

Real exchange rate misalignment and macroeconomic implications: recent evidence from Ghana

NANA KWAME AKOSAH *^{a,b}, PROVIDENCE BOATENG MIREKU^b AND
EMMANUEL OWUSU-AFRIYIE^c

^aWits Business School, University of the Witwatersrand, 2 St David's Place, Parktown, Wits 2050, Johannesburg, South Africa.

^bResearch Department, Bank of Ghana, Box 2674, Accra, Ghana.

^cFinancial Stability Department, Bank of Ghana, Box 2674, Accra, Ghana.

* Corresponding author's emails: akosahk@gmail.com; 1770303@students.wits.ac.za;
nana.akosah@bog.gov.gh

Abstract

We evaluate the degree of real exchange rate (REER) misalignment and its macroeconomic implications for the Ghanaian economy using quarterly data (2000Q1-2015Q3). Our results uncovered a clear misalignment of the actual REER from its equilibrium level throughout the sample period, although the REER was close to its equilibrium level at the end of 2012. The study also revealed a weak positive undervaluation-economic growth nexus for Ghana. Overvaluation was observed to exert disinflationary pressures, while undervaluation tends to increase inflationary pressures in Ghana. The study thus suggests that the use of REER undervaluation as a deliberate industrial policy instrument for sustained economic growth may be counterproductive in the context of Ghana, as such policy may potentially undermine price stability objective of the central bank.

Keywords: Equilibrium Exchange Rate; Misalignment; Ghana.

1. Introduction

Real exchange rate (RER)¹ equilibrium and misalignment attract keen interest in policy circles and open macroeconomics literature, regardless of a relatively vast literature that exists in the area. The intense focus on the subject is largely due to a lingering unresolved question of how to realign the exchange rate for a country in order to recover its “real” external competitiveness “in equilibrium”. In addition, it remains practically and conceptually ambiguous to accurately detect RER misalignments due to lack of consensus on the methodology to estimate the equilibrium RER (see, Hinkel and Montiel, 1999). Particularly, an unresolved pertinent issue in the modern literature pertains to the notion that equilibrium RER (henceforth, ERER) is an unobserved variable, making an accurate measure of RER misalignment still nebulous. Indicators that are commonly used to measure RER equilibrium and misalignment include nominal and real effective exchange rates, productivity and other competitiveness measures, terms of trade, current account and balance of payments outlook, interest rate differentials, and parallel market exchange rates. The difficulty is that these indicators may not always permit policy-makers to precisely ascertain the degree of misalignment in order to identify the apropos timing and extent of intervention needed at any point in time (Montiel and Hinkle, 1999). Edwards’ (1989, 2000) seminal work was the first significant effort to build an equilibrium exchange rate specifically for developing countries based on reduced-form single equation approach. He finds that only real (fundamental) variables influence the equilibrium RER in the long run, while monetary shocks are important determinants in the short run. Subsequently, Elbadawi (1994), Montiel (1997, 1999) as well as Baffes, Elbadawi and O’Connell (1999) used co-integration techniques to quantify the equilibrium exchange rate. Montiel (1997) suggests that co-integration is a superior method of estimating the real exchange rate over the PPP methodology.

Besides, the capacious empirical attention on RER misalignment hinges on the general consensus in policy circles that RER misalignment has considerable macroeconomic implications for any economy. It is generally acknowledged that RER misalignment can occur under any exchange rate regime (either

¹ The RER is defined as the ratio of the domestic consumer price index to the foreign consumer price index, multiply by nominal exchange rate. An equilibrium RER refers to a theoretical RER that would have prevailed if the economy was simultaneous in internal and external balance. Internal balance refers to the economy operating at full employment and at full capacity output, while external balance refers to a sustainable current account position given a country’s desired capital position, as a net lender or borrower.

flexible exchange rate, fixed exchange rate, or any hybrid of the two regimes). This is intuitively due to the fact that market determined exchange rate may deviate considerably from its “equilibrium value” suggested by fundamentals in the short term (see, Hyder and Mahboob, 2006). On one hand, the literature posits that RER overvaluation has deleterious effects on the economy (see, Edwards, 1986²; Dollar, 1992; Razin and Collins, 1999). Another stand of the literature argues that RER undervaluation may accelerate economic growth among developing and emerging economies, accentuating the role of the relative price of traded to non-traded goods as an instrument of industrial policy in the process of economic convergence (see, Hausmann, Pritchett and Rodrik, 2005; Rodrik, 2008). Consequently, some countries (especially China) have tried to remain competitive by pursuing very active exchange rate policies to undervalue their currencies in order to foster economic growth through export promotion. These developments have however led to a renewed debate in both academic and policy cycles regarding the use of exchange rate as industrial policy tool to promote sustained economic growth, particularly in developing sub-Saharan African (SSA) economies.

Like many developing countries, the periodic bumps in Ghana’s exchange rates trajectory, (reflecting in sporadic excessive depreciation), have fomented an enormous apprehension among policy makers, academia, social and political commentators. The tendency has been for most macroeconomic targets (such as inflation rates, fiscal and current account deficits) to be overshoot (see Table 1 below).

TABLE 1: KEY MACROECONOMIC OUTTURNS VRS TARGETS IN GHANA (2013-2014)

Indicators	2013		2014	
	Target	Actual	Target	Actual
Real GDP Growth (%)	8.0	7.1	7.1	4.0
Inflation (%)	9.0	13.5	13.5	17.0
Budget Deficit (% of GDP)	9.0	10.1	8.8	10.3
Current Account Deficit (% of GDP)	<10	11.9	7.8	9.6

Source: Bank of Ghana and Ministry of Finance

² According to Edwards (1986), RER misalignment generates incorrect signals to economic agents and hence, results in greater economic instability.

These macroeconomic gaps reflect in excessive volatility on the foreign exchange market normally in the first half of the year. This has sparked several policy fundamental questions including: (1) what are the underlying drivers as well as the degree of RER misalignment in Ghana? (2) what are the macroeconomic repercussions of RER misalignment (on output and inflation) in Ghana? (3) If there is a positive growth-undervaluation nexus, can it be exploited by policymakers in Ghana?

Several attempts have been made to determine RER misalignment in a number of African countries. More recent studies include Mathisen (2003) on Malawi; Iimi (2006) on Botswana; Eita and Sichei (2006) on Namibia; Asfaha and Huda (2002) on South Africa; Aliyu (2007) on Nigeria; Ndhlela (2013) on Zimbabwe; Coulibaly and Gnimassoun (2013) on West Africa; among others. In particular, a few number of studies have focused on Ghana, notable among them include Sackey (2001); Youngblood (1993 & 2004); Opoku-Afari (2004); Opoku-Afari, Morrissey and Lloyd (2004); Youngblood and Apaloo (2007); Abbey, Jebuni, Gockel and Hester (2007); Iossifov and Loukoianova (2007); Daboh (2010); Kwakye (2012); Amoah (2017) and Amoah and Aziakpono (2017). The detailed findings of these empirical works are thoroughly reviewed in Section IIB.

However, it is essential to note that the foregone studies have largely examined RER equilibrium and misalignment up to the end of 2013 using predominantly annual dataset. However, they do not provide explanation for the more recent nominal exchange rate depreciation of 2014 and 2015, as to whether it reflect a correction from previous years of overvalued domestic currency or originating from inherent structural weakness of the economy. Consequently, this paper contributes substantially to the literature by extending the dataset to capture development in the year 2015 in order to ascertain whether the domestic currency has overly or marginally depreciated from its equilibrium level. The study also applies high frequency data (quarterly dataset), making it more relevance for quicker monetary policy response to RER disequilibrium. Besides, there is still imperfect knowledge on the macroeconomic implications of RER misalignment in the case of Ghana and this is the focus of the current study.

This study thus complements and extends the empirical literature on RER in the following dimensions: first, unlike previous studies that are based on single exchange rate index, the current study estimates the equilibrium real effective exchange rate (EREER) equation for three different RER indices based on the approaches of both the behavioural (BEER) and permanent (PEER) equilibrium real exchange rate. Thus, it proffers alternative assessments of RER

misalignments for Ghana which is germane for policy analysis and decision making. Second, the study ranks the fundamental determinants according to the loading of each variable in the computation of ERES using standardized coefficients, which offer critical policy implications. Third, we define episode of excessive misalignment (either overvaluation or undervaluation) as periods where our calculated misalignment exceeds a determined threshold computed using empirical bootstrapping technique. Fourth, we conduct an event analysis study of the behaviour of economic growth and exchange rate policy (including forex intervention, monetary and fiscal arrangements, etc.) during episodes of RER misalignment. Five, we examine the asymmetric effect of RER misalignment on the economy by investigating separate effects of overvaluation and undervaluation on economic growth and inflation in Ghana.

The rest of this paper is organized as follows: Section II presents a brief theoretical and empirical literature on equilibrium REER and misalignment. Section III describes the methodology and data used in the empirical analysis. Section IV presents the empirical results, while Section V provides the conclusion and policy suggestions.

2. Literature review

This section provides review of theoretical and empirical literature on equilibrium RER and misalignment as well as the macroeconomic implications of the latter, particularly for the developing economies.

2.1. Theoretical literature on equilibrium RER and misalignment

Conceptually, real exchange rate (RER) misalignment refers to a situation where a country's actual RER deviates from the ideal or equilibrium RER. This is computed as follows.

$$RERM_t = \frac{(ARER_t - ERES_t)}{ERES_t} * 100, \quad (1)$$

Where *RERM* denotes real exchange rate misalignment; *ARER* is the actual real exchange rate and *ERES* is the ideal or equilibrium real exchange rate. Thus, the determination of real exchange rate misalignment entails the measurements of both the *ARER* and *ERES*. In Equation (1), a currency is labelled “undervalued” when it is more depreciated than *ERES* (i.e. $ARER_t > ERES_t$) and “overvalued” when it is more appreciated than *ERES* (i.e. $ARER_t < ERES_t$).

However, there are several definitions for actual exchange rate in the Open Macroeconomic literature, contingent on the purpose for which it is intended. These are: the nominal exchange rate, the effective exchange rate, the real exchange rate and the equilibrium exchange rate measures. The nominal or “bilateral” exchange rate (S) refers to the official exchange rate at which one currency exchanges for another. A “multilateral exchange rate”, also known as “effective exchange rate,” refers to the trade-weighted exchange rate. Other measures attempt to relate the exchange rate to the competitiveness and overall performance of the economy. Generally, ARER is often measured based on the “internal” and “external” concepts. The internal concept measure of ARER is defined as the ratio of domestic prices of nontradables (P^{NT}) and tradables (P^T) within a single country and is computed as:

$$ARER = \frac{P^{NT}}{P^T}, \quad (2)$$

Consequently, the real exchange rate in equation (2) is an indicator of domestic resource allocation incentive in the home economy. On the other hand, the external concept of the ARER is based on the purchasing power parity (PPP) definition, which in its absolute terms, defines the ARER as the nominal exchange rate (S) adjusted for relative domestic and foreign prices:

$$ARER = S * \frac{P^D}{P^F}, \quad (3)$$

Where, S is measured here as foreign currency units per domestic currency, while P^D and P^F are domestic and foreign prices respectively. Equation (3) thus compares the relative prices of baskets of goods consumed or produced in different economies. In both concepts, an increase implies ARER appreciation, while a fall connotes depreciation.³ Nevertheless, the most common challenge of using the definition based on “external concept” is the problem of finding appropriate proxies for the price indices involved.

Despite its relevance in the macroeconomic literature, the actual (observable) values of the exchange rate do not pin down what the equilibrium (long-run) values are. Therefore, ascertaining the ERER is germane as it enables a determination of the “right” nominal exchange rate (S), which is an important policy variable. But, the practical calculation of the ERER has remained contentious in the extant literature. Practically, the opinions on this subject

³ For instance, when the price of nontradables rises relative to the price of tradables, the ARER appreciates, whereas if the price of tradables increases relative to the price of nontradables, the RER depreciates.

may be divided into three main categories (see, Williamson, 1994; Isard and Faruquee, 1998; Hinkle and Montiel, 1999). The first strand of ERER is the price-based criteria, (such as purchasing power parity (PPP)⁴ and its variants), which considers that exchange rate is always in equilibrium, and also echoes the current and expected macroeconomic situation. The approach has been widely tested in the empirical literature (for instance, Taylor, 1988; McNown and Wallace, 1989; Bahmani-Oskooee, 1993; Sarantis and Stewart, 1993; Moosa and Bhatti, 1996; Baharumshah and Ariff, 1997; Mollick, 1999; Chinn, 2000; and Choudhry, 2005). However, MacDonald (2000) argued that PPP-based studies have reflected a very slow speed of reversion of the exchange rate towards the PPP value.

The second view is the solvency and sustainability based criteria, which is based on the notion that exchange rate misalignments may exist but in practice, these deviations cannot be quantified. The solvency and sustainability based criteria, especially the fundamental equilibrium exchange rate (FEER) approach ⁵, evaluates equilibrium exchange rate as a function of real economic fundamentals. Williamson (1985, 1994) defined FEER as a real effective exchange rate that simultaneously secures internal and external balances for a given number of countries at the same time.⁶ Obstfeld and Rogoff (1995) however argued that the overreliance of trade elasticity may generate an inaccurate estimate of the FEER trajectory.

The third strand is the model-based criteria, shared by those estimating equilibrium RER. The main thrust of this category is that RER misalignments cannot just be detected by comparing the current values of RER with long-term equilibrium levels. But it should also consider that RER may deviate from that equilibrium level due to different cyclical situations in the domestic economy and abroad. This strand is largely based on the early works of MacDonald (1997) and Clark and MacDonald (1998) regarding the behavioural (BEER) and permanent (PEER) equilibrium exchange rate approaches which empirically

⁴ The PPP basically relies on the law of one price (LOP) which states that freely traded commodities, when measured in a common currency, should cost the same everywhere under a perfectly competitive setting.

⁵ Some empirical application of the FEER approach in developing economies include Elbadawi and Soto (1997); Devarajan (1997); Baffes, Elbadawi and O'Connell (1999); Dufrenot and Yehoue (2005).

⁶ The FEER models focuses on economic fundamentals that affect the equilibrium current and capital account balances, such as domestic and foreign real incomes, and factors influencing national savings and investment, such as permanent fiscal consolidation (see Macdonald, 1998).

estimates the fundamental determinants of RER.⁷ The theoretical underpinnings of these approaches rest on the basic concept of uncovered interest rate parity (UIP). The BEER methodology is based on the current levels of the fundamental determinants of RER, while the PEER approach estimates the equilibrium RER using the long run sustainable levels of economic fundamentals. Therefore, the misalignment based on the BEER approach is referred to as current misalignment, while that from the PEER approach is referred to as total misalignment. The general consensus however is that the analysis based on both BEER and PEER is necessary for policy decision as it offers better understanding of whether the misalignment is largely driven by temporary or permanent shocks of the fundamentals (see Clark *et al*, 2000; Maeso-Fernandez *et al*, 2001).

In view of this, the extant literature highlights three notions of equilibrium RER as follows:

- Short-term equilibrium exchange rate (STEER) - exchange rate compatible with the current economic situation, excluding purely financial shocks;
- Medium-term equilibrium exchange rate (MTEER) - exchange rate prevailing when its fundamental determinants are at sustainable medium-term values. Usually, this situation is characterized by the simultaneous existence of internal balance and external balance;
- Long-term equilibrium exchange rate (LTEER) - exchange rate consistent with a situation of internal balance, in which there are no reasons for changes in capital movements and in which the ratio of net foreign assets to GDP remains constant.

Consequently, more than one exchange rate measure may need to be calculated depending on what policy issues or research questions one wishes to address. Ultimately, different constructions of exchange rate measurements will likely lead to different estimates of the equilibrium rates.

The choice of approach for determination of both the ARER and ERER will considerably depend on data availability as well as each country's circumstances.

2.2. Empirical literature on developing economies

There is extensive empirical literature on estimating equilibrium REER and misalignment for developing economies. Notably, however, Edwards' (1989,

⁷ Notable recent studies using these approaches including Stoke and Watson (1993); Clarida and Gali (1995); Gonzalo and Granger (1995); Clostermann and Schnatz (2000); Maeso-Fernandez *et al*, (2001); Osbat *et al*, (2003); Schnatz *et al*, (2003); Egert, (2004); Egert *et al*, (2006); Goo, (2006); Iossifov *et al* (2007); Kwakye (2012).

1994) seminal work was the first substantial effort to construct an equilibrium REER exclusively for developing countries. The study reveals that only real (fundamental) variables influence the equilibrium REER in the long run. He also identifies that changes in monetary shocks are however critical determinants in the short run. Montiel (1997, 1999) and Baffes, Elbadawi and O'Connell (1999) use co-integration techniques to estimate the equilibrium REER. Montiel (1997) particularly proposes that the co-integration technique is a superior method of estimating the real exchange rate over the PPP methodology. Razin and Collins (1997) determined equilibrium REER based on a reduced-form REER equation derived from a Mundell-Fleming model. In terms of appropriate model specification for developing economies, Williamson (1999) encouraged the usage of reduced-form single equation for these economies. He argued that large multi-dimensional model may not be suitable for developing countries, as most of these economies are small.

Like the other regional blocks, several empirical studies on the determination of EREER and misalignment have focused on Sub-Saharan African (SSA) region. Notable recent works include Asfaha and Huda (2002) that used a one-step Engel-Granger technique and a five year moving average technique to estimate the exchange rate misalignment for South Africa over the period 1985-2000. The long-run fundamentals in this case were terms of trade; government expenditure; openness of capital account; trade restrictions; technological and productivity improvements. They find episodes of undervaluation of the rand from 1985Q1 to 1988Q1 and also from 1997Q2 to 2000Q4. The rand was however observed to be overvalued during the period 1988Q3-1998Q2. Using Vector Autoregressive (VAR) technique, they found that the exchange rate misalignment accounted for 20 percent variation of the South African economy's international competitiveness (Asfaha and Huda, 2002:14).

Iimi (2006) used the BEER approach to examine the extent of exchange rate misalignment in Botswana for the period 1985-2004. The fundamental determinants for the estimation of the EREER included the interest rate differential; the terms of trade; a proxy for the Balassa-Samuelson effect; fiscal risk premium variable which depends on government income and expenditure; and the net foreign assets (a proxy for capital inflow). With the exception of the finding that an increase in the net foreign assets results in an equilibrium depreciation of the currency, the empirical results were consistent with the theoretical literature in all cases. The study also reveals that the *pula* was undervalued in the late 1980s but was overvalued by 5 percent in the later years of the study which impacted on Botswana's competitiveness in the short- and medium-term.

Similarly, Aliyu (2007) used the BEER methodology to appraise the exchange rate misalignment for Nigeria over the period 1986Q1-2006Q4. The economic fundamentals used to estimate ERER included terms of trade, net foreign assets, index of crude oil price volatility, government fiscal stance, the foreign reserve scaled by GDP, and finally monetary policy. The empirical results reveals that the exchange rate in Nigeria was undervalued over the periods 1989Q3-1991Q4; 1994Q1-1995Q1; 1996Q2-1999Q1; and 2001Q4-2006Q4. The study attributed the last period of undervaluation to good democratic practice, foreign exchange inflows on the back of rising crude oil prices, and gains from the banking sector consolidation experienced in Nigeria at the time. On the other hand, the study suggests that the exchange rate was overvalued for the following periods 1986Q1-1989Q2; 1992Q1-1993Q4; 1995Q2-1996Q1; and 1999Q2-2001Q3. The overvaluation of the Naira was attributed to policy changes that occurred during these periods.

Applying both cross sectional and time series analyses, De Broek and Slok (2006) appraise the extent of real exchange rate misalignment in 26 transition economies over the period 1991-1998. The sample for the cross-sectional analysis includes 10 EU accession countries and 16 other transition economies. The time series analysis applied the BEER methodology using economic fundamentals such as productivity, money-to-GDP ratio, trade openness, government consumption, commodity prices and terms of trade. On the whole, the empirical results from the cross-sectional analysis suggest that exchange rates were generally misaligned at the beginning of the transition period, but as the years go by, the misalignment was corrected.

2.3. Empirical literature on equilibrium RER and misalignment for Ghana

Quite a few empirical studies on ERER and misalignment have concentrated on Ghana. For instance, Sackey (2002) developed a model for the equilibrium exchange rate in Ghana for the period 1962-1996. The long-run determinants of the equilibrium exchange rate were terms of trade; net foreign aid inflows; government consumption; “commercial policy” (openness); and technological progress. The short-run determinants of the equilibrium exchange rate included the above-mentioned variables excluding the terms of trade and including the nominal devaluations variable. The results were consistent with economic theory with the exception of the aid variable which refuted the notion of the Dutch disease where an increase in net foreign aid inflows is expected to appreciate the exchange rate. Particularly, the nominal devaluations variable depreciates the exchange rate in the short-run, which is also as expected in the theoretical literature.

In a study that applied Vector Autoregressive (VAR) and multivariate orthogonal decomposition techniques, Opoku-Afari, Morrissey and Lloyd (2004) determined equilibrium RER and the extent of misalignment for Ghana over the period 1966-2000. The fundamental determinants deployed in their study included terms of trade, degree of openness (a proxy for export trade, as imports were perceived not to vary too much in Ghana during the time of the study), technological change (using growth in total factor productivity from the Solow-residual, obtained via growth accounting methods) and official inflows of foreign aid. The empirical results indicated that aid inflows tend to appreciate the real exchange rate in the long-run, consistent with the Dutch Disease theory. In contrast, they observed that increases in technological change, trade openness (exports) and terms of trade tend to depreciate the real exchange rate in the long run. In the short-run, however, the only variable that was found to have a significant depreciating effect on the real exchange rate was trade openness, implying that changes in exports are the major driver of exchange rate misalignment. The study also showed that the ARER adjusts sluggishly to its equilibrium, epitomizing policy ineffectiveness or inflexibility.

Youngblood and Apaloo (2006) also determine the extent of exchange rate misalignment of the cedi over the period 1965-2004. The fundamental determinants of the equilibrium exchange rate in their study included the terms of trade, net capital inflows and commercial policy (openness). The study underscores the proclivity for the exchange rate in Ghana to converge to the equilibrium in the long-run. They however intimated that divergences in the cedi arise in the short-run owing to cyclical changes in the fundamentals and policies that impede convergence.

Iossifov and Loukoianova (2007) applied the BEER method and the Vector Error Correction Models (VECM) to estimate the equilibrium RER and misalignment for Ghana for the period 1983Q1-2006Q3. The fundamental determinants for the estimation of EREER included the per capita growth rate differential between Ghana and its major trading partners; the real interest rate differential; and the weighted average real world prices of Ghana's four main export commodities. The empirical results showed that increases in all fundamentals lead to an exchange rate appreciation, consistent with the *a priori* expectations. The error correction estimates also suggested that 14 percentage points of any misalignment between ARER and EREER is corrected in each quarter. The study revealed that the ARER reverts to its equilibrium after a shock, provided the shock does not reoccur. It was further observed that the

ARER was below its equilibrium value (ERER) during the period 1999-2000 but was close to its equilibrium value during 2006Q3.

Kwakye (2012) determined real exchange rate misalignment for Ghana for the period 1980-2010, based on the BEER methodology. The economic fundamentals or “real” factors used in this study included productivity (measured as GDP per capita), trade openness, real relative interest rate, government expenditure (scaled by GDP), terms-of-trade, and foreign reserves (scaled by GDP). Also nominal macroeconomic variables, represented by domestic credit and the budget deficit (all scaled by GDP), were included. The study detected that the ERER is influenced to a significant extent by “fundamental” or “real” factors. He observed that the nominal macroeconomic variables however had no significant effect on the ERER for the sample period. The actual RER was misaligned relative to the equilibrium value either way – i.e. overvaluation or undervaluation – throughout the study period. The results indicate strong real overvaluation during the period 1981-1983, and moderate overvaluation or undervaluation for other sub-periods.

Applying the Johansen cointegration and error correction methods, Amoah and Aziakpono (2017) estimated the equilibrium ERER to determine the extent of misalignment of the Ghanaian cedi for the period 1980Q1-2013Q4. The empirical results suggest significant misalignment of the exchange rate, based on the BEER approach. In particular, the study observed undervaluation for the period preceding the redenomination exercise in 2007, while overvaluation was detected thereafter. Given the extent of overvaluation at the time, the study suggested that a once-off devaluation of a minimum of 20% could bring the exchange rate close to its equilibrium level.

As aforesaid, the previous studies have largely examined equilibrium RER and misalignment using predominantly annual dataset up to 2013. In this regard, these studies do not provide explanation for the more recent nominal exchange rate depreciations of 2014 and 2015, as to whether they reflect a nominal correction from previous years of overvalued currency or originating from inherent structural weakness of the economy. Consequently, this paper contributes substantially to the literature by extending the dataset to capture development in the year 2015 in order to ascertain whether the domestic currency has overly or marginally depreciated from its equilibrium level. The study also applies high frequency data (quarterly dataset), making it more relevance for quicker monetary policy response to RER disequilibrium.

2.4. Macroeconomic effects of RER misalignment

Economists and policymakers largely acknowledge the importance of unearthing the nature and degree of impact of RER misalignment on efficient macroeconomic management. Unequivocally, however, the direct theoretical and empirical relationship between exchange rate misalignment and macroeconomic indicators are yet to be copiously comprehended. In view of this, empirical studies continue to make attempts to understand this relationship by exploring relationships that encompass diverse measures of exchange rate misalignment in traditional growth regression models.

Deriving real exchange rate misalignment based on BEER approach, Ndhlela (2012) empirically analyzed the relationship between real gross domestic product growth and real exchange rate misalignment for Zimbabwe. After controlling for other structural and policy variables, the study demonstrates that RER misalignment exerts a significant negative impact on economic growth in Zimbabwe. On a whole, the results provided support to the hypothesis that chronic real exchange rate overvaluation was a key fundamental behind the post-2000 economic growth contraction in Zimbabwe.

Particularly in West Africa, the assessment of equilibrium exchange rate has become critical given the agenda of the six member states (Ghana, Nigeria, Gambia, Liberia, Guinea and Sierra Leone) to have a single currency. This is because the establishment of a monetary union necessitates member countries to comply with specific quantitative and qualitative targets. For instance, Coulibaly and Gnimassoun (2013) argued that exchange rate misalignment may depict the level of economic competitiveness and serve as an indicator of the sustainability of a monetary union. For effective comparison, it is imperative to appraise the extent of RER misalignment for each member state against the set target for monetary union.

Using panel Generalized Methods of Moments (GMM), Raji (2012) investigated the implication of real exchange rate misalignment on economic performance and unionization of West African Monetary Zone (including Ghana, Nigeria, Gambia, Liberia, Guinea and Sierra Leone) over the period 2002Q4–2010Q4. The study observed a negative and statistically significant effect of RER misalignment (for both overvaluation and undervaluation though the former was insignificant) on economic growth for the WAMZ member countries over the sample period. In contrast, the study indicated that equilibrium RER impacted positively on economic performance in the WAMZ countries. Nevertheless, there is inadequate knowledge on the macroeconomic implications of RER misalignment in the case

of Ghana and this is the focus of the current study.

3. Data and Methodology

3.1. Main dataset

Unlike previous researches, the current study adopts three real effective exchange rate (REER) indices computed by staff of Bank of Ghana to determine the equilibrium RER and the associated misalignment for Ghana over the sample period 2000Q1 to 2015Q3. These REER indices include:

a) REER index for 18 major trading partners⁸ (LREER_Broad). The weight for each trading partner was based on the respective shares of total foreign trade with Ghana over the period 2006-2012.

Table 2 displays the relative weights of the major trading partners while Table 3 shows the respective weights of the countries under the Euro Area.

TABLE 2: TRADE WEIGHTS COMPUTED FROM BALANCE OF PAYMENTS DATA (2006-2012)

	Countries	Trade weights
1	Euro Area	0.3461
2	South Africa	0.1578
3	China	0.0812
4	US	0.0596
5	Nigeria	0.0565
6	UAE	0.0406
7	UK	0.0387
8	India	0.0264
9	Canada	0.0162
10	Malaysia	0.0146
11	Turkey	0.0141
12	Korea Republic	0.0135
13	Brazil	0.0134
14	Japan	0.0134
15	Togo	0.0132
16	Côte d'Ivoire	0.0128
17	Thailand	0.0126
18	Australia	0.0089
Total		0.9400

Source: Authors

⁸ However, the number of major trading partners in this study becomes 26 countries when each of the nine trading partners in the Euro Area is treated as individual country.

TABLE 3: TRADE WEIGHTS FOR MAJOR TRADING PARTNERS IN EURO AREA

	EU Countries	Weights
1	Netherlands	0.0777
2	France	0.0627
3	Switzerland	0.0507
4	Belgium	0.0457
5	Italy	0.0417
6	Germany	0.0297
7	Spain	0.0187
8	Sweden	0.0117
9	Estonia	0.0077
Total		0.3461

Source: Authors

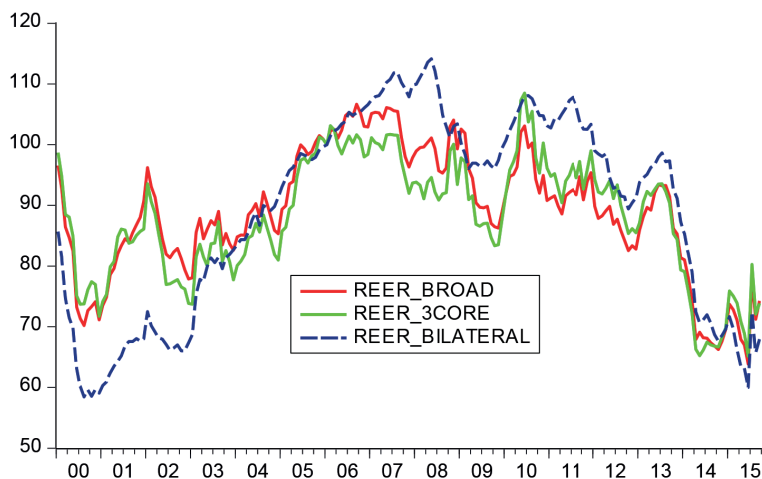
b) REER index for three Core Currencies including the US Dollar, the British Pound Sterling and the Euro (REER_3Core). The weight of each currency was obtained by normalizing the total shares of three trading partners (the USA, the Euro Area and United Kingdom) over the period 2006-2012 to one. In view of this, the Euro Area (which encompasses nine countries) assumes the highest average weight of 0.78. This was followed by the USA (0.13) and the UK (0.09) over the trading period of 2006-2012.

c) Bilateral REER index, computed as the US Dollar per Ghana Cedi (LREER_Bilateral).

Figure 1 displays the evolution of the three REER indices over the period 2000M01 to 2015M09.

It is apparent that the REER has experienced significant volatility over the sample period. We also observed that the index for broad REER and that for the three core currencies (REER_3Core) generally co-moved throughout the period. However, REER_Bilateral index has exhibited some pockets of divergence from the REER_Broad and REER_3Core indices, although all the three indices closely tracked each other since 2013. In particular, the indices reveal significant real depreciation between 2013H2 and 2014Q1, suggesting an improvement in Ghana's trade competitiveness. This paper however investigates whether the observed volatilities of the REER index also connote a deviation from its equilibrium path by using formal estimation technique.

FIGURE 1: DEVELOPMENTS OF REER INDICES



Source: Authors

For the determination of equilibrium REER and misalignment, we select fundamental variables based on the literature and the country-specific characteristics. The first variable is the terms of trade, which indicates the effect of foreign demand and supply on the tradable sector. Improvement in the terms of trade has both income and substitution effects. The income effect leads to REER appreciation because aggregate spending on goods (including non-tradables) increases and thereby raising their prices. The substitution effect is due to the decrease in relative price of imported goods, leading to real depreciation. Consequently, the terms of trade's influence on the REER cannot be signed a priori, as this depends on whether income or substitution effect dominates.

The second fundamental is the extent of openness to trade (OPNESS), measured as the sum of export and import scaled by GDP. Likewise, the sign of OPNESS is not explicitly pre-determined. On one hand, openness to trade may increase competition in the tradable sector, causing relative price of tradable to fall. This will result in RER appreciation. On the other hand, increases in openness are expected to lead to real depreciation in the non-tradable sector in order to restore equilibrium (see Iossifov *et al*, 2007).

The third fundamental determinant is productivity growth, measured as the real GDP growth differential between Ghana and the USA (denoted as RGDIFF). According to the professed Balassa-Samuelson effect, higher productivity generally raises relative wage of domestic economy which in turn reflects in

higher prices of non-tradables, leading to RER appreciation. Nonetheless, higher productivity could also result in lower relative price of tradables, inducing RER to depreciate. Therefore, a negative sign for productivity growth is also plausible, especially in an economy like Ghana which relies heavily on importation of capital and intermediate good for domestic economic activities. Consequently, the sign for productivity in this paper remains ambiguous.

The fourth fundamental variable is capital inflow, proxy by net foreign assets (NFAG), which is measured as the total foreign assets minus total foreign liability of the banking system, scaled by GDP. NFAG (capital inflows) may have a positive or negative effect on REER. On one hand, an increase in NFAG is expected to lead to real appreciation as the inflows are likely to raise domestic absorption and shift the composition of potential GDP towards non-traded goods.⁹ On the other hand, an increase in NFAG induced by high current account deficits may increase the indebtedness of a country with the tendency of reversing direction when there is the slightest perception of imminent risks.

Unlike other economies where private sector dominates economic activities, the public sector remains the predominant driver of domestic economic activities in Ghana. This has reflected in perennial government expenditure overruns and external imbalances (current account deficits) over past two decades. Therefore, unlike the previous studies that used the usual government expenditure as fundamental fiscal determinant of equilibrium RER, this study rather prefers to capture risk premium (RISKP). This is largely underpinned by the fact that the latter accounts for both the persistent fiscal slippages (largely underpinned by frequent expenditure excesses) and the rapid pace of public debt accumulation. In this paper, risk premium is measured as the total public debt (external plus domestic debt) scaled by GDP, rather than external debt to GDP ratio widely used in the literature.¹⁰ A rising risk premium turns to trigger capital flight

⁹ The term also captures the effects of current and past intervention. Brissimis *et al.* (2005) indicate intervention can affect the estimated equilibrium relationship, in the event that central banks target the exchange rate at a level other than the PPP level.

¹⁰ The inclusion of domestic debt in this paper was premised on our observation that non-residents (foreigners) are permitted to hold domestic government treasury securities with maturities of at least 2-years without any holding period. For instance, non-residents (foreigners) holding of domestic debt was about 16.7 percent as at end-December 2015, increasing further to 20.7 percent at the end of May 2016. This suggests a possible inherent exchange rate risk in the domestic debt structure of Ghana should non-resident investors decide to disinvest coupled with the fact that there is no holding period alongside weak or non-existent secondary market in Ghana. Consequently, the use of only external debt/GDP as a proxy for risk premium (as widely professed in the literature) may underestimate the sovereign risk premium in the case of Ghana.

and this often leads to depreciation in RER. Therefore, we expect it to carry a negative sign.

In addition to the above fundamentals, we capture some salient monetary policy variables to particularly address lingering structural issues. First, continuous monetary accommodation of fiscal policy (persistent fiscal dominance) has remained topical issue in policy cycles. As a result, we assess the effect of central bank's financing of the deficit on the evolution of REER, using central bank's net credit to government (BNCGG).¹¹ This variable is deemed critical as it tends to serve twin purposes on account of the definition of broad money supply (which, in terms of sources, is a combination of net foreign assets [NFA] and net domestic assets [NDA]) as well as deficit financing. On one hand, an increase in central bank's net claim on government (a sub-component of NDA) implies an increase in broad money supply via net domestic assets channel. On the other hand, rising central bank's net claim on government to some extent reflects increasing government expenditure via deficit financing from the central bank.

Another key feature is the statutory surrender requirement in Ghana which mandates exporters to relinquish part of the foreign exchange proceeds to Bank of Ghana. As a result, the central bank in turn provides foreign exchange support for the importation of oil and other essential commodities, whenever necessary. That is, the central bank's intervention or support in the foreign exchange market is likely to affect equilibrium RER, especially when the intervention engenders an actual RER that deviates from the PPP level (see, Brissimis, 2005). In the same vein, an increase in central bank's foreign exchange support also reflects a rise in broad money supply via the NFA channel.

Recently, the central bank also introduced and/or reinforced foreign exchange measures during the first half of 2014 which received considerable public apprehension and was subsequently withdrawn during the third quarter of 2014. So we attempt to examine the impact of such event on REER using a dummy variable (DUMFX) that takes a value of 1 for the first two quarters of 2014 when the measures were enforced and 0 otherwise.

On the whole, we used quarterly time series data covering the period 2000Q1 - 2015Q3. The dataset was obtained from Bank of Ghana, Ministry of Finance and Ghana Statistical Services.

¹¹ Some studies (including Kwakye, 2012) used overall domestic credit and real interest rate differentials but the former had insignificant effect on equilibrium REER.

3.2. Model Specification

We determine the long run relationship between the REER and its fundamentals as well as the degree of misalignment based on the analysis of Clark *et al* (1999, 2000). Since Ghana is small-opened developing economy, this study specifies a single equation model following Williamson's (1994) advocacy for the usage of such specification for developing economies. Consequently, the long run relationship between the real effective exchange rate (REER) and the economic fundamentals is specified as follows:

$$LREER_t = \beta_0 + \sum_{i=1}^n \beta_i Z_{t-i} + v_t, \quad (4)$$

Where $LREER$ denotes log of effective real exchange rate; β_i is a vector of coefficients; Z represents the vector of the aforementioned economic fundamentals that are expected to influence the exchange rate in the medium to long term; v_t is a random disturbance .

Prior to the estimation of a long run relationship between the real exchange rate and its fundamentals, we test for the stationarity of the individual variables. In this paper, we apply both Augmented Dickey-Fuller (ADF) and Philip-Perron (PP) unit root tests.

We estimate the equilibrium REER in equation (4) using Bound Testing Autoregressive Distributed Lag (ARDL) method based on Schwarz information criterion. Particularly, the ARDL approach is indifferent of the data generation process (i.e. stationarity or otherwise) of the variables under consideration and hence, suitable for variables with different order of integrations.

Importantly, if the long run REER in equation (4) is a valid cointegration function, it will have an equivalent short run error correction model (ECM). The corresponding short run ECM is specified as follows:

$$\Delta LREER_t = \lambda_0 + \sum_{i=1}^p \varphi_i \Delta LREER_{t-i} + \sum_{i=0}^p \gamma_i \Delta Z_{t-i} + \psi_1 ECM_{t-1} + v_t, \quad (5)$$

Where Δ represent the first difference operator, ECM_{t-1} is the lagged error term generated from the cointegration model in equation (1), while λ_0 , φ_i , γ_i and ψ_1 are parameters to be estimated. Particularly, for a long run cointegrating relationship to exist, the adjustment coefficient, ψ_1 , must be negative, significant and less than one.

4. Empirical results and inferences

4.1. ARDL estimates of equilibrium REER

The unit root test results in Table 4 show that the fundamental determinants have different order of integration.

TABLE 4: RESULTS FROM UNIT ROOT TESTS

	Augmented Dickey Fuller (ADF) Test				Philip-Perron (PP) Test			
	None	Constant	Constant & trend	First difference	None	Constant	Constant & trend	First difference
LREER	[0.533]	[0.387]	[0.685]	[0.000]*	[0.521]	[0.313]	[0.582]	[0.000]*
LREERC	[0.545]	[0.232]	[0.526]	[0.000]*	[0.527]	[0.161]	[0.412]	[0.000]*
LBREER	[0.780]	[0.203]	[0.988]	[0.000]*	[0.563]	[0.704]	[0.988]	[0.001]*
RGDIFF	[0.006]*	[0.002]*	[0.009]*	[0.000]*	[0.011]**	[0.002]*	[0.011]**	[0.000]*
RISKP	[0.055]***	[0.173]	[0.973]	[0.014]**	[0.156]	[0.663]	[0.864]	[0.000]*
TOT	[0.451]	[0.185]	[0.555]	[0.000]*	[0.540]	[0.202]	[0.591]	[0.000]*
NFAG	[0.258]	[0.031]**	[0.147]	[0.023]**	[0.226]	[0.167]	[0.848]	[0.000]*
OPNESS	[0.047]**	[0.303]	[0.082]***	[0.005]*	[0.000]*	[0.028]**	[0.149]	[0.000]*
BNCGG	[0.328]	[0.161]	[0.429]	[0.000]*	[0.423]	[0.148]	[0.375]	[0.000]*
BOGFX	[0.001]*	[0.001]*	[0.007]*	[0.000]*	[0.000]*	[0.000]*	[0.002]*	[0.000]*

Notes: Values in square brackets are p-values; *, ** & *** denote 1%, 5% & 10% significant levels respectively.

As shown in Table 4, all the three RER indices, terms of trade and central bank's net claim on government exhibited non-stationary process at level but they become stationary after first differencing, implying an I(1) process. On the other hand, variables such as openness to trade, growth differentials and central bank's foreign exchange supply generally exhibit stationary process at levels (an I[0] process), while the results for variables including net foreign asset and risk premium were mixed.

Consequently, the unit root test results motivate and validate the use of ARDL approach for the estimation of the long run relationship between REER index and the fundamentals. Table 5 presents the diagnostics of the estimated optimal ARDL model based on Schwarz-Bayesian information criteria.

TABLE 5: ARDL MODEL DIAGNOSTICS BASED ON SCHWARZ INFORMATION CRITERION (SIC)

	LREER _t	LREERC _t	LBREER _t			
			LB1	LB2	LB3	LB4
	ARDL (1211000)	ARDL (3001000)	ARDL (2201000)	ARDL (22110003)	ARDL (200100030)	ARDL (20030000)
R-squared	0.938	0.905	0.985	0.989	0.989	0.987
Log likelihood	172.76	160.46	184.77	193.02	193.46	189.39
F-Stats [P-value]	62.68[0.00]	49.89[0.00]	274.84[0.00]	225.13[0.00]	274.41[0.00]	290.30[0.00]
DW- Statistic	2.293	2.137	1.774	2.19	2.249	2.169
Serial Correlation Test	8.754[0.068]	5.742[0.219]	3.925[0.416]	2.236[0.692]	5.341[0.254]	5.253[0.262]
Test of Functional Form	1.282[0.257]	0.013[0.908]	1.481[0.224]	1.661[0.198]	2.395[0.122]	0.0525[0.819]
Normality Test	0.531[0.767]	0.027[0.986]	4.952[0.084]	2.554[0.279]	0.078[0.962]	2.490[0.288]
Hetero-skedasticity Test	0.522[0.470]	3.109[0.078]	1.631[0.202]	0.715[0.398]	0.297[0.585]	1.367[0.242]

Notes: Values in [] are P-values

Source: Authors

As illustrated in Table 5, the overall power of the ARDL model was good with an R-square averaging 94 percent. This means that only about 6 percent of the variation in the dependent variable could not be explained by the explanatory variables. The models generally satisfy the all diagnostic tests at 5 percent significant level ¹², indicating that the estimates are valid for inferences. Devoid of any major econometric drawback accompanied by a higher explanatory power, long run parameter estimates were subsequently derived.

The long run parameter estimates are reported in Table 6 and models 1-3 are our preferred estimations. The ARDL analysis of the determinants of the REER for Ghana points to the existence of a long run relationship between the REER, real GDP growth differentials between Ghana and USA, terms of trade, openness, net foreign assets, risk premium and other monetary policy

¹² Homoskedasticity was observed based on the lack of significance of the Lagrange Multiplier (LM) test at 5% significant level. In addition, the LM test for serial correlation revealed the absence of this problem, while the lack of significance based on the Ramsey Reset test for functional form also connotes that the model was correctly specified at 5% significant level. More so, the test for normality of the error term indicated that the error term was normally distributed at 5% significant level and the standard student t-values were thus valid in predicting the sample results to the unknown population.

indicators (such as central bank's claim on government, central bank's foreign exchange support for oil and non-oil exports as well as dummy for recent foreign exchange measures). In general, our results show that higher degree of openness to international trade, favourable term of trade and rising net foreign assets tend to engender REER appreciation in the long run. In contrast, increase in the differential between the rate of growth of the real GDP in Ghana and its main trading partners, rising risk premium and increasing central bank's net claims on government tend to induce REER depreciation in the long run.

TABLE 6: LONG RUN ESTIMATES OF REER

	LREER_t	LREERC_t	LBREER_t			
	1	2	3	4	5	6
Regressors	Coeff [T-Ratio]	Coeff [T-Ratio]	Coeff [T-Ratio]	Coeff [T-Ratio]	Coeff [T-Ratio]	Coeff [T-Ratio]
Growth differentials	-0.004[-2.30]**	-0.008[-0.71]	-0.005[-2.06]**	-0.003[-1.71]***	-0.001[-1.01]	-0.002[-1.57]
Terms of trade	0.009[2.53]**	0.006[1.97]***	0.003[0.96]	0.006[1.34]	-0.002[-0.51]	-0.004[-1.07]
Net foreign asset/GDP	0.004[1.91]***	0.003[1.62]	0.006[3.13]*	0.006[3.28]*	0.004[2.29]**	0.004[1.77]***
RISK premium	-0.002[-5.14]*	-0.002[-5.34]*	-0.002[-6.44]*	-0.003[-6.41]*	-0.002[-5.31]*	-0.002[-6.87]*
Openness	0.008[5.24]*	0.007[5.21]*	0.007[4.47]*	0.008[4.66]*	0.006[4.068]*	0.006[3.89]*
BOG net claim on government	-0.008[-2.06]**	-0.005[-1.33]	-0.011[-1.96]***	-0.009[-1.63]	-0.012[-2.10]**	
Bog foreign exchange supply				-0.008[-1.96]***	-0.008[-1.96]***	-0.001[-0.60]
Dummy for recent forex measure					-0.106[-2.51]**	-0.145[-2.61]**
Intercept	1.931[50.88]*	1.918[53.00]*	2.006[52.20]*	1.984[49.67]*	2.033[53.70]*	2.029[50.67]*

Notes: *, ** & *** denote 1%, 5% & 10% significant levels respectively.

Source: Authors

The analogous parsimonious short run error correction model is reported in Table 7. The parameter estimate of the error correction term is negative, statistically significant and less than one as expected, implying that the determinants granger cause REER index in the long run.

TABLE 7: SHORT RUN PARSIMONIOUS RESULTS FOR REER

	Chg. in REER _t		Chg. in LBREER _t			
	1	2	3	4	5	6
Regressors	Coeff [T-Ratio]	Coeff [T-Ratio]	Coeff [T-Ratio]	Coeff [T-Ratio]	Coeff [T-Ratio]	Coeff [T-Ratio]
Chg. In REER _{t-1}	0.304[3.14]*					
Chg. In LREERC _{t-1}		0.381[3.43]*				
Chg. In LBREER _{t-1}			0.253[2.42]**	0.246[2.38]**	0.242[2.45]**	0.341[4.28]*
Chg. In growth differential _t	-0.009[-1.90]***	-0.004[-0.72]	-0.004[-1.12]	-0.003[-0.66]	-0.004[-1.07]	-0.006[-1.88]***
Chg. In growth differential _{t-1}	0.001[3.11]*		0.001[2.81]*	0.001[2.95]*		
Chg. In terms of trade	0.003[2.94]*	0.003[2.11]**	0.001[1.04]	-0.001[-0.66]	-0.0004[-0.51]	-0.001[-1.13]
Chg. In net foreign asset/GDP _t	-0.002[-1.89]***	-0.002[-1.89]***	0.002[0.22]	-0.0001[-0.01]	-0.006[-0.95]	0.002[0.32]
Chg. In net foreign asset/GDP _{t-1}						0.002[1.96]***
Chg. In net foreign asset/GDP _{t-2}						0.002[2.94]*
Chg. In RISK premium	-0.007[-4.83]*	-0.009[-4.43]*	-0.007[-4.05]*	-0.001[-4.31]*	-0.005[-3.10]*	-0.006[-3.77]*
Chg. In Openness	0.003[5.16]*	0.003[4.80]*	0.002[4.21]*	0.002[5.19]*	0.002[3.57]*	0.002[3.54]*
Chg. In BOG net claim on government	-0.003[-1.95]***	-0.002[-1.32]	-0.003[-2.17]**	-0.003[-1.79]***	-0.003[-2.43]**	
Chg. In BOG foreign exchange supply				-0.000[-0.28]	-0.0001[-0.36]	-0.0002[-0.63]
Chg. In BOG foreign exchange supply _{t-1}				0.002[3.24]*	0.002[2.97]*	
Chg. In BOG foreign exchange supply _{t-2}				0.001[2.49]**	0.001[3.18]*	
Dummy for recent forex measure					-0.029[-3.45]*	-0.038[-4.23]*
Intercept	0.723[5.03]*	0.907[5.38]*	0.593[4.33]*	0.562[4.25]*	0.572[4.64]*	0.536[4.12]*
ECM Term _{t-1}	-0.374[-5.21]*	-0.473[-5.57]*	-0.295[-4.34]*	-0.283[-4.32]*	-0.281[-4.57]*	-0.264[-4.02]*

Notes: *, ** & *** denote 1%, 5% & 10% significant levels respectively.

Source: Authors

The empirical result shows a relatively faster speed of adjustment of actual to equilibrium REER in Ghana when compared to findings of other studies.¹³

The estimate of the error-correction coefficient in the REER equation (model 1) suggests that 37 percent of any misalignment between the actual and equilibrium REER is corrected in each quarter. In other words, the mean lag of the adjustment is about 3 quarters. However, the speed of adjustment appears relatively slower for the bilateral REER index (model 3) but faster for the REER index for the three core currencies (model 2).

In particular, the direction of impact of the determinants on the REER in the short run is largely akin to that of the long run. However, BOG's foreign exchange support for oil and non-oil imports has positive effect on REER (appreciation) in the short run, while its long run impact was negative (depreciation). The results also suggest that the recent BOG foreign exchange measure (during the first half of 2014) had a negative impact on bilateral REER (depreciation).

Having identified an existence of a long run relationship between essential determinants and REER in Ghana, we ranked the fundamental determinants according to their relative impact on changes in the REER using standardized OLS regression. Table 8 presents the estimates of the standardized OLS regression.

¹³ For instance, Iossifov and Loukoianova (2007) and Kwakye (2012) report the statistically significant error-correction coefficients of (-0.14) and (-0.97) respectively for Ghana, while MacDonald and Ricci (2003) report the statistically insignificant error-correction coefficient of (-0.08) for South Africa.

TABLE 8: RANKING OF THE FUNDAMENTALS USING STANDARDIZED OLS ESTIMATION

	LREER	LREERC	LBREER	
Variable	Coeff[T-Stat]	Coeff[T-Stat]	Coeff[T-Stat]	Coeff[T-Stat]
RISK premium	-1.091[-5.11]*	-1.343[-6.22]*	-1.059[-10.90]*	-1.066[-10.864]*
Openness	0.906[5.39]*	1.090[6.42]*	0.492[6.44]*	0.490[6.381]*
BOG net claim on government	-0.514[-4.20]*	-0.339[-2.74]*	-0.201[-3.62]*	-0.201[-3.586]*
Net foreign assets	0.092[0.85]	0.119[1.07]	0.226[4.53]*	0.220[4.353]*
Growth differentials	0.006[0.07]	0.055[0.62]	0.027[0.69]	0.025[0.643]
Terms of trade	0.158[1.47]	0.159[1.47]	-0.037[-0.77]	-0.034[-0.708]
Bog foreign exchange support				0.023[0.689]
	Diagnostics			
R-squared	0.731	0.725	0.944	0.945
S.E. of regression	0.547	0.552	0.248	0.25
Log likelihood	-45.238	-45.863	2.045	2.318
Prob(F-statistic)	(0.000)*	(0.000)*	(0.000)*	(0.000)*

Notes: *, ** & *** denote 1%, 5% & 10% significant levels respectively.

Source: Authors

Based on the preferred Model 1, the result in Table 8 clearly shows that risk premium has a dominant negative influence on REER index in Ghana. This underscores the critical effect of the perennial fiscal overruns on the evolution of REER in Ghana. This is followed sequentially by openness to trade (+), central bank's net claims on government (-), net foreign assets (+), terms of trade (+) and real GDP growth differentials between Ghana and the trading partners (+).

4.1.1. REER equilibrium and misalignment

We then proceed to compute indices for the equilibrium REER using the derived long run elasticities based on the preferred estimates in Table 6 for the three REERs (Model 1-3). However, the discussion is only based on the REER index for 18 major trading partners (REER_BROAD). We check the robustness of our results using graphical presentations of the three core and bilateral REER indices. We compute two indices of equilibrium REER. One is based on the Behavioural equilibrium (BEER) computed by using the observed values of macroeconomic determinants and the other is based on the permanent equilibrium exchange rate (PEER) using the permanent components of the

fundamental determinants. The rationale is that the macroeconomic determinants that enter in the BEER equation are not necessarily at their equilibrium level, because the fundamentals may oscillate around their “equilibrium” value. The permanent component of each variable is obtained by removing the cyclical components from the relevant economic fundamentals, using the Hodrick-Prescott (HP) filter (with the standard smoothing factor of 1600 for quarterly data). Nevertheless, in this paper, the PEER (BEER) are computed as the sum of the product of each estimated coefficients and the permanent components (actual series encompassing both the transitory and permanent components) of the relevant economic fundamentals, as shown in equation (6).

$$PEER = \sum_{i=1}^n \beta_i Z_{it}^P \quad (6)$$

$$BEER = \sum_{i=1}^n \beta_i Z_{it}^B \quad (7)$$

Where Z_{it}^P is a vector of permanent component of economic fundamentals; Z_{it}^B is a vector of the actual series of economic fundamentals; β^s denote vector of the estimated coefficients; $i = 1, \dots, n$ is the number of relevant variables.

Based on equations (6) and (7), we further derived two concepts of misalignment computed as the percentage deviation of the actual values of REER from equilibrium REERs (based on the *BEER* and *PEER* concepts). To be more precise, the REER misalignment indices (based on PEER and BEER approaches) are computed as follows:

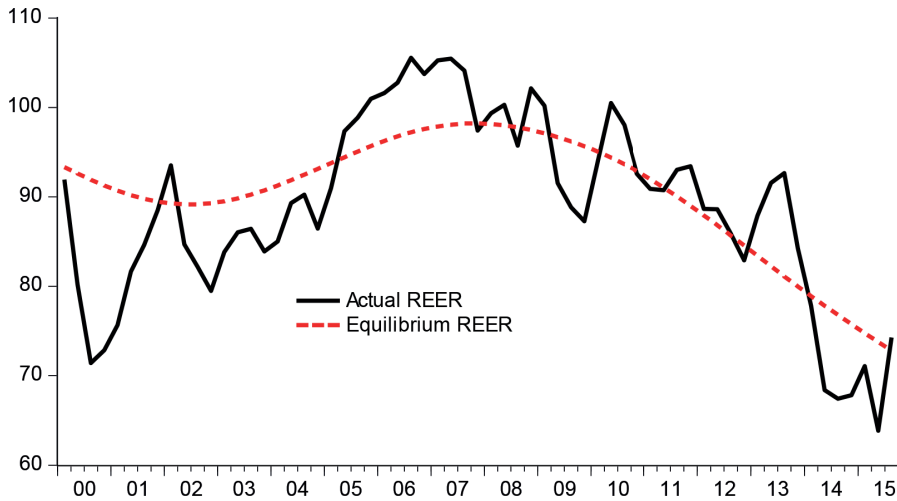
$$MISALIGN_{PEER} = \frac{(AREER - PEER)}{PEER} * 100, \quad (8)$$

$$MISALIGN_{BEER} = \frac{(AREER - BEER)}{BEER} * 100, \quad (9)$$

where AREER is the actual REER, $MISALIGN_{PEER}$ denotes RER misalignment index based on PEER approach, and $MISALIGN_{BEER}$ represents RER misalignment index based on BEER approach. We however focus the analysis of misalignments on the *PEER* because this equilibrium concept hinges on sustainable or permanent values of the fundamentals.

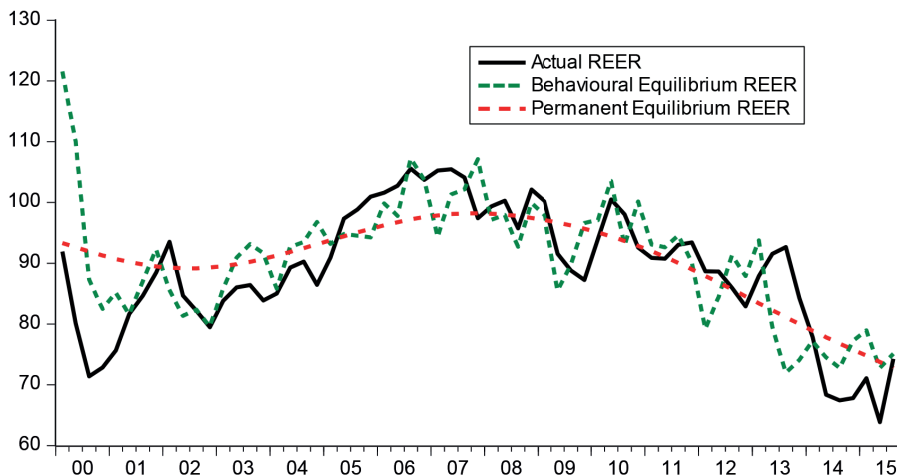
Figure 2 shows the evolution of actual REER (*AREER*) and permanent equilibrium REER (PEER) for the 18 trading partners, while Figure 3 provides developments of AREER, the estimated BEER and PEER for the BROAD_REER over the sample period.

FIGURE 2: ACTUAL AND PERMANENT EQUILIBRIUM REER FOR THE BROAD INDEX



Source: Authors

FIGURE 3: ACTUAL AND EQUILIBRIUM REER FOR THE BROAD INDEX



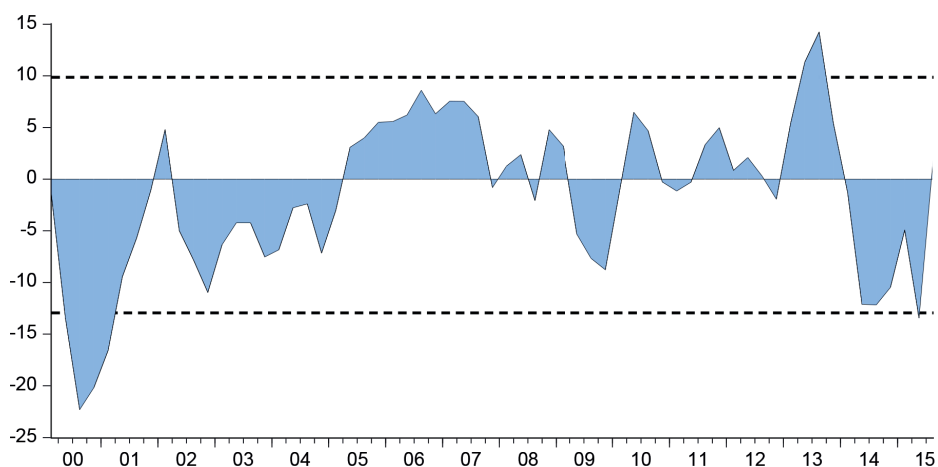
Source: Authors

Figure 3 vividly demonstrates the PEER to be less volatile (smoothed) than the BEER, suggesting that the volatility of the Ghanaian Cedi is largely driven by fluctuations in the transitory (temporal) components.

Accordingly, we estimate the extent of REER misalignment based on PEER approach for the Broad index. Figure 4 displays the quarterly misalignment, while Figure 5 illustrates the total (annual) misalignment of the Broad REER index.

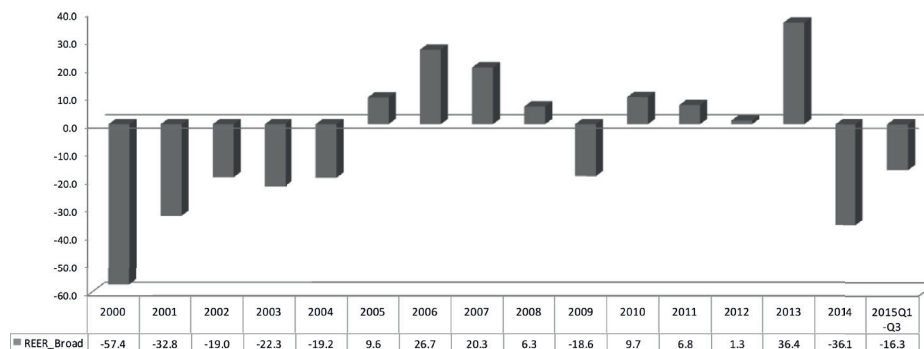
The result also shows strong evidence of REER misalignment on either side (i.e. overvaluation or undervaluation) throughout the sample period. We note that the evolution of the REER in Ghana is clearly consistent with major shifts in policy regimes over the sample period and confirms the robustness of our estimates. On the whole, we identified REER undervaluation for the period 2000-2004, 2009 and first half of 2015. On the contrary, overvaluation was observed during the period 2005-2008, 2010-2013 and the third quarter of 2015. In addition, the actual REER was almost at its equilibrium level in 2012, recording a slight overvaluation of 1.3% (see Figure 5).

FIGURE 4: MISALIGNMENT OF BROAD REER INDEX



Source: Authors

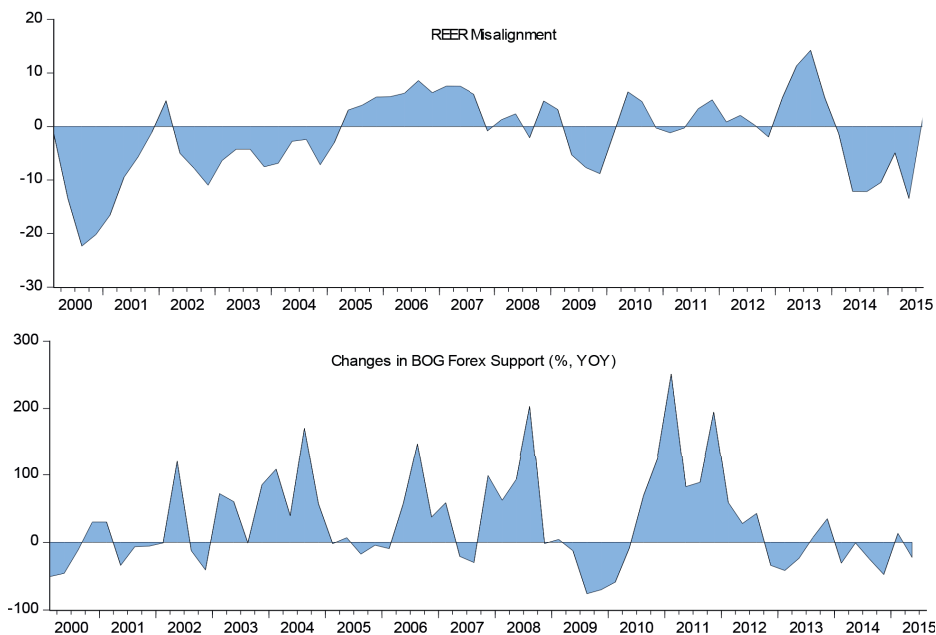
FIGURE 5: ANNUAL REER MISALIGNMENT FOR BROAD REER INDEX (%)



Source: Authors

Our results generally corroborate with the findings of Kwakye (2012). Moreover, the REER misalignment appears to track the developments of foreign exchange support for oil and non-oil imports by the central bank (see Figure 6 below).

FIGURE 6: EVOLUTION OF REER MISALIGNMENT AND BOG FOREIGN EXCHANGE SUPPORT



Source: Authors

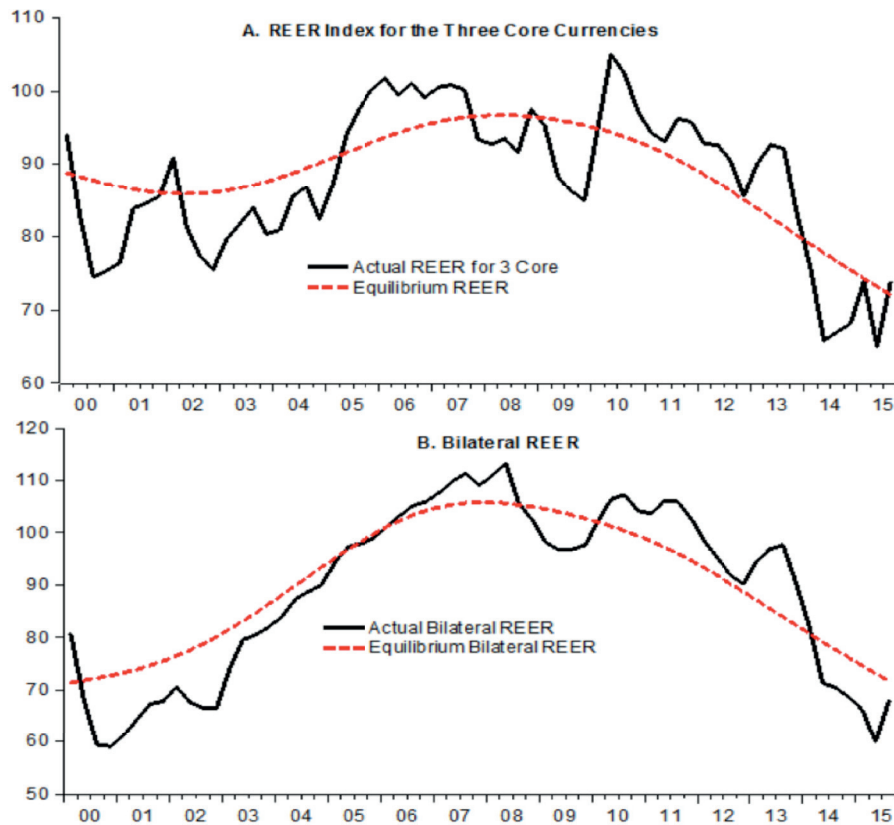
The empirical results reveal a quite substantial undervaluation in 2000, falling below the critical lower bound at 95 percent confidence level. This was occasioned by a significant depreciation of the domestic currency, attributed to the uncertainty that surrounded the third general election and the resultant fiscal excesses. On the other hand, REER overvaluation was extremely excessive during 2013, outstripping the critical upper bound at 95 percent confidence level. This is, among others, the result of post-election fiscal and monetary tightening as well as increased foreign exchange support by the central bank (see Figure 6). Our analysis also uncovered that the election cycles in Ghana, especially during the last quarter of 2000, 2008 and 2012, were associated with considerable REER undervaluation. This is largely attributable to the usual excessive nominal exchange rate depreciation during the period.

Another important phenomenon uncovered is the considerable REER appreciation over the period 2005-07, which peaked at 8.6% in 2006Q3. This largely reflects the significant inflows from multilateral donors (which strengthened the central bank's ability to increase its foreign exchange intervention or support) as well as strong economic performance during the year. However, the substantial REER undervaluation in 2009 could also be linked with the portfolio reversals triggered by the global financial crisis which notably hampered the extent of foreign exchange support by the central bank (see Figure 6), alongside significant drop in economic growth during the year. The REER overvaluation over the period 2010-13 could also be linked to the huge capital inflows towards the nascent oil and gas industry in 2010-11.

REER was over-corrected during the first half of 2014 following the excessive overvaluation in 2013, largely induced by a huge nominal depreciation which was perhaps triggered by a considerable decline in BOG support (see Figure 6). The situation reversed with some observed real appreciation during the second half of 2014, following a decision by the government to seek IMF support in August 2014 which revived investor confidence in the economy. The gains appeared to be ephemeral as the REER subsequently undercut its equilibrium level during the first half of 2015 (slightly below the critical lower bound at 95 percent confidence level), mainly on account of a sharp nominal depreciation.

Thereafter, the REER has recovered substantially during the third quarter of 2015, slightly above its equilibrium level by about 2 percent. Although this is corroborated by the three core index in Figure 7, the bilateral REER index in Figure 7 seems to suggest that the currency is still undervalued at about 5 percent in 2015Q3 (compared with an undervaluation of 18 percent in 2015Q2). The strong recovery of the REER during 2015Q3 was largely on the back of strong fiscal and monetary policy tightening as well as the expectation of huge inflows from the floatation of Eurobond, cocoa syndicated loan and other donor funds during the second half of 2015.

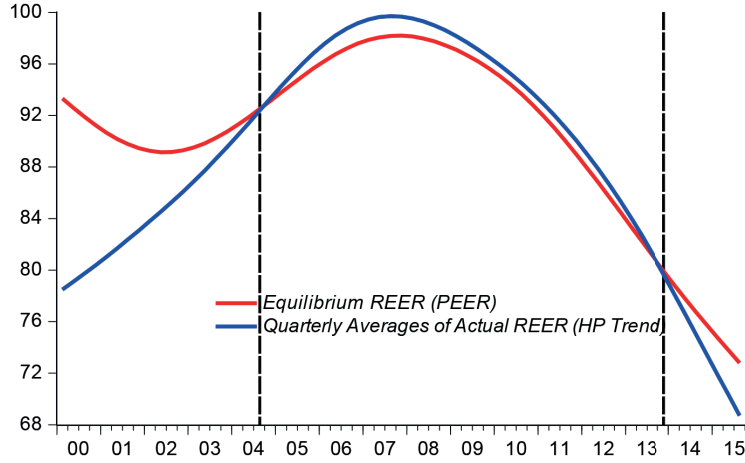
FIGURE 7: ACTUAL AND PERMANENT EQUILIBRIUM REER FOR THE THREE CORE AND BILATERAL INDICES



Source: Authors

Another critical observation is that the fitted PEER seems to be adequately tracked by the permanent components of the quarterly averages of actual REER since 2004Q3 (see Figure 8). This implies that policy makers could easily and roughly gauge the equilibrium REER by using the quarterly averages of the permanent components of actual REER for quick policy decision.

FIGURE 8: EVOLUTION OF PEER (BROAD) AND QUARTERLY AVERAGES OF ACTUAL REER



Source: Authors

4.2. Macroeconomic implications of REER misalignment

In this section, we investigate the effect of REER misalignment on economic growth and inflation in Ghana. Essentially, we estimate economic growth model using equation 10 that focuses on the growth effect of both internal and external balances in addition to inflation dynamics and REER misalignment in Ghana.

$$lrgdp_t = \beta_0 + \beta_1 fiscg_t + \beta_2 lcpi_t + \beta_3 tbal_t + \beta_4 MISALIGN_t + \varepsilon_t, \quad (10)$$

where $lrgdp_t$ is log of real GDP; $fiscg_t$ is fiscal balance scaled by GDP; $lcpi_t$ is log of consumer price index; $tbal_t$ is trade balance (i.e. export minus import) scaled by GDP; and β_i are the long run coefficients to be estimated; with the expectation that $\beta_1 > 0$; $\beta_2 < 0$; $\beta_3 > 0$; $\beta_4 < 0$; while ε_t is the error term. We establish a long run relationship between the variables using a residual-based Engle-Granger (1981) Two-Step Cointegrating Method (EGTSM). The use of EGTSM was motivated by Johansen's (1995) assertion that both stationary variables and trend-stationary variables are allowed in a co-integration equation, provided that there are at least two non-stationary variables that are integrated of the same order.

In the case of REER misalignment effect on inflation, the following equations are estimated:

$$lcpi_t = \alpha_0 + \alpha_1 fiscg_t + \alpha_2 lrgdp_t + \alpha_3 lnpsc_t + \alpha_4 MISALIGN_t + \mu_t, \quad (11)$$

$$lcpi_t = \alpha_0 + \alpha_1 fiscg_t + \alpha_2 lrgdp_t + \alpha_3 lnpsc_t + \gamma_1 RUV_t + \gamma_2 ROV_t + \mu_t, \quad (12)$$

Where *lnpsc* denotes domestic nominal private sector credit, *RUV* represent periods of real undervaluation; *ROV* denotes period of real over-valuation; with expectation that $\alpha_1 > 0$, $\alpha_2 > 0$, $\alpha_3 > 0$; $\gamma_1 > 0$, $\gamma_2 < 0$; while μ_t is the disturbance term. That is, the paper splits the RER misalignment series into periods of overvaluation (positive values) and under-valuation (negative values).

As the method stipulates, we first estimated equation (10) at levels and obtain the residual (error) terms. A unit root test is then performed on the residual terms to examine the order of integration. If the residuals are stationary, then a long run relationship exists between the variables (see, Asteriou and Hall, 2007). After that, a second regression is estimated in first difference which also includes the lagged values of the generated error terms (in levels). In this case, for cointegration to exist between the variables, the coefficient of the lagged value of the error term, which also measures the speed of adjustment to equilibrium, should be negative, less than one and statistically significant.

However, since macroeconomic data interact among themselves, the OLS estimator tends to suffer from endogeneity bias. For robustness, we therefore employed other approaches proposed in the literature on econometric theory that do not only correct for endogeneity bias but also accommodate for nuisance parameters and serial correlation in data. These include the fully modified OLS estimators (FMOLS)¹⁴, dynamic OLS estimators (DOLS)¹⁵ and Canonical cointegrating regression (CCR)¹⁶. In line with the literature, we also ascertain the existence of cointegrating in the DOLS, FMOL and CCR approaches using both residual-based Engel-Granger and Philip-Ouliaris tests, and Hansen's parameter Instability test¹⁷. Table 9 presents the estimates for economic growth for the sample period 2000Q1 to 2015Q3.

¹⁴ Phillips and Hansen's (1990) FMOLS estimator employs a semi-parametric correction to eliminate the problems caused by the long run correlation between the cointegrating equation and stochastic regressors' innovations. The resulting FMOLS estimator is asymptotically unbiased and has fully efficient mixture normal asymptotics allowing for standard Wald tests using asymptotic Chi-square statistical inference.

¹⁵ Kao and Chiang's (2000) DOLS method involves augmenting the cointegrating regression with lags and leads of changes in the explanatory variables, so that the resulting cointegrating equation error term is orthogonal to the entire history of the stochastic regressor innovations.

¹⁶ Park's (1992) CCR is closely related to FMOLS, but instead employs stationary transformations of the data to obtain least squares estimates that remove the long run dependence between the cointegrating equation and stochastic regressors' innovations. Like FMOLS, CCR estimates follow a mixture normal distribution which is free of non-scalar nuisance parameters and permits asymptotic Chi-square testing.

¹⁷ The Engle-Granger and Phillips-Ouliaris tests for cointegration are simply unit root tests applied to the residuals obtained from a single OLS estimation of Equations 10, 11 and 12. They both

TABLE 9: EFFECT OF REER MISALIGNMENT ON GDP GROWTH IN GHANA

	EGTSM	FMOLS	CCR	DOLS
	Coeff[T-Value]	Coeff[T-Value]	Coeff[T-Value]	Coeff[T-Value]
Prices	0.23[14.13]*	0.23[14.52]*	0.22[11.94]*	0.22[3.36]*
Fiscal balance	-0.01[-2.40]**	-0.02[-3.52]*	-0.03[-3.30]*	-0.03[-1.76]
Trade balance	-0.01[-2.37]**	-0.01[-1.85]***	-0.004[-1.18]	-0.001[-0.08]
REER misalignment	-0.002[-1.78]***	-0.002[-1.83]***	-0.001[-1.66]	-0.003[-0.99]
Intercept	2.71[35.81]*	2.72[37.68]*	2.74[31.37]*	2.75[8.79]*
Short Run				
Ch. in prices	-0.65[-3.94]*			
Ch. in fiscal balance	-0.006[-1.63]			
Ch. in trade balance	-0.004[-1.82]***			
Ch. in REER misalignment	-0.003[-2.77]*			
Intercept	-0.032[-4.14]*			
ECM _{t-1}	-0.60[-5.15]*			
Model Diagnostics				
R-squared	0.89	0.88	0.87	0.99
Sum squared resid.	0.14	0.15	0.15	0.01
Prob(F-statistic)	{0.000}*	na	na	na
Durbin-Watson stat	1.62	1.74	1.83	2.14
Unit Root Test on residuals	{0.010}**	{0.010}**	{0.000}*	{0.000}*
Normality Test	{0.287}	{0.318}	{0.371}	{0.912}
Heteroscedasticity test	{0.781}	na	na	na
Hansen Parameter Instability Test	na	>{5.27}	>{0.20}	>{0.20}
Engle-Granger Cointegrating Test	na	{0.09}***	{0.09}***	{0.09}***
Phillips-Ouliaris Cointegrating Test	na	{0.000}*	{0.000}*	{0.000}*
Included observations	63	62	62	54

Notes: [] denotes t-value; {} represents p-value and *, ** & *** denote 1%, 5% & 10% significant levels respectively; An increase in REER Misalignment implies overvaluation, while a decrease means undervaluation.

¹⁷ cont. have a null hypothesis that the series are not cointegrated, all linear combinations of, including the residuals from OLS, are unit root non-stationary, against the alternative of cointegration. The two tests differ in the method of accounting for serial correlation in the residual series; the Engle-Granger test uses a parametric, augmented Dickey-Fuller (ADF) approach, while the Phillips-Ouliaris test uses the non-parametric Phillips-Perron (PP) methodology.

As shown in Table 9, our estimates generally satisfy all diagnostic tests and also suggest an existence of a long run cointegration relationship between real GDP growth and REER misalignment (overvaluation), prices, fiscal and trade balances (scaled by GDP). Notably, empirical results reveal a negative long run impact of REER overvaluation on real GDP growth in Ghana. We also identify a short run negative effect of REER overvaluation on real GDP growth, based on the EG2TM estimation. This suggests that REER overvaluation has adversely affected economic growth in Ghana over the sample period. This is consistent with the findings of Ghura *et al* (1993) for a panel of 33 SSA countries, Klau (1997) for CFA zone, and Fosu (2000) for developing African countries. By inference, the study establishes a positive undervaluation-growth nexus in the case of Ghana although the link is less robust (significant at 10% alpha level). In term of magnitude, a 10 percent increase (decrease) in REER overvaluation (undervaluation) leads to a decrease (an increase) in real GDP growth by 0.02 percent per quarter, over the long run in Ghana.

In terms of REER disequilibrium effects on domestic CPI inflation, Table 10 presents the estimates for CPI inflation equation for the sample period.

The empirical results generally pinpoint that REER misalignment exacerbates inflationary pressures in the long run. Further analysis specifically illustrates that REER undervaluation heightens domestic inflationary pressures and this is statistically significant across the various estimation techniques. On the contrary, we observe a weak dampening effect of REER overvaluation on inflation, as the impact from the former was statistically insignificant across the estimation methods. It is essentially to mention that the observed general inflationary effect of REER misalignment is not surprising as REER undervaluation has remained prevalent over the sample period. We further examine whether policymakers can deliberately exploit REER misalignment (especially undervaluation) to boost macroeconomic performance in Ghana, applying an impulse response function (IRF) from a 3-variable VAR framework including REER misalignment, real GDP growth and inflation. In this regard, we ascertain how inflation responds to one standard deviation shocks to either side of REER misalignment (i.e. overvaluation or undervaluation). Based on our definition of REER, a one

¹⁷cont. On the other hand, Hansen's (1992) parameter Instability test has a null hypothesis of cointegration against the alternative of no cointegration. According to the test, the alternative hypothesis of no cointegration suggests evidence of parameter instability. It uses test statistic, L, which arises from the theory of Lagrange Multiplier tests for parameter instability, to evaluate the stability of the parameters.

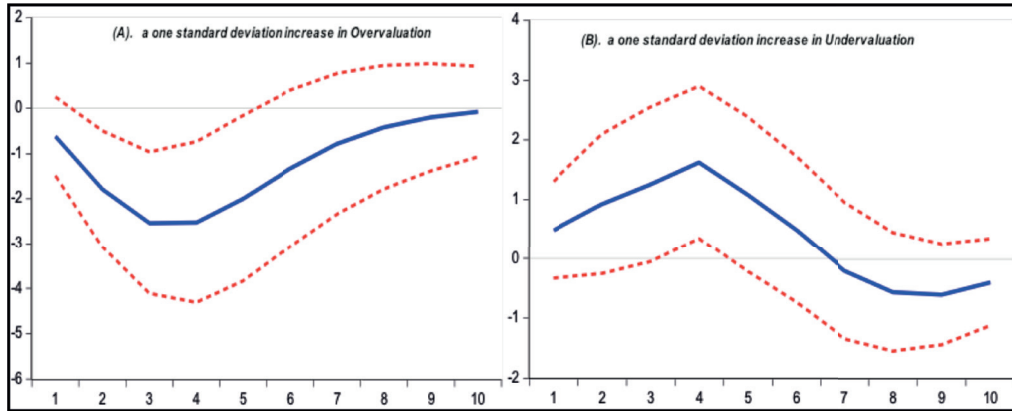
standard deviation shock to REER misalignment connotes an increase in overvaluation. To assess whether the effect is symmetric, we inverted the REER misalignment index by multiplying by negative one, so that an increase in REER would imply an undervaluation. Figure 9 presents the IRFs for inflation to innovations in REER misalignment in Ghana over the sample period.

TABLE 10: LONG RUN EFFECT OF REER MISALIGNMENT ON CPI INFLATION

Regressors	FMOLS		CCR		DOLS	
	Coeff [T-Value]	Coeff [T-Value]	Coeff [T-Value]	Coeff [T-Value]	Coeff [T-Value]	Coeff [T-Value]
Intercept	1.56[1.52]	1.47[1.46]	1.10[0.82]	1.03[0.76]	-1.65[-1.04]	-1.80[-1.10]
Log real GDP _t	0.09[0.26]	0.13[0.37]	0.24[0.54]	0.27[0.60]	1.21[2.22]**	1.26[2.26]**
Log private sector credit _t	1.04[12.39]*	1.03[12.38]*	1.02[9.61]*	1.01[9.50]*	0.81[6.57]*	0.79[6.25]*
Fiscal deficit _t (% of GDP)	0.05[3.13]*	0.05[3.00]*	0.07[3.08]*	0.06[2.97]*	0.10[5.06]*	0.09[4.70]*
REER misalignment_t	0.005[2.23]**		0.005[2.15]**		0.004[1.75]***	
REER undervaluation_t	0.01[2.24]**		0.01[2.07]**		0.01[1.72]***	
REER overvaluation_t	-0.000[-0.00]		-0.0002[-0.03]		-0.001[-0.16]	
Model Diagnostics						
R-squared	0.98	0.98	0.98	0.98	0.99	0.99
Sum squared resid	0.45	0.43	0.51	0.49	0.12	0.11
Normality Test	{0.883}	{0.820}	{0.742}	{0.703}	{0.413}	{0.652}
Unit Root Test on residuals	{0.000}*	{0.000}*	{0.000}*	{0.000}*	{0.001}*	{0.002}*
Hansen Parameter Instability Test	>{0.200}	>{0.200}	>{0.200}	>{0.200}	>{0.200}	>{0.200}
Engel-Granger Cointegrating Test	{0.496}	{0.574}	{0.496}	{0.574}	{0.496}	{0.574}
Phillips-Ouliaris Cointegrating Test	{0.054}***	{0.062}***	{0.054}***	{0.062}***	{0.054}***	{0.062}***
Included observations	62	62	62	62	60	60

Notes: [] denotes t-value; {} represents p-value and *, ** & *** denote 1%, 5% & 10% significant levels respectively;

FIGURE 9: RESPONSE OF INFLATION TO IMPULSES IN REER MISALIGNMENT



Notes: Numbers at the horizontal axis denote quarters

Source: Authors' own construct

The results from the IRFs suggest that a one standard deviation shock to overvaluation dampens inflationary pressures in Ghana (see LHS of Figure 9). The disinflationary pressures tend to bottom up during the 3rd quarter (and this is statistically significant at 5% alpha level), but eased gradually afterwards. On the contrary, a one standard deviation shock to undervaluation tends to exacerbate inflationary pressures in Ghana for the short run (see RHS of Figure 9). Inflationary pressures peaked during the 4th quarters (and is statistically significant at 5% alpha level) in response to excessive undervaluation and decline subsequently. In terms of magnitude of effects, our results however suggest a stronger disinflationary effect of excessive overvaluation than inflationary impact of excessive undervaluation in Ghana for the short run.

In synthesis, the study establishes a weak positive undervaluation-economic growth nexus for Ghana. The empirical results also show that excessive undervaluation generates inflationary pressures, making a deliberate use of REER undervaluation as a policy tool for sustain economic growth untenable in the case of Ghana. This is because such policy would undermine the price stability objective of Bank of Ghana.

5. Conclusion and policy suggestions

We investigate the degree and evolution of real exchange rate misalignment and then assess its macroeconomic implications in Ghana using quarterly data over the period 2000Q1-2015Q3. This papers employed three trade-weighted real effective exchange rates (REERs) estimated by staff of Bank of Ghana,

based on the respective country's share of the total foreign trade for the period 2006-2012. These include (1) REER index for 18 trading partners; (2) REER index for the three core currencies (including the US dollar, the British pound Sterling and the euro); and (3) REER index for bilateral exchange rate between Ghana and the US dollar. We establish the long run relationship between the respective trade-weighted REER and the macroeconomic fundamentals using ARDL approach. In particular, we also ascertain the relative importance of the fundamentals using standardized estimation technique. The equilibrium REER was estimated using both behaviour (BEER) and permanent (PEER) equilibrium exchange rate, following McDonald (1997) and Clark and McDonald (1998).

The paper further assesses the macroeconomic impact of REER misalignment in Ghana in order to evaluate whether undervaluation could be used as a deliberate industrial policy instrument for sustained economic growth and stability in Ghana. In this case, we employ several cointegration estimation techniques for growth and inflation analyses. Specifically, we examine asymmetric effects of REER misalignment on inflation using both cointegration estimation techniques and impulse response function from a multivariate VAR framework. In other words, the study particularly investigates separate effects of overvaluation and undervaluation on domestic inflation in order to proffer cogent policy recommendation regarding the deliberate use of exchange rate policy for concurrent realization of economic growth and price stability. Our empirical findings are summarized as follows:

We observed that the fundamentals such as growth differentials, BOG net claims on government and risk premium have negative impact on REER (depreciation) in both short and long run. On the contrary, rising net foreign assets, increasing degree of openness and favourable terms of trade strengthen the REER (appreciation) in both short and long run. BOG foreign exchange support has positive effect on REER in the short run, while its long run impact was negative (bilateral). The recent BOG foreign exchange measure was found to have negatively impacted on the REER.

In addition, the empirical results from the standardized regression revealed that risk premium has a predominant influence on REER developments, underscoring the impact of the persistent fiscal overruns on REER. This is followed sequentially by openness to trade, BOG net claims on government, net foreign assets, terms of trade, growth differentials and BOG foreign exchange support.

Another cogent observation is that the PEER is less volatile (smoothed) than the BEER, suggesting that the volatility of the Ghanaian Cedi is largely driven by fluctuations in the transitory (temporal) components. There is also a clear evidence of misalignment of the actual REER from its equilibrium level throughout the same period. In particular, the domestic currency was generally found to be undervalued in real terms during the period 2000-2004, 2009, 2014 and the first half of 2015. The undervaluation was quite substantial in 2000, 2014 and the first half of 2015, as the magnitude was either close or below the lower critical bound at 95 percent confidence level. This may be attributable to considerable nominal exchange rate depreciation and a reduction in BOG foreign exchange support. On the other hand, we observed overvaluation for the periods 2005-2008, 2010-2013 and the third quarter of 2015. But the overvaluation appears quite excessive in 2013, as it exceeded the upper critical bound at 95 percent confidence. We noted that the direction and degree of misalignment largely reflected policy decisions and importantly the extent of foreign exchange market intervention/support by the central bank.

Regarding macroeconomic implication, REER overvaluation was found to exert a debilitating effect on economic growth in Ghana, both in the short run and long run, which is consistent with the findings of Yotopoulos and Sawada (2005) for 153 cross country dataset; Raji (2012) for WAMZ member countries; and Ndhlela (2012) for Zimbabwe. Our results thus reinforce the view that an overvaluation tends to dampen economic growth in Ghana over the long term. Symmetrically, the result also indicates a positive undervaluation-economic growth nexus in the case of Ghana. In synthesis, we establish a weak positive undervaluation-economic growth nexus for Ghana.

On the other hand, excessive overvaluation appears to exert disinflationary pressures and this is statistically significant in the short run but generally insignificant in the long term. In contrast, excessive undervaluation generates inflationary pressures in Ghana and this is statistically significant in both the short run and long run. In terms of magnitude, however, we observed a stronger disinflationary effect of excessive overvaluation than inflationary impact of excessive undervaluation in Ghana in the short run.

By implication, our results suggest that a deliberate use of REER undervaluation as an industrial policy instrument for sustained economic growth via trade competitiveness may be counterproductive in the case of Ghana. This is because any significant undervaluation may undermine the price stability objective of the central bank of Ghana due to the readily pass through of exchange

rate depreciation to prices. This may also apply to economies with similar characteristics to Ghana, particularly with large components of foreign goods in their consumption baskets. Consequently, we emphasize that market-driven policies should be directed at exerting significant control over the identified key fundamentals relating to debt accumulation, monetary accommodation and in the long term, promote diversification of the economy in order to achieve stability in the exchange rate.

Biographical Notes

Nana Kwame Akosah is a PhD (Economics) candidate at the Wits Business School of the University of the Witwatersrand, Johannesburg, South Africa. He holds a Master of Science degree in Economic and Financial Forecasting (Merits) from London Metropolitan University, UK and a BA (Hons) in Economics and Geography (with Distinction) from the Kwame Nkrumah University of Science and Technology. He concurrently works as an Economist at the Research Department of Bank of Ghana (BOG), a position he has held since October 2010. At the Bank, he is responsible for the development and maintenance of the Bank's Macroeconomic Modelling and Forecasting Framework in support of monetary policy process. Nana is also a member of Inter-Agency Modelling Team (IMAT), under the auspices of the Office of the Vice-President of the Republic of Ghana. He is a member of the editorial board of the Ghanaian Journal of Economics and has also reviewed a number of articles for peer reviewed journals, including, but not limited to *Applied Economic Letters*, *African Review of Economics and Finance* (AREF) Journal, and *Macroeconomics and Finance in Emerging Market Economies*. In terms of research, Nana has published widely in prominent peer reviewed journals, notably, the *Applied Economic Letters*, *Journal of Economic Studies*, *Macroeconomics and Finance in Emerging Market Economies*, the *West African Economic Review*, among others. His research interests are focused on macroeconomics and monetary policy in emerging and developing economies.

Providence Boateng Mireku holds an MPhil in Monetary Economics and Finance (Joint Class Prize) from the University of Glasgow, Scotland, UK and a B.A (Hons) Economics from the University of Science and Technology, Kumasi, Ghana. He held a position of an economist at the Bank of Ghana since October, 2006. He worked in the erstwhile Monetary Policy Analysis and Financial Stability (MPAFSD) and currently works within the Balance of Payments Unit at the Research Department of Bank of Ghana. His professional interest covers the fields of Macroeconomics and Monetary Policy.

Emmanuel Owusu-Afriyie is currently a PhD Candidate at the University of Ghana, reading PhD in Development Economics. He is an Economist at Bank of Ghana, a position he has held since August 2002. He was one of the pioneer staff to provide technical support for the Monetary Policy Committee of the Central Bank during its meetings which commenced in September 2002. His professional interest has spanned fiscal policy analysis, financial stability issues and real sector analysis including conducting surveys on private sector business confidences, consumer confidence and payments sector.

Acknowledgements

The authors are extremely thankful to the two anonymous referees of AREF who benevolently proffered comments and suggestions that helped improve the quality of this paper. The opinions expressed herein reflect those of the authors and do not represent those of the Central Bank. The authors are responsible for any errors in the paper.

References

- Alberola, E. S., Cervero, S., Lopez, H., Ubide, A., (1999). Global equilibrium exchange rates: euro, dollar, “ins”, “outs” and other major currencies in a panel cointegration framework. *IMF Working Paper*, No. 99/175.
- Aliyu, S.U.R., (2007). Real exchange rate misalignment: an application of behavioural equilibrium exchange rate (BEER) to Nigeria. Available at: http://mpra.ub.uni-muenchen.de/10376/1/MPRA_paper_10376.pdf [Accessed 24 August 2012].
- Amoah, L., (2017). Exchange rate behaviour and macroeconomic performance in Ghana. A Doctoral dissertation, Faculty of Economic and Management Sciences at the University of Stellenbosch.
- Amoah, L., Aziakpono, M. J., (2017). Exchange rate behaviour in Ghana: is there a Misalignment? *The Journal of Developing Areas*, 51(4), 261-276.
- Asfaha, S.G., Huda, S.N., (2002). Exchange rate misalignment and international trade competitiveness: a cointegration analysis for South Africa. A paper presented at the TIPS Annual Forum. Glenburn Lodge, Muldersdrift.
- Asteriou, D., Hall, S. G., (2007). ‘Applied econometrics: a modern approach. Revised edition, Palgrave MacMillan, pp. 306-331.

- Baffes, J., Elbadawi, I., O'Connell, S. A., (1999). Single equation of the equilibrium real exchange rate', in L. Hinkle - P. Montiel (eds.), *estimating equilibrium exchange rates in developing countries*. Washington D.C.: The World Bank.
- Baharumshah, A. Z., Ariff. M., (1997). Purchasing power parity in South East Asian Countries: a cointegration approach. *Asian Economic Journal*, 11, pp. 141-154.
- Bahmani-Oskooee, M., (1993). Purchasing power parity based on effective exchange rate and cointegration: 25 LDCs experience with its absolute formulation. *World Development*, 21, pp. 1023-1031.
- Balassa, B., (1964). The purchasing power parity doctrine: a reappraisal. *Journal of Political Economy*, 72, pp. 584-596.
- Bayoumi, T., Clark, P., Symansky, S., Taylor, M. (1994). The robustness of equilibrium exchange rate calculations of alternative assumptions and methodologies. In John Williamson (ed.), *Estimating equilibrium exchange rates*. Institute for International Economics, Washington D.C., pp. 19-60.
- Beveridge, S., Nelson, C., (1981). A new approach to decomposition of economic time series into permanent and transitory components with particular attention to measurement of the business cycle. *Journal of Monetary Economics*, 7(2), pp. 151-174.
- Boamah, M. I., (2013). Exchange rate pass-through in countries of the proposed West African Monetary Zone (WAMZ). *Review of Economics and Finance*, 3, 74-82.
- Brissimis, S. N., Sideris, D. A., Voumvaki, F. K., (2005). Testing long run purchasing power parity under exchange rate targeting. *Journal of International Money and Finance*, 24, pp. 959-981.
- Chinn, M. D., (2000). The usual suspects: productivity and demand shocks and Asian-Pacific exchange rates. *Review of International Economics*, 8(1), pp. 20-43.
- Choudhry, T., (2005). Asian currency crisis and the generalized PPP: evidence from the Far East. *Asian Economic Journal*, 19(2), pp. 137-157.
- Clark, P. B., MacDonald, R., (1999). 'Exchange rates and economic fundamentals: a methodological comparison of BEERs and FEERs. IMF Working Paper 98/67 (Washington: International Monetary Fund).

- Clark, P. B., MacDonald, R., (2000). Filtering the BEER a permanent and transitory decomposition. *IMF Working Paper* 00/144.
- Cline, W. R., Williamson, J., (2007). Estimates of the equilibrium exchange rate of the renminbi: Is there a consensus, and, if not, why not?' *Peterson Institute for International Economics*.
- Clarida, R. H., Gali, J., (1994). Sources of real exchange rate fluctuations: how important are nominal shocks? *Carnegie-Rochester Conference Series on Public Policy* 41, pp. 1-56.
- Clostermann, J., Schnatz, B., (2000). The determinants of the euro-dollar exchange rate: synthetic fundamentals and a non-existing currency. *Deutsche Bundesbank Discussion Paper* no. 2/00.
- Daboh, L., (2010). Real exchange rate misalignment in the West African Monetary Zone. *Journal of Monetary and Economic Integration*, Vol. 10, No. 2.
- De Broek, M., Slok, T., (2006). Interpreting real exchange rate movements in transition countries. *Journal of International Economics* (1): 368- 383.
- Devarajan, R., (1997). Real exchange rate misalignment in the CFA Zone. *Journal of African Economies*, Vol. 6, No. 1, pp. 35-53.
- Driver, R. L. Westaway, P. F., (2004): 'Concepts of equilibrium exchange rate. *Bank of England Working Paper* No. 248.
- Dufrenot, G., Yehoue, E., (2005). Real exchange rate misalignment: a panel co-integration and common factor analysis. *IMF Working Paper* 05/164 (Washington: International Monetary Fund).
- Edwards, S., (1988). Exchange rate misalignment in developing countries. *The World Bank Occasional Paper* Number 2, New Series. Washington, D.C.
- Edwards, S. (1989). Real exchange rates, devaluation and adjustment: exchange rate policy in developing countries. Cambridge, Massachusetts: MIT Press.
- Edwards, S., (1994). Real and monetary determinants of real exchange rate behaviour: theory and evidence from developing countries. In J. Williamson (eds.). *Estimating Equilibrium Exchange Rates*. Washington, D.C.: IIE. (Chapter 4).
- Egert, B., (2004). Assessing equilibrium exchange rates in CEE Acceding Countries: Can we have DEER with BEER without FEER? A critical survey of the literature', *BOFIT Discussion Paper*, No.1, Bank of Finland, Helsinki.

- Egert, B., Halpern, L., MacDonald, R., (2006). Equilibrium exchange rates in Transition Economies: taking stock of the issues. *Journal of Economic Surveys*, Vol. 20, No. 2, pp. 257-268.
- Eita, J. H., Sichei, M. M., (2006). Estimating the equilibrium real exchange rate for Namibia. *Department of Economics Working Paper* (2006-08). University of Pretoria: South Africa.
- Elbadawi, I., (1994). Estimating long run real exchange rates. In estimating equilibrium exchange rates. Edited by J. Williamson (Washington: Institute for International Economics).
- Elbadawi, I. A., Soto, R., (1997). Real exchange rate and macroeconomic adjustment in Sub-Saharan Africa and other Developing Countries', in Elbadawi, I. and R. Soto, (eds.), foreign exchange market and exchange rate policies in Sub-Saharan Africa. *Journal of African Economies*, Supplement to 6.3: 74-120.
- Fosu, A. K., (2000). The international dimension of African economic growth. Center for International Development, Working Papers, Harvard University.
- Gonzalo, J., Granger, C.W.J., (1995). Estimation of common long-memory components in co-integrated systems. *Journal of Business and Economic Statistics*, Vol. 13, pp. 27-36.
- Goo, S.W., (2006). Inflation and exchange rate policy: The experience of Indonesia, South Korea and Thailand. Mimeo, School of Economics, University of Adelaide.
- Ghura, D., Grennes, T. J., (1993). The real exchange rate and macroeconomic performance in Sub-Saharan Africa. *Journal of Development Economics*, 42, pp. 155-74.
- Hansen, B. E., (1992). Tests for parameter instability in regressions with I(1) processes. *Journal of Business and Economic Statistics*, Vol. 10, No. 3, pp 321-335.
- Hansen, J., Roeger, W., (2000). Estimation of real equilibrium exchange rates. European Commission, Economic Papers no. 144.
- Hausman, R., L. Pritchett, Rodrik, D., (2005). Growth accelerations. *Journal of Economic Growth*, 10(4), pp. 303-329.
- Hinkle, L. E., Montiel, P. J., (1999). Exchange rate misalignment. World Bank, New York: Oxford University Press.

- Imi, A., (2006). Exchange rate misalignment: An application of the behavioural equilibrium exchange rate (BEER) to Botswana. *IMF Working Paper* WP/06/140, Washington, D.C.
- Iossifov, P., Loukoianova, E., (2007). Estimation of a behavioural equilibrium exchange rate model for Ghana. *IMF Working Paper*, WP/07/155.
- Isard, P., Faruquee, H., (1998). Exchange rate assessment - extensions of the macroeconomic balance approach. *IMF Occasional Paper* No. 167 (Washington: International Monetary Fund).
- Jordaan, A. C., Eita, J. H., (2012). Real exchange rate misalignment and economic performance in an emerging economy: Evidence from South Africa. DAAD Partnership Workshop in Mauritius.
- Kao, C., Chiang, M. H., (2000). On the estimation and inference of a cointegrated regression in panel data. *Advances in Econometrics*, Vol. 15, pp. 179–222.
- Klau, M., (1998). Exchange rate regimes and inflation and output in Sub-Saharan countries. Bank for International Settlements Working Papers, No. 53.
- Kwakye, J. K., (2012). Determination of real exchange rate misalignment for Ghana. *Institute of Economic Affairs Monograph*, No. 31.
- MacDonald, R., (1997). What determines real exchange rates? The long and short of it. *IMF Working Papers*, WP/97/121, January, Washington DC.
- MacDonald, R., (2000). Concepts to calculate equilibrium exchange rates: An overview. Discussion Paper 3/00, Economic Research Group of the Deutsche Bundesbank.
- MacDonald, R., Ricci, L., (2003). Estimation of the equilibrium real exchange rate for South Africa. *IMF Working Paper* WP/03/44 (Washington DC).
- MacDonald, R., Dias, P., (2007). Behavioural equilibrium exchange rate estimates and implied exchange rate adjustments for ten countries. Prepared for the workshop on Global Imbalances at Peterson Institute of International Economics, Washington DC.
- Maeso-fernandez, F., Osbat, C., Schnatz, B., (2001). Determinants of the euro real effective exchange rate: A BEER/PEER approach. *European Central Bank Working Paper* no. 85.
- Mathisen, J., (2003). Estimation of the equilibrium real exchange rate for Malawi. *IMF Working Paper*, WP/03/104.

- Meese, R. A., and Rogoff, K., (1983). Empirical exchange rate models of the seventies: do they fit out of sample? *Journal of International Economics*, 14, pp. 3-24.
- McNown, R. and Wallace, M., (1989). National price level, purchasing power parity, and cointegration: a test of four high inflation economies. *Journal of International Money and Finance*, 8, pp. 533-545.
- Mollick, A.V., (1999). The real exchange rate in Brazil: mean reversion or random walk in the long run? *International Review of Economics and Finance*, 8, pp. 115-126.
- Montiel, P., (1997). Exchange rate policy and macroeconomic management in ASEAN countries. In J. Hicklin et al. (eds.). *Macroeconomic Issues Facing ASEAN Countries*. Washington, D.C.: IMF.
- Montiel, P., (1999). Determinants of the Long run Equilibrium Real Exchange Rate: An Analytical Model. In Hinkle L. and Montiel P. (eds), *Exchange Rate Misalignment: Concepts and Measurement for Developing Countries*, Oxford University Press, pp. 264-292.
- Moosa, I. A., and Bhatti, R. H., (1996). Does purchasing power Parity hold between Japan and other Asian Countries. *Journal of International Economic Studies*, 10, 85-94.
- Ndhlela, T., (2012). Implications of real exchange rate misalignment in developing countries: theory, empirical evidence and application to growth performance in Zimbabwe. *South African Journal of Economics*, 80(3), 319-344.
- Obstfeld, M., Rogoff, K., (1995). Exchange rate dynamics redux. *Journal of Political Economy*, Vol. 103, pp. 624-60.
- Opoku-Afari, M., Morissey, O., Lloyd, T. (2004). Real exchange rate response to capital inflows: A dynamic analysis for Ghana. *CREDIT Research Paper* No. 04/12.
- Osbat, C., Ruffer, R., Schnatz, B., (2003). The rise of the yen vis-à-vis the (“synthetic”) euro: is it supported by economic fundamentals? *European Central Bank Working Paper* no. 224.
- Park, J. Y., (1992). Canonical cointegration regression. *Econometrica*, Vol. 60, No. 1, pp. 119-143.
- PFeffman, G. (1985). Overvalued exchange rates and development. *Finance and Development* (March) 17-19.

- Phillips, P. C. B., Hansen, B. E., (1990). Statistical inference in instrumental variables regression with 1(I) processes. *Review of Economic Studies*, Vol. 57, pp. 99-125.
- Razin, O., S. M. Collins, (1999). Real exchange rate misalignments and growth. In Assaf Razin and Efraim Sadka (eds.), *The Economics of Globalization: Policy perspectives from public economics*. Cambridge, New York and Melbourne: University Press, pp. 59-81.
- Sackey, H.A., (2001). External aid inflows and the real exchange rate in Ghana. *African Economic Research Consortium RP110*. Nairobi: AERC.
- Sarantis, N., Stewart C., (1993). Seasonality, cointegration and the long run purchasing power parity: evidence for sterling exchange rates. *Journal of Applied Economics*, 25, pp. 243-250.
- Schnatz, B., Vjjselaar, F., Osbat, C., (2003). Productivity and the (“synthetic”) euro-dollar exchange rate. *European Central Bank Working Paper*, No: 225.
- Stock, J.H., Watson, M. W., (1998). Testing for common trends. *Journal of the American Statistical Association*, Vol. 83, pp. 1097-1107.
- Taylor, M. P., (1988). An empirical examination of long run purchasing power parity using cointegration techniques. *Journal of Applied Economics*, 20(10), pp. 1369-1381.
- Williamson, J. (1994). ‘Estimates of FEERS’. In: J. Williamson ed. *Estimating Equilibrium Exchange Rates* (Washington: Institute for International Economics).
- Williamson, J., (1985). The exchange rate system. *Institute for International Economics*, Washington.
- Wren-Lewis, S., (1992). On the analytical foundations of the fundamental equilibrium exchange rate. In Hargreaves, C P (ed), *Macroeconomic modelling of the long run*, Edward Elgar.
- Yotopoulos, P. A., Sawada, Y., (2005). Exchange rate misalignment: a new test of long-run PPP based on cross-country data. Centre for Advanced Research in Finance, Faculty of Economics, University of Tokyo.
- Youngblood, C. E. (1993). ‘Determinants of the real exchange rate in Ghana: implications for export promotion. *The Journal of Management Studies*. University of Ghana, Legon.

Akosah, Mireku and Owusu-Afriyie: REER misalignment and macroeconomic implications

Youngblood, C. E., (2004). Equilibrium real exchange rate framework. Trade and Investment Reform Program, Improved Policy Reform and Financial Intermediation, USAID Contract No. 641-C-00-98-00229, Sigma One Corporation.

Youngblood, C. E., Apaloo, L. K., (2006). Estimating Ghana's real effective exchangerate 1965-2004. Available at: <http://www.docstoc.com/docs/6107241/Estimating-Ghana's-equilibrium-real-exchange-rate-1965-2004>.