. The results also indicate that the REER and the EREER were in line as at September 2013 with the deviation falling steadily from its peak in December 2011 (see **Graph 2**).

Graph 2



5.0 Conclusion

Given the relationship between a country's currency and its competitiveness, the study set out to calculate Jamaica's FEER in the context of the country's persistent external imbalances. The study revealed periods of both overvaluation and undervaluation of the REER based on the equilibrium measure. Importantly, the exchange rate depreciation since December 2011 has brought the REER in line with the equilibrium measure, as shown by the FEER.

Periods in which the REER fell outside the standard deviation bands were generally associated with major shocks to the Jamaican economy, for example, the decline in investor confidence in 2003 and the recent impact of the global financial crisis. The response to these shocks points to the need for monetary and fiscal policies that will ensure that the macroeconomic fundamentals are in a state such that the economy will be more resilient to shocks, making it less likely for the REER to deviate from the equilibrium measure. This should be a likely outcome of the fiscal

policy adjustment being pursued in Jamaica's EFF Arrangement with the IMF. It is expected that a lowering of the debt to more sustainable levels will reduce the probability of an increase in future tax obligations of the private sector. This, in turn, should generate the confidence necessary for investors to engage in real sector activities, thus bringing the country to full employment levels and generating the foreign exchange necessary to maintain external balance. It is also possible that bringing the economy to a state of internal and external balance would assist in making the equilibrium rate itself more predictable and better understood by market players, thus reducing the volatility of the nominal exchange rate.

In a context where Jamaica did not experience a sharp rise in its growth rates during the periods when the REER was undervalued, the results of this study, coupled with previous work by Henry and Longmore (2003) suggest that improving Jamaica's external accounts will require continued focus on structural reform. In this regard, the IMF programme has been framed in the context of ensuring macroeconomic and financial market stability. The programme also includes several initiatives aimed at fostering a friendlier business environment, improving the legislative framework, reducing the cost of doing business including the cost of energy, reducing the bottlenecks to major private sector investment, undertaking tax reform, among other things. In general, the programme addresses a number of issues outlined in the World Bank's 2013 Global Competitiveness Report required to improve Jamaica's competitiveness and the macroeconomic environment. This recognizes that a competitive exchange rate remains important to growth and development but should only be seen as one ingredient in the broader policy mix.

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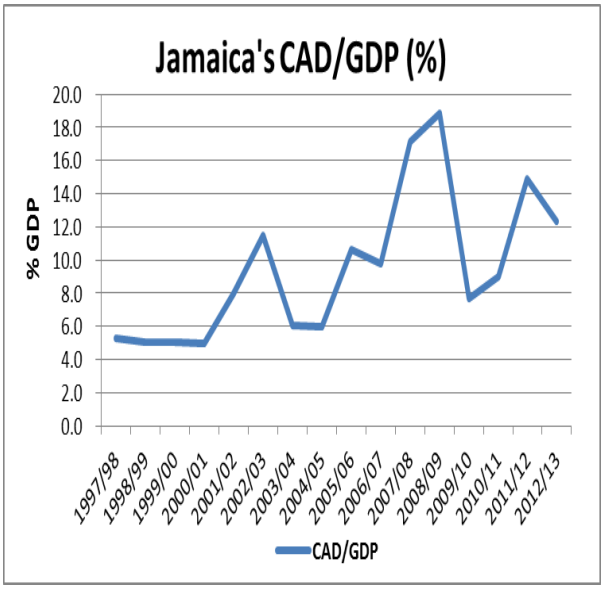
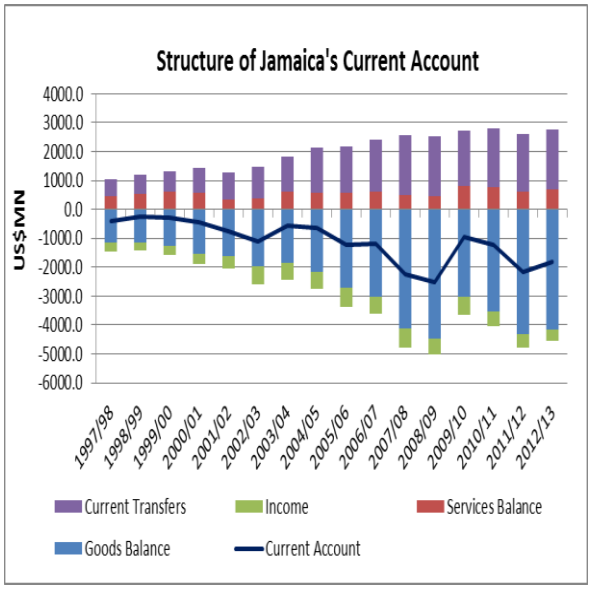
7.0 Appendix

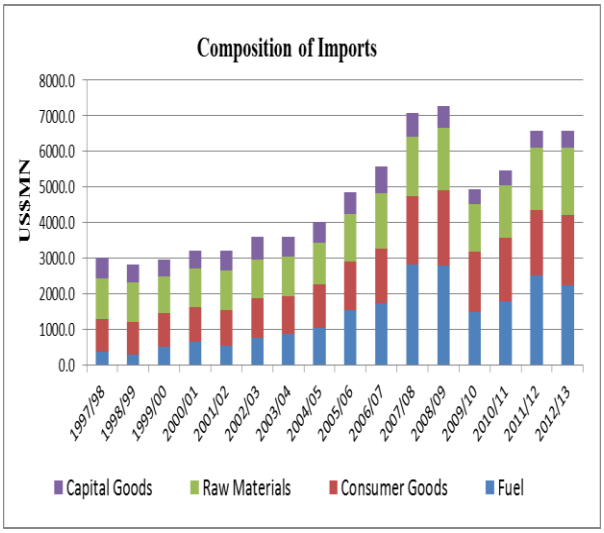
Graph 1



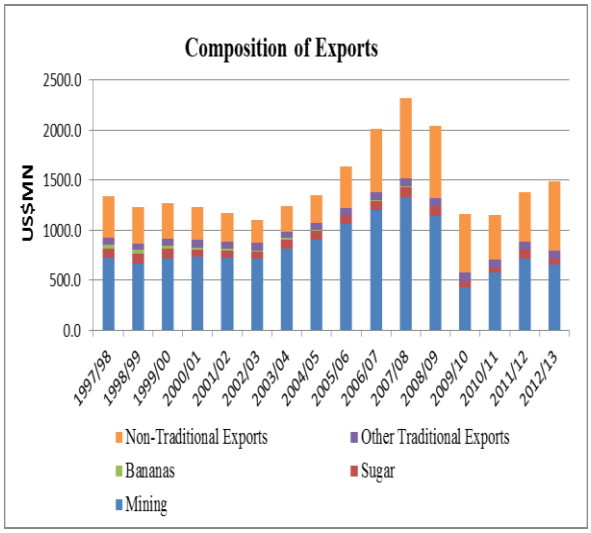
Graph 2



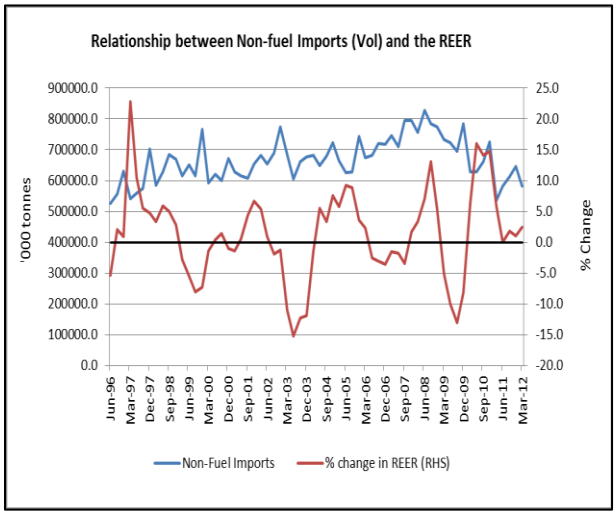
Graph 3



Graph 4



Graph 5



Graph 6

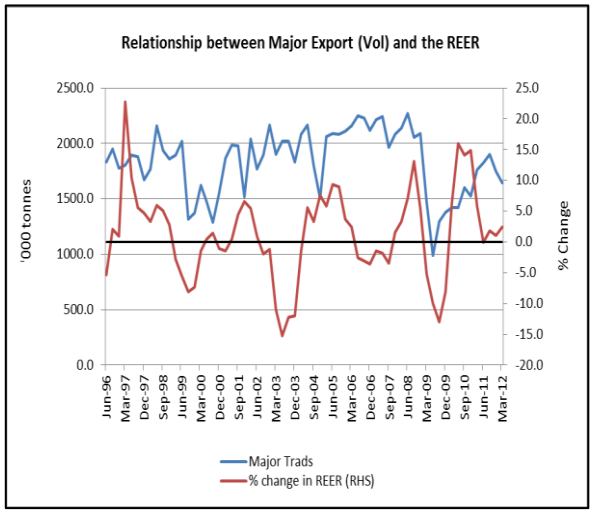


Table 1

Summary of Empirical Approaches to Estimating Equilibrium Exchange Rates			
	CHEER	*BEER*	*FEER*
Name	Capital Enhanced Equilibrium Exchange Rates	Behavioural Equilibrium Exchange Rates	Fundamental Equilibrium Exchange Rates
Introduced by		Clark and McDonald (1997 and 1999)	Williamson (1985 and 1994)
Theoretical Assumptions	Model combines both components of the PPP and UIP conditions in determining equilibrium exchange rates.	Starting point is the real UIP condition with a risk premia. Expected future movements in real exchange rates determined by fundamental variables.	The equilibrium value is defined as that level of the exchange rate that assures simultaneous achievement of internal and external balance. Flock of stock not in equilibrium
Positive or Normative Approach		Positive approach - use current values of variables and current policies.	Normative approach - use not only current variables but also desireable model relationships and trajectories which would like to be achieved.
Variables	relative prices,nominal interest rate differentials, and the nominal exchange rate	Terms of trade,the relative price of traded to nontraded goods, proxied by the ratio of CPI to PPI; and net foreign assets as a ratio of GNP. In each case these variables are measured as relative to their foreign counterparts.	Net foreign liabilities , trade controls, investment, productivity, terms of trade, government spending.
Relevant Time Horizon	Short run (forecast)	Short run (forecast)	Medium run
Statistical Assumptions	Stationary, with emphasis on speed of convergence	Non-stationary	Non-stationary
Dependent Variable	nominal exchange rate	real exchange rate	real effective exchange rate
Estimation Method	Direct	Direct	Underlying Balance

Table 2
Results of Unit Root Test

	NFL	TOT	CGR	PROD	OPEN	FDI
ADF Statistics (levels)	-0.41	-0.14	-7.05***	-0.81	-2.90*	-2.91**
ADF Statistics (first difference)	-5.04***	-11.16***		-3.92***		

Table shows results for the Augmented Dicky-Fuller (ADF) and Phillips-Peron (PP) unit root tests where the *** denotes rejection of the null hypothesis at the 1 per cent level and ** denotes rejection at the 5 per cent level and * denotes rejection at the 10 per cent level

Table 3

Wald Bounds Test			
		Critical Bounds (5 %)	
	F-Statistic	Lower	Upper
Group Regressors	5.31	1.82	2.99

Table 4

Unrestricted Error Correction Model		
Variable	**Coefficient**	**Significance**
C	3.71	***
@TREND	0.00	*
D(LNNFL)	-0.44	***
D(LNNFL(-2))	0.17	
D(LNNFL(-3))	0.19	
D(LNCGR(-1))	-0.05	
D(LNTOT)	-0.08	*
D(LNTOT(-3))	-0.08	*
D(LNPROD)	0.35	
D(LNOPEN)	-0.09	***
D(LNOPEN(-2))	0.07	*
D(LNFDI)	-0.02	**
D(LNFDI(-1))	-0.02	***
D(LNFDI(-2))	-0.01	
LNREER(-1)	-0.36	***
LNNFL(-1)	-0.22	***
LNCGR(-1)	0.10	**
LNTOT(-1)	-0.26	***
LNPROD(-1)	0.17	
LNOPEN(-1)	-0.09	**
LNFDI(-1)	0.00	
Level of significance: * = 10.0 per cent; ** = 5.0 per cent; *** = 1.0 per cent		

Table 5

Long-Run Equation		
Variable	**Coefficient**	**Significance**
C	8.14	***
LNNFL(-1)	-0.26	***
LNCGR(-2)	0.05	
LNTOT	-0.25	***
LNTOT(-1)	-0.09	
LNTOT(-2)	-0.24	***
LNPROD	0.11	*
LNOPEN	-0.08	***
LNFDI(-1)	-0.02	***

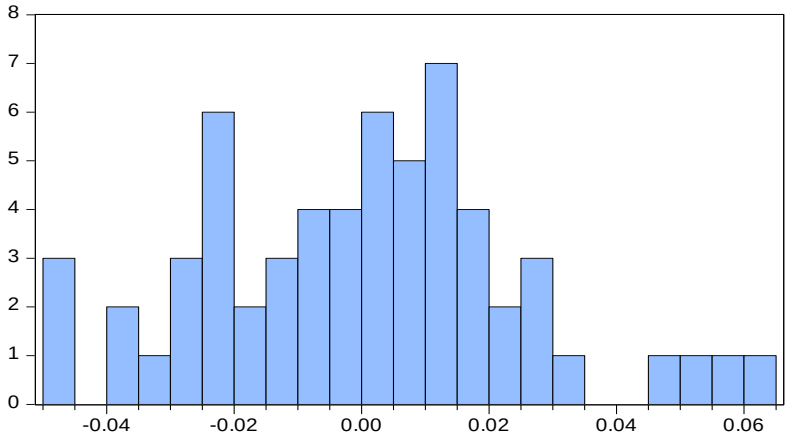
Level of significance: * = 10.0 per cent; ** = 5.0 per cent; *** = 1.0 per cent

Table 6

Error Correction Model		
Variable	**Coefficient**	**Significance**
D(LNNFL(-1))	-0.36	***
D(LNNFL(-3))	-0.13	
D(LNNFL(-4))	0.07	
D(LNCGR(-2))	0.03	
D(LNTOT)	-0.08	**
D(LNTOT(-1))	-0.07	***
D(LNINV(-3))	-0.04	
D(LNPROD(-2))	-0.32	***
D(LNOPEN)	-0.03	
D(LNOPEN(-2))	0.05	***
D(LNFDI(-2))	0.01	
D(LNFDI(-3))	0.00	
ECM(-1)	-0.27	**

Level of significance: * = 10.0 per cent; ** = 5.0 per cent; *** = 1.0 per cent

Graph 7



Series: Residuals
Sample 1998Q2 2013Q1
Observations 60

Mean	9.09e-16
Median	0.001561
Maximum	0.060331
Minimum	-0.049224
Std. Dev.	0.024778
Skewness	0.186869
Kurtosis	2.912528
Jarque-Bera	0.368328
Probability	0.831799