Exchange Rate Behaviour in Ghana: Is there a Misalignment?[1]

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Abstract

The behaviour of exchange rates in Ghana over the last three years has been topical. The cedi has been perceived to be misaligned especially after the redenomination exercise in 2007. The problem with exchange rate misalignment is that it often results in resource misallocation and could hamper overall economic growth if it is persistent. This paper examines the equilibrium real effective exchange rate (REER) of the Ghanaian cedi for the period 1980 – 2013 using the behavioural equilibrium exchange rate (BEER) approach and subsequently investigates the extent to which the cedi is misaligned. The error correction model (ECM) is employed to estimate the long run and short run dynamics of the exchange rate. Results from the Autoregressive Distributed Lag (ARDL) approach indicate the terms of trade and openness exert significant positive and negative influence on the equilibrium real exchange rate respectively. Results also show that there is significant misalignment of the exchange rate from 1981 – 1983. However, since 1984, the exchange rate has been moving within a marginal misalignment threshold of 7%. By implication actual real effective exchange rate has been moving relatively in line with its equilibrium trajectory.

Key words: Real effective exchange rate, misalignment, Ghana
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1.0 Introduction

The importance of the exchange rate cannot be overemphasised. Changes in the exchange rate tends to affect prices, interest rates, trade flows and general economic activity. Since the exchange rate crisis in Latin America, England and Spain as well as in Mexico in the 80's and early 90's, there has been growing interest among international economists on the behaviour of real exchange rates (Özlale & Yeldan 2004). That is, the short and long run movements, trends and patterns of the real exchange rate and interactions with other macroeconomic variables. In the long run, maintaining the real exchange rate at a level close to its equilibrium is imperative for sustained growth particularly from the export sector irrespective of exchange rate regime (Edwards 1988; Kemme & Roy 2006). A persistent departure of the real exchange rate from its equilibrium path propelled by factors independent of the economy's underlying macroeconomic fundamentals refers to real exchange rate misalignment (Edwards 1989).

It is well documented in literature that misaligned real exchange rates typically tend to distort relative prices. It sends wrong signals to economic participants and could lead to misallocation of scarce economic resources. The unsustainability of such misallocation may hamper private investments and stifle growth. Actual real exchange rate lying above its equilibrium indicates that it is overvalued while for undervalued real exchange rates, the actual real exchange rate lies below its equilibrium value. Overvalued real exchange rates cause prices of goods in the tradable sector to fall because of relatively low demand. The fall in prices becomes a disincentive for further investment and slows down economic activity in the tradable goods sector. On the other hand, undervalued exchange rates have the tendency of building inflationary pressures in an economy because the domestic price of tradables increases. Recurrent misalignment of the real exchange rate could therefore have severe consequences for macroeconomic stability.

In Ghana, since exchange rates became completely liberalized in 1988 with the initiation of the interbank market system, there have been various episodes of appreciation and depreciation. Particularly, few years after the redenomination exercise in 2007, the persistent volatile movement and depreciation of the cedi against major trading currencies has been a topical issue[4].

[4] http://www.theafricareport.com/West-Africa/why-is-ghanas-currency-collapsing.html;

Even though certain occurrences like trade liberalization programs[5], the global financial crisis, exportation of crude oil, low production in the manufacturing sector, worsening of the country's fiscal and balance of payment position over the period may have an impact on the movement of the Ghanaian cedi, it remains uncertain if the volatile movement of the cedi are as a result of the after-effect of the redenomination exercise or changes in Ghana's economic fundamentals.

The movements in the value of the cedi has raised much concern among policy makers, researchers and firms alike. The objective of this study, therefore, is to investigate misalignment of the Ghanaian cedi. In order to achieve this, the study will examine the factors that influence the real effective exchange rate in Ghana and then determine the equilibrium real effective exchange rate. Assessment of the equilibrium exchange rate of Ghana (as well as for each of the member states) is also critical given the agenda of the six West African states (Ghana, Nigeria, Gambia, Liberia, Guinea and Sierra Leone) to have a single currency. This is because exchange rate misalignment may depict the level of economic competitiveness as well as serve as an indicator of the sustainability of a monetary union (Coulibaly & Gnimassoun 2013). Even though this issue has been explored in Ghana, the focus has been on the pre-redenomination and the pre-global financial crisis period. This study goes further than previous studies to cover the recent period after the redenomination exercise and the global financial crisis and characterised by increase in foreign exchange receipts through oil exports. Furthermore, while previous studies have relied on the Engle granger approach and Johansen and cointegration approach, this study explores a different approach, the Autoregressive Distributed Lag Approach (ARDL) developed by Pesaran and Shin (1999) to investigate exchange rate misalignment in Ghana. Unlike the Johansen procedure which imposes a restrictive assumption of I(1) for all regressors, the ARDL is more flexible as it can be applied to regressors that are I(0) or I(1) as well as mutually cointegrated. Moreover, it allows for the estimation of the error correction term. This study however, employed the Johansen approach to establish the weak exogeneity of the dependent variable as well as number of cointegrating vectors.

[5] Ghana and Ivory Coast2 were the first countries to initial the interim Economic Partnership Agreement between the European Union and West Africa at the end of 2007

The key findings of this study support findings of earlier studies that terms of trade, openness, fiscal position and net foreign assets have a significant influence on the real exchange rate. By implication, strategies to boost competitiveness of Ghana's trade with the rest of the world is very critical. The study also reveals that since 2000, movements away of actual real effective rate from its equilibrium path have been within a threshold of not more than 7%. This probably suggests that short run divergence of the actual real exchange rate from its equilibrium value may be due cyclical changes in the macroeconomic fundamentals.

The rest of the paper is as follows. Section two presents some stylized facts on exchange rate developments in Ghana and an overview of the macroeconomic performance of Ghana. Theoretical and empirical review of literature is presented in section three followed by the analytical framework and the empirical model in section four. In section five results from the ARDL estimation is discussed. Section six summarises the findings of study and concludes.

2.0 Exchange rate developments in Ghana

2.1 Exchange Rate Policy in Ghana

Ghana is a classic example of a small open economy which has experienced different regimes of exchange rates as seen in table 1. Exchange rate policy in Ghana has been predisposed to the direction of the various political administrations since the time of independence. The fixed exchange rate system was adapted from 1957 to 1982. Throughout that period, the cedi was fixed to the British pound up to 1966 and the American dollar up to 1982 by law and a cycle of controls and fiscal adjustments were put in place to take care of potential excesses in foreign currency demand. A typical example of these controls was the import license issues. The choice of a fixed exchange rate policy by the government was motivated more by political ambitions (Harrigan and Oduro, 2000). The fixed exchange rate adopted during the period, however, resulted in drastic declines in exports as well as declines in foreign exchange earnings leading to unfavourable balance of payment and deflation (Dordunoo 1994).

Following the launch of the Economic Recovery Program (ERP) in 1983 exchange rates were liberalized and the devalued. The real foreign exchange cost in purchasing power parity (PPP) which necessitated adjustments of exchange rates on quarterly basis in conformance with

comparative inflation rates of the country's main trade partners was introduced and implemented between 1983 and 1984. By the last month in 1984, the government adopted a policy of intermittent foreign exchange devaluations to replace the adjustments made on quarterly basis because the exchange rate was perceived to be overvalued (Bank of Ghana, 2010). By 1986, the government adopted the auction market approach to enhance the adjustment of exchange rates as well as the liberalization of trade. This way, exchange rates were partially determined through the interactions between the forces of demand and supply. The auction market approach introduced the dual exchange rate system whereby the first window maintained the fixed but amendable exchange rate fixed at ₵90.00: US$1.00 and the second employed the weekly auction system organized by the Bank of Ghana, which allowed the determination of exchange rates by market forces. The rates in both windows were applied to specific activities. While the first window rate applied to transactions involving the government, importation of petroleum and cocoa and traditional export deals, the rate in the second window was used in every other transaction. These two arrangements were also unified by February, 1987. By 1988, the exchange rate was completely liberalized with the legislation that allowed forex bureaux to operate legally (Bhasin 2004). By 1990, the weekly retail auction was substituted by the interbank wholesale system under which the interbank exchange rate (the composite exchange rate) was introduced. In 1992, the system of wholesale auctioning was brought to an end and substituted with the inter-bank market.

Table 2.1: Exchange Rate Policy Regimes in Ghana from 1957 - 2014

Regime	Period	Policy
1	1957 – 1966	Fixed to British pound
2	1966 – 1982	Fixed to American dollar
3	1983 – 1986	Multiple exchange rate system auction
4	1986 – 1987	Dual exchange rate system-auction determined dual retail auction system
5	1987 – 1988	Dutch auction system
6	1988 – 1989	Foreign exchange bureaux
7	1990 – 1992	Wholesale and inter-bank systems
8	1992 – 2014	Inter-bank market. The bank of Ghana selling and buying rates are determined by the average daily retail rates of the commercial banks.
9	2007	Redenomination of the cedi

Source: Bank of Ghana

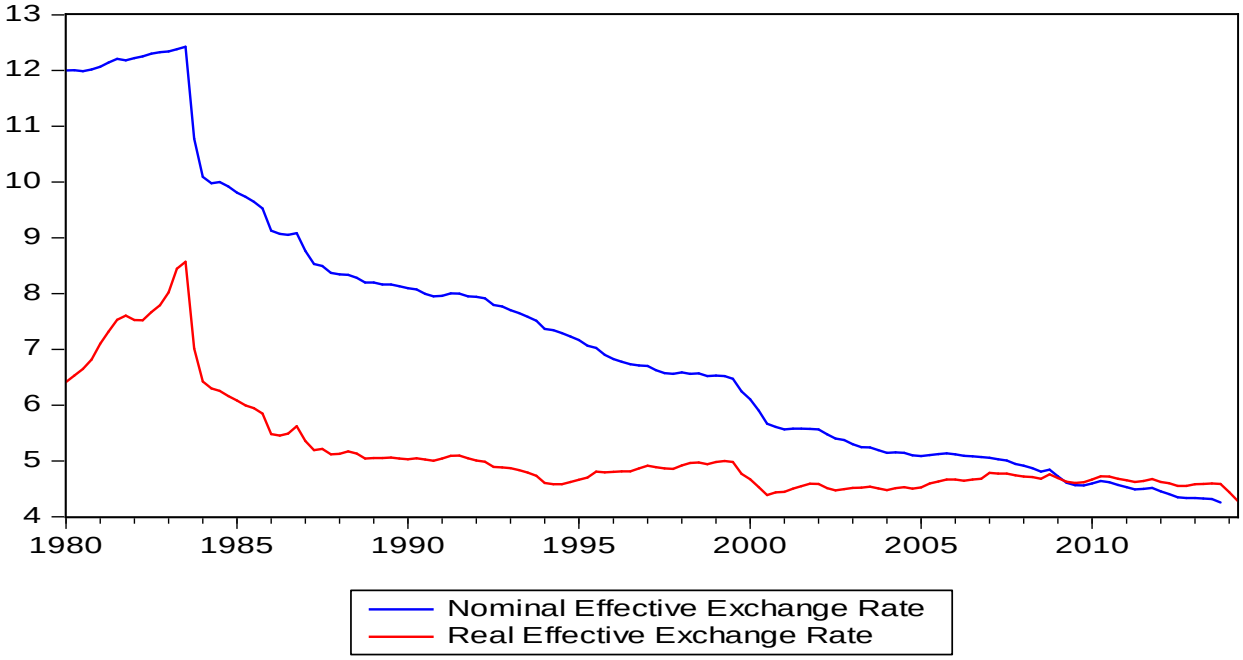
In June 2007, there was a re-denomination of the cedi by the Bank of Ghana, which led to the initiation of the new Ghana cedi to replace the old cedi. The purpose of the exercise was to deal

with the high numerical values of prices. It was perceived that the re-denomination exercise will curtail the problem of carrying huge loads of money to transact business with its attendant risks and enhance book and statistical record keeping. The value of the cedi relative to the dollar before the redenomination was in the range of ¢9,300 to ¢10,000. It became ¢0.93 – ¢1 to 1USD after the redenomination.

2.1 Movements in the nominal effective exchange rate and the real effective exchange rate

The nominal effective exchange rate (NEER) and the real effective exchange rate (REER) are prominent in exchange rate discussion even though much reference is made to the REER because it is one of the key indicators of an economy's external competitiveness. In Ghana, both the NEER and the REER have been moving in line with the changes in the exchange rate regime over time. They have generally been trending downwards. As shown in figure 2.1, both the NEER and REER started depreciating in 1983 after the economic reforms through which exchange rates were liberalized. Another notable depreciation was in 1999 which occurred as a result of the unfavourable terms of trade around the period. Even though the NEER has mostly been higher than the REER, they equalised around the early part of 2010. Since the latter part of 2011, the REER has been above the NEER.

Figure 2.1 Movements in NEER and REER, 1980 – 2013 (in logs)



Author's construct with IFS data

2.3 Overview of the performance of macroeconomic fundamentals in Ghana

Macroeconomic indicators have been relatively stable since the beginning of 1990 probably as a result of the economic reforms[6] in 1983 and the relatively stable political environment. Real GDP growth rate which was an average of 0.9 between the periods 1961 to 1983 reached about 4.9% between 1984 and 2006. Real GDP per capita increased sharply in 2011 after the country joined the league of oil-exporting economies but has since been decelerating. Possibly due to the poor performance of the export and industrial sectors in line with increases in utility tariffs and the intermittent power rationing[7] exercise. High levels of inflation posed challenges for macroeconomic management in the early 80's (around 125% in 1983). This was somehow curtailed through the financial sector reforms in 1988. The country subsequently adopted the inflation targeting (IT) approach to monetary policy initially in 2002 and made a formal announcement of the adoption of the policy in 2007. The objective of the inflation targeting policy was to make price stability the primary long term goal of monetary policy. Since the adoption of the IT, inflation has been relatively low (single-digit inflation of 8.7 and 9.1 were attained in 2011 and 2012 respectively). Fiscal balance has mostly been in deficit since independence as a result of huge government expenditure outweighing low revenue generation and mobilization capacity of government. The current account balance also shows a consistent trend of deficit creating financing gaps in the economy of Ghana. Conventionally, different governments have resorted to both internal and external financing as a means of closing the financing gap. Aid inflows, official development assistance (ODAs), foreign direct investments (FDI) as well as remittances are important sources of external capital (Opoku-Afari 2004). Foreign direct investment (FDI) as a percentage of GDP recorded an average of 0.19% from 1980 to 1989; 1.72% from 1990 to 1999 and 4.76% from 2000 to 2012. Overseas Development Assistance (ODAs) as percentage of GDP decreased from 8.8% in 2000 to 5.2% in 2010 due to the effects of the global financial crisis on developing countries.

[6]Ghana was among countries in Africa that adopted the IMF/World Bank supported Structural Adjustment Program (SAP) as well as the Economic Recovery Program (ERP). Reforms were implemented in in different sectors of the economy with a lot of attention on the financial sector.

[7] This was mainly due to the shutdown of the West African Gas Pipeline in August, 2012. ,

Table 2.2: Summary of Macroeconomic Indicators

	2000	2005	2010	2013
Real GDP growth	3.7	5.9	8.0	7.5
Real GDP per capita growth	1.28	3.18	5.47	5.3
CPI (2010 = 100)	21.12	52.93	100	132.47
CPI Inflation (annual %)	25.19	15.12	10.71	11.61
Budget balance % of GDP	(9.81)	(2.9)	(9.5)	(7.8)
Current account balance % of GDP	(6.56)	(10.29)	(8.54)	(11.81)
Real effective exchange rate	94.15	102.39	100	88.35
Nominal effective exchange rate	343.74	166.08	100	74.36

Data from IMF, IFS, World Economic Outlook and World Bank, World Development Indicators

The economy of Ghana is small relative to its major trading partners. Ghana's export structure is basically made up of agricultural commodities of which the export of cocoa beans is a major export earner for the economy of Ghana. Minerals like gold and diamond and oil[8] are also very important foreign exchange earners. Minerals contribute about 80% of revenues from mining activities and 15% in corporate taxes. The reliance on few exports in raw form often make the economy susceptible to terms of trade shocks. The economy is also heavily dependent on imports which are usually made up of machines, vehicles, computers and other sophisticated equipment and accessories including general goods from more developed economies. This makes the demand for imports highly inelastic as compared to demand for the country's exports which are elastic. By implication, exchange rate policy is very critical for the performance of such an economy.

3.0 Literature Review

3.1 Measuring Equilibrium Exchange Rate and Exchange Rate Misalignment

Over time different approaches to determining the equilibrium exchange rate have evolved. The Purchasing Power Parity (PPP) theory is one of the earliest approaches of determining equilibrium real exchange rate. There is, however, an underlying assumption in this theory that the equilibrium real exchange rate is constant over time. The equilibrium exchange rate is

[8] The exportation of oil in Ghana begun in 2011

therefore derived by taking the value of the real exchange rate in a base year, usually a year in which it is believed that there was external equilibrium. A number of studies (Driver & Westaway 2005; Macdonald 2000; Rogoff 1996; Saayman 2007) testing the PPP hypothesis have, however, provided empirical evidence to suggest that the mean reversion of the exchange rate to a constant level is very low/non-existent creating a general perception that the PPP does not hold especially in the short run. Another short fall of the PPP is its narrow focus on monetary sources of exchange rate movements. Impliedly, there are no considerations of the effects of real factors (Edwards 1989; Ghura & Grennes 1993).

Other approaches of exchange rate equilibrium determination acknowledge the importance of real factors in driving real exchange rate movements. These real factors are often referred to as macroeconomic *fundamentals* (Ajevskis et al. 2012; Nilsson 2004). Hence, changes in these fundamentals consequently spur changes in the real exchange rate and its equilibrium value. Different fundamentals have been noted in literature to influence the real exchange rate depending on the country/countries under study or the theoretical model employed. Common among these fundamentals are trade or commercial policy variables including openness, trade restrictions and tariffs; fiscal policy factors including government consumption expenditure, international economic environment factors like terms of trade, net foreign assets, net foreign debt and domestic supply-side factors representing the rate of technological progress (Balassa-Samuelson effect[9]) of an economy.

Accordingly, econometric approaches have been used to estimate the real exchange rate equation to detect a long term association between the exchange rate and the macroeconomic fundamentals. After this has been established, a suitable filter[10] is used to derive the permanent values of the equilibrium exchange rate. Then the difference between the permanent values of the fundamentals used for determining the equilibrium exchange rate and the actual exchange rate produce the extent of misalignment. When the variation in the actual real exchange rate

[9] See Balassa (1964) and Samuelson (1964)

[10] A number of filters are available including the Beveridge and Nelson (1981), Stock and Watson (1998), Clarida and Gali (1995) and Gonzalo Granger (1995) methodology. The Hodrick-Prescott (HP) has been employed in most empirical studies.

reflects changes in its statistically related economic fundamentals, it is said to be in equilibrium (Clark & MacDonald 1998). Otherwise, the exchange rate is misaligned.

Empirically, different approaches of estimating the equilibrium exchange rate have emerged in literature with roots grounded in either the fundamental equilibrium exchange rate (FEER) or the behavioural equilibrium exchange rate (BEER). While the FEER assumes macroeconomic balance and external sustainability, the BEER assumes that the equilibrium exchange rate is determined through the behaviour of a pertinent and relevant set of fundamentals[11] that drive changes in real exchange rate in the long run. Thus, the concept underlying the FEER is normative as it involves ad hoc judgement on the size of key variables whereas the BEER is devoid of normative bias and completely statistical (Hossfeld 2010). The FEER, popularised by Williamson (1985), is described as the exchange rate necessary for the simultaneous attainment of both the internal and external equilibrium. Internal equilibrium occurs when the economy under consideration operates at the full employment level of output with low inflation. The external balance occurs when the current account position is at an appreciable sustainable level over a medium term horizon after controlling for inflows of resources and foreign debt. On the other hand, the BEER, popularised by (Clark & MacDonald 1998), allows the consideration of cyclical and temporary movements of the real exchange rate. Fundamentals are, therefore, not necessarily considered at their full employment levels. Primarily, what the BEER does is to compare the behaviour of the exchange rate to movements in specific macroeconomic fundamentals. Following from (Clark & MacDonald 1998), the theoretical foundation of the BEER approach can be traced to the risk-adjusted uncovered interest rate parity (UCIP) stated as;

$$E_t[\Delta s_{t+k}] = (i_t - i_t^*) - c_t \qquad (1)$$

where s_t denotes the price of a unit of foreign currency, i_t is the nominal interest rate, and c is the risk premium with a time-varying parameter . $E_t[.]$ is the rational expectations operator based on the information pertaining at time t, Δ represents the first difference operator, $t+k$ is the maturity horizon of the asset (bonds) and superscript * depicts foreign variables. In order to

[11] Variables are guided by theory on exchange rate determination

change variables from nominal to real variables, the inflation differential $E_t[\Delta p_{t+k} - \Delta p^*_{t+k}]$ is deducted from both sides of equation (1). The new relationship can be written as:

$$q_t = E_t[q_{t+k}] - (r_t - r_t^*) + c_t \qquad (2)$$

where $r_t = i_t - E_t[\Delta p_{t+k}]$ and $r_t^* = i_t^* - E_t[\Delta p^*_{t+k}]$ represents the domestic and foreign real interest rate respectively and q_t is the real exchange rate defined as $q_t = e_t + p_t^* - p_t$; e_t represents the nominal exchange rate, p_t and p_t^* respectively represent domestic and foreign prices. The real exchange rate moves toward a time-varying equilibrium path over the long run period. In equation (2), the real exchange rate is a function of the expected future real exchange rate, real interest rate differential and the risk premium. The theory assumes that the unobservable expected future real exchange rate, $E_t[q_{t+k}]$, is determined by the long run macroeconomic fundamentals, Z_t. The long run equilibrium exchange rate is denoted as $\hat{q}$ and assumed to be equal $E_t[q_{t+k}] = E_t[\ 'Z_t]$.

3.2 Relationship between exchange rate fundamentals and the real exchange rate

After (Edwards 1989) and (Clark & MacDonald 1998) literature is now replete with empirical studies that employ different sets of variables in estimating the equilibrium exchange rate. (Edwards 1989) classified the variables in two broad categories: (i) external fundamentals which comprise the international terms of trade, external capital flows and interest rate differentials (ii) domestic fundamentals include policy related variables like import tarrifs, quotas and export taxes; exchange and capital controls; government expenditure composition and non-policy fundamentals like the rate of technological progress. The theoretical relationships between the macroeconomic fundamentals and the equilibrium real exchange rate detailed in (Edwards 1989; Montiel 2002) are summarised as follows:

Terms of trade

Theoretically the effect of terms of trade shock to the real exchange rate is ambiguous. A positive terms of trade shock induces a positive income effect. That is, an increase in the purchasing power results in an increase in the demand and price of nontradables, thereby appreciating the equilibrium real exchange rate. On the substitution side, consumption towards

tradables (imports in this case) tends to increase leading to a depreciation of the equilibrium exchange rate. On the other hand, when the terms of trade deteriorates, it induces a negative income effect (that is a fall in domestic purchasing power) which results in a reduction in the quantity demanded of nontradables and a depreciation of the exchange rate. From the substitution effect, quantity demanded of traded goods (importables) declines. This shifts demand in favour of nontradables resulting in a real appreciation. The combined effect of changes in the terms of trade on the real exchange rate will depend on the whether the income or the substitution effect is more dominant.

Openness

The degree of trade openness has often been used to represent the influence of trade policy and trade restrictions on the real exchange rate. An increase in trade restrictions (tariffs and quotas) cause domestic price of imported goods to increase. Through the substitution effect, the quantity demanded and volume of imports declines, thereby inducing an increase in the demand and price of goods in the nontradable sector. This has an appreciating effect on the equilibrium exchange rate. On the other hand, an increase in openness (reduction in trade restrictions) leads to a decline in the domestic price of imported goods and as well increase the volume of imports on the domestic market which drives up competition and forces prices of nontradables down. As a result, equilibrium real exchange rate depreciates.

Government consumption expenditure

The effect of government consumption expenditure depends on whether the expenditure is focused on goods in the tradable or nontradable goods sectors. While increased spending on nontradables tends to increase the relative price of nontradables and results in an appreciation of the equilibrium real exchange rate, increased spending on tradables has the effect of depreciating it. By implication, high fiscal deficit and external debt as a result of increasing government expenditure tend to have the same effect.

Net foreign assets and capital flows

Changes in the capital account balance like rising net foreign assets and capital inflows tends to appreciate the equilibrium real exchange rate. For example, an increase in capital inflows/net

foreign assets is likely to increase current expenditure on both tradables and nontradables. In order to maintain internal equilibrium in the current period, the increase in the price of nontradables will lead to an equilibrium real appreciation. The equilibrium real exchange rate is likely to appreciate in this case. On the other hand, following from standard intertemporal macroeconomic models, countries with high net foreign liabilities require a more depreciated real exchange rate to obtain trade surpluses needed to defray external liabilities.

Real interest rate differential

The impact of monetary policy on the real exchange rate can also be significant. The real interest rate differential captures the difference between a country's real interest rate and that of its trading partners. An increase in a country's real interest rates (followed by increases in international transfers) will impact the equilibrium real exchange rate in similar pattern as increase in net capital inflow. Increased net capital inflow will lead to an expansion in the monetary base. This will also result in increased current expenditure. If majority of such expenditure are directed towards nontradables (tradables) the result will be REER appreciation (depreciation).

Productivity

The Balassa-Samuelson (1964) hypothesis postulates that when productivity in the tradable goods sector of a country increases relative to its trading partners, the real exchange rate of that country tends to appreciate. Increased productivity causes wages in the tradable goods sector to rise. As wages across the tradable goods sector and the nontradable goods sectors equalise demand for nontradables, drives up the price of goods in the nontradable sector compared to its trading partners increase and appreciates the equilibrium real exchange rate (MacDonald and Ricci, 2003).

3.3 Empirical Literature

The subject of equilibrium exchange rate determination and exchange rate misalignment has attracted a lot of empirical attention. Both time series and cross country studies have been conducted extensively in developed economies, emerging economies and developing economies.

After the work of (Clark & MacDonald 1998) which focused on comparing results of the BEER and the FEER approaches for the G-3[12] currencies, a number of empirical studies have been conducted on advanced economies and emerging economies[13]. Chowdury (2012) employed the Autoregressive Distributed Lag (ARDL) model developed by Pesaran and Shin (1999) to explore the dynamics, structural breaks and determinants of the real exchange rate of Austrialia. A good number of studies[14] have been conducted in China probably as a rebuttal to its alleged engineering of undervaluation strategies in order to maintain a consistent current account surplus to the detriment of its trading partners.

Studies focusing on developing countries was pioneered by the work of Edwards (1988, 1989) and extended by Rodriquez (1989) and Elbadawi (1994). Edwards (1989) advanced a theoretical model for explaining short and long run determinants of the real exchange rate and their influence on the equilibrium. Accordingly, the most important long run determinants of the equilibrium real exchange rate are; (i) the level and composition of government consumption; (ii) external terms of trade; (iii) import tariffs; and (iv) capital flows. Other variables include technological progress to capture the Balassa effect and the investment to GDP ratio. The model was applied to a panel of 12 countries, using the fixed effect approach. Findings show that both the real and nominal variables influence the real exchange rate in the short run whereas only real variables influence the real exchange rate in the long run. Edward's work inspired a lot of studies on equilibrium exchange rate determination and exchange rate misalignment in developing countries. These include among others Cottani et al (1990) for a sample of developing countries, Elbadawi (1994) for Chile, Ghana and India, Olopoenia (1992), Obadan (1994), Baye and Khan (2002) and Aliyu (2007) for Nigeria, Eita and Sichei (2006) for Namibia, Iimi (2006) for Botswana, Parikh (1997), Aron et al. (1997) and Asfaha (2002) for South Africa, Korsu and Braima (2011), Ndhela (2012) for Zimbabwe and Hyder and Mahboob (2006) for Pakistan.

[12] US, Germany and Japan

[13] See Nilson (2002) for Sweden; Özlale and Yeldan (2004) and Dağdeviren (2012) for Turkey; Kemme and Roy (2006) for Poland and Russia; Hossfeld (2010) for the US and 16 of its major partners; Chowdury (2012) for Australia, Baak (2012) for Korea

[14] Such studies include Zhang (2001), Funke and Rahn (2005), Goh and Kim (2006), Wang et al (2007), Cheung et al (2007), Gan et al (2013)

In Ghana, a number of studies have been conducted to estimate a model for the equilibrium real exchange rate of Ghana. Early among such studies include Elbadawi (1994), Sackey (2001), Youngblood and Apaloo (2006). More recent studies have gone further to investigate misalignment of the real exchange rate. These include Iossifov and Loukoianova, (2007), Abbey et al. (2007), Daboh (2010) and Kwakye (2012). It can be observed that most of the analysis have ended in 2006 and thus the effect of the redenomination in 2007 on the real exchange rate and possible misalignment has not been examined in the literature.

Findings on the nature of misalignment has been quite divergent except for the period 1981 to 1983 and early 2000s where overvaluation and undervaluation were noted in occur all studies respectively. Generally, evidence suggest that throughout the period from 1980 to 2006, the REER was either overvalued or undervalued. In Iossifov and Loukoianova, (2007), during the period between 1999 and 2000 the REER was below its estimated equilibrium level. It, however, appreciated thereafter bringing it in line with the equilibrium. At the latter part of 2006 the REER was quite close to its predicted equilibrium level. The error correction coefficient also indicates that 14% of any misalignment of the actual from the equilibrium REER is corrected in each quarter. Abbey et al. (2007) finds that the real effective exchange rate since 2002 has exhibited signs of overvaluation in contrast with its estimated equilibrium values especially after 2004. On the contrary, in the period between 1986 and 1988 as well as from 1999 to 2000 the real effective exchange rate seemed to have been undervalued. It was the period from 1994 to 1995 that the exchange rate seemed to be exactly equal to the equilibrium values estimated. The error correction coefficient is 65%. In Kwakye (2012), however, the error correction term indicates a 97% rate of adjustment to equilibrium of any misalignment of the exchange rate yearly suggesting a comparatively faster rate of convergence to the equilibrium.

A general observation in the review of the literature on Ghana is that due to issues of data unavailability, the number of real variables employed as explanatory variables determining the equilibrium real exchange rate have differed across empirical studies. Nonetheless, majority of studies have considered different proxies of terms of trade, openness, government consumption

expenditure, net foreign assets, capital flows and technological progress in the estimation of the real exchange rate.

While earlier studies in Ghana mostly employed the Engle and Granger approach, recent studies have employed the Johansen cointegration procedure. It can be observed that the Johansen approach has been used even in the presence of small sample sizes except for Iossifov and Loukoianova, (2007) that used quarterly data. This study contributes to the literature by applying another econometric modelling approach, the Autoregressive Distributed Lag Approach (ARDL) to investigate misalignment of the Ghana's REER. This approach is more flexible and also allows the estimation of the error correction model.

4.0 Analytical Framework

The order of integration of the variables is examined using tests proposed by Elliot et al. (1996) (DF-GLS) and the Ng and Perron (2001) (the M-test) (hereafter NP) because they possess superior power against very persistent alternatives. The Augmented Dickey Fuller (ADF) and the PP tests have been criticised in the literature because their low power against I(0) alternatives closer to being I(1). These methods test the null hypothesis of a unit root as against the alternative of no unit root.

This study applied the ARDL modelling developed by Pesaran and Shin (1999) and extended by Pesaran et al. (2001) (PSS Bounds testing approach). The advantages of the ARDL approach over the Johansen procedure lies in the fact that it is relatively more flexible. While the Johansen approach imposes a restrictive assumption that all the variables should be integrated in the same order I(1), for the ARDL approach the variables can be of different orders of I(0), I(1) or a mix of both. The ARDL procedure applies adequate numbers of lags to capture the data generating process (DGP) in a general-to-specific-modelling framework (Laurenceson and Chai, 2003). Apart from the fact that ARDL is robust even in modelling small samples relative to other econometric models, it allows the estimation of a dynamic error-correction model. Lastly, ARDL modelling is also robust against simultaneous equation bias and autocorrelation, given that the orders of the ARDL model are sufficiently selected based on any model selection criterion. A limitation of the ARDL method (just like other single equation methods) is that it assumes that

the dependent variable is endogenous in the system. It is possible that this may not hold. Hence, to establish whether or not exchange rate in our model is endogenous, the exogeneity test based on the Johansen approach was first carried out. Also, the Johansen approach was used to determine the number of cointegrating vector(s). For the purpose of the analysis, the ARDL is applied to a model where only one cointegrating vector is found and exchange rate is endogenous in the system.

After estimation of the long run model, the extent of exchange rate misalignment is investigated. In order to examine the extent of exchange rate misalignment, the Hodrick-Prescott (H-P) filter is used to derive the permanent values of each of the explanatory variables. This is because the macroeconomic fundamentals may exhibit a significant degree of short term "noise" while the long run equilibrium real effective exchange rate should not do so. The Hodrick-Prescott (1997) (H-P) filter is widely used in many studies[15] to obtain a smooth estimate of the long term component of a series The penalty parameter is set at $a = 1600$ for quarterly series. The permanent values along with the parameters derived from estimating the equilibrium model is then used compute the permanent real effective exchange rate (PEER). The misalignment is thereafter computed as the difference between the actual (published) real effective exchange rate and the PEER. The real exchange rate misalignment will be calculated as: $MIS_t = \log REER_t - \log EREER_t$, where $\log EREER_t$ is the estimated equilibrium real effective exchange. The Ghanaian currency is overvalued if the difference shows a positive value and undervalued otherwise.

4.1 Empirical Model Specification

The theoretical framework that is used in modelling the equilibrium real exchange rate is the BEER. The selection of the BEER draws from the fact that it allows for distinction between long run and short run determinants of the real exchange rate unlike other theoretical models. Consistent with the theoretical underpinnings of the BEER model and characteristics of the Ghanaian economy, the log-linear form of the model that is used to estimate the determinants of the long-run equilibrium of real effective exchange rate is specified and estimated as follows:

[15] Iossifov and Loukoianova (2007), Elbadawi et al. (2012), Gan et al. (2013),

$$LREER_t = \sim_0 + {}_1 L\overset{+}{TOT}_t + {}_2\overset{+}{NFA}_t + {}_3\bar{LIM}_t + {}_4\overset{+/-}{LED}_t + {}_5\overset{+}{RIRD}_t + £_t \quad (3)$$

where *LREER* represents the log of real effective exchange rate which is used as the measure of real exchange rate. A good number of empirical studies refer to the real effective exchange rate (REER) because it is weighted by trade shares of major trading partners and controls for third country effects. The REER is expressed in foreign currency terms and thus, an increase in the REER indicates an appreciation. *LTOT* represents the log of terms of trade. This variable is important in Ghana's case because of country's participation on the international market. *NFA* represents net foreign assets. *LIM* represents the log of imports to GDP ratio and this is used as the proxy for commercial policy. Earlier papers have employed the ratio of the sum of exports and imports to GDP. Given that Ghana's economy is heavily dependent on imports, this study used the log of imports to GDP ratio in order to derive its unique effect on the REER. *LED* represents log of external debt. External debt in the economy of Ghana has been rising persistently owing to low domestic revenue mobilization resulting in high fiscal deficits. Subscript *t* represents the time index and $£_t$ represents the disturbance term which is assumed to be independently and identically normally distributed. An error correction model (ECM) is also as follows:

$$\Delta LREER_t = \sim_0 + {}_1 L\,TOT_{t-1} + {}_2\,NFA_{t-1} + {}_3 L\,IM_{t-1} + {}_4 LED_{t-1} + {}_5 RIRD_{t-1} + \sum_{i=1}^{m} a_i \Delta LTOT_{t-1} + \sum_{i=1}^{n} b_1 \Delta NFA_{t-1} + \sum_{i-1}^{p} c_i \Delta LIM_{t-1} + \sum_{i=1}^{q} d_i \Delta LED_{t-1} + \sum_{i=1}^{r} e_i \Delta RIRD_{t-1} + £_t \quad (4)$$

where Δ represents the first difference operator, $£_t$ represents the residuals.

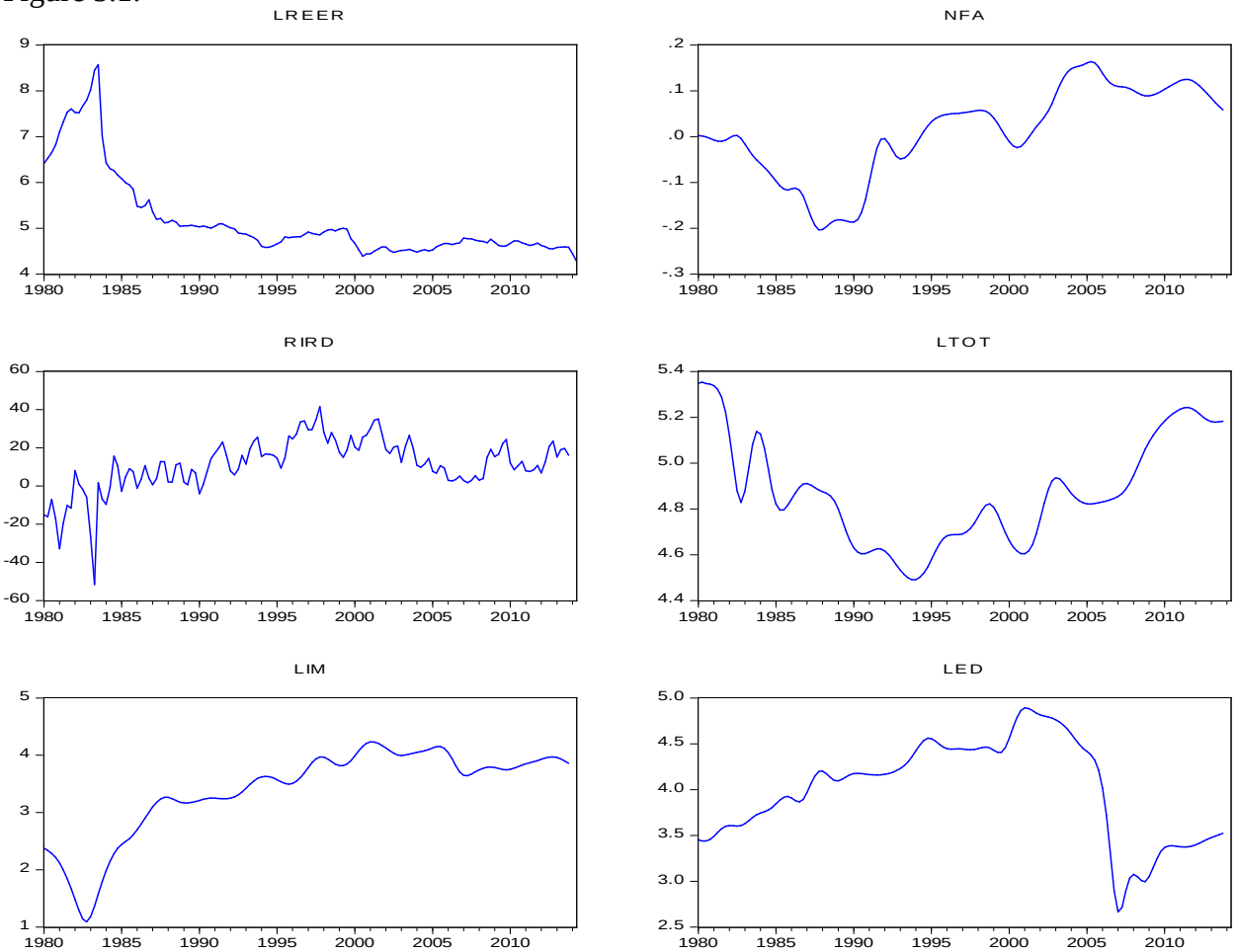
4.2 Data

The sample consists of quarterly data from 1980 to 2013 sourced from the IMF, International Financial Statistics (IFS) and the World Bank's World Development Indicators (WDI). Details of the proxies and measurement of the variables used in the study are summarised in appendix.

5.0 Empirical Results

The pattern of the variables that determine the REER is plotted over time and shown in figure 5.1. It can be observed that after the REER (LIM) attained its highest (lowest) values in the early 80's, it has generally been trending downwards (upwards). The RIRD also seem to have been more volatile in the period before the 90's probably as a result of the unstable economic climate. External debt increased steadily from 1980, reached a maximum in 2001 and began to decline. Since 2007, the variable has been trending upwards. Unit root test is conducted next to examine the stationarity of the variables.

Figure 5.1:



Note: Computed based on data from IFS and WDI. LED is the log of external debt proxy for fiscal stance; LIM is log of imports, a proxy for openness; LREER is the log of real effective exchange rate; LTOT is the log of terms of trade; NFA is the net foreign assets % of GDP, RIRD is the real interest rate differential.

5.1 Test for stationarity

Table 5.1: Stationarity Test Results

Test			Variables					
			LREER	**NFA**	**RIRD**	**LTOT**	**LIM**	**LED**
DF-GLS	Level	drift	-0.47	-1.43	-0.21	-0.67	-1.30	-1.18
		drift & trend	-1.88	-1.87	-2.27	-0.74	-3.24[b]	-1.86
	ΔLevel	drift	-6.77[a]	-2.43[b]	-12.52[a]	-4.03[a]		-3.21[a]
		drift & trend	-7.44[a]	-2.47	-12.79[a]	-4.24[a]		-3.26[b]
NP	Level	drift	-0.80	-5.38	-0.25	-1.00	-0.67	-3.82
		drift & trend	-7.29	-9.94	-9.92	-1.59	-6.00	-9.51
	ΔLevel	drift	-51.77[a]	-31.26[a]	-141.01[a]	-11.19[b]	-5.14	-100.58[a]
		drift & trend	-56.13[a]	-35.72[a]	-145.87[a]	-35.50[a]	-14.51[c]	-120.23[a]

Critical Values

	DF-GLS		NP	
	Drift	Drift & trend	Drift	Drift & trend
1%	-2.58	-3.54	-13.8	-23.8
5%	-1.94	-3.00	-8.1	-17.3
10%	-1.62	-2.70	-5.7	-14.2

Note: level of significance is denoted by a = 1%, b = 5% and c = 10%

It is important to report stationarity test results in order to take cognisance of the order of integration of all the variables. As shown on the table, most of the variables are I(1) according to the DF-GLS and NP tests except for log of import that is an I(0) in one case.

5.2 Estimation of short and long run relationship

Table 5.2: Bounds Tests Results

Computed F-Statistic	4.982023	
Critical bounds (5%)	LCB: 2.39	UCB: 3.38
Critical bounds (10%)	LCB: 2.08	UCB: 3.00
Critical bounds (1%)	LCB: 3.06	UCB: 4.15

Notes: LCB is the lower critical bound; UCB is the upper critical bound

The bounds testing procedure (BTP) is used in testing the long run relationship between the real effective exchange rate and the explanatory variables. For equation (3), null hypothesis of the BTP tests the joint significance; $_1 = _2 = _3 = _4 = _5 = 0$ using an *F*-test with a nonstandard distribution. Two groups of asymptotic critical values are computed by Pesaran et al. (2001) and

they categorize the regressors as either I(0), I(1) or mutually cointegrated. After comparing the *F*-statistic with the critical values a decision is made. Whenever the value of *F*-statistic lies above the upper critical bound (UCB), then the regressors are I(1) and when it lies below the lower critical bound (LCB), then they are I(0). However, if the value of the *F*-statistic lies within the interval of the UCB and the LCB, then from Pesaran et al. (2001), "inference is inconclusive and the order of integration between the underlying variables are required for a conclusive inference". The results of the test indicate that the computed *F*-statistic of 4.98 in table 5.2 lies above the UCB at 1% level of significance. Thus, there is evidence to conclude that there is a long run relationship between the real effective exchange rate and the explanatory variables. The existence of a long run relationship implies that an error correction model can be estimated. The result of the long run test is shown in table 5.3.

Table 5.3: Estimated long run coefficients

Dependent variable: LREER

ARDL (1, 0, 7, 2, 0, 2) lag length selected based on Schwarz Bayesian Criterion

Regressor	**Coefficient**	**Standard Error**	**T-Ratio**	**[Prob]**
LED	0.214907	0.120688	1.780685	[0.0777]
LTOT	0.812100	0.318960	2.546089	[0.0123]
LIM	-1.109666	0.108857	-10.193830	[0.0000]
NFA	1.525930	0.583051	2.617147	[0.0101]
RIRD	0.015788	0.007742	2.039299	[0.0438]
C	3.839100	1.944635	1.974200	[0.0508]

Breusch-Godfrey Serial Correlation LM Test:

F-statistic	0.255096	Prob. F(1,110)	0.6145
Obs*R-squared	0.298466	Prob. Chi-Square(1)	0.5848

The Johansen approach was used to test the weak exogeneity of the dependent variable as well as the number of cointegrating vectors. The test confirmed that the REER is truly endogenous to the model and the existence of one cointegrating vector. The model was then estimated using the ARDL approach.

In the long run, a 1% increase in terms of trade results in 0.8% increase (appreciation) in the real effective exchange rate. The coefficient is significant and the sign is positive indicating the significance of term of trade on the equilibrium real effective exchange rate. The positive coefficient of the terms of trade also suggests the substitution effect overrides the income effect. Hence, domestic producers tend to allocate more resources into the production of tradable goods. This result confirms the theoretical predictions in Edwards (1989) and Montiel (2002) and also supports empirical findings of earlier studies in Ghana including Sackey (2001), Youngblood and Apaloo (2006), Iossifov and Loukoianova (2007), and Abbey (2007). The elasticity coefficient is higher than 0.47% in Abbey and 0.35% in Iossifov and Loukoianova (2007) but lower than 1.75% in Kwakye (2012).

The results show that log of imports (openness) exerts a negative and statistically significant influence on Ghana's real effective exchange rate. By implication, programs targeted at increasing openness and eliminating restrictions on trade tend to depreciate the real exchange rate. A 1% increase in openness depreciates the REER by 1.1percent. This result confirms findings of Youngblood and Apaloo (2006), Kwakye (2012) and Elbadawi and Soto (1994) and contrasts that of Daboh (2010).

The impact of external debt on the long run REER is positive suggesting that expansionary government spending appreciates the REER. This may also imply that government expenditure ultimately tends to push up prices of goods in the nontradable sector. This result corroborates the preponderance of literature and empirical finding of Kwakye (2012) against that of Abbey et al. (2007) and Daboh (2010). The coefficient of 0.21 is statistically significant.

The results also indicate that net foreign assets has an appreciating effect on the real effective exchange rate. A one percentage point increase in net foreign implies is accompanied by 1.53 percentage point increase in the REER in the long run. This confirms the theory that stipulates that increases in the net foreign assets boosts demand mostly in the nontradable sector. This result contrasts that of Kwakye (2012).

The real interest rate differential has a positive impact on the real exchange rate. This is also in line with the theory that increases in the real interest rate differential boosts demand mostly in the nontradable sector. Thus in the long run, a one percent increase in the real interest rate

differential between Ghana and its trading partner's results in a 0.02 percent appreciation of the REER.which is rather small compared to the finding of Iossifov and Loukoianova (2007). This result contrasts that of Kwakye (2012).

The short run result shown in table 5.4 is discussed next briefly as the focus of this paper rests on the long run relationship. Both the long and short run equations passed all the diagnostic test of serial correlation and heteroscedasticity.

Table 5.4: Error Correction Representation

Dependent variable: LREER

ARDL(1, 0, 7, 2, 0, 2) lag length selected based on Schwarz Bayesian Criterion

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LED)	0.017750	0.099819	0.177825	0.8592
D(LTOT)	-4.281220	1.435199	-2.983016	0.0035
D(LTOT(-1))	9.454745	3.717323	2.543428	0.0124
D(LTOT(-2))	6.036329	5.278234	1.143627	0.2552
D(LTOT(-3))	-29.521248	5.570007	-5.300038	0.0000
D(LTOT(-4))	20.262094	5.009474	4.044754	0.0001
D(LTOT(-5))	2.257171	3.477474	0.649083	0.5176
D(LTOT(-6))	-5.580009	1.336711	-4.174434	0.0001
D(LIM)	0.039775	0.322907	0.123178	0.9022
D(LIM(-1))	-0.922014	0.308357	-2.990085	0.0034
D(NFA)	0.209623	0.730116	0.287109	0.7746
D(RIRD)	0.002680	0.001075	2.493774	0.0141
D(RIRD(-1))	-0.003232	0.001032	-3.130820	0.0022
CointEq(-1)	-0.169993	0.030770	-5.524661	0.0000

Cointeq = LNREER - (0.2149*LED + 0.8121*LTOT -1.1097*LIM + 1.5259 *NFA + 0.0158*RIRD + 3.8391)

The nature of the relationship between the explanatory variables and the real effective exchange rate in the short run is captures by their lagged differences. From the results in table 5.4 a significant coefficient of -4.28 implies that terms of trade depreciates the REER initially and subsequently appreciates the REER in the short run. The proxy for openness, log of imports is also seen to depreciate the REER in the short run with a coefficient of -0.92. Increases in the real interest rate differential in the short run is also associated with an initial appreciation and subsequently a depreciation. The real effective exchange rate corrects itself by the speed of adjustment which is given by the coefficient of the error correction term. This speed of adjustment is measured by the size of the error correction term (ECM_{t-1}) shown on table 5.4. The coefficient is significant and correctly

signed (negative) indicating stability. A 17% speed of adjustment indicates a relatively fast rate of convergence to equilibrium following disequilibrium. While the ECM_{t-1} of 17% per quarter is quite close to that found in Abbey (2007) of 65% per year and Iossifov and Loukoianova (2007) of 14% per quarter, the ECM_{t-1} in Kwakye (2012) is rather high at 97% per year.

5.3 Exchange rate misalignment

The fact that cointegration exists between the real effective exchange rate and the explanatory variables allows one to derive estimates of the equilibrium real effective exchange rate. In order to examine the extent of exchange rate misalignment, the Hodrick-Prescott (1997) (H-P) filter is used to derive the permanent values of the estimated equilibrium real effective exchange rate. The real exchange rate misalignment will be calculated as: $MIS_t = \log REER_t - \log PEER_t$, where $\log PEER_t$ is the permanent values of the estimated equilibrium real effective exchange. The Ghanaian currency is overvalued if the difference shows a positive value and undervalued otherwise. Figure 5.2 shows a plot of the actual and permanent real effective exchange rate.

Figure 5.2 Real Effective Exchange rate: Actual vs. Equilibrium Values

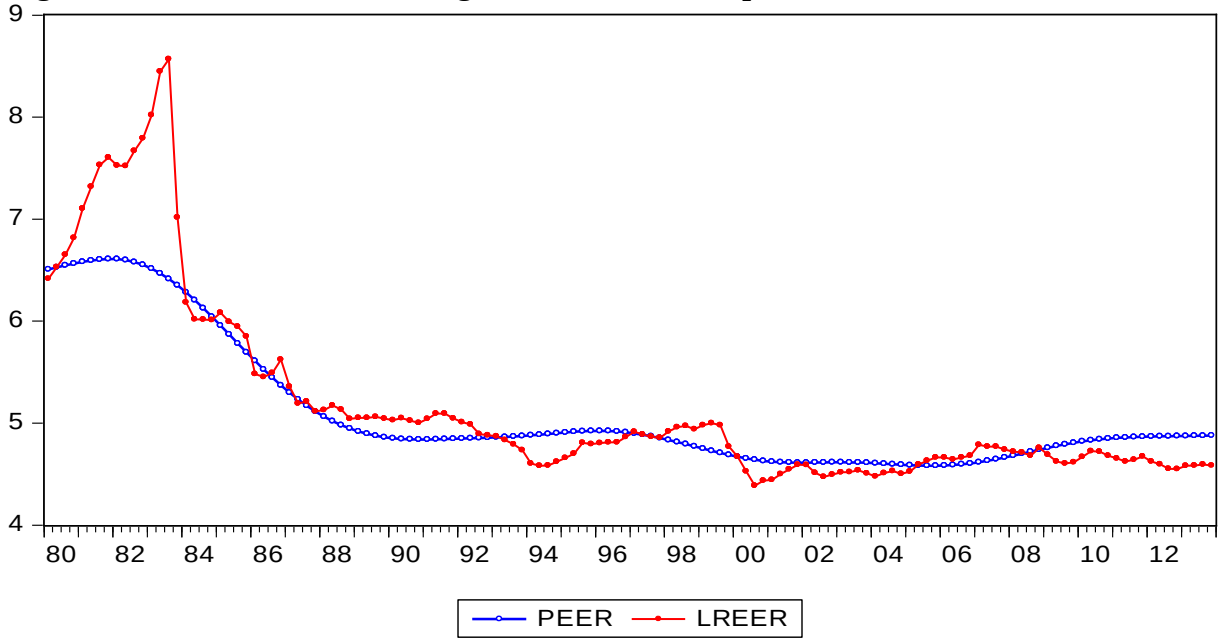
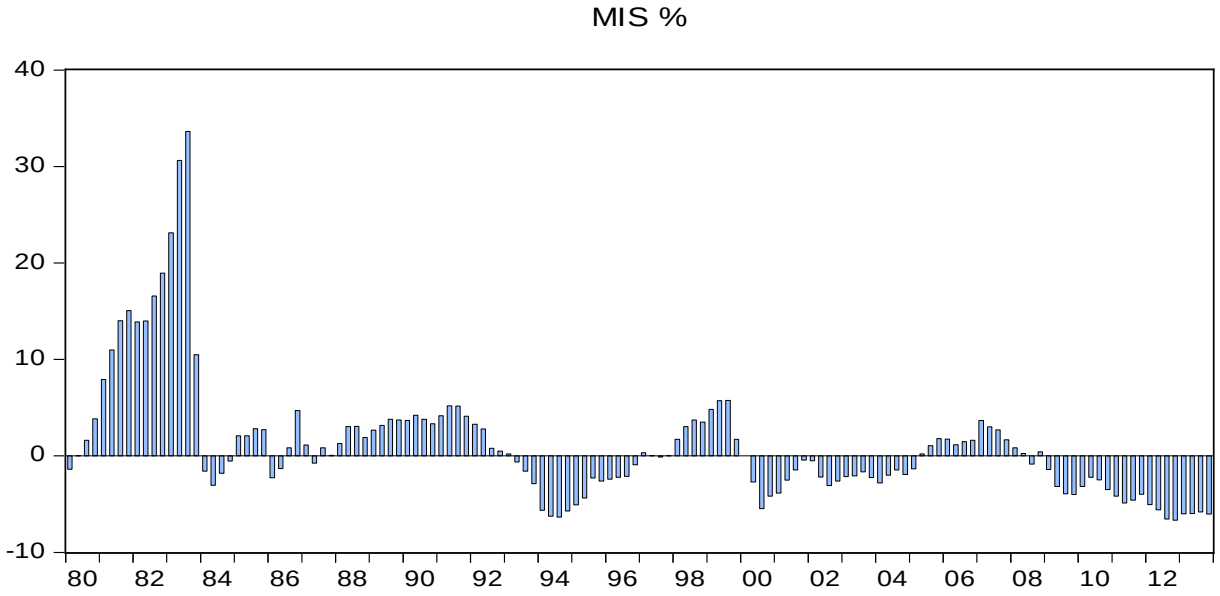


Figure 5.3 Misalignment between the actual and equilibrium real effective exchange rate



The results indicate that the real effective exchange rate was significantly overvalued between 1981 and 1983. The overvalued exchange rate may be attributed to fixed exchange rate regime prevailing in that period. Accordingly, the balance of payment statistics during that period point to severe deficit which was simply unsustainable. Thus, after the launch of the Structural Adjustment Program in 1983 exchange rates were liberalized. This allowed the government to strategically devalue the cedi, which happened in 1984 as well as in 1986 after which I became overvalued. It became undervalued again from 1994 up to 1996 after which the trend of overvaluation set in again. From 1999, the unfavourable terms of trade around the period resulted in an undervalued REER which persisted till 2004. Another trend of overvaluation set in around 2005 and was exacerbated by the redenomination in 2007. Since 2009, the REER is observed to be relatively undervalued. Notably, the overvaluation and undervaluation have been marginal around a threshold of 10%. This result supports the finding of Iossifov and Loukoianova (2007) and Kwakye (2012) who observed the actual real effective exchange rate has been relatively close to its equilibrium value since 2005. Accordingly, the relative fast speed of adjustment of 17% per quarter ensures that any misalignment from equilibrium path is quickly restored. In conclusion the results indicate of a number of things. First, that short run divergence of the actual real exchange rate from its equilibrium value may be due cyclical changes in the macroeconomic fundamentals. Secondly, that the redenomination of the Ghanaian cedi and the global financial

crisis in 2008 have not exerted significant impact to influence movement of the REER away from its equilibrium path. Lastly, that the movements in the exchange rate are relatively consistent with the path dictated by the macroeconomic fundamentals of the economy.

6.0 Summary and Conclusions

In the context of the BEER model, this study examined the long run relationship between specific macroeconomic fundamentals and the real effective exchange rate. The real effective exchange rate and these fundamentals were found to be cointegrated using the bounds testing procedure. Thus the error correction model was also estimated to disentangle the short run from the long run shocks in the movement of the real effective exchange rate. Generally, the cointegration estimation of the real effective exchange rate as well as the error correction model corroborates the theoretical assertions and the results are to a large extent consistent. The derived equilibrium real effective exchange rate series as well as the resulting misalignment index comfortably reflect episodes manifested in Ghana's macroeconomic history. The results of the study indicate that terms of trade has a significant appreciating effect on the equilibrium real effective exchange rate while openness and the structural adjustment program initiated in 1983 has a depreciating effect on the equilibrium exchange rate. It also confirms the results of earlier studies that the real exchange rate was severely overvalued between 1981- 1983. However, after that period even though there have been episodes of misalignment, they have been mild and not persistent. The evidence particularly suggests that since 2000, movements away of actual real effective rate from its equilibrium path have been within a threshold of not more than 7%.

The empirical findings of this study have implications for strategies to boost competitiveness of Ghana's trade with the rest of the world. First, to the extent that terms of trade appreciates the real exchange rate, it is important to create an enabling environment that particularly supports the export sector and makes it more competitive. Reforming the agricultural sector to add value and move from exporting raw to semi-processed and processed goods will be beneficial to draw in more foreign exchange earnings. This will require concerted efforts from both the government and the private sector to significantly improve and increase economic activity in the industrial sector of Ghana. Policies that support and encourage the export of non-traditional goods will

reap a lot of benefits for the economy. In this way, given that Ghana has already embarked on a number of trade liberalization programs, the receipts from a vibrant export sector is likely to mitigate and offset the depreciation of the exchange rate as a result of the increase in openness.

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Appendix A

Variable	Description	Source
Real effective exchange rate (REER)	The REER is calculated by geometrically weighting the nominal bilateral exchange rates seasonally adjusted for relative consumer prices of Ghana and its trading partners. This variable is computed under the Information Notice System (INS) of the IMF and published in the International financial Statistics. The natural log form is used. An increase in the value of the REER indicates an appreciation whereas a decrease indicates depreciation.	IMF's International Financial Statistics
Terms of trade (TOT)	Computed as the percentage ratio of the export unit value indexes to the import unit value indexes. Data on net barter terms of trade are available on annual basis on WDI.	World Development Indicators (WDI)
Openness (LIM)	The ratio of the total value of imports (M) relative to GDP. An increase in the ratio reflects an increase in the degree of openness of the economy to international trade and hence possible reduction in trade taxes.	World Development Indicators (WDI)
Fiscal Stance (LED)	Constructed as the share of total external debt percentage of GNI	World Development Indicators (WDI)
Net Foreign Assets (NFA)	Computed as the ratio of net foreign assets relative to GDP at current prices. NFA is the sum of net holdings of portfolio equity assets, foreign direct investments assets, debt assets, financial derivative assets and foreign exchange reserves excluding gold.	World Development Indicators (WDI)
Real interest rate differential	Derived by subtracting the foreign real interest rate from Ghana's real interest rate. The foreign real interest rate is calculated by arithmetically weighting the real interest rates of the top three trading partners of Ghana which are UK, US and Germany. Due to data constrains, only the top three trading partners were used which was also the case in Iossifov and Loukoianova (2007) and Baak (2012) where some trade partners were excluded due to lack of consistent data. The trade weights used in calculating the REER is therefore re-scaled to reflect trade among the top three trading partners and subsequently used to calculate the real interest rate differential. The real interest rate is the nominal interest rate on 91-day treasury bills minus inflation (change in CPI) except in the case of UK where the retail price index and Germany where the GDP deflator (which are highly correlated with the earlier series of the CPI) was used due to lack consistent data.	IMF's International Financial Statistics

Trade weights applied

	1979M1 – 1989M12	1990M1 – 1995M2	1996M1-2004M2	2005M1 to current
US	37.7	28.9	37.5	42.3
UK	46.3	40.0	34.4	26.9
Germany	22.0	31.1	28.1	30.8

Note: original trade weights taken from IMF, Information Notice System and rescaled so that weights sum to 1.

Summary of previous empirical studies on exchange rate equilibrium and misalignment on Ghana

Author	Period	Variables employed	Equilibrium approach	Econometric approach	ECT
Youngblood and Apaloo (2006)	1956 - 2004	Terms of trade Commercial policy Net capital inflows		Engle-granger	
Iossifov and Loukoianova (2007)	1984 - 2006	Real interest rate differential, Productivity differential, Terms of trade Fiscal balance to GDP, Trade openness Net foreign assets Real world prices of major export products	BEER	Johansen Maximum Likelihood Approach and Error correction model	14% per quarter
Kwakye (2012)	1980 - 2010	Trade openness Real relative interest rate Terms of trade Government expenditure, Foreign reserves, Productivity Domestic credit Budget deficit	BEER	Johansen Maximum Likelihood Approach and Error correction model	97% per year
Abbey	1983 - 2006	Terms of trade, Productivity differentials, Government consumption expenditure share of GDP, Noninterest recurrent Government expenditure relative to GDP Net aid relative to GDP Net private transfers relative to GDP	BEER	Johansen Maximum Likelihood Approach and Error correction model	65% per year
Daboh (2010)	1970 - 2006	Terms of trade, Government expenditure, Trade restrictions, Exchange and capital controls Technological progress.	Edwards (1989)	Johansen Maximum Likelihood Approach and Error correction model	81.5% per year