Determining the Equilibrium Exchange Rate for Jamaica:
A fundamentalist approach.

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Abstract

This paper estimates the equilibrium exchange rate for Jamaica over the short-run (SR), medium-run (MR), and long-run (LR) in order to assess its implications for competitiveness. The mean reverting properties of the real exchange rate (RER) is employed as the metric for the equilibrium exchange rate. Three distinct fundamentalist based approaches are used to evaluate the dynamic process of mean reversion in the RER. Key drivers of the dynamics of the RER are also identified over each horizon. The MR Behavioural Equilibrium Exchange Rate (BEER) was found to be the most appropriate model for Jamaica, supporting both the UIP and PPP conditions. In addition, there was strong evidence of a Balasa-Samuelson effect in the determination of Jamaica's equilibrium exchange rate and it's impact on competitiveness. The models proved useful in signaling foreign exchange market instability, in particular, the MR and LR models pointed to an appreciation in the nominal exchange rate in early 2010.

JEL Classification: C62, F31, F32, O24

Keywords: equilibrium exchange rate, real exchange rate, current account, co-integration

[1] The views expressed in this paper are those of the author and do not necessarily represent those of the BOJ.
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1 INTRODUCTION

1.1 Why Equilibrium Exchange Rates?

The level and variability of exchange rate is widely held as a gauge for international competitiveness and macroeconomic stability. A country's level and trend in international competitiveness may establish whether it is or will be a net importer, exporter, borrower, lender, debt stricken, crisis bound or fundamentally sound. In establishing a sound macroeconomic environment, a stable exchange rate is needed to build confidence and promote long-term planning and investment among foreign and domestic stakeholders. The Bank of Jamaica (BOJ) is charged with the responsibility of maintaining stability within the foreign currency market toward this end. It becomes crucial for the bank to identify an equilibrium level of exchange rate to be targeted in carrying out its mandate. This paper seeks to achieve that goal by identifying the equilibrium exchange rate for three distinctive time horizons based on the fundamental variables that are most influential over the respective time spans. Active comparison of the market exchange rate and the range of equilibrium exchange rates will reveal existing or potential misalignment in the foreign currency market.

1.2 Contextual Overview

Jamaica, a small developing country is a net importer of traded goods and services. The country relies heavily on foreign currency inflows from tourism, remittances, foreign direct investments, and bauxite exports. Increased competition and elimination of preferential privileges among longstanding traditional exports such as banana, and sugar has stimulated concerns of reduced competitiveness for the nation during the past decade.

Jamaica remains vulnerable to external shocks that affect major export markets and the cost of imported raw materials. A key factor contributing to the cost of production is imported oil that severely impeded Jamaica's economic activity in the international oil shocks of the 1970's and recently, mid to late 2000's. In the same time periods, earning from tourism, bauxite exports and access to foreign financing contracted, resulting in a balance of payment crisis for the territory. In the early 1990's Jamaica liberalized its foreign exchange market resulting in significant depreciation of the local currency. By the mid to late 1990's, the country experienced a financial

crisis that led to significant public debt accumulation.[2] All instances reflected instability in the foreign currency market and brings to fore the key role that economic fundamentals play in exchange rate determination.

This paper is unique in the approach of evaluating equilibrium exchange rate over three distinctive time horizons. The ability to conduct inter-temporal comparisons could provide critical information to foreign currency policy intervention by the Central Bank of Jamaica. The paper addresses concerns about the BOJ's use of the Real Effective Exchange Rate (REER) as its primary indicator of competitiveness. In this analysis, the REER and alternative measures of competitiveness are compared to periods of disequilibrium to determine whether a misalignment were predominantly due to expected changes in the REER or by other productivity factors that conflicts with expected changes in the REER.[3]

1.3 Outline of Paper

Section 2 of this paper follows with a conceptual framework outlining the underpinnings of equilibrium exchange rates. Section 3 follows with a literature review of a few investigative researches specific to Jamaica and a summary of the key theoretical models of equilibrium exchange rate grouped within three distinctive time horizons (SR, MR, & LR). Section 4 gives a description of the data, key fundamental variables, and competitiveness indicators. Section 5 provides a trend analysis of the key fundamental variables for Jamaica followed by Section 6 which outlines the econometric methods employed in carrying out the various empirical tests. Section 7 presents the econometric results following which Section 8 evaluates the key indicators of competitiveness in relation to periods of disequilibrium. Section 9 concludes with a survey of the interpreted findings and provides recommendations.

[2] The Jamaican financial crisis of the mid to late 1990's was attributed to significant build up of non-performing loans attributed to poor financial regulation and imprudent business practices. The GOJ opted for a bailout in guiding the economy back to recovery.

[3] There are instances when competitiveness can be enhanced from rising productivity. In such cases the exchange rate appreciates from a resulting increase in the demand for domestic currency. This contradicts the common perception that in order to become more competitive, the exchange rate needs to depreciate.

2 CONCEPTUAL FRAMEWORK

2.1 Exchange Rates Defined

Mishkin (2004) defines exchange rate as "the price of one currency in terms of another". This is also the nominal exchange rate. A real exchange rate is 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 (trade prices, consumer prices, wholesale prices, producer prices, GDP deflators, labour costs etc), the measurement of real exchange rate can take on very different values, direction, and interpretation. The real exchange rate (RER) can be expressed in the manner shown in equation 1. A representation of the real effective exchange rate (REER) is derived from a composite weighting of the RER between the range of key trading partners. This is expressed in equation 2 below:

$$RER = NER_{ijt}(P_{it} / P_{jt}^{*}) \quad \textbf{(1)}$$

$$REER = \prod_{j=1}^{n}\left[NER_{ijt} P_{it} / P_{jt}^{*}\right]^{\omega ij} \quad \textbf{(2)}$$

Where *RER* and *REER* is the real exchange rate and real effective exchange rate respectively; NER_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*.[4] In the geometric mean calculation, ω_{ij} is the weight of the foreign country *j* in the total trade of country *i*.

2.2 Exchange Rates Parity Conditions

There are two fundamental bases on which theorists believe exchange rate adjustments are made. These include the Purchasing Power Parity (PPP) and the Uncovered Interest Parity (UIP). Formally stated, PPP is based on the Law of One Price, which implies that in two countries (producing an identical good with minimal transportation costs and barriers to trade) the exchange rate should be such that the price of the good remains the same throughout the world irrespective of the country in which it is produced (see Mishkin 2004). PPP extends this law of one price to require that any adjustments in the price or cost of producing the particular good will result in an appropriate adjustment in the exchange rate to ensure that the law of one price holds.

[4] Real effective exchange rate (REER) is contrasted to the bilateral exchange rate which is the exchange rate between the domestic country and a single foreign country. Like the REER, it is normally expressed as the quantity of foreign currency it takes to acquire one unit of the domestic currency. Hence an appreciation is represented as an increase in the exchange rate while depreciation is reflected as a reduction.

UIP is based on the Theory of Asset Demand, with the assumption that currency transfers between territories are free of capital mobility restrictions, rendering deposits in foreign currency a perfect substitute for deposits in domestic currency. In light of this, the decision to hold foreign or domestic currency deposits will depend on the rate of interest offered on the respective deposit account. Both domestic and foreign investors will shift deposits to the currency or territory that offers a higher rate of interest. The uncovered interest parity condition therefore requires that the exchange rate be adjusted to correct any prevailing interest rate deviations (arbitrage opportunities) between the observed territories.

2.3 Equilibrium Exchange Rate

The conditions of PPP and UIP are equilibrium conditions that identify the ideal level of exchange rate between a domestic economy and its trading counterpart. The PPP condition holds when the exchange rate is such that the price of a local good is indifferent to the price of an identical foreign good. The UIP condition holds when the exchange rate is such that the interest return on domestic currency is indifferent to the interest return on foreign currency deposits. The key difference between the two is that PPP is more likely to hold over the LR due to stickiness of prices over time, while UIP is predominantly a SR equilibrium condition due to the lower level of friction in capital market interest rate determination.

From a theoretical perspective, SR models emphasize equilibrium exchange rate based on rational market behaviour in light of all available information[5]. MR models emphasize the attainment of a sustainable internal and external trade balance; while the LR models emphasize the structural role that fiscal debt stock and stock flow adjustments will play in determining the equilibrium exchange rate.

It is important to identify an equilibrium exchange rate for two reasons. They are: (1) the effective monitoring and targeting (monetary policy) of a desired real exchange rate for stability in the foreign currency market; and (2) preserving the level of competitiveness of key industries based on the relative price of imports and exports with an emphasis on enhanced productivity and a sustainable balance of payment position. This paper seeks to address both areas of concern.

[5] There are also statistical methods that seek to decompose permanent components from trends in exchange rates. Such models rely on the condition of convergence for proof of equilibrium and are less applicable when a specific equilibrium level is sought after.

3 LITERATURE REVIEW

3.1 Investigative Contribution

Previous studies related to exchange rate in Jamaica demonstrate that equilibrium convergence on the basis of uncovered interest parity (UIP) is evidently weak (see McFarlane 2003). McFarlane (2003) incited that prolonged deviation from UIP equilibrium was attributed to a time varying risk premium ascribed to fiscal dominance in relative asset supplies. In estimating Jamaica's real equilibrium exchange rate, Williams (2008) demonstrated that two normative approaches gave conflicting results for exchange rate misalignment in 2008 where one model suggested a state of over-valued currency, and the other, a state of equilibrium. A third method, being a more positive approach, suggested a state of equilibrium.[6]

Henry (2001) sought to address the issue surrounding an appropriate measure of competitiveness for Jamaica. He indicated that the real effective exchange rate (REER) might not adequately capture the level of competitiveness in Jamaica. Henry (2001) concluded that, contrary to typical belief, depreciation does not necessarily lead to an improvement in external competitiveness. The validity of the REER as a measure of competitiveness was also evaluated by Henry and Longmore (2003) while investigating its impact on elements of Jamaica's current account. The results show little correspondence of the REER to fluctuations in current account components. Additionally, changes in the REER proved to be insignificantly related to selected exports. Henry (2001) recommended the use of alternative measures of competitiveness in conjunction with the REER. Those suggested were unit labour cost, profitability among tradables, ratio of tradables to non-tradables, and the ratio of trade Balance to total trade.

In an extensive survey investigating the concepts of equilibrium exchange rates, Driver and Westaway (2004) expressed the structural form used to explore equilibrium relationships between exchange rate and the cross-section of fundamental and transitional variables. The structure is expressed in equation 3 below.

$$e_t = \beta' Z_t + \theta' T_t + \varepsilon_t \quad \textbf{(3)}$$

[6] Williams (2008) utilized three methods, which were the Macroeconomic Balance (MB) approach, the External Sustainability (ES) approach, which are both normative in nature. The last method recognized as the Equilibrium Exchange Rate (ERER) approach is a more direct or positive estimation method.

Where e_t represents the specified exchange rate at time period t, Z_t is a vector of MR and LR economic fundamental variables, T_t is a vector of transitional variables encompassing lagged dependent, independent and other variables utilized to capture SR dynamics. Both β' and θ' are coefficient vectors for the respective fundamental and transitional variables. The following explores the theoretical underpinning of the SR, MR, and LR equilibrium models.

3.2 Short-Run Models

Short-run equilibrium exchange rate is projected from a combination of fundamental and transitional variables. The SR equilibrium exchange rate is the estimated rate for which unexpected variations (ε_t) are abstracted out. Driver and Westaway (2004) specify the SR structure of the equilibrium exchange rate as shown in equation 4.

$$e_t^{SR} = \beta' Z_t + \theta' T_t \quad \textbf{(4)}$$

SR models reflect capital market dynamics that capture the actions of asset holders in response to available market information. This is predominantly explained by the UIP condition. The range of SR models investigated include the: Flexible Price Monetary Models (FPMM); Sticky Price Monetary Models (SPMM) proposed by Dornbusch (1976); Portfolio Balance Model (PBMM) presented by Frankel (1993), MacDonald and Taylor (1992) and Taylor (1995); the Capital Enhanced Equilibrium Exchange Rate (CHEER) model presented by MacDonald (2000); and the Behavioral Equilibrium Exchange Rate (BEER) model presented by Clark and MacDonald (1997 and 1999).

The modeling of equilibrium exchange rate has been widely assessed in economic literature. The FPMM was made popular in the early 1970's post Brenton-Woods shift towards floating exchange rate regimes in the industrialized world: see Rapach and Wohar (2001) and Moura et al (2008). The FPMM proposed that prices are flexible and that PPP holds continually; see Frankel (1976) and MacDonald (1992). The poor performance of the FPMM, however, (see Meese and Rogoff 1983), led to the recommendation of alternative strategies for explaining foreign exchange rate movements. Dornbusch (1976) introduced the SPMM, suggesting that prices take time to adjust, thereby causing nominal and real exchange rates to overshoot equilibrium levels. Dornbusch (1976) showed that with distorted interest rates, exchange rates eventually revert to the PPP equilibrium level based on the velocity of price adjustments.

There are, however, other shortcomings that the FPMM and SPMM did not address. Of key concern is the UIP assumption of no restrictions on the mobility of capital between territories. Evidence in support of: home bias, liquidity difference, solvency risk, tributary differences, and the presence of currency exchange rate risks supports the notion of imperfect substitution of assets across borders; see Moura et al (2008). The PBMM was therefore established to remedy the asset market limitation by including a risk premium variable. The model also incorporated stock-flow effects, such as current account misalignments in explaining equilibrium exchange rates (see MacDonald, 1992).

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.[7] The CHEER model combines both components of the PPP and UIP conditions in determining equilibrium exchange rates. Whereas the PBMM utilized a risk premium variable to capture the effects of imperfect capital mobility, the CHEER utilizes price differentials to capture this effect. The BEER model is also premised on the UIP condition which accounts for imperfect capital mobility with a risk premium. In the analysis BEER, Clark and MacDonald (1997 and 1999) used other variables regarded as fundamentals to explain variations in the REER.

3.3 Medium-Run Models

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 (balance or steady state).[8] The internal balance relates to full employment of resources while external balance relates to a sustainable current account position that is consistent with convergence to a LR steady state of stock flow.[9] At the MR level, all "nominal inertia would have been washed out of the system" as noted by Driver and Westaway (2004). This nullifies unexplained and transitional forces on the equilibrium exchange rate rendering its determination

[7] It is postulated that when interest rate differentials are non-zero, and are needed to finance the capital account, it could result in disequilibrium in the PPP determined real exchange rate. Driver and Westaway (2004) p.37.

[8] Internal full employment is otherwise regarded as the Non Accelerating Inflation Rate of Unemployment (NAIRU).

[9] The term "stock" in the literature refers to the public debt stock of a country while "stock-flows" refer to the fiscal surplus or deficit that will determine the future accumulation or diminishing of indebtedness.

wholly on the basis of estimated medium term economic fundamentals.[10] The structure of the MR equilibrium specification is expressed in equation 5:

$$e_t^{MR} = \beta' \hat{Z}_t \quad \textbf{(5)}$$

The range of MR models contemplated for this analysis include the: Fundamental Equilibrium Exchange Rate (FEER) model investigated by Wren-Lewis (1989 and 1992); and the Desired Equilibrium Exchange Rate examined by Artis and Taylor (1993). The BEER method is also considered for the MR analysis.

The internal and external balance conditions for the FEER are premised on the optimal levels of capital flow (K) and current account (CA) balance demonstrated by Clark and MacDonnald (1998). Faruqee, Isard, and Masson (1998) showed that the difference between savings and investment will represent external balance. Any deviation from the estimated CA and the actual CA after considering seasonal trends and specification errors, will unveil the FEER that is required to maintain some optimal level of the income and savings condition. The term Desired Equilibrium Exchange Rate (DEER) is another name for the FEER that highlights the normative characteristic of the model, see Bayoumi et al (1994) and Artis and Taylor (1993).

The FEER and DEER methodology is characterized as normative in that the indicators of internal and external balance are subjectively calculated to derive ideal/optimal/desired levels.[11] The optimal calculations are then superimposed in the determination of an equilibrium exchange rate. A representation of the FEER was conducted for Jamaica by Williams (2008) using two established methods of calculating equilibrium norms.[12] The results yielded inconsistent results where one method, the external sustainability approach (ES), alluded to a state of equilibrium and the other, macroeconomic balance approach (MB), a significant overvaluation. A BEER model was also estimated which suggested that Jamaica was in a state of MR equilibrium, consistent with the ES approach.

In an assessment of extensions to the MB Approach, Isard, Faruqee and Debelle (1998) demonstrated that both a partial adjustment model and error correction model generated

[10] Driver and Westaway (2004) suggest that the premise on which equilibrium exchange rate is wholly dependent on fundamental variables is only valid if there are no significant hysteresis effects and that adjustments take place within the reasonably short run.

[11] The normative method of the FEER is considered by some a limitation since the ideal levels are superimposed by the investigator by a calculated means. The normative nature of FEER is alluded to by the founder Williamson (1994) and other seminal papers such as Clark & MacDonald (1998), p.6, and Driver & Westaway (2004) p.46.

[12] These two methods included the Partial Macroeconomic Balance (MB) approach suggesting disequilibrium while the External Sustainability (ES) approach suggested a stable exchange rate in 2008.

satisfactory explanations of the CA behavior in relation to various explanatory factors affecting the savings and investment balance. Clark and MacDonald (1998), however, point out that, unlike the BEER approach, the FEER has no theoretical basis on which a convergence to equilibrium is explained. Rather the FEER is simply a method of calculating an equilibrium exchange rate given optimal levels of the CA and Savings & Investment balance. Any adjustment to the exchange rate is then assumed to be dependent on the relative position of the actual exchange rate to the calculated equilibrium rate.

The paper places greater emphasis on the positive approach of equilibrium determination where as the BEER is adopted for the MR model. The method employed by Fernandez et al (2001), utilized the BEER estimation technique to explain the REER

3.4 Long-Run Models

LR equilibrium exchange rate is considered to be the level consistent with equilibrium stock-flows. At this stage there are no endogenous tendencies for change, all MR related bubbles and cyclical effects are nullified (see Driver & Westaway 2004). The LR equilibrium expression is presented in equation 6, where the bar represents the LR state of variables.

$$\bar{e}_t^{LR} = \beta' \bar{Z}_t \qquad \textbf{(6)}$$

In the literature, two predominant methods are utilized in observing LR equilibrium exchange rates. They include (1) the purely statistical approach where focus is placed on the decomposition of a permanent component of the exchange rate trend; and (2) the fundamentals approach, which seeks to explain equilibrium exchange rate based on a desirable (steady state) level of capital or stock-flow expected to be attained in the long-haul.

The models explored for conducting the LR analysis include the Natural Real Exchange Rate (NATREX) approach presented by Stein (1994), Stein and Allen (1995), and Stein and Paladino (1998); the Permanent Equilibrium Exchange Rate (PEER) model, and the Structural Vector Autoregression (SVAR) model utilized by Clarida and Gali (1994).

The NATREX approach is an offshoot of the FEER which incorporates the impact of fundamentals in conjunction with some predefined measure of full employment and desirable current account balance consistent with the investment and savings identity. The NATREX can be used for either MR or LR analysis. After estimation, the equilibrium level is derived from

setting residuals equivalent to zero. The PEER model is represented as a decomposition of the permanent component of the BEER model. Whereas the NATREX is based on the normative characteristics of the FEER, the PEER is instead, based on the positive approach of the BEER model.

The SVAR model is useful in identifying key shocks that have and are likely to affect the real exchange rate. The method however, cannot provide a reliable equilibrium exchange rate level due to starting point limitations. Emphasis is therefore placed on the fundamentals based approach, and in particular the BEER method following which the permanent component is decomposed to reveal an equilibrium RER path. This method of estimating the PEER is adopted from Fernandez et al (2001).

3.5 Model Selection

One criterion for model selection is that of being fundamentally determined. Additionally, data availability has restricted our selection to models where adequate data can be sourced. The more normative methods of estimating equilibrium exchange rates are rejected in favour of positive approaches.

The CHEER was selected for the SR model with sufficient variables to capture effects of UIP, PPP and risk premium. The BEER method was used for both SR and MR analysis on the grounds of being wholly determined by fundamental variables. The PEER, which is a decomposition of the BEER was also selected on the basis of being a more positive approach than the alternative models.

Other SR Models were rejected on grounds of poor performance (Meese and Rogoff 1983). The MR FEER model was also rejected on the basis of inconsistent results presented for the case of Jamaica by Williams (2008), and for the less than positive approach employed in its estimation. The NARTREX being an offshoot of the FEER was also rejected on similar grounds. The SVAR was considered less than desirable due to the statistical limitation in determining the appropriate starting point.

4 DATA DESCRIPTION

Monthly data was used for the period April 1995 to July 2009. The Nominal Exchange Rate (NER) was used as the dependent variable for the SR CHEER model while the Real Exchange Rate (RER) was used for the BEER and PEER models. The RER was expressed as foreign dollars per unit of domestic dollars. Hence, an increase in the RER represents an appreciation. The NER however, was represented as domestic dollars per unit of foreign dollar which means an increase reflects an appreciation. In light of the above, the RER is equivalent to the inverted NER adjusted by the ratio of foreign to domestic consumer prices. The range of fundamental variables considered is presented below.

Domestic Price (PRID) - Domestic prices are used to capture the impact of inflation on exchange rate. The transmission may either be by a substitution or income effect. As it pertains to the former, when domestic prices increase, local consumers are expected to shift demand away from the more expensive domestic goods to the relatively cheaper foreign goods. In such circumstances, the demand for domestic currency relative to the foreign currency decline resulting in depreciation. The income effect reflects a greater demand for the domestic currency to maintain the same level of consumption. As such, domestic inflation would result in an appreciation. The domestic price (PRID) is expressed as the log of Jamaica's Consumer Price Index (CPI).

Foreign Price (PRIF) - Foreign prices, like domestic prices also affects the exchange rate by way of the substitution and or income effect. By substitution, an increase in foreign prices will trigger an increase in the demand of relatively cheaper domestic goods away from more expensive foreign goods. In this case, more domestic currency is demanded relative to the foreign currency resulting in an appreciation of the domestic currency. The income effect reflects a greater demand for the foreign currency to maintain the same level of consumption. As such, foreign inflation would result in a depreciation of the domestic currency. In this paper, the log of US Consumer Price Index is used to represent the foreign price (PRIF).

Domestic and Foreign Interest Rates (INTD & INTF) - Interest rates are expected to have a direct impact on currency holdings. Higher domestic interest rates, all things being equal, are expected to result in a shift of currency holdings away from foreign denominated assets to domestic denominated assets. When foreign interest rates increase the expected response is reversed. The

domestic interest rate used for this paper is Jamaica's 6 month annualized Treasury bill rate in decimals. The foreign interest rate used is the US 6-month annualized LIBOR rate.

Interest Rate Differential (RIRD) [negative] – Trends in the interest rate differential is expected to capture the uncovered interest parity (UIP) condition which requires that the exchange rate adjust to prevent any arbitrage emerging from interest rate differentials between territories. Therefore, an increase in the Jamaican interest rates (INTD) relative to the US interest rate (INTF) would typically attract investors away from USD to JMD denominated holdings (deposits). However, the theory of UIP requires that the exchange rate will depreciate (adjust) to nullify the attractiveness of one currency holding over another. The relationship between the RER and the RIRD is therefore expected to be negative. The real interest rate differential (RIRD) is derived from the INTD net of Jamaica's 12 month headline inflation rate minus the INTF net of the US 12-month inflation rate.

Net Foreign Asset (LNFA) [positive] – The impact of the LNFA on the exchange rate is considered from two perspectives. From a portfolio balance perspective, a current account deficit or worsening thereof will require financing from international investors who will demand higher yields, which can only be achieved by exchange rate depreciation if interest rates are taken as given. Therefore a deterioration (decline) in the LNFA by way of increased foreign currency liability should lead to depreciation (decline) in the RER and vice versa in light of the portfolio balance effect. The alternative reasoning is that debt attained to finance CA deficits will attract interest payments. It is only by way of an improved trade balance that premiums can be afforded. This will require a depreciation (decline) of the domestic currency in order to increase competitiveness, improve the trade balance, and hence, ability to service such loans. The relationship between the RER and LNFA is therefore expected to be positive. The LNFA is calculated as the total foreign assets held by Jamaica's Central Bank, Commercial Bank & Central Government in millions of USD minus total foreign liability held by the same institutions. The values are then expressed in logs after normalizing to remove negative values[13].

Net Government Debt Differential (LNGDD) [negative] – This risk premium is included in SR models to take account of limitations associated with the presence of imperfect mobility of capital across borders. When domestic debt increases relative to foreign denominated debt, the domestic

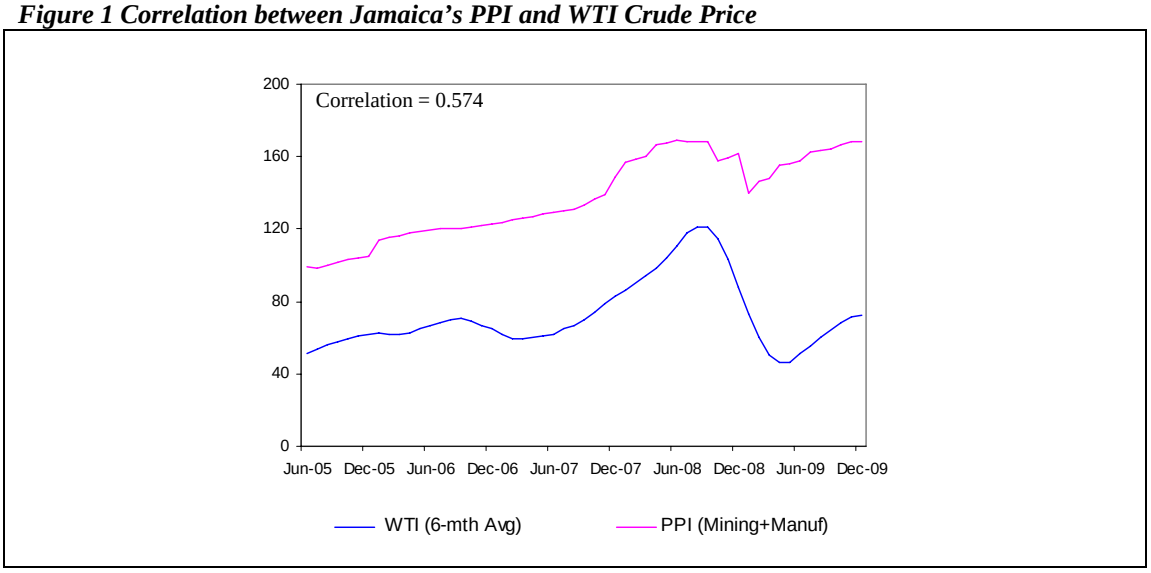
[13] Jamaica holds a net liability position with a negative NFA value. The series is normalization to eliminate negative values to accommodate the taking of logs.

risk premium will increase. Since investors require higher compensation for this added risk, if interest rates are given, then the domestic currency will depreciate (decline). This reflects an expected negative relationship between RER and LNGDD. For the purpose of this paper LNGDD is expressed as the log of total GOJ and BOJ domestic debt in millions of USD minus the log of total foreign debt liabilities held by the same institutions in millions of JMD.

Productivity (Balassa Samuelson) [positive] PROD

Higher productivity generates increased wealth and higher capacity for domestic spending. In a case where the level of productivity among tradable goods increases, wages and employment are also expected to increase. Assuming a high degree of labour mobility across tradable and non-tradable sectors, wage prices will also be bided up in the non-tradable sector. When domestic wages increase, prices are bided up generating a higher demand for domestic currency. This higher currency demand triggers an appreciation (increase). It is this positive relationship between productivity and domestic currency appreciation that has been coined the Balassa Samuelson effect.[14]

Figure 1 Correlation between Jamaica's PPI and WTI Crude Price



Typically productivity is indexed by the ratio of GDP to total labour employed. However due to data limitations an alternative but popular proxy is utilized to measure productivity in the tradable

[14] The Balassa-Samuelson Effect demonstrates that when examining a country's competitiveness, anything that causes the productivity in the tradables sector to increase more than proportionate to productivity growth in the non-tradable sector, will bring about an appreciation of the real exchange rate vis-à-vis its trading partner.

sector.[15] The Productivity index (PROD) is calculated as the log difference between Jamaica's consumer and producer price indices, minus the log difference between the US consumer and producer price indices. Jamaica's Producer Price Index is proxied by the West Texas Intermediate (WTI) crude oil price due to the limited time-span available for the PPI.[16] The PPI reflects the simple average of both the Mining and Manufacturing Producer Price Indexes for Jamaica. The correlation between Jamaica's monthly PPI and the 6-month average of the WTI is 0.57 and considered a reasonable proxy on this basis (See Figure 4.1).

Terms of Trade [positive] – TOT is an indicator of the degree of competitiveness between trading partners. A country that depends heavily on oil, for instance, a country might experience deterioration in its TOT if oil prices increase whereas; an oil exporting trading partner would experience an improvement in its TOT. The theoretical underpinnings suggest that a change in the TOT has both income and substitution effects on the exchange rate, see Melecky & Komarek (2005). Consider a case where the price of exported goods on the world market increased causing an improvement in the domestic TOT. The substitution effect suggests that domestic producers will drive-up production among tradables and away from non-tradables. The resulting wage increases that follow, spurs demand across both tradable and non-tradable sectors. The favorable price and boost in current account position that follows will stimulate an appreciation of the domestic currency. The Income effect emerges when a rebalancing adjustment of the exchange rate takes effect to restore internal equilibrium between both tradables and non-tradables. For Jamaica, a positive relationship is expected between the RER and the TOT. TOT is expressed as the ratio of BOJ's export and import indices. The variable is then logged for consistency.

The following variables recommended by Henry (2001) were used in the analysis as a measure of competitiveness. Due to data limitations, the analysis of competitiveness within Jamaica is restricted to quarterly trends for the time period March 1998 to December 2009. The variables include Unit Labour Cost (ULC), Ratio of Tradables to Non Tradables (TNT), and Trade Balance to Total Trade (TBT).

Real Effective Exchange Rate (REER) – The REER as defined in equation 2 is actively used as a measure of competitiveness by the Bank of Jamaica. Jamaica's REER is the geometric mean of

[15] Fernandez, and Schnatz (2001).pp12.
[16] Jamaica's Producer Price Index (PPI) has its first data point in January 2005 and is available on a monthly frequency.

bilateral exchange rates weighed by trade share among the largest 10 largest trading partners. The REER is expressed as the cost of one local dollar in terms of the weighted foreign currencies thereby representing an appreciation when increased and depreciation when reduced. The REER is typically used as a measure of competitiveness whereby an increase (appreciation) in general terms signifies a decrease in competitiveness and the inverse, an increase in competitiveness.

Unit Labour Cost (ULC) – Unit labour cost captures how much a country spends to produce a unit of output. A lower ULC represents a lower level of output per dollar spent on labour, hence a decline in productivity. An increase in ULC therefore represents a greater level of productivity. As such a country is deemed to be more competitive when the ULC increases and less competitive when there is a decline. For our purpose, the ULC for Jamaica is calculated as Total real value added at basic prices divided by total wages paid to the employed labour force. A relative ULC is derived from the ratio of Jamaica's ULC divided by the OECD calculated ULC for the US (see Figure 3B in Appendix).

Ratio of Tradables to Non Tradables (TNT) – The ratio of Tradables to Non-tradables is an indicator of productivity. When Tradables increase relative to Non-tradables, it suggests relatively more wealth is being directed towards the production of goods for trade. As such, it implies greater profitability among tradables relative to non-tradables. A higher ratio is therefore consistent with increased competitiveness. Greater productivity leads to increased employment and a greater demand for the domestic currency. This point to the well-known Balassa-Samuelson effect of a resulting domestic appreciation where there is increased productivity attributed to increased competitiveness.

Trade Balance to Total Trade (TBT) – The ratio of trade balance to total trade (TBT) captures the shifting bias of trade to either imports or exports. TBT is calculated as the twelve month balance of total imports minus total exports, all divided by the sum of total import and export. An increase in TBT therefore captures an increasing bias towards the importation of goods while a decrease suggests an increasing bias toward exports. The former reflects a deterioration in the terms of trade while the latter an improvement.

5 DATA TREND ANALYSIS

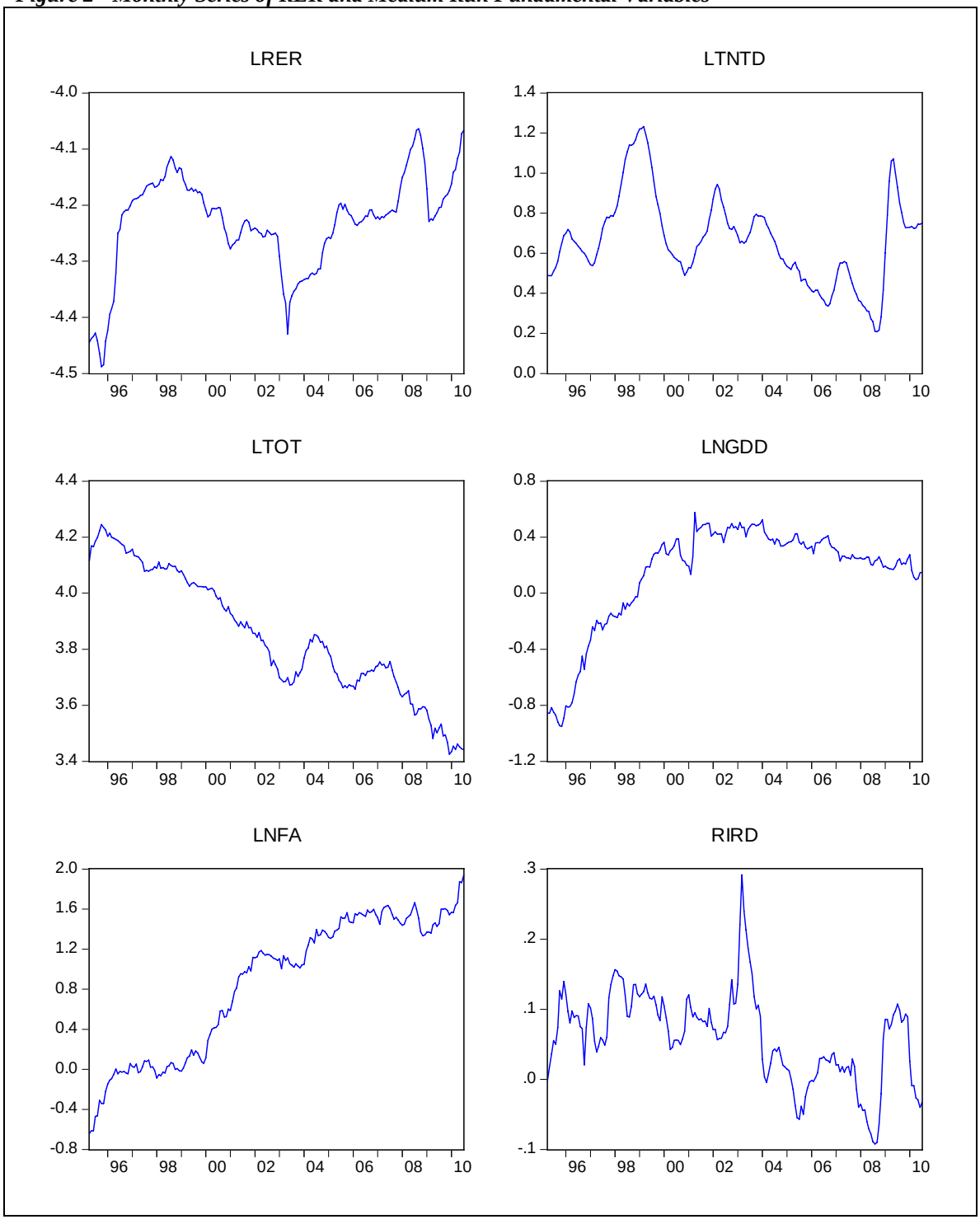
Trends of the variables reviewed in the previous section are shown in figure 2A and figure 2B. All trends are expressed in logs except for domestic interest rate (INTD), foreign interest rate (INTF), and the real interest rate differential (RIRD). Between Oct-1995 and Aug-1996 real exchange rates (RER) appreciated consistently and significantly from the lowest point in the period under review. This was followed by a gradual increase to the peak of the late 1990's in Aug-1998. This correlated with the financial sector crisis in the late 1990's. In the four-year period that followed (August 1998 to December 2002) LRER declined with moderate oscillations.

Within the period December 2002 and May 2003 the LRER experienced a steep falloff venturing close to the lowest level experienced in the financial sector crisis. This coincided with the foreign exchange market instability of 2003. Following this, the real exchange rate reverted to a strong upward trend over the period May 2003 to July 2005 (2.3 years) potentially reflecting a correction in the foreign exchange rate. The exchange rate then remained relatively stable for a period of 1.5 years (July 2005 to October 2007). Immediately following this relative stability, the real exchange rate appreciated with a significant and consistent slope over the 12-month period to October 2008. This coincided with the hike in global oil prices and deterioration in the US Housing market which culminated in a global economic crisis.

In the first two months of 2009, there was a drastic depreciation of the real exchange rate to levels consistent with the one year stability observed during mid 2005 to late 2007. The monetary authority had by this time made significant interest rate hikes and initiated a pact with currency traders for exchange rate stability. Whereas the NER remained relatively stable for the remainder of 2009 and early 2010, the RER reflected strong appreciations reflecting some underlying changes in the ratio of domestic and foreign prices.

The Tradable and Non-Tradable differential (LTNTD) bears some resemblance to the LRER in the first half of the dataset. In the late 1990's, the LTNTD reflected a sharp increase but returned to previous levels by 2000. Whereas the LRER gradually declined towards 2002, LNTD reflected a positive spiked in 2001 and started a gradual but oscillatory decline towards 2008. In the Global economic crisis that escalated in 2008, the LTNTD spiked significantly reaching levels just shy of the peak level that followed the financial sector crisis of the late 1990's. In 2009, LTNTD tapered off sharply but by just half the increase that preceded it.

Figure 2 - Monthly Series of RER and Medium Run Fundamental Variables



The Terms of Trade (LTOT) depicted a general downward trend for the major part of the data set. Nonetheless, the trend reflected slight oscillations and some cyclical shifts over the range. The LTOT demonstrated no coincidental movement with the LRER in the 1995 to 1996 period when

the LRER appreciated drastically. Nonetheless, following this period, variations in the LTOT appeared to move in direct relation to the LRER for the 6 year period to 2002 end. Following the strong depreciation of the LRER in the first 5 months of 2003, the LTOT and the LRER have since moved in opposite direction. In the three year period to 2010 the LTOT reflected a persistent downward trend. This was in contrast to strong upward shocks for the LRER in both the period leading up to and during the global economic crisis.

The domestic and foreign debt differential, termed Net Government Debt (LNGDD) also reflects some similarity with trends in the LRER for the first half of the dataset. The LNGDD steeply but decreasingly increased during the financial sector crisis of the late 1990's. In the decade that followed (2000 to 2010), the LNGDD gradually declined in an oscillatory manner irrespective of the notable disruptions in LRER due to the 2003 foreign exchange market instability and the global economic crisis.

The difference between total foreign asset and total foreign liability in Jamaica, termed Net Foreign Asset (LNFA), displayed key relationships with the LRER. In the mid 1990's when the LRER begun to spike, LNFA also displayed a strong increase, but quickly leveled off and remained stable until the start of 2000. At this point, LNFA once more began a steep upward trend for approximately two years. It was at the end of this incline that the LRER plunged in 2003 reflecting the foreign exchange market instability. LNFA displayed a mild reversion following the 2003 crisis but then continued a mild upward trend to some stable level observed from 2005 to mid 2008. In mid 2008 when the global financial crisis escalated, the LNFA displayed a mild negative jolt and has returned to a steep upward trend through out 2009 and early 2010.

The real interest rate differential (RIRD) reflected two significant spikes throughout its trend. These included the sharpest spike observed in early 2003 coinciding with the 2003 foreign exchange market instability; and the other immediately following the escalation of the global financial crisis in late 2008. The RIRD reflected significant variability throughout the entire period investigated but has displayed a notable downward trend within the ten year period of 1998 to 2008. This time period marks the end of the financial sector crisis and the start of the global economic crisis.

6 ECONOMETRIC METHOD

Both the CHEER and BEER empirical investigations utilized co-integration techniques that are outlined in steps 1 to 4 below. Step 5 represents the additional step employed having completed the BEER, to arrive at results for the PEER.

(1) Conduct unit root tests on the range of variables to ensure valid properties of the selected series for estimation
(2) Determine the appropriate equilibrium specification using Transitional variables and the given MR and LR variables.
(3) Conduct Co-integration tests on the MR and LR variables accounting for any additional exogenous variables.
(4) Estimate the Vector Error Correction Model (VECM) and demonstrate credible results based on sign of co-integrating parameter, speed of convergence, and strength of exogeniety among other variables.
(5) Decompose the Transitional and Permanent components for the joint BEER and PEER model.

6.1 CHEER Methodology

The CHEER model adopted for this paper follows the investigative approach of MacDonald & Marsh (1997). The CHEER enhances the PPP condition with interest rate components that are responsive to capital market dynamics (UIP). This is represented in equation (4 & 7).

$$NER_t = \beta_1 P_t - \beta_2 P_t^* + \beta_3 I_t - \beta_4 I_t^* + \varepsilon_t \quad \textbf{(7)}$$

Where:

NER_t	=	column vector of spot exchange rate between the US and JA[17].
P_t	=	vectors of domestic consumer prices in logs
P_t^*	=	vectors of foreign consumer prices in logs
I_t	=	vectors of annualized 3 month domestic interest rate
I_t^*	=	vectors of annualized 3 month foreign interest rate
β_k	=	coefficients vectors of the CHEER specification for k = 1 to 4.
ε_t	=	the random disturbance component.

[17] Measured as USD per JMD, therefore an increase represents an appreciation.

All variables are expressed in logs except for domestic and foreign interest rates that are represented in decimals. Stationarity tests are first conducted on the range of variables as a prerequisite for co-integration analysis. The commonly used Augmented Dickey Fuller and Phillips Perron tests were used for this purpose. A range of diagnostic tests were then conducted on varying deterministic components. Tests for no serial correlation and normality in the errors, required for appropriate error correction methodologies were also implemented. The numbers of co-integrating vectors are then evaluated by way of the Johansen trace and maximum eigen value tests. Multiple co-integrating vectors require the Johansen maximum-likelihood procedure in order to appropriately estimate error correction. Otherwise the standard Engel Granger methodology would suffice.

The sign and significance of the cointegrating coefficient are then evaluated for proof and speed of error correction in the specified model. With proof of error correction, the VECM residual is tested for white noise and significance of constant and trend. The cointegrating coefficient is expected to remove all information from the residuals leaving a white noise and no significant constant or trend. At this stage the estimated component of the cointegrating equation, considered to be the equilibrium, is then decomposed and compared to the actual exchange rate. Any deviations between the two (equilibrium and actual exchange rate) is labeled the exchange rate misalignment as represented by the CHEER model.

6.2 BEER Methodology

The BEER model adopted is based on the methods employed by Clark and MacDonald (1998). The recommend structural form of the BEER model derived from equation (8) is represented in equation 9.

$$RER_t = \beta_1 Z_{1t} + \beta_2 Z_{2t} + \gamma T_t + \varepsilon_t \quad \textbf{(8)}$$

$$RER_t = BEER_t + \gamma T_t + \varepsilon_t \quad \textbf{(9)}$$

where:

RER_t	=	column vector of Jamaica's US-bilateral real exchange rate
Z_{1t}	=	vectors of LR fundamental variables
Z_{2t}	=	vectors of MR fundamental variables
β_1, β_2	=	coefficients vectors of the equilibrium specification.
T_t	=	vector of transitory factors
γ	=	reduced form coefficient vector.

ε_t = the random disturbance component.

Consistent with Clark and MacDonald (1998), this paper classifies the MR variables captured in the Z_{1t} matrix and the longer LR variables captured in the Z_{2t} matrix. The variables utilized in the MR matrix includes the terms of trade (LTOT), net foreign asset (LNFA), and the measure of productivity represented by trade to non-tradable differential (LTNTD). Net government debt differential (LNGDD) was also included to capture the risk premium stemming from adjustments to the fiscal stock position over the long haul while the real interest rate differential (RIRD) captures the inter-temporal effects of UIP. The range of dummy variables, constant, trend and components of the ARIMA structure that are proven significant at the 5% level are classified as Transitional variables T_t. The BEER model is represented as shown in equation 10.

$$RER_t = \left[\beta_1 RIRD_t + \beta_2 LNGDD_t + \beta_3 LTOT_t + \beta_4 LNFA_t + \beta_5 LTNTD_t\right] + \gamma T_t + \varepsilon_t \qquad \textbf{(10)}$$

The path of the RER determined by the VEC specification is considered the equilibrium RER and represents the SR to MR BEER. This is then matched against the original RER to determine periods of over and under valuation (equilibrium misalignment). Clark and MacDonald (2000) highlights that real interest rate differentials are likely to reflect business cyclical developments as opposed to systematic trends over longer periods. On this basis, a SR BEER is calculated with RIRD as a fundamental variable, and then a MR BEER with RIRD excluded among transitional variables.

6.3 PEER Methodology

The PEER presented by Fernandez et al (2001) is adopted for this analysis. Whereas the BEER establishes equilibrium using actual fundamental values, the PEER superimposes equilibrium conditions on the fundamentals within the BEER specification. Hence, the PEER may be considered an augmented BEER representation. In accordance with Clark & MacDonald (1998) the PEER can be depicted as shown in equation 11, and 12,

$$RER_t = \beta_1 \overline{Z}_{1t} + \beta_2 \overline{Z}_{2t} + \gamma T_t + \varepsilon_t \qquad \textbf{(11)}$$

$$RER_t = PEER_t + \gamma T_t + \varepsilon_t \qquad \textbf{(12)}$$

where the bars in equation 11 represents equilibrium levels of fundamentals, and β_1, β_2 and γ are the original vectors of coefficients from equation 8. As demonstrated by Clark & MacDonald (1998), a Hodrick-Prescott (H-P) filter is used to attain LR trends of the fundamentals for the Z bars. The decomposed permanent component is considered to be the LR PEER. This too is

matched against the original RER to determine periods of over and under valuation of the domestic currency for the LR.

7 ECONOMETRIC RESULTS

Model results for the three time horizons are presented within this section. These include (1) the SR Capital Enhanced Equilibrium Exchange Rate (CHEER) model, (2) the MR Behavioral Equilibrium Exchange Rate (BEER) model, and (3) the LR Permanent Equilibrium Exchange Rate (PEER) model.

7.1 CHEER Model Results

Equation 6 was used to evaluate the CHEER. All variables were stationary in the first difference satisfying the necessary condition for cointegration. Simple regression results in approximately 95% of the variation in the RER being explained by the fundamental variables. Including a constant trend and dummy variables resulted in over 99% explanation of the variation in the NER. Additionally, the Jarque Bera null hypothesis of no normality was strongly rejected for the residual.

To formally test the presence of cointegration appropriate lag length tests were first conducted on the range of variables for which the SC and HQ recommended the nth lag of two (2). The Johansen trace and maximum eigenvalue tests found evidence of one (1) cointegrating vector at (n-1) lags. With proof of cointegration, the VECM methodology was estimated on a single lag (n-1), accounting for one (1) cointegrating vector and no trend in the cointegrating equation. From the results, all variables except for the interest rate for Jamaica were statistically significant at the 5% critical level.

Among the variables, an incorrect sign but significant coefficient was found on the foreign price. Additionally, the domestic interest rate was incorrectly signed but was the only insignificant variable. Nonetheless, the cointegrating coefficient (-0.15) was significant at both the 5% and 1% critical level and appropriately signed (see Table B in appendix). The speed of adjustment is estimated with a half-life of 6 months. Both the Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) unit root tests confirms a unit root in levels of the residual with no significant constant and trend. Hence, all information is considered captured by the VECM.

The evidence suggests that while variations in Jamaica's price level partially conform to PPP with strong statistical significance, the domestic interest rate, though insignificant, contradicts the UIP condition (see Table B in appendix). Variation in the US price index, however, wholly contradicts the PPP condition reflecting a full (unity) pass-through into domestic prices by way of exchange valuation. This was opposed to the adjustment being made to the value of the US Dollar to keep foreign prices constant. The results confirm that Jamaica is a price taker and is required to adjust the value of its currency for both domestic and foreign price changes for a given unit of foreign currency.

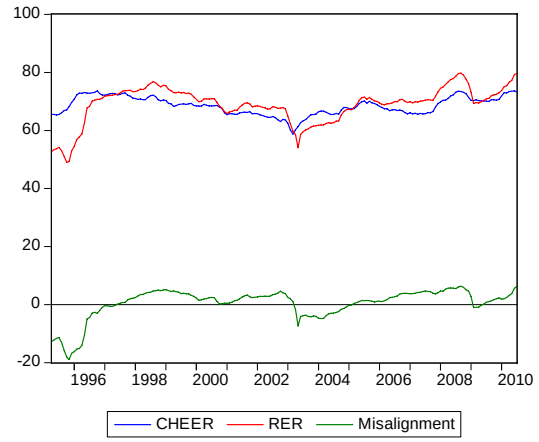
The US interest rate impacted the exchange rate with the expected sign in accordance with the UIP condition. The evidence reflected a full pass-through characterized by a coefficient of unity (see CHEER[A] in Table B of Appendix). Changes in Jamaica's interest rate appear to have no significant effect on exchange rate in accordance with the UIP condition. An increase in the domestic interest rate is, therefore, not met with a relative appreciation of the USD (depreciation of domestic dollar) required to prevent portfolio shifts in currency holdings. This will create the conditions for greater currency speculation when the domestic interest rate changes. The unexpected sign may suggest that holders of JMD denominated assets are unwilling to shift holdings to USD when domestic interest rates fall thereby requiring no depreciation of the USD. It might suggest a bias towards domestic currency holding given the prevalence of high interest premiums. On the contrary the results my also reflect the dominance of interest rate policy used for stabilizing speculative behaviour in the domestic foreign currency market. The latter would eliminate the need for an exchange rate correction in line with the UIP condition.

An increase in Jamaica's price level resulted in a general depreciation of the domestic currency. The evidence reflects a weakening in the JMD by approximately 50% of the price increase in order to mitigate the full impact on trade (see CHEER[A] in Table B of appendix). This is in accordance with PPP but for which only a partial adjustment is made. On the contrary, higher US prices are not met with a relative appreciation of the JMD hence contradicting the PPP condition. This result is however, reasonable considering that Jamaica depends on the USD for purchasing a large share of its capital and raw materials that are not provided locally for export.

The results demonstrate that increases in the US interest rate will result in an appreciation of the JMD thereby preventing shifts away from JMD to USD denominated asset holdings. Therefore, the evidence suggests that UIP related exchange rate adjustments are to be expected when the US

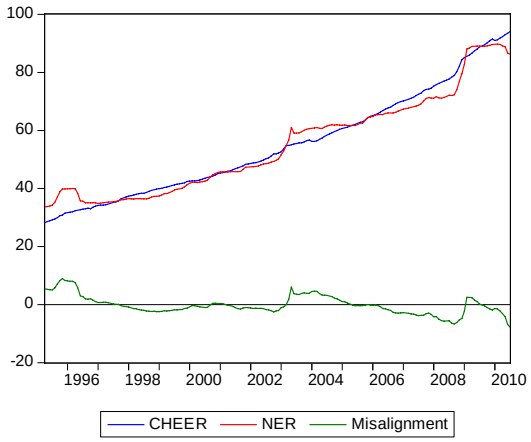
Figure 3 – Monthly Actual and Equilibrium Exchange Rates

CHEER - Real Equilibrium vs. Actual Exchange Rate



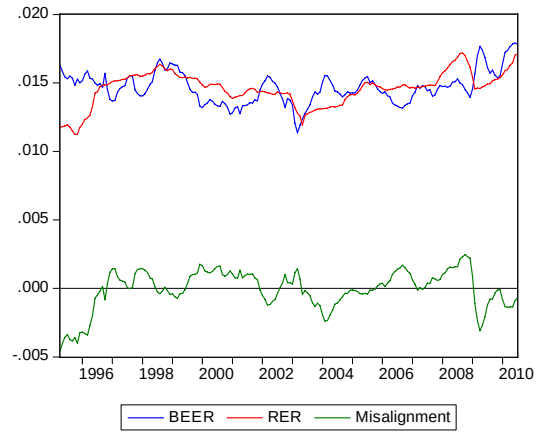
a

CHEER - Nominal Equilibrium vs. Actual Exchange Rate



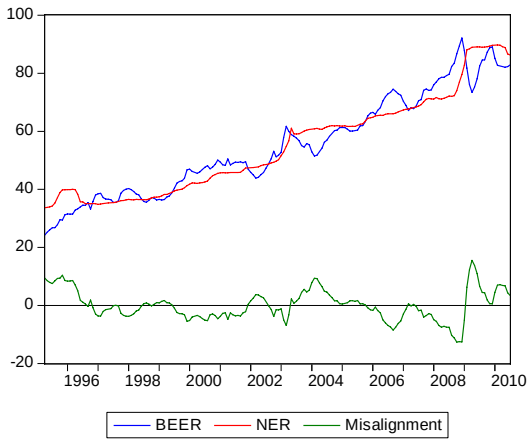
b

BEER(A) – Real Equilibrium vs. Actual Exchange Rate



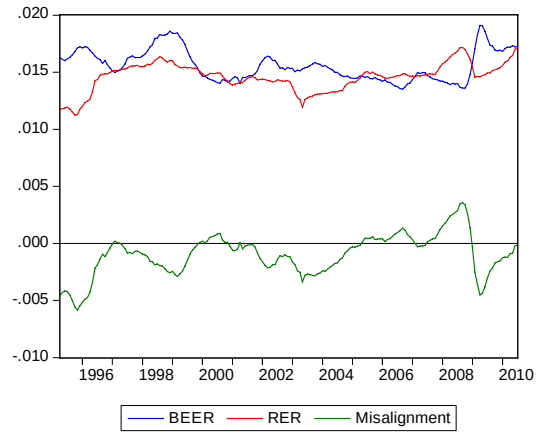
c

BEER(A) - Nominal Equilibrium vs. Actual Exchange Rate



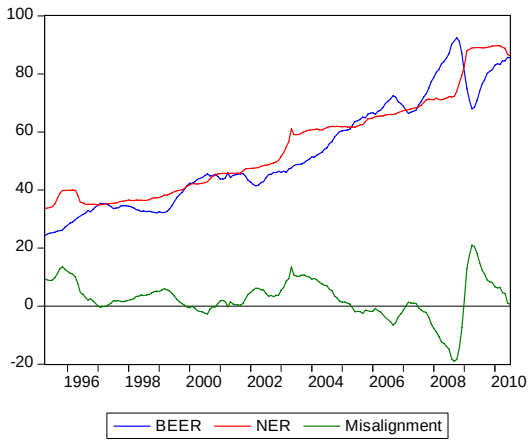
d

BEER(B) – Real Equilibrium vs. Actual Exchange Rate

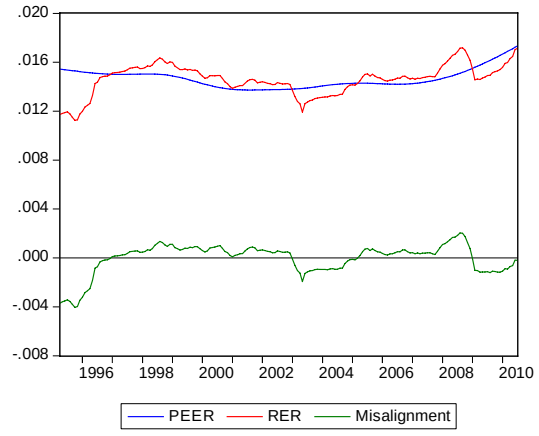
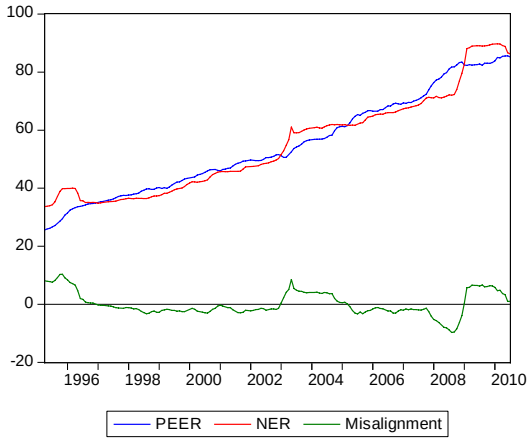


e

BEER(B) - Nominal Equilibrium vs. Actual Exchange Rate



f

PEER - Real Equilibrium vs. Actual Exchange Rate	PEER - Nominal Equilibrium vs. Actual Exchange Rate
	
g	h

Clark and MacDonald (1998) characterized total misalignment as $q_t - \beta_1' \overline{Z}_{1t} - \beta_2' \overline{Z}_{2t}$ where q_t is the exchange rate of concern and $\overline{Z}_{1t}$ and $\overline{Z}_{2t}$ are the LR and MR fundamentals respectively. The PEER is the LR equilibrium with Hodrick-Prescott filtered fundamentals. RER expressed as USD per JA$1 hence increase equates to an appreciation. NER expressed as JMD per US$1 hence increase equates to a depreciation.

interest rate change. Nonetheless domestic interest rate polices may distort UIP based adjustment to the exchange rate. When the interest rate differential is used in place of separate interest rates within the SR model (see CHEER2 in Table B of Appendix), the UIP condition was nonetheless confirmed, but only at a 10% critical value. The results suggest that when domestic interest rates increase, or US interest rates decline, the JMD will depreciate thereby eliminating the tendency to shift to JMD holdings. This effect reflected only a 50% pass-through thereby retaining some incentive for portfolio shifting in the SR.

Figure 3a & b shows the SR real and nominal equilibrium exchange rate (CHEER) vis-à-vis the respective actual exchange rate for the period being investigated. The results demonstrate that in the period 1995 to mid 1996, the Jamaican dollar was severely undervalued for which a speedy correction was made by the start of 1997. In the 2003 foreign exchange market instability the JMD became undervalued on account of market psychology from uncertainty. The resulting disequilibrium gradually dissipated over the following two years. Evidence of SR disequilibrium is observed from early 2006 and was further exacerbated in 2007 when oil prices begun climbing to historical highs. Since August 2008, a month after oil prices began falling, the foreign exchange rate went into a period of expanded overvaluation. A significant depreciation resulted

towards the end of 2008 to bring exchange rate inline with equilibrium. In the period that follows 2009 and early 2010, there are signs of the JMD strengthening against the USD in real terms.

7.2 BEER Model Results

The BEER model was estimated using equation 9. All variables were stationary in the first difference satisfying the necessary condition for co-integration. A simple regression resulted in approximately 35% of the variation in the RER being explained by the fundamental variables. Of the five (5) variables, only three (3) were significant at the 5% critical level. However, including constant and dummy variables resulted in over 82% of explained variation with all variables significant at the 5% and 1% critical level. Additionally, the Jarque Bera null of no normality was strongly rejected for the residual.

Lag length tests was based on the FPE, AIC, SC and HQ filters all recommending the nth lag of two (2). The Johansen trace and maximum eigen value tests were then conducted to determine the number of cointegrating vectors. The results show that there was no more than 1 cointegrating vector at (n-1) lags. With proof of cointegration, the VECM methodology was estimated on a single lag (n-1), accounting for one (1) cointegrating vector and no trend in the cointegrating equation. The results show that, all variables except for Jamaica's Terms of Trade (TOT) and Net Foreign Asset (NFA) had the correct sign. These two variables however, were respectively insignificant at the 5% and 10% critical level (see Table B in Appendix). The cointegrating coefficient (-0.06) was significant at both the 5% and 1% critical level and appropriately signed (see Table B in appendix). The speed of adjustment is estimated with a half-life of 13 months. The resulting residual proved to be a unit root in levels with no significant constant or trend which supports the notion that all information has been captured. The evidence suggest that there are no significant explanatory power of the theoretically recommended TOT and NFA in explaining variations in the bilateral exchange rate between Jamaica and the USA as both fundamentals were insignificant and inappropriately signed (see Table B in Appendix).

Among the factors that proved theoretically consistent and significant were the productivity indicator proxied by (TNTD) which supports the Balassa Samuelson effect where an increase in productivity will enhance competitiveness while appreciating the domestic currency. Additionally, the differential between domestic and foreign debt (NGDD) strongly supports the notion that increasing domestic debt will result in a depreciation of the domestic currency vis-à-vis its US counterpart. The real interest rate differential (RIRD) significantly reflects the expected

UIP relationship between the domestic and foreign interest rate. The results show that when Jamaica's interest rates increase relative to US interest rates; the JMD will depreciate to cancel the arbitrage that emerge. This also indicates that when fundamental variables are included in the specification, the true process underlying the UIP is revealed. The result supports the relevance of utilizing a fundamentals based approach to evaluate exchange rate dynamics.

Figure 3.c & d graphically compares the BEER (SR) with the actual real exchange rate. With the explanatory power of RIRD, BEER (SR) appears to be much more in sync with the actual RER. The main disequilibrium featured was in relation to the financial crisis in the mid to late 1990's. The other two disturbances that were cited in the CHEER models were also reflected in the BEER (SR) but with much less deviation from equilibrium. The BEER (SR) therefore appears to be a much better guide to where the exchange rate should be in the SR. A MR fundamentally consistent equilibrium rate was derived by omitting variations in the RIRD and is represented as BEER (MR) (see Figure 3e and 3f). When decomposed, the model demonstrated that for the entire period of 1996 to early 2005, the exchange rate was biased towards being undervalued. Similar to the CHEER, the BEER (MR) revealed that both the financial crisis of the mid to late 1990's and the financial instability of 2003 were periods of excessive depreciation. Nonetheless, there was evidence of convergence. The 2007 to 2008 period of rising oil prices which culminated in an exacerbated global financial crisis, was a period of significant appreciation in the real exchange rate. Nonetheless, the nominal exchange was kept artificially overvalued during the period following which a significant correction (depreciation) took place within the period October 2008 to February 2009. Following from early 2009 in the face of a foreign currency pact, the BEER(B) suggested that the JMD was strongly undervalued setting the stage for a domestic currency appreciation. Nonetheless stability remained throughout 2009 while the equilibrium BEER(B) moved towards convergence with the actual exchange rate.

7.3 PEER Model Results

The PEER model was estimated using equation 11. The parameters are the same as those specified within the BEER(A) model. It was not deemed necessary to calculate two PEER since the cyclical components or the RIRD are believed to be filtered out in the HPF transformation. The PEER revealed that the extended undervaluation relating to the financial crisis of the 1990's, the foreign exchange market disruption of 2003, and the overvaluation leading up to the 2008 global financial crisis were all distinctive periods of disequilibrium. The PEER proved useful in highlighting the deviation from equilibrium in periods leading up to the financial sector crisis of

the mid to late 1990's and the period approaching the escalation of the global financial crisis in late 2008 (see Figure 3g and 3h). The PEER was however not very useful in signaling the likely 2003 foreign currency market disruption. On these grounds, the PEER may be more useful in monitoring currency misalignment related to structural adjustments affecting economic fundamentals as opposed to speculative disruptions attributed to market psychology as was witnessed in 2003.

8. COMPETITIVENESS

By determining the equilibrium exchange rate, periods of disequilibrium can be more clearly identified. It is perceived that extended periods of disequilibrium may result in suboptimal levels of competitiveness. The paper therefore seeks to assess the effects of disequilibrium on Jamaica's level of competitiveness. The measures of competitiveness adopted for this purpose include the REER, ULC, TNT, and TBT. Changes in these measures of competitiveness are matched against the computed misalignment for the CHEER, BEER[A], BEER[B], and PEER (see Figure 3 A, B, & C in the Appendix). Considering that competitiveness indicators are available for the period 1998 to present, key relationships between disequilibrium and competitiveness may only be deduced from the last two (2) period's of misalignment. The following sheds light on the key relationships between competitiveness and disequilibrium for the last two crises featured in 2003 and 2008.

8.1 Foreign Currency Market Instability (2003)

In this period all three models (CHEER, BEER[B] & PEER) reflected a significant shift towards a strongly undervalued JMD in real terms (see Figure 3A in appendix). During this period the REER reflected an increase in competitiveness signaled by a significant depreciation. At this point Jamaica's ULC switched from a consistent deterioration to no change in competitiveness (see Figure 3B in appendix). The TNT indicator of competitiveness reflected no significant change in competitiveness that was demonstrated by relatively stable TNT during the 2003 period. The TBT, similar to the REER and ULC during this period, reflected a notable improvement in competitiveness as this was the only period during which there was a substantial bias towards exports. This period of a relatively undervalued domestic currency reflected a general improvement in competitiveness. Nonetheless, as the instability of 2003 corrected toward the various measures of equilibrium, the level of competitiveness based on the TBT continued to deteriorate.

8.2 Global Economic & Financial Crisis (2008)

During this period all measures of misalignment except for BEER[A] reflected a strong and persistent shift away from equilibrium beginning as early 2006 for the CHEER and mid 2007 for BEER[B] and PEER. This resulted in an overvalued Jamaican dollar (see figure 3 in appendix). By mid 2008 continuing onwards, a sharp correction was evident in both the SR CHEER and SR and MR BEER, and LR PEER models. The two phases were strongly correlated to the significant hike in crude oil prices leading up to mid 2008 (phase1) that experienced a significant correction following this period (phase 2).

In the first phase of mounting overvaluation, the REER reflected a consistent deterioration in the level of competitiveness. In the second phase where exchange rates were corrected, but for which MR and LR models reflected an undervaluation, the REER sharply switched to a strong improvement in Jamaica's level of competitiveness. In the first phase of an expanding overvaluation (strengthening) of the Jamaican dollar, domestic ULC worsened while US ULC deteriorated. Both trends suggested a relatively stable to declining level of competitiveness in Jamaica which was consistent with REER signals of competitiveness. In the second phase however, domestic ULC reverted to comparable levels before phase one of the 2008 Global economic crisis. It is to be noted that the US ULC continued to descend into the negative bands reflecting a net improvement in Jamaica's level of competitiveness. This is also consistent with the REER measures of competitiveness during this period.

Similar to the REER and ULC indicators, the TNT ratio captured a falloff in competitiveness in the first phase of expanding overvaluation. The trend, however, persisted into the second phase where levels of competitiveness gauged by the TNT continued to deteriorate.

The TBT reflected continued deterioration in the terms of trade throughout the entire period of the Global economic crisis. The result indicated that there remains a bias towards an expanding deterioration in the trade balance which captures persistent levels of declining competitiveness. Therefore TBT is consistent with TNT in both phases but inconsistent with the second phase competitiveness measures for the REER and ULC. It is noteworthy that productivity measures of competitiveness indicated by the TNT and TBT may contradict the commonly used REER measure for competitiveness. This outcome provides supports for the Balassa-Samuelson effect.

9. CONCLUSION

This paper sets out to determine the equilibrium exchange rate for Jamaica over three distinct time horizons (SR, MR, & LR). A fundamentals based approach was used in modeling the dynamics of mean reverting tendencies as implied by the theories of PPP and UIP. With the use of co-integrating techniques, proof of mean reversion was confirmed in the models presented. Error Correction coefficients were all significant reflecting reasonable speeds of adjustment with a half life ranging from 6 to 13 months for SR to MR models respectively.

The SR model demonstrated that variations to the Jamaican price level are met with partial adjustment in the exchange rate in accordance with PPP. According to the CHEER [A] model, a 1% increase in Jamaican prices results in an approximate 0.5% relative appreciation of the USD vis-à-vis the JMD. No such transmission was evident in changes to US prices. Instead, a 1% increase in US prices was transferred in full to Jamaica, whereby the JMD depreciated against the USD by the same 1%. Both impacts were statistically significant. The non-PPP based US price adjustment may be attributed to the heavy reliance of Jamaica on imported raw materials used for production. In this case, PPP is not expected to hold given that Jamaica does not produce similar products and given its size would have little power in setting prices.

Results from the SR model demonstrated that a change in Jamaica's interest rate is not met with an appropriate adjustment in the exchange rate in order to eliminate tendencies for investors to switch currency holdings. This contradicts the UIP condition but for which the adjustment was marginal, and statistically insignificant. This may be attributed to the distortion of interest rate policies aimed at curtailing or moderating domestic currency depreciations. The US interest rate responded in accordance with the UIP condition and reflected full adjustment in the exchange rate to correct tendencies to shift currencies to alternate currency holdings. The SR results using the CHEER model confirm the weak existence of UIP for Jamaica as indicated by McFarlane (2003). However, the UIP condition was found to be significant and fully accounted for when the MR (BEER) was utilized incorporating the explanatory power of exchange rate related fundamental variables.

The MR and LR models reflected expected signs for all variables except TOT and NFA. Both variables however, were statistically insignificant. In summary, the Balassa-Samuelson theory was confirmed demonstrating that the exchange rate will appreciate when productivity increases.

This was also supported by trends in the TNT productivity measure of competitiveness which showed deterioration in competitiveness as productivity levels declined in the second phase of the global financial crisis. Also the negative correlation between exchange rate and the risk premium imposed by government debt was significant. Hence, increasing the domestic debt relative to foreign debt will lead to a general depreciation of the domestic currency. The interest rate differential was also significant with a negative sign suggesting than increases in the Jamaican interest rate relative to the US interest rate will be met by a depreciation of the domestic currency that will offset any tendency to switch hold to domestic currency denominated assets.

The 2003 financial sector instability and the 2008 global financial crisis reflected clear signals that an undervalued currency resulted in increased levels of competitiveness. The productivity and trade flow measures of competitiveness (TNT & TBT) however, conflicted with the REER and ULC measures of competitiveness in the second stage of the global financial crisis. In this case, persistent decline in productivity resulted in periods of undervaluation and was characteristic of declining competitiveness. This is inline with the proposition made by Henry (2001), that depreciation does not necessarily mean improved competitiveness.

It is recommended that utilization is made of the SR equilibrium models explored in this paper to actively monitor potential disequilibrium caused by foreign exchange market psychology. The MR and LR equilibrium models are however recommended in the process of actively monitoring the impact of structural changes on misalignment in the foreign exchange market. Whereas the REER is useful in citing instances of increased competitiveness based on relative import and export prices, it excludes the essential impact of productivity on determining competitiveness. It is therefore recommended that he BOJ adopts alternative measures of Competitiveness with the objective of capturing productivity effects.

10. BIBLIOGRAPHY

Artis, Michael J., and Mark P. Taylor, (1993), "DEER Hunting: Misalignment, Debt Accumulation and Desired Equilibrium Exchange Rates", IMF, IMF Working Papers, WP/93/48, (June)

Atkins, Fiona, 2000, "*Revisiting the Exchange Rate Debate: The Jamaican Experience*", Journal of International Development, vol.12, pp.121-131.

Bayoumi, Tamim, Peter Clark, Steve Symansky, and Mark Taylor (1994), "*Robustness of Equilibrium Exchange Rate Calculations to Alternative Assumptions and Methodologies*", IMF, IMF Working Papers, WP/94/17 (February)

Clark, Peter, and Ronald MacDonald, (1998), "*Exchange Rates and Economic Fundamentals: A Methodological Comparison of BEERs and FEERs*", IMF, IMF Working Papers, WP/18/67.

Dockery, Everton, and Karl Taylor, (2008), "*On the Validity of Long-Run Purchasing Power Parity: A look at Two Selected Caribbean Economies Exchange Rate*", Journal of Money, Investment and Banking, Issue 1 (2008).

Driver, L, Rebecca and Peter F. Westaway, 2004, "*Concepts of equilibrium exchange rates*",. Bank of England, Working Paper no. 248.

Francis, A., 1998, "*Is the Jamaican Dollar Overvalued?*", Social and Economic Studies, Vol.47, Issue 4, pp.29-45.

Franklin, Famalia and Rohan Longmore, 2008, "*Price-Setting Behaviour in the Jamaican Foreign Exchange Makret"*, Bank of Jamaica.

Franklin, Tamalia and Rohan Longmore, 2008, "*Pric-Setting Behaviour in the Jamaican Foreign Exchange Market*", Journal Of Economic Literature

Henry, Chandar, 2001, "*Measuring Competitiveness in the Jamaican Economy*", Bank of Jamaica (BOJ) Working Papers, (October)

Henry, Henry, Rohan Longmore, (2001), "*Current Account Dynamics and The Real Effective Exchange Rate: The Jamaican Experience"*, Bank of Jamaica, Working Paper, March 2003.

Isard, Peter, and Hamid Faruqee et.al (1998), "*Exchange Rate Assessment: Extensions of the Macroeconomic Balance Approach*", International Monetary Fund (IMF), Occasional Paper (167).

MacDonald, Roland, and Ian W. Marsh (1997), "*On Fundamentals and Exchange Rates: A Casselian Perspective*", The MIT Press, The Review of Economics and Statistics, Vol 79, No.4 (November).

MacDonald, Ronald, and Mark Taylor, (1992), "*Exchange Rate Economics: A Survey*", IMF, IMF Staff Papers, Vol. 39, No. 1 (March)

MacDonald, Ronald, Preethike Dias (2007), *"The Behavioral Equilibrium Exchange Rate of the Czech Koruna"*, University of Glasgow and Peterson Institute of International Economics, Washington DC.

Maeso-Fernandez, Francisco, Chiara Osbat, Bernd Schnatz, (2001), *"Determinants of the Euro Real Effective Exchange Rate: A BEER/PEER Approach"*, European Central Bank, Working Paper No. 85, November 2001.

Marsh, Ian, and Stephen Tokarick (1994), "*Competitiveness Indicators: A Theoretical and Empirical Assessment*", International Monetary Fund, Working Paper (WP/94/29)

McFarlane, Lavern (2003), *"The UIP and Time Varying Risk Premium: An Application to the Jamaican Bond Market"*, Bank of Jamaica, Working Paper, November 2003.

Meese, Richard A, and Kenneth Rogoff (1993), "*Empirical Exchange Rate Models of the Seventies: Do they fit out of Sample?*", Journal of International Economics, Vol. 14 (February 1983), pp. 3-24.

Meese, Richard A, and Kenneth Rogoff (1993), "*Empirical Exchange Rate Models: Sampling Error or Misspecification?*", Exchange Rates and International Macroeconomics, ed. By Jacob A. Frenkel (Chicago: University of Chicago Press, 1984)

Melecky, Martin, Lubos Komarek (2005), *"Behavioural equilibrium exchange rate estimates and implied exchange rate adjustments for ten countries"*, Transition Studies Review, 14 (1), pp. 105-121, 2007

Moura, M, Adauto Lima, and Rodrigo Mendonca, (2008), "*Exchange Rate and Fundamentals: The Case of Brazil*", IBMEC Working Paper, WPE-66-2008.

Paiva, Claudio, (2001), "Competitiveness and the Equilibrium Exchange Rate in Costa Rica", IMF, IMF Working Papers, WP/01/23 (February)

Pineda, Emilio, Paul A. Cashin and Yan Sun, 2009, "*Assessing Echange Rate Competitiveness in the Eastern Caribbean Currency Union"*, IMF, Working Paper no. 09/78.

Williams, Pierre, 2008, "*Estimating Jamaica's Real Equilibrium Exchange Rate*", Bank of Jamaica (BOJ) Working Papers.

11. APPENDIX

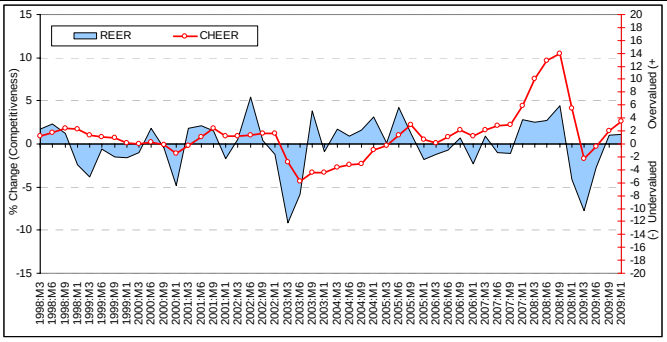
Table A - Unit Root Tests for Monthly Fundamental Variables

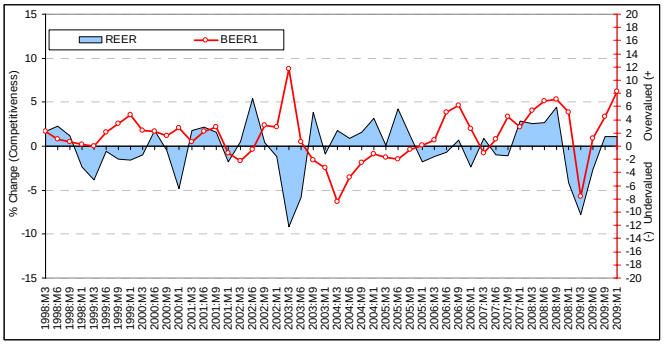
Variables		ADF		PP	
LRER	levels	-2.680	[c]*	-2.605	[c]*
	1st diff	-8.381	***	-8.489	***
LPRI_ja	levels	-2.527	[c,t]	-0.503	[c]
	1st diff	-6.438	[c]***	-6.438	[c]***
LPRI_us	levels	-3.313	[c,t]*	-3.148	[c,t]*
	1st diff	-8.758	[c]***	-6.850	[c]***
INT_ja	levels	-3.170	[c,t]*	-0.818	
	1st diff	-9.508	***	-9.514	***
INT_us	levels	-1.495		-1.394	
	1st diff	-5.280	***	-11.052	***
LNFA	levels	-2.974	[c]**	-2.856	[c]*
	1st diff	-12.864	[c,t]***	-12.864	[c,t]***
RIRD	levels	-4.111	[c,t]***	-2.782	[c]*
	1st diff	-8.989	***	-9.214	***
LNGDD	levels	-3.493	***	-3.784	***
	1st diff	-15.950	[c,t]***	-15.927	[c,t]***
LTNTD	levels	-3.160	[c]**	-3.191	[c]**
	1st diff	-9.183	[c,t]***	-9.398	[c,t]***
LTOT	levels	-2.627	[c,t]	-2.971	[c,t]
	1st diff	-11.764	***	-11.764	***
Significance is indicated as *** at 1%, ** at 5%, and * at 10%					

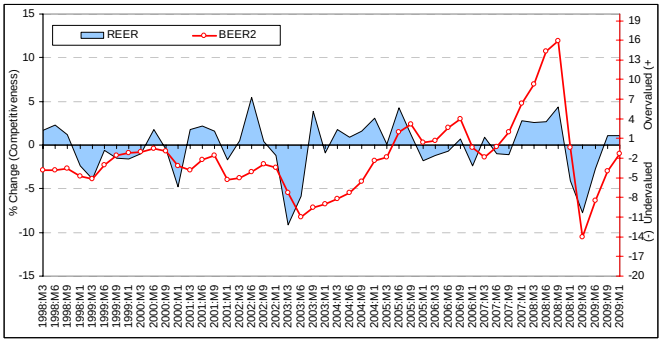
Table B - Estimation Results for PPP, UIP, CHEER & BEER Models

		A	B	C	D	E
Period	**Sign**	**SR**	**SR**	**SR**	**SR**	**MR**
NAME	**[+/-]**	**PPP**	**UIP**	**CHEER(A)**	**CHEER(B)**	**BEER**
Dependent		LNER	LNER	LNER	LNER	LRER
PRI_JA	[-]	**-0.2523** (-1.833)**	---	**-0.4845** (-4.077)***	**-0.2348** (-1.728)**	---
PRI_US	[+]	1.0298 (1.078)	---	**-0.9558** (-2.057)**	0.2071 (0.517)	---
INT_JA	[-]	---	**-0.1968** (-1.935)**	0.0441 (0.435)	---	---
INT_US	[+]	---	0.4167 (0.951)	**1.0122** (2.7687)***	---	---
LTNTD	[+]	---	---	---	---	**0.3627** (7.498)***
LNGDD	[+/-]	---	---	---	---	**-0.1595** (-3.371)***
LTOT	[+]	---	---	---	---	-0.1898 (-1.547)*
RIRD	[-]	---	---	---	**-0.2071** (-1.535)*	**-0.9938** (-5.369)***
LNFA	[+]	---	---	---	---	-0.0018 (-0.042)
CONSTANT		-5.8150	-2.2415	2.3682	-3.7580	-3.651
TREND	[-]	**-0.0062** (-2.915)***	**-0.0062** (-33.903)***	---	**-0.0054** (-2.473)***	---
COINT Coeff	[-]	**-0.1294**	**-0.1592**	**-0.1501**	**-0.1454**	**-0.0561**
		(-4.634)***	(-5.414)***	(-4.941)***	(-5.327)***	(-3.448)***
Half Time (mths)		**7**	**5**	**6**	**6**	**13**
R-Squared Adj-Rsquared		0.364 0.337	0.377 0.351	0.380 0.345	0.394 0.364	0.308 0.270
DW Statistic Jarque-Bera (Prob)						
Significance is indicated as *** at 1%, ** at 5%, and * at 10% , Significant Coefficients in bold						

Figure 3A – REER and Misalignment







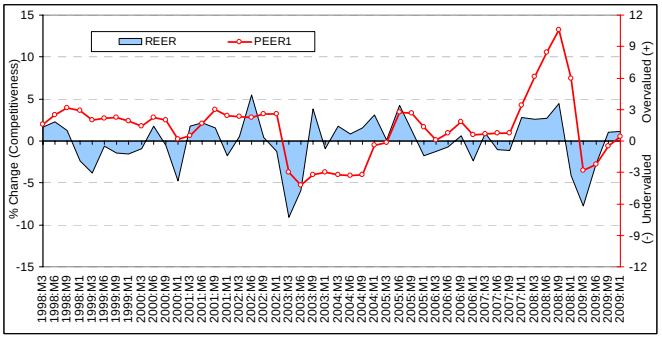
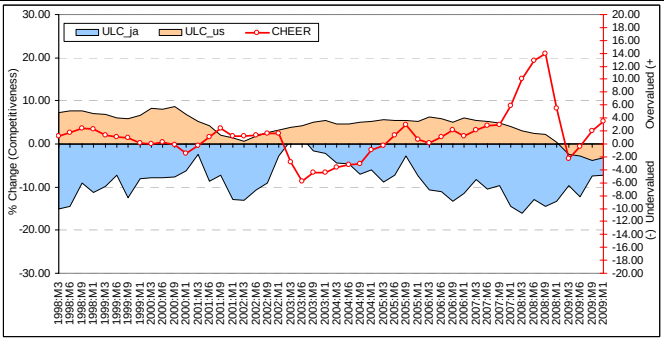
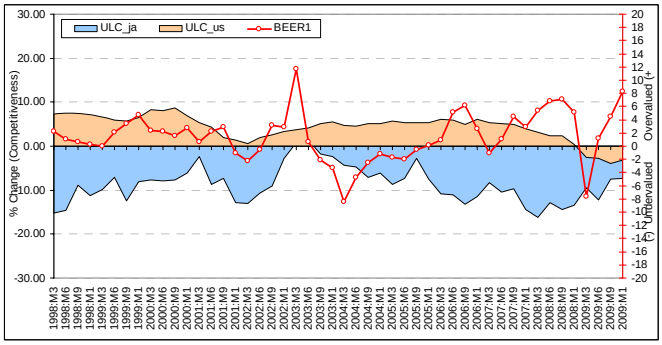
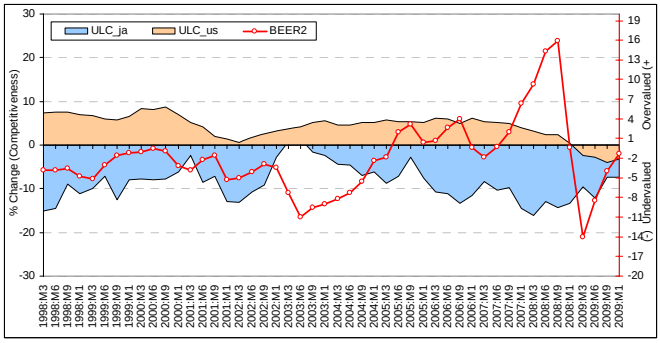


Figure 3B – ULC and Misalignment







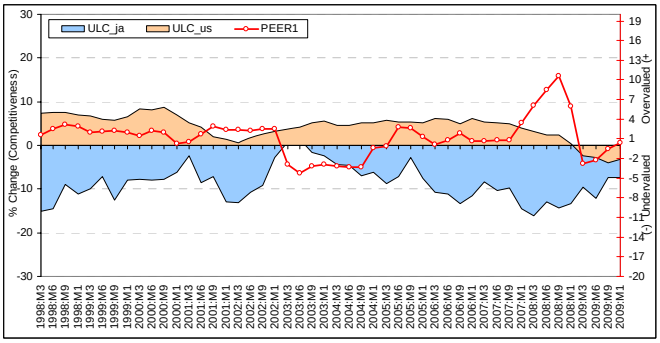
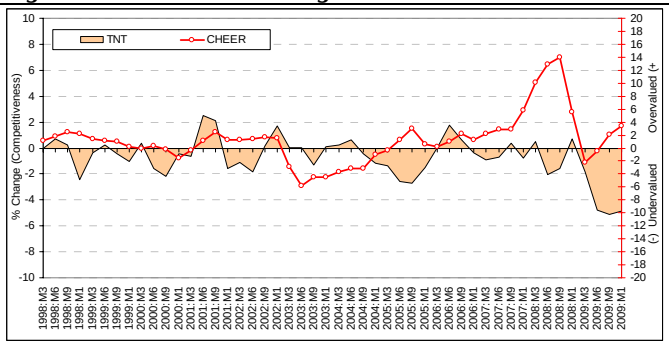
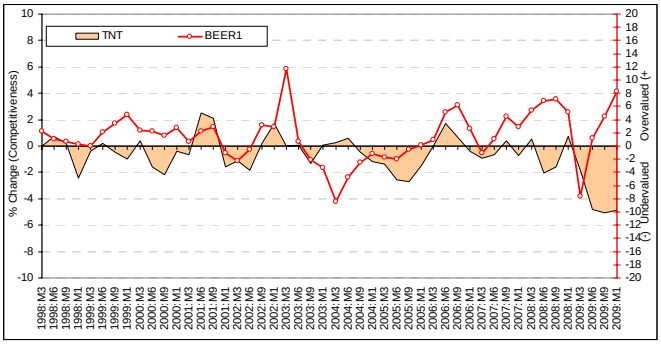
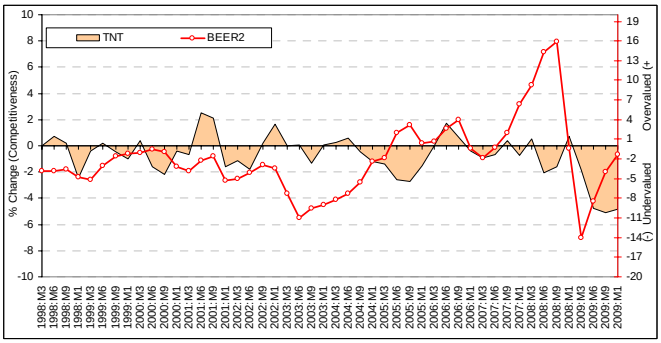


Figure 3C – TNT and Misalignment







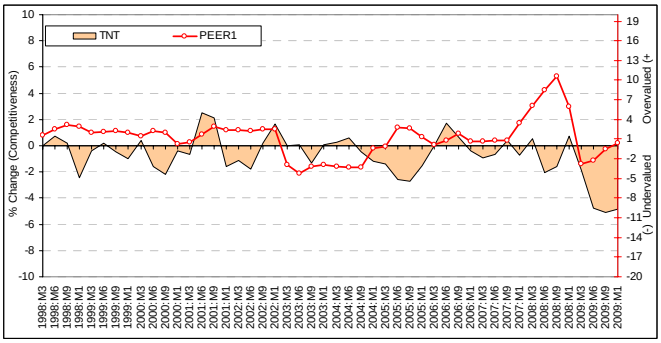


Figure 3D – TBT and Misalignment