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REAL EXCHANGE RATE MISALIGNMENT AND ECONOMIC PERFORMANCE IN SUB-SAHARAN AFRICA: A DYNAMIC PANEL DATA APPROACH

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LIST OF ACRONYMS

ARER	Actual Real exchange Rate
BEER	Behavioral Equilibrium Exchange Rate
BOP	Balance of Payments
BS	Balassa Samuel effect
CA	Current Account
CEE	Central and Eastern European Countries
CPI	Consumer Price Index
DOLS	Dynamic Ordinary Least Square
ERER	Equilibrium Real Exchange Rate
FDI	Foreign Direct Investment
FEER	Fundamental Equilibrium Exchange Rate
FM-OLS	Fully-Modified Ordinary Least Square
GDP	Gross Domestic Product
GMM	Generalized Method of Moments
IEB	Internal External Balance
IMF	International Monetary Fund
LDCs	Least Developing Countries
NAIRU	Non-accelerating Inflation Rate of Unemployment
NATREX	Natural Rate of Exchange
PPP	Purchasing Power Parity
REER	Real Effective Exchange Rate
RER	Real Exchange Rate
SSA	sub-Saharan Africa
SUR	Seemingly Unrelated Regression Econometric Model
WDI	World Development Indicator
WPI	Whole Sale Price Index

Abstract

The objective of this study is to investigate the impact of real exchange rate misalignment on the long-run growth of 29 sub-Saharan African countries using a panel data from 1980 to 2007. We first estimate the effects of macroeconomic fundamentals on the real exchange rate of SSA using the more efficient Dynamic panel OLS cointegration estimation technique of Kao and Chiang *(2000), from which misalignment indicators are derived. We have found terms of trade and capital flow have positive significant impact on ERER. We have also estimated four different kinds of economic growth regression models using the two step system GMM estimator which is proved to be helpful in resolving econometric problems of endogeneity, heteroskedasticity, autocorrelation and omitted variable biases. The results for the two-step System GMM panel growth models signify that real exchange rate misalignment, its variability and higher undervaluation have strong negative effect on the economic growth of SSA. In contrast, smaller undervaluation is found to have a significant positive effect on economic growth. Consequently, SSA governments' policies should be directed on achieving a moderately depreciated exchange rate.*

Chapter One

Introduction

1.1 Background of the study

It is widely recognized that exchange rate policy has become among the central macroeconomic policy issues in the academic and policy circles. Consequently, it is critically essential to clearly comprehend and understand each exchange rate concepts and their interaction with other macroeconomic variables such as economic growth.

There are a variety of alternative and often contradictory definitions of real exchange rate (RER). The earliest definition of RER is the purchasing power parity (PPP) principle of RER. According to this traditional definition, RER is nominal exchange rate (E) multiplied by the ratio of foreign and domestic price level (P*/P) (Kubota M., (2009); Tamsir Cham, (2010) and others). However, the most common definition of RER in the literature is given by the relative price of tradable to the price of nontradable goods (Ghura and Greenes (1993); Elbadawi etal (2008); Ildiko M. (2008); Shah Hussain (2008)). Although this doctrine has a firm theoretical foundation, it lacks a clear empirical counterpart. A number of empirical studies applied its operational definition which is given by nominal exchange rate (E) multiplied by the ratio of foreign price level of tradable (P_T^*) and domestic price level of nontradables (P_N). Where P_T^* and P_N are proxied by whole sell price index (WPI) of US and consumer price index (CPI) of the home country.

Real exchange rate (RER)[1] is noted as good proxy for a country's competitiveness in international markets. It is also recognized as an important element in macroeconomic

[1] The RER is generally defined in this thesis as the inverse of the operational definition of the relative price of traded goods to non traded goods. Note that in our definition of RER (which is given by P_N/ EP_T^*), an increase (decrease) denotes a real appreciation (depreciation) of the local currency (see chapter 2 for more detail).

management. Because of its importance, the RER has, therefore, been accorded a prominent role in the adjustment programmes supported by International Monetary Fund (IMF). Mungule K. O (2004), has also argued that the RER not only affects general economic performance and international competitiveness, but also different sectors of the economy, foreign trade flows, balance of payments, external debt crisis, employment, structure of production, consumption and allocation of resources in the economy. The stability of RER, for that reason, helps to stabilize all these interrelated sectors.

Equilibrium real exchange rate (ERER), an other crucial exchange rate concept, has been defined by Edwards (1989) as "*the relative price of tradable goods to the price of nontradable that, for a given long-run equilibrium values of other relevant variables such as trade taxes, international prices, capital and aid flows and technology, results in simultaneous attainment of equilibrium in the external and internal sectors of the economy*". As to Edward, internal equilibrium is attained when the nontradable sector clears and external equilibrium is attained when the current account balance is in equilibrium. The variables which play a larger role in the determination of internal and external balance are called fundamental determinants of RER.

The actual real exchange rate may depart from its equilibrium level. This phenomenon, which is the main focus of the study, is called exchange rate misalignment. An exchange rate is labeled undervalued[2] when it is more depreciated than this ideal, and overvalued when it is more appreciated persistently than this ideal. Such misalignments are widely believed to influence economic behavior. In particular, Overvaluation is expected to hinder economic growth while

[2] The definition of undervaluation and overvaluation plays a key role in the discussion of exchange rate misalignment and economic performance. In our definition, if misalignment and economic growth are negatively related then the more overvalued (appreciated) the currency then the smaller the economic growth is and the converse also holds true.

undervaluation is sometimes thought to provide an environment conducive to growth (Razin & Collins S. 1997; Kubota M, 2009; Elbadawi etal, 2008) though it may also harm the performance of the economy by causing inflationary pressures (Siregar R. and Rajan R., 2006). Edwards (1988 and 1989) has classified exchange rate misalignment in two to broad categories. The first one is macroeconomic induced misalignment that occurs when there is an inconsistency between macroeconomic policies and the official nominal exchange rate system. The second type of misalignment is known as structural misalignment. It takes place when changes in the fundamental determinants of the equilibrium RER are not translated in the short-run into actual changes of the RER.

1.2 Statement of the problem

A comprehensive examination of economic performance due to fluctuations in the traditional growth determinants such as accumulation of capital, structural and institutional rigidities, labour productivity, research and development, and technological progress is discovered to be insufficient. There are also a number of factors that have been widely confirmed to influence economic growth. As long a go Agarwala (1983) and recently Eichengreen B., (2007) have shown, exchange rate misalignment is by far the single most important distortion affecting economic growth and societal welfare, particularly in developing countries.

An excellent theoretical explanation of the adverse effects of prolonged exchange rate misalignment on growth is illustrated by Razin and Collins (1997). In their influential study, they have asserted misalignments of RER can influence economic growth at least through two transmission mechanisms. Initially, misalignment could influence domestic and foreign investment. This can substantially hamper the capital accumulation process which is recognized to be a vital engine of growth. Secondly, RER disequilibrium could affect the tradable sector and the competitiveness of this sector with the rest of the world. From modern growth literatures the performance of the tradable sector is generally presupposed to be a key component of economic growth. Consequently, exchange rate misalignment could have a significant deleterious effect on growth.

Among the empirical studies dealing with the misalignment growth nexus (such as Berg and Miao (2010); Rodrik (2008); Elbadawi etal (2008); Edwards (1988); Vieira F., MacDonald R. (2010) and others), a great majority of them find a negative correlation between exchange rate misalignments and growth for a broad geographical samples of developed and developing countries that have included some African countries. They alleged the more overvalued the currency, the smaller the per capita growth rate. A fairly unique contemporary empirical work developed by Aguirre and Calderón (2006) has also suggested that the effect of RER misalignment on growth is non-linear, which means that when real exchange rate depreciation is too high the impact on growth is negative but when it is small or moderate it can be growth enhancing.

Although chronic RER misalignment has been acknowledged as a major source of disappointing growth in developing countries (Edwards (1988, 1989); Ghura and Grennes, (1993)), there is limited empirical evidence on its importance in SSA. To the best of our knowledge, the only study made using data exclusively on SSA is that of Ghura and Greenes (1993). This study has obtained a negative link between SSA growth and the misalignment of currencies. The authors concluded that inappropriate domestic macroeconomic and trade policies which lead to RER misalignment appear to be important factors that contributed to the economic distress in SSA.

Most of the literature on RER misalignments has focused on the harmful effects of a real overvaluation of the currency (Elbadawi etal 2008; Gilles J. and Etienne B. Yehoue, 2005; Aguirre and Calderon, 2005; Razin and Collins, 1999). This strand of the literature argues that RER overvaluation of the currency has an adverse impact on economic performance. Unstable and overvalued RERs provided weak incentives to exports and thus growth. Sustained real overvaluation reflects unsustainable macroeconomic conditions making economies vulnerable to speculative attack and currency crisis (Juthathip J., 2009; Aguirre and Calderon, 2005).

In contrary, a bulk of the literature argues that undervaluation facilitates growth among developing countries through increased competitive advantage and stresses the role of export enhancing industrial policy in the process of economic advancement (like china and East Asian tigers). Hence, RER undervaluation may trigger growth (Hausmann, Pritchett and Rodrik, 2005; Rodrik, 2008). Theoretically, Rodrik (2008) argues that RER undervaluation acts as a second-best mechanism to alleviate distortions of various institutional weaknesses in developing countries and, hence, foster structural change and stimulate growth. However, persistent real undervaluation could also lead to economic overheating, higher import prices (thereby dampen investment and growth) and misallocate resources between tradable and nontradable sectors due to expected currency appreciation[3] as argued by Jongwanich J. (2009).

The other key research area where there is wider controversy is the measurement of exchange rate misalignment. The measurement of the exchange rate misalignment for appropriate policy intervention is an important issue. However, the literature in this area has not reached a clear consensus. This is because measuring the degree of misalignment is difficult, as it involves

[3] Undervaluation (persistent depreciation) without a change in the fundamentals of ERER could result in higher inflation rate. This higher inflation results in higher prices for nontradables. Our RER expressed as the ratio of the prices of nontradables to tradables will rise which signifies an appreciation of the currency.

measuring an unobserved variable, the equilibrium RER. For many years, policymakers have been relying on misalignment measures based on the so-called PPP doctrine. It consists of the choice of a base period in which the economy is thought to have been in equilibrium, and then the RER for this year is assumed to be the equilibrium for the rest of the sample period (Dufrenot G.J. and Yehoue E., 2005). This approach is obviously criticized because the ERER is not a static indicator and moves over time as the economy's fundamentals move.

After the failure of the PPP approach, theories of ERER estimation based on economic fundamentals have been emerged at the end of 1980s. However, majority of these investigations are constrained by using short time series data for developing countries, absence of panel data econometrics methodologies for cross country analysis (which have attractive results) and they mainly focused on estimating RER misalignment at single country level. Recently, econometric theorists have developed new methods that help to apply some time series techniques to panel data. However, this very recent literature has not included other fundamental shocks such as government shocks that generate significant long run impact on ERER. The consequence is that most of these estimations run the risk of not being robust, and leading to non reliable measures of misalignment.

This paper will contribute to the literature by tackling these critical weaknesses. In particular, this study updates the works of Grennes and Ghura in the following dimensions. Firstly, the study will employ exclusive richer data on sub-Saharan African countries where empirical study on this area is very meager. Secondly, we shall adopt the reduced form single equation RER determination model which have been developed for developing countries by Edwards (1989) and latter extended by the works of Elbadawi (1994), Edward (1994), and Elbadawi and Soto (1997).

We will determine ERER using panel unit root and the more recent panel cointegration techniques. Government spending is supposed to be included in the ERER equation along with terms of trade, openness, net foreign asset and technology which have been the only fundamentals in most of the previous cross country studies. Thirdly, long-run RER misalignment indicator will be estimated based up on the above result and the appropriate filter. Fourthly, we will apply dynamic panel growth model to estimate the likely effect of currency misalignment and its variability on growth. Finally, we will investigate the presence of non-linear relationship between economic growth and undervaluation.

1.3 Objectives of the study

The general objective of this study is to explore the dynamic effects of exchange rate misaligned on the economic performance of SSA. Specifically the aim of this study is three fold:

- To investigate the long-run impacts of internal and external fundamentals on RER using panel unit root and cointegration techniques. Then to construct an exchange rate misalignment indicator.
- To assess the relationship between economic performance and RER misalignment as well as its volatility using dynamic panel data approach.
- To scrutinize the presence of any non-linearity between undervaluation of real exchange rate and economic performance.

1.4 Research Questions

On the whole, the objective of this study is to furnish robust answers and inferences for the subsequent research questions:

- What are the major determinants of equilibrium real exchange rate in Sub-Saharan Africa? Is there a protracted real exchange rate misalignment?
- What are the responses of economic growth to fluctuations in RER misalignment of the sub-region?
- Do smaller and higher undervaluations of exchange rate have a different impact on economic growth?

1.5 Significance of the Study

Depressed economic development is the acute economic problem for sub-Saharan African countries. Having a clear picture on the fundamental factors influencing economic growth and economic development is the central agenda to devise appropriate policies and strategies. Majority of developing countries, in particular sub-Saharan Africa, are using a managed floating exchange rate system. Substantial institutional failures coupled with more or less a rigid exchange rate policy will result severe exchange rate misalignment. Therefore, by understanding the nature and impact of RER misalignment on the economic performance, the study contributes a lot to the literature. It can also complement country level studies and serve policy makers and academicians to understand the causes and consequences of RER misalignment so that it could be possible to implement the required prudent adjustments for sub-Saharan African countries.

1.6 Limitations of the study

This investigation tries to comprehend the link between exchange rate misalignment and economic growth in sub-Saharan Africa where other similar studies are very scanty in the area. Regardless of its great contribution to the literature and relevant policy making process, the study will have the following three limitations. Firstly the study focuses only on the direct effect of RER misalignment on economic growth. But economic growth can be indirectly affected by RER misalignment through lower investment, lower productivity, scanty FDI and lower export volume which are deemed to be the key sources of growth. Secondly, data for the study will be extracted from various data base sources. It will be a big challenge to get all the variables under a single source. Thirdly, it will be very cumbersome to calculate the real effective exchange rate index for all the sample countries. Further more, it is not an easy task to distinguish the main trading partners, which is a focal issue to compute real effective exchange rate for each country in the sample. Accordingly, we will compute real exchange rate index to determine equilibrium RER and RER misalignment variables. Despite the fact that the study will be constrained by these three limitations, our results are extremely indispensable in various dimensions.

1.7 Organization of the paper

The rest of the study will be structured in the following manner. First an extensive overview of the theoretical and empirical literature on equilibrium RER and RER misalignment will be made in the next section. The theoretical framework, the econometric models and the sources and nature of the data will be sequentially provided in chapter three. Under chapter four, the statistical and econometric results as well as their interpretations will be reported and discussed in detail. The last chapter will present the conclusion and recommendations of the study.

Chapter Two

Review of the Literature

2.1 Survey of the theoretical literature

2.1.1 Basic Concepts and Definitions of Exchange Rate

Before we start reviewing about the various theoretical models of equilibrium exchange rate, it is useful to clarify the basic definitions of the exchange rate concepts. Nominal exchange rate (E) is simply the price of one currency in terms of another. Since two currencies are involved in the concept of nominal exchange rate, there are two different ways of giving the quotation of it (Gandolfo G., 2002, Keith P., 2006):

- The Price quotation system (American system): In this method nominal exchange rate is defined as domestic currency units per unit of foreign currency.
- The Volume quotation system (English system): Under this method nominal exchange rate is defined as the number of units of foreign currency per unit of domestic currency. It is obviously the reciprocal of the pervious one.

Even though it is not important which method of expressing the exchange rate is employed, it is necessary to be careful when pondering about the rise and fall of the exchange rate because the meaning will be very different depending up on which definition is applied[4].

2.1.1.1 Defining Real Exchange Rate (RER)

Real magnitudes are derived from the corresponding nominal magnitudes by eliminating the changes solely due to price changes, which can be done in a variety of ways. But this issue is

[4] In this study we shall adopt the price quotation system which is the most commonly employed technique in the empirical literature (Keith P. 2006). In this case, an appreciation of nominal exchange rate is a decrease and depreciation is an increase in the amount of nominal exchange rate.

more complicated in the case of real exchange rate. There is no wider consensus in the literature about which relative price of goods should be called RER. Among the several explanations that have been given in the literature (Edwards 1988, 1989, Balasa 1964, Ghura and Grennes 1993, among others) a few of the most commonly known are discussed below.

According to Edwards (1988), the earliest definition of RER is the PPP approach. The PPP approach points out that the real exchange rate is equal to nominal exchange rate (E) multiplied by the ratio of foreign price level (P*) to the domestic price level (P). This version of the RER is relative price of foreign to domestic consumption or production baskets.

However, recently different authors have defined the RER in terms of the two dependent economies: tradable and nontradable sectors[5]. The oldest notion of RER in this category, which has a firm theoretical foundation (Edwards 1988), is defined as the relative price of tradable with respect to nontradable goods: $\mathrm{RER} = \frac{\textit{Price of tradable goods}}{\textit{price of nontradable goods}} = \frac{\mathrm{P_T}}{\mathrm{P_N}}$. Where, $\mathrm{P_T}$ and $\mathrm{P_N}$ are the domestic price indexes of tradable and nontradable[6] respectively.

Although the definition of RER given above is analytically useful, it lacks a clear empirical counterpart. In other words, it is difficult to calculate in real life situations (Edwards 1988, 1989 and Ghura and Grennes 1993). A more operational definition of the real exchange rate is given by: $\mathrm{RER} = \frac{EP_T^*}{\mathrm{P_N}}$. Where E is the official nominal exchange rate measured as the amount of

[5] Tradable goods are those goods that have export or import potential and whose price is determined in the international market. However, nontradable commodities are goods or services that can not be transacted among countries because of their intangibility nature and higher transportation cost. Hence the price of non-tradables is determined by the demand for and supply of domestic economic agents.

[6] The share of non-tradable sector has been found to be significant among the transition and developing economies (see Siregar R. and Rajan R., 2006)

domestic currency per unit of foreign currency, and P^*_T is the foreign currency price of tradable. In measuring RER in the above equation, quite a lot of economists have used the U.S. wholesale price index (WPI_{US}) as proxy for P_T^* and the domestic Consumer price index (CPI) as the proxy for P_N. Following this convention, an increase in the bilateral RER represents a real depreciation of the currency.

In this study, we will employ the reciprocal of the operational definition ($i.e. \text{RER} = \frac{P_N}{EP_T^*}$) , which is extensively used by majority of the empirical investigations (Aguirrea A., Calderón C. (2006), Edwards, (1989), Nouira R. and Sekkat K., 2010, Ildiko M. (2008) and others) and an increase in RER represents appreciation and a decrease represents a depreciation of the real exchange rate of the currency.

2.1.1.2 Defining Real Effective Exchange Rate (REER)

Most countries of the world do not conduct all their trade with a single foreign country. So policy makers are not concerned with what is happening to their exchange rate against a single foreign currency but against a weighted basket of foreign currencies with which the country trades. The effective exchange rate is a measure of whether or not the currency is appreciating or depreciating against a weighted basket of foreign currencies. As remarked in Gandolfo G., 2002, and McCown T., Pollard P., and Weeks J., (2007) the REER index is a key relative price, which measures the overall competitiveness of domestic goods on world markets.

2.1.1.3 Defining Equilibrium Real Exchange Rate (ERER)

The equilibrium real exchange rate (ERER) is one of the most important concepts in open economy macroeconomics. Since exchange rate misalignment refers to the sustained departure of actual RER from its equilibrium real exchange rate (ERER), an understanding of the theory of ERER is a fundamental step in any attempt to understand exchange rate misalignment.

Some theories highlight exchange rates are determined in foreign exchange markets by the demand and supply for currencies, where the real exchange rate should always be at its equilibrium value. This is clearly related to the market equilibrium exchange rate illustrated by Williamson (1985), which defined equilibrium condition as a situation that equates supply of and demand for a currency in the absence of government intervention. However, the time frame is an important point to consider when discussing equilibrium. Driver, R. and Wren-Lewis, S. (1998) discuss three different types of equilibrium concepts, namely, long-run, medium and short-term equilibrium. The model that will be used in our study relates closely to the long-run equilibrium concepts, especially regards movements toward such equilibrium rate.

To calculate the extent of misalignment from equilibrium level, we must include a proxy measure of an unobserved latent variable - that is, the ERER. Following Edwards (1989) and Nurks (1945) as sited by Elbadawi etal (2008), we can also define the ERER, for a given sustainable values of fundamental variables, results in the simultaneous attainment of both internal and external equilibrium. From the definition, the ERER is not an unchallengeable value. If there is any change in the fundamental determinants of ERER, it tends to affect the country's external and internal balance, and ERER changes. Further more, the ERER will be affected not only by its fundamentals but also by the expected future evolution of these variables (Ibid).

2.1.2 Theoretical Models of Equilibrium Real Exchange Rate Determination

There is voluminous literature about the determination of the equilibrium real exchange rate. Hinkle and Montiel (1997), Siregar R. and Rajan R., (2006), Elbadawi and Soto (2008), MacDonald R., (2000), Edwards, and Savastano M. A., (1999), Jong E. (1996), McCown T etal (2007) presents a succinct overview of exchange rate determination theories, the most popular of which are reviewed below.

Generally, the empirical models of ERER determination can be classified into two categories: the first set of studies are based on the Purchasing Power Parity (PPP), and the second set of studies endeavored to estimate the equilibrium RER by using econometric models based on economic fundamentals. The latter set of models, developed at the end of the 1980s and at the beginning of 1990s, includes Behavioral Equilibrium Exchange Rate (BEER) model, the reduced-form Equilibrium Real Exchange rate (ERER) model, the fundamental equilibrium exchange rate (FEER) model, and Natural Real Exchange Rate model.

The goal of some models, such as FEER and Reduced form single equation models, is to estimate an exchange rate in which the simultaneous satisfaction of internal and external balances are associated with the economic fundamental variables. Recognizing the limitations of the PPP, a great deal of attention is given on those fundamental exchange rate determinants models. Among those models, the reduced-form ERER model, as illustrated below, is believed to be the most appropriate method in assessing the equilibrium real exchange rate for developing countries. Thus, this method is used in this research.

2.1.2.1 Purchasing Power Parity (PPP) Approach

The Purchasing Power Parity (PPP) theory is perhaps the earliest and one of the most traditional exchange rate theories about equilibrium exchange rate determination. According to Pilbeam (2006), the PPP theory is generally attributed to Gustav Cassell’s writing in the 1918, though its intellectual origin date back to the writings of 19th century British economist David Recardo.

However, majority of the scholars have confirmed that Cassel was the first to name the PPP theory. The basic concept underlying the PPP theory is that arbitrage forces will lead to the equalization of goods prices internationally once the prices of goods are measured in the same currency. The proponents of the theory contend, without PPP there would be no meaningful way of discussing overvaluation or undervaluation of exchange rates.

The PPP theory can be classified in to absolute and relative PPP versions. Basically, the absolute PPP follows the '*law of one price*'[7]. If the PPP holds in the long run then exchange rates will be adjusted to ensure the equal relative purchasing power of currencies. Mathematically, the equation of absolute PPP can be expressed as $E = \frac{P}{p^*}$, where E is the nominal exchange rate or spot rate as defined before, and P and P* denote the general price level in the home and foreign country, respectively. The specification of absolute PPP theory for the purposes of empirical estimation has nearly always involved some variant of the following equation: $E_{it} = P_{it} - P_{it}^*$ where all variables are in logarithms.

The relative PPP is the most commonly used version of PPP theory. According to the relative version of the PPP theory the percentage change of the exchange rate equals the difference in inflation rates between the two countries over time (Jong de E., 1996). The relative PPP theory refers to rates of the exchange rate of a currency will be equal to the difference in inflation rates between the home and foreign country. Hence, the relative PPP can be mathematically expressed as $\%\Delta E_t = \%\Delta P - \%\Delta P^*$, where $\%\Delta P$ is home country's inflation rate and $\%\Delta P^*$ is the foreign country's inflation rate; $\%\Delta E_t$ denotes the percentage change in exchange rate at time t.

[7] The law of one price simply says that in the presence of a competitive market structure and in the absence of transportation costs and other barriers of trade, identical products which are sold in different markets will sell at the same price when expressed in terms of a common currency.

However, there are a number of reasons in which the PPP doctrine might be a wrong and misleading indicator for ERER, especially in developing countries. Firstly the equilibrium exchange rate is not a static indicator but rather moves over time as the economy's macroeconomic fundamentals do (Villavicencio A. L., 2007, Edwards 1989, and Cottani, J.A., Cavallo, D.F., Khan, M.S., 1990). Secondly, the law of one price does not hold if there is market failure which is a pervasive phenomenon in developing countries. The third shortcoming of using this measure is that PPP only accounts for monetary sources of exchange rate fluctuations and does not capture exchange rate fluctuations attributed to real factors (Aguirre A. and Calderon C., 2005). A number of studies have also clarified that the PPP doctrine of modeling ERER does not work because of productivity differential in tradable and nontradable goods (Balassa B., 1964), imperfect information, different preferences of consumers around the world and excessive government intervention in the economy (McCown etal, 2007). Edwards and Savastano M., (1999), after an extensive review of the literature, have concluded that the PPP theory is particularly weaker for LDCs than for industrial countries.

2.1.2.2 The Fundamental Equilibrium Exchange Rate (FEER) Model

Recognizing the limitations of PPP, a great deal of attention has focused on constructing alternative measures of ERER based on some fundamental exchange rate determinants. One of the most widely used measures, largely credited to Williamson (1994)[8], is the concept of fundamental equilibrium exchange rate (FEER). Williamson (1994) defines FEER as a real exchange rate that simultaneously ensures internal and external balances in *medium term* period.

[8]The FEER concept was originally proposed by Williamson (1985), which then enlarged rapidly by the literature (Elbadawi, I. and R. Soto (2008)).

Internal balance in this circumstance is defined as a stage when actual GDP equals to potential GDP[9], so it is consistent with the NAIRU[10]. External balance, on the other hand, is characterized as a sustainable BOP position over a medium-term horizon, ensuring desired net flows of resources provided that internal balance is maintained. A minimum criterion for external balance is that the current account balance be "sustainable" over time (Siregar R. and Rajan R., 2006).

In its simplest form, this model specifies a behavioral equation for the current account (CA) that depends on the real exchange rate, as its most pivotal determinant, along with potential domestic and foreign outputs. By setting the estimated CA equation equal to the negative of an exogenously given level of net capital flows in the medium run, the FEER could be simply derived as a function of "optimum" outputs and "sustainable" capital flows (Elbadawi, I. and R. Soto (2008)). Hence, in contrast to the simple PPP approach, the FEER approach which is a normative issue recognizes that the ERER will fluctuate across time as factors impacting sustainable internal and external balances change.

However, several shortcomings has been raised regarding the adequacy of the FEER approach for understanding the behavior of the RER and, hence, the usefulness of its policy implications. First, the estimation of the medium term equilibrium capital account, a key component of the FEER model, is problematic. As noted by Clark and MacDonald (1998), while the current account model and potential output for the country in question and its main trading partners could be estimated using well established theoretical and empirical procedures, the same cannot be said about the determinants of the optimum Capital Account. Consequently, the literature has relied on normative, and/or judgmental, approaches for calculating this variable. Second, by

[9] It implies zero level of out put gap.
[10] NAIRU: non-accelerating inflation rate of unemployment

focusing on three key fundamental determinants, the FEER model ignores other potentially important medium-term exogenous and policy fundamentals, such as the terms of trade, openness and trade policies, aid and remittance flows. These are argued to be critical for RER analysis in middle and low-income developing countries. Third, a much more important critique of the FEER model is that by being essentially a medium-term flow equilibrium model, it does not account for long-run stock equilibrium considerations. Fourth, a related and equally important problem with the FEER approach is that it does not address the critical issue of the dynamics of adjustment of the RER, including the potential role of exchange rate and monetary policies in influencing the speed of convergence to the equilibrium RER (Elbadawi I. and R. Soto (2008); Siregar R. and Rajan R., 2006; and Edwards and Savastano M., (1999).

2.1.2.3 The Behavioral Equilibrium Exchange Rate (BEER) Model

The Behavioral Equilibrium exchange rate (BEER) approach modifies the FEER approach by focusing on the actual medium term and long term ERER determining fundamentals. This approach is free from any normative elements of theoretical background in contrast to that of the FEER (Ibid)[11]. Hence, this measure is a behavioral statistical approach, linking the real exchange rate and the fundaments in a single equation.

The initial building block of the BEER approach, which has been developed by Clark and MacDonald (1998, 2000), is the uncovered interest parity, where the equilibrium exchange rate in period t is explained by the expectation of the real exchange rate in t+l and the real interest differential with maturity t+k. Clark and MacDonald then assume that the unobservable

[11] According to Siregar R. and Rajan R., (2006), the BEER may converge to the FEER in the medium-run under the condition where economic fundamentals driving the changes in the equilibrium exchange rate are at the full employment and sustainable levels.

expectation of the exchange rate is the long-run equilibrium real exchange rate. Hence, the current equilibrium exchange rate is the sum of two components: the systematic long-run component and the real interest rate differential. Next, the authors relate the long-run equilibrium real exchange rate to fundamentals –say, the Harrod-Balassa-Samuelson effect and the net foreign assets in Clark and MacDonald (2000).

Edwards and Savastano (1999) survey the literature and conclude that in spite of the obvious progress on the adoption of this method in empirical papers, the BEER models are still subject to a number of shortcomings. The most significant limitations pointed out are: absence of explicit intertemporal considerations in empirical applications of these models, lack of an apparent understanding of the effects of capital inflows on real exchange rates[12], and lack of a general equilibrium connection between the equilibrium real exchange rate and the current account position of a particular country. Further more, this approach is rather a statistical one, linking the real exchange rate to a set of macroeconomic variables through a single equation setting in which the choice of the fundamentals is more ad hoc than based on a theory.

In general, as remarked by Mazier J., Aflouk N., Saadaoui J., (2010), the BEER approach can be easily managed to give fruitful results. However, the theoretical basis can be regarded as underdeveloped and the recent improvements have been mainly econometric and statistic.

2.1.2.4 The IMF's ERER Determination Model

One of the basic targets of the IMF's implementation of Internal-External Balance (IEB) approach[13] is to produce a more satisfactory measure of the desired capital account term. One

[12] As explained before, capital inflows are incorporated in the long-run ERER equation in the form of net foreign assets by Clark and MacDonald (2000).
[13] See MacDonald R., 2000 and Isard and Masson (1999) for more discussion on this topic.

important element in this approach is the recognition that the equilibrium current account can be viewed as the difference between desired saving ($\bar{S}$) and desired investment ($\bar{I}$) which in turn is equal to the sustainable capital account. The equilibrium real exchange rate is then calculated as the real effective exchange rate that will generate a current account equal to $\bar{S} = \bar{I}$. More specifically, the IMF works with the following variant of the relationship:

S(def, gap, dep, (y-y)) – I(gap, dep, (y-y*)) = CA(Q, gap, gapf).* Where, *def* is government deficit, *gap* is the difference between actual and potential output, *gapf* is the difference between foreign actual and potential output, *dep* is dependency ratio, *(y-y*)* is the difference between actual and equilibrium out put, and *Q* is the real exchange rate. The IMF's IEB approach defines two different measures of equilibrium RER: medium run current account equilibrium and long run current account equilibrium (MacDonald R., 2000). This approach is less common in the existing empirical literature.

2.1.2.5 The Natural Rate of Exchange (NATREX) Approach

The BEER approach, which is an extension of the FEER, does not capture the nature of the convergence process from the actual rate to its equilibrium level. In response to this, Stein developed the NATREX approach, which is defined as the rate that would prevail if speculative and cyclical factors could be removed while unemployment is at its natural rate (Stein, 1994).

On this basis, the NATREX is similar to the medium-term equilibrium concept embodied in the FEER, which allows for an explanation for the short-run dynamics. Hence, the short-run dynamics differentiate the NATREX from the FEER approach. Accordingly, the principal difference is that the NATREX takes its point of departure from a theoretical dynamic stock-flow model to achieve the level of ERER that depends upon the relative thrift and productivity differences. In short, the NATREX extends the PPP and FEER models by focusing on the periods when fundamentals are not stationary (Ildiko M. 2008).

As emphasized by McCown, Pollard and Weeks (2007), the weakness of the model is that it concentrates on the medium term but only assume arbitrary capital flows. However, a full understanding of a medium-term economy requires consideration of both international financial markets and capital flows. Therefore, the equilibrium international financial market position is needed to assess the ERER in the real economy.

2.1.2.6 The Reduced Form Single Equation ERER model

The reduced form single equation approach of ERER model, first designed by Edwards (1989) for developing countries, derives the ERER from a wide variety of theoretical models and most of these efforts have been based on the contributions of Elbadawi (1994), Edwards (1994), and Elbadawi and Soto (1997). The ERER model has been considered sufficient to depict the characteristics of the transformation process of developing countries and suitable for the measurement of a developing country's equilibrium exchange rate (Kubota M., 2009).

Many authors develop this ERER determination model from theoretical models (like representative agent, intertemporal frameworks, with price flexibility, perfect competition and rational expectations), and from which a reduced form for the equilibrium RER is derived. This reduced form relates the long-run equilibrium real exchange rate to a set of internal and external variables, called the RER fundamentals. These fundamentals usually include the terms of trade, productivity differentials, the country's openness to international trade, import tariffs and government spending. While some authors have tried to use a relatively large number of “fundamentals” in their regression equations, others have restricted their analyses to a small number of variables.

The fundamental variables used to compute ERER are decomposed into their permanent and transitory components, and long-run values (or permanent component) of the fundamentals are used to compute ERER. This permanent component is so-called the permanent equilibrium exchange rate, PEER (MacDonald, 2000). Although researchers have not agreed on the procedure to calculate the permanent component of the fundamentals, a variety of trend-cycle decomposition techniques such as Beveridge and Nelson (1981), the Hodrick-Prescott (HP) filter, the band-pass filter (Baxter and King, 1999) have been used in the literature.

This approach is a rigorously derived methodology from apparent theoretical models. It is particularly whispered to be helpful for developing countries. Based on this, we will conduct our study of modeling the equilibrium exchange rate on this reduced form framework. We will provide the detailed derivation of this model in the next chapter.

2.2 Previous empirical literature

Under this subdivision of the literature, we will present a brief overview of the evidence in the literature on the link between RER misalignments and economic performance. We observe that the literature not only evaluates the relationship between misalignment and growth, but also the link with some sources of growth such as investment, productivity, export growth, and foreign direct investment among others. The empirical literature, provided below, demonstrates the strong interrelationship between growth, and sources of growth with RER misalignment.

The empirical literature on this arena, which is not an extensive one but has recently grown, clarifies the strong adverse effect of exchange rate misalignment on economic growth. Large swings in RERs mean greater uncertainty with respect to relative prices. The results are greater risks, shorter investment horizons, high adjustment costs as production moves back and forth from tradable to nontradable sectors, and financial instability as expectations of exchange rate changes lead to interest rate volatility. Lack of correct alignment in the RER means lower profitability in the industries in which relative prices are reduced (Cottani, etal (1990)). The literature, further, highlights that most of the time misalignment takes the form of domestic currency overvaluation hurting tradable activities. This affects growth performance adversely since productivity improvements tend to be concentrated in export or import competing industries.

The empirical literature has been assessed based on five criteria, as clearly shown in the table below. These criteria are: the performance indicator employed (economic growth, export, investment, saving and import), the equilibrium exchange rate model used (BEER, FEER, PPP, single reduced model and others), the econometric methodology adopted (time series, panel, GMM, and SUR), the number and group of countries sampled and the sign of relationship identified between exchange rate misalignment and economic performance indicator. Regarding the performance indicator used, around thirteen various studies have utilized economic growth as dependent variable; four studies have utilized engines of growth as well as growth as explanatory variables; and the study of Jongwanich J. (2009) have used export as performance indicator.

Table 2.1 A summary of the empirical literature on RER Misalignment and Economic Performance.

Author(s) and year	Performance indicator (Dependent variable (s))	ERER determination model (RER Misalignment model used)	Econometric Estimation methodology adopted	Sample of the study	Effects of misalignment on economic performance identified
Ghura & Grennes (1993)	Economic Growth, Export/GDP, Import/GDP, Investment ratio, Savings/GDP	PPP, BLACK & reduced model based	Panel data, annual pooled OLS and IV	33 SSA countries (1972-1987)	Adverse effect
MacDonald Vieira F., (2010)	Economic growth (Per Capita GDP growth)	PPP and Single equation reduced models	Panel data: Fixed effect & Random effect, cointegration and System GMM	24 Developed, 66 Emerging and LDCs (1980-2004)	Adverse effect
Razin & Collins (1997)	Economic Growth (Average annual growth in GDP per capita)	MODEL based on RER fundamentals	Panel data: Fixed Effects	93 developed and developing countries (1975-1992)	Non-linear
Cottani, Cavalo and Khan (1990)	Economic Growth, Investment, Export, and Agricultural growth	PPP; MODEL based on RER fundamentals	Cross Section OLS	24 Developing Countries (1960-1983)	Adverse effect
Dollar (1992)	Economic Growth	MODEL based on RER fundamentals	Cross Section OLS	95 Developing Countries (1976-1985)	Adverse effect
Elbadaw I., Soto R., and Kaltani L. (2008)	Growth and Export	Reduced form single equation model of ERER	Panel pooled mean group (PMG) estimator and S-GMM	Developed and Developing countries (1970-2004)	Adverse effect
Juthathip Jongwanich (2009)	Export	reduced form model implying Internal and External Balances	General-to-specific modeling (GSM) for cointegration test	8 east and southeast Asian countries (1995–2008)	Adverse effect
Sallenave A., (2010)	GDP per capita growth)	BEER	Dynamic panel data model	G20 countries (1980-2006)	Adverse effect
Rodrik (2008)	Economic growth	PPP eliminating BS effect	GMM-IV	184 countries (1950-2004)	Adverse effect

Aguirre and Calderon (2006)	Economic Growth	Single equation model	GMM	60 developed and developing countries (1965-2003)	Non-linear
Toulaboe D. (2000)	Economic growth	Reduced form single equation model	Panel data: fixed effect	33 developing countries,	Adverse effect
Ildikó M., (2008)	Economic growth	BEER	Panel GMM and Time series	CEE countries (1998_I to 2007_IV)	Adverse effect
Edwards (1989)	Economic growth	Single equation model	Panel; fixed effect IV	12 countries	Adverse effect
Eichengreen (2007)	Economic Growth	FEER	GMM	56 countries	Adverse effect
Prasad, Rajan and Subramanian (2007)	Economic Growth, Investment	PPP	GMM	45 developed and developing countries	Adverse effect
Easterly (2001)	Economic Growth	BLACK market, MODEL based	SUR with decade avg.	70 countries, (1960-1999)	Adverse effect
Nouira R. and Sekkat K., (2010)	Economic Growth	Single equation model	Panel cointegration, OLS & GMM	52 developing countries, (1980-2005)	Non-linear

As stated before almost all of the empirical investigations have come up with the conclusion that RER misalignment has an undesirable impact for the economy of a country. David Dollar, in a his well known paper of 1992, implied that outward oriented developing countries tend to grow more when compared to inward oriented economies. He analyzed 95 developing countries in the period 1976-1985 and, based on an "outward orientation"[14] index constructed, concludes that the more outward oriented the country, the higher its per capita growth rates. Classifying the countries in three groups, Latin America, Africa and Asia, he demonstrates that the latter, that are well known for their successful development strategy, are more outward oriented than African or Latin American countries (Dollar 1992).

[14] According to Dollar (1992), the index derived here measures the extent to which the real exchange rate is distorted away from its free trade level by the trade regime (which is a policy induced misalignment of RER). The more the distortion of the RER, the lesser the outward the country is and the lower the per capita growth level.

Ghura and Grennes (1993), based on pooled time series and cross-section data for 33 Sub-Saharan African countries, found a negative relationship between RER misalignment and indicators of economic performance such as economic growth, export, import and saving. They concluded that inappropriate domestic macroeconomic, trade, and exchange rate policies appear to be one of the important factors that contributed to the economic distress in virtually all Sub-Saharan African countries. Likewise, Cottani etal (1990) and Elbadawi etal (2008) found a strong negative correlation between exchange rate misalignment and different economic performance indicators for a sample of 24 developing and 83 developed and developing countries respectively. More recently, Juthathip J. in 2009 examined the equilibrium real exchange rate and real exchange rate misalignments in developing Asian countries during the period 1995–2008. In the study, the relationship between real exchange rate misalignment and export performance was investigated. The study expressed financial crisis and slowdown of growth occurred at the time of overvalued exchange rate and the reverse happened at the period of under valued exchange rate.

One of the most important earlier empirical works that tries to measure the impacts of exchange rate misalignment on growth based on the notion of internal and external equilibrium was Edward (1989). The author built an index of exchange rate disequilibrium for developing countries using a single equation methodology suitable for developing countries. The study found the existence of an inverse correlation between per capita income growth rates with the index that represents exchange rate misalignment. Besides this, the investigation of Razin and Collins in 1997 using almost the same methodology to that of Edward (1989) has argued the policy of keeping the real exchange rate depreciated is generally associated with competitive export performance and thereby accelerated economic growth. Razin and Collins highlighted appreciated (moderately depreciated) currencies are associated to lower (higher) per capita growth rates.

As it is illustrated in the above table, we have found two recent studies that have employed the BEER methodology for ERER determination. They have also implemented the dynamic panel data econometrics method for the estimation of the impact of RER misalignment on economic growth. These are the analysis of Sallenave A., (2010) on G-20 countries and the investigation of Ildikó M., (2008) on CEE countries. Their main result confirmed that while very high overvaluation appears to be associated with slower growth, moderate to high (but not very high) undervaluation appears to stimulate growth. In light of the above discussion, it can be argued that RER misalignment can distort price signals, results in a misallocation of resources across sectors, and generate severe macroeconomic disequilibria. Although these two studies are claimed to be robust because of the adoption GMM methodology, they are criticized due to the adoption of BEER methodology which is recognized to be a normative and subjective method with poor theoretical rationalization for the model of ERER employed.

The weaknesses of the above two studies had been acceptably done by earlier empirical inquiries of Aguirre and Calderon, 2006 (for a sample of 60 developed and developing countries), Toulaboe D., 2000 (for a sample of 33 developing countries) and Nouira R. and Sekkat K., (2010). These different studies had used reduced single equation techniques to estimate equilibrium RER indexes instead of the BEER methodology. Alike the other empirical results, exchange rate misalignment is found to have a negative effect on economic performance in Toulaboe D. investigation. However, Aguirre and Calderon (2006) as well as Nouira R. and Sekkat K., (2010) have identified a negative but non-linear relationship between economic growth and RER misalignment.

A quit unique recent empirical effort by Rodrik (2008) examines the effect of real exchange rate misalignment on growth for a set of 184 countries and for a panel data from 1950 to 2004. The author develops an index to measure the degree of real exchange rate undervaluation adjusted for the Balassa-Samuelson effect (productivity differential between the tradable and the non tradable sectors) using real per capita GDP data. The main empirical result is that growth is higher in countries with more undervalued real exchange rates and the effect is linear and similar for both under and overvaluation, implying that an overvalued real exchange rate hurts growth while an undervalued rate fosters growth. The magnitude and statistical significance of the estimated coefficient for real exchange rate undervaluation is higher for developing countries due to the fact that such countries are often characterized by institutional fragility and market failures.

Easterly (2001) developed an empirical investigation on real exchange rate misalignment and growth in order to compare the results with previous empirical studies by implementing seemingly unrelated regression (SUR) econometric model on a 39 year panel data of developing countries. The main empirical evidence supports the argument that a real depreciated (appreciated) exchange rate is associated to higher (lower) growth rates.

A brief historical review of the literature on real exchange rate and growth, focusing attention on possible channels through which the real exchange rate might have an impact on long-run economic growth was provided by Eichengreen (2007). The author argued in favor of a more depreciated real exchange rate as long as this is not associated with higher exchange rate volatility. The combination of a depreciated real exchange rate and low volatility is regarded as a favorable combination for developing and emerging economies, where a more dynamic export sector is usually an important part of the process for achieving higher and sustained economic growth rates. The study has recommended developing countries such as Africa and Latin America should keep their real exchange rate at a competitive level with a lower volatility since they are relevant for accelerated growth as the high growth experience of East Asian economies.

MacDonald and Vieira (2010) developed a historical review of the literature on real exchange rate and growth. They obtained that most of the empirical studies have utilized single model specifications to construct RER misalignment index. The authors, in contrast to the majority of the literature, adopted two different model specifications to construct measures of real exchange rate misalignment[15] for a set of ninety countries using time series data from 1980 to 2004. The ultimate results for the two-step System GMM panel growth models indicates that the coefficients for real exchange rate misalignment are negative for different model specification and samples, which means that a more depreciated (appreciated) real exchange rate helps (harms) long-run growth. The estimated coefficients are remarked to be higher for developing and emerging countries.

This study, on the other hand, will focus on exclusive data of sub-Saharan Africa countries where research on this subject is very little; RER adjustment is some what different compared to other developing regions; and economic growth depends largely on the fate of exporting sectors. This study, consequently, might shed light on the key policy recommendations that are specific to Sub-Saharan Africa.

[15] The authors used random and fixed effect models as well as panel cointegration methods where the panel co integrated method is found to be more relevant for the computation of RER misalignment.

Chapter Three

Methodological Issues and Data

In this section, as a continuation of the previous one, we will discuss in depth the methodology that we have applied. Firstly, we will derive the theoretical model for equilibrium RER, and secondly we will discuss and decide on the most appropriate panel data unit root and cointegration econometric techniques which are helpful to estimate ERER and real exchange rate misalignment indices. Thirdly, we will demonstrate the growth equation, the suitable econometric estimation techniques, and finally we will briefly show the sources and the nature of our data.

3.1 The Theoretical Model of Equilibrium Real Exchange Rate

As we have explained in the previous sections, we shall adopt the reduced form single equation RER determination model which, for the first time, have been developed by the seminal work of Edwards (1989) for developing countries. This intertemporal model has been subsequently extended and augmented by the works of Elbadawi (1994), Edwards (1994), and Elbadawi and Soto (1997). We will formulate the ERER model, based on the above works, for sub-Saharan African countries by the simultaneous interactions of the demand and supply sides of the various sectors that make up the economy in each country as it is elaborated next.

Assume a small economy with three productive sectors (importable, exportable and non-tradable goods), for which the international prices of traded goods is supposed to be exogenous. The domestic price of tradables is, then, determined by the levels of tariffs to importables (t_m), tariffs to exportables (t_x) and the nominal exchange rate (E). The following expressions relate the domestic prices of exportables (P_x), nominal exchange rate (E), and importables (P_m) to their international prices:

$$P_x = E(1-t_x)p_x^* \quad (3.1)$$

$$P_m = E(1+t_m)p_m^* \quad (3.2)$$

Where, p_x^* and p_m^* are the international prices of exportable and importables. The price of tradables can be defined as the weighted average of the price of exportables and importables, so that it can be expressed as:

$$P_T = p_x^{\alpha} p_m^{1-\alpha} \quad (3.3)$$

Substituting equation 3.1 and 3.2 in equation 3.3, we have the following equation for the domestic price index of tradable goods:

$$P_T = [E(1-t_x)p_x^*]^{\alpha}.\ [E(1+t_m)p_m^*]^{1-\alpha} \quad (3.4)$$

The price of non-tradables, on the other hand, is endogenously determined as the result of the interaction of supply and demand forces in the domestic market.

The total demand (expenditure) for the non-traded goods, designated by A_N, is disaggregated in to consumer expenditure (X_{PN}) and government expenditure (X_{GN}) components. This is due to the fact that consumers and the government may have different propensities to spend on non-traded goods. The total demand for non-traded goods in this economy is expressed as:

$$A_N = X_{GN} + X_{PN} \quad (3.5)$$

Government expenditures, which are fixed policy variables, on total goods and non-traded goods are defined by the equations of: $X_G = gY$ and $X_{GN} = g_n X_G = g_n(gY)$. Where g and g_n are the ratios of government expenditures to income and government expenditure on non-traded goods to income respectively.

Private sector expenditure on non-tradables, on the other hand, is endogenously determined as a function of the domestic price of exports (P_x), imports (P_m), and non-tradables (P_N). The total demand for non-traded goods in this economy (Equation 3.5), therefore, can alternatively be expressed as:

$$A_N = X_{GN} + X_{PN} = g_n(g.Y) + d_n(P_x, P_m, P_N)[A-g.Y] \quad (3.6)$$

The supply of non-traded goods, which is also specified as a function of total income depends on the prices of tradables and non-tradables as shown in the equation below.

$$S_N = s_n(P_x, P_m, P_N, Y) \quad (3.7)$$

Where, d_n and s_n in the above two equations represent as a function of the variables under the brackets.

The price of non-traded goods (P_N) can be determined by the interaction of the non-traded goods market (i.e. $A_N = S_N$). As we put it in its simplest form below, P_N can be computed by equating 3.6 and 3.7.

$$g_n(g) + d_n(P_x, P_m, P_N)[\frac{A}{Y} - g] = s_n(P_x, P_m, P_N) \quad (3.8)$$

Using the definition of the real exchange rate as the ratio of non-tradables and tradables we have:

$$\text{RER} = \frac{P_N}{P_T} = \frac{P_N}{E[[(1-t_x)p_x^*]^{\alpha}.[(1+t_m)p_m^*]]^{1-\alpha}} \text{ .... (3.9)}$$

Solving equation 3.8 and equation 3.9 gives us an expression for the level of the RER that ensures instantaneous equilibrium in the non-traded goods market, for given levels of exogenous and policy fundamentals (as indicated in Elbadawi, 1994; and Elbadawi and Soto, 1997) as:

$$\text{RER} = f(A/y, \text{TOT}, t_x, t_m, g_n, g) \text{…….……………………………………………………(3.10)}$$

Where, TOT represents the terms of trade (which is given by, p_x^*/p_m^*). There is a need to complete the model by endogenizing domestic absorption (A) and by incorporating technological progress in the above equation. As to the determinants of domestic absorption, various theoretical as well as empirical investigations have argued that net foreign asset and domestic absorption has a direct link (Dufrénot, and Etienne Y., 2005 and others) through the channel of capital inflow. According to these studies, a boost in net foreign asset payments from abroad will raise capital inflow and then increase the sustainable absorption level.

The final form of the single intertemporal ERER model, that fulfills the simultaneous equilibrium in traded and non-traded goods, can be developed by adding technological progress in our model. Technological progress has been identified in the literature as an important determinant of real exchange rate (particularly by Balasa (1964) and Samuelson (1964), for the first time). As shown below, productivity in tradable sector will result in appreciation of RER. In line with these theoretical illustrations, we will estimate the following long-run equation, using panel DOLS cointegration technique, for the equilibrium RER:

$$\log(\text{RER})_{it}=\alpha_i+\alpha_2\log(\text{Prod})_{it}+\alpha_3\log(\text{TOT})_{it}+\alpha_4(\text{NFA})_{it}+\alpha_5\log(G)_{it}+\alpha_6\log(\text{Open})_{it}+\mu_{it}$$

…………………………………………………………………………………………. (3.11)

Where i which runs from 1 to N denote the sample of Sub-Saharan African countries, and t that goes from 1 to T represents time (from 1980 to 2007). In the above equation: Prod is the level of productivity, log(TOT) is the logarithm of terms of trade, NFA is net foreign asset, log(G) is the log of the ratio of total government expenditure to GDP and log(Open) is the logarithm of the ratio of total trade(i.e. export plus import) to GDP. The error term is assumed to be identically and independently distributed with mean zero.

Theoretical models and empirical studies such as Elbadwai (1994), Edward (1988, 1989), Ghura D., and Grennes T.J. (1993), Aguirre A., and Calderón C. (2006), Ildiko M. (2008), Hyder Z. and Mahboob A. (2006), Toulaboe D., (2000) and others have proposed and ascertained the following signs for each fundamental variable in determining the behavior of RER.

The independent variable represented by Open is a proxy for commercial policies (t_x, t_m). This proxy variable is used due to the difficulty in obtaining a reliable time series data for t_x and t_m. Moreover, degree of openness of the economy is also likely to be a proxy for implicit commercial policy such as quota and exchange controls. Trade liberalization policy increases the openness of an economy to international trade. Trade liberalization will make future consumption of importable very cheap; this in turn makes consumers to substitute from non-tradable to tradable goods and leads to a depreciation of the country's real exchange rate.

The impact of terms of trade on RER is theoretically ambiguous and can take either sign depending on the substitution and income effects. More specifically, the worsening of terms of trade has a positive substitution effect on RER due to increase in import prices. On the other hand, the terms of trade worsening will also have a negative income effect on RER, which in turn may lead to downward pressures on the prices of all goods. If the substitution effect dominates income effect, then the impact of terms of trade deterioration will be an appreciation of RER, otherwise it will be depreciation.

The impact of government consumption on RER depends not only on government inter-temporal budget constraints but also on the composition of government consumption between tradable and nontradable goods. If government consumption contains a larger share of nontradable goods then the increase in government consumption will lead to appreciation of RER. Due to data unavailability on government consumption on non-tradable, only government consumption as a ratio of GDP (G/GDP) is supposed to be utilized.

The technological progress variable (Prod) is proxied by growth rate of GDP. It is also expected to either appreciate or depreciate the real exchange rate, depending on the sector in which the technological progress occurred. An improvement in productivity results in more efficient production in the sector where the change occurred. According to Balassa (1964) and Samuelson (1964), productivity growth tends to be concentrated in the tradable sector where larger productivity increases extended over a long period than the nontradable goods sectors. Their argument is most easily captured by assuming little productivity changes in nontradables. Then, over time, different countries' real incomes per worker will grow by differing degrees, depending on their rates of productivity increase in the tradables sectors. Real wages will also go up most in the countries where such productivity increases are the greatest. Yet wages cannot be expected to go up only in the tradables sectors. Labor market equilibrium requires that wage rises extend also to areas with no productivity increase (for workers of equivalent skill and training). This in turn means that the price level of nontradables will move up more in those countries with more rapid productivity increases in the tradables sectors. If the real exchange rate is defined as:

$\frac{P_N}{EPT}$, this real exchange rate will end up rising by more, the greater is the increase in real income of the country. The result is a real exchange rate appreciation for the country.

As far as the impact of net capital inflows on RER is concerned, it depends on the magnitude of net foreign assets flow. Higher net foreign asset will result in higher capital inflows which involve stronger demand for both tradables and nontradables (i.e. lead to a higher domestic absorption) and RER appreciation.

3.2 Real Exchange Rate Misalignment

The deviations of actual real exchange rate from its long-run equilibrium level, which generates incorrect signals to economic agents, results in distortion in resource allocation, significant welfare costs, and greater economic instability and poor economic performance (Edwards, 1989) is called exchange rate misalignment.

The misalignment of real exchange rate can arise because of two reasons. Firstly it can occur when there are changes in fundamentals that trigger a change in the equilibrium RER, but that are not reflected in changes in the actual RER. A different type of misalignment takes place when macroeconomic policies become incompatible with maintaining internal and external equilibrium, and give rise to a sustained appreciation of the actual RER. From a theoretical standpoint, the concept of misalignment requires assuming that there exist institutional or other types of rigidities that prevent the RER from adjusting rapidly towards its medium to long-run equilibrium level (Edwards and Savastano M, 1999).

As to the majority of single equation models, we should pursue the following four steps to compute RER misalignment indicator.

Using the appropriate historical panel data, we will first estimate the above long-run RER model by cointegration technique. The long run RER model, equation 3.11, is estimated using the more efficient panel dynamic OLS cointegration technique, as elaborated below.

In the second step the RER fundamentals are decomposed (filtered) into their permanent and transitory components as:

$X_{it} = XP_{it} + Xt_{it}$ ……………………………..……………………………………………..(3.12)

Where X_{it}'s are the fundamentals, and XP_{it} and Xt_{it} are the permanent (trend) and transitory (cycle) components of fundamental i in period t for each individual sample countries respectively. The literature proposes a series of techniques which can be used in order to decompose a series into its permanent and transitory component (like Hodrick-Prescott (HP) filter, band-pass filter or Beveridge-Nelson decomposition) considering the permanent component of the series as their sustainable value. There is no consensus on which trend-cycle decomposition method is most appropriate. In this investigation, like the works of Sallenave A., (2010), and Atingi-Ego M., and Sebudde R. k., (2004), HP filter is applied to determine the trend component of the fundamental factors.

The HP Filter is a smoothing method that is widely used among macroeconomists to obtain a smooth estimate of the long-term trend component of a series. The method was first used in a working paper by Hodrick and Prescott (1997) to analyze postwar U.S. business cycles. According to Atingi-Ego M., and Sebudde R. k., (2004), the HP filter computes the smoothed series XP_{it} of X_{it} by minimizing the variance of $\boldsymbol{X_{it}}$ around XP_{it}, subject to a penalty that constrains the second difference of XP_{it}. That is, the HP filter chooses XP_{it} to minimize:

$\sum_{t=1}^{T}(X_{it} - XP_{it})^2 + \lambda \sum_{t=2}^{T-1}((XP_{i,t+1} - XP_{it}) - (XP_{it} - XP_{i,t-1}))^2$……………………..…..(3.13)

The penalty parameter λ controls the smoothness of the series XP_{it}. The larger the λ, the smoother XP_{it} will be. As λ approaches to infinity, XP_{it} approaches to a linear trend.

The third step consists of using the XP_{it}'s, which are interpreted as the long-run sustainable values of the fundamentals, and the estimated cointegration regression coefficients of the dynamic OLS, $\hat{a}_i$'s, to construct an equilibrium path for the RER (RER_{it}^{*}). In other words, we can compute RER_{it}^{*} by substituting the sustainable value of the fundamental factors obtained in the second step into the long-run relationship estimated in the first step.

In the fourth, and final, step the degree of misalignment (MIS_{it}) is computed as the difference, at any moment in time, between the equilibrium (RER_{it}^{*}) and the actual (or observed) real exchange rate (i.e. RER_{it}). That is, misalignment indicator is obtained as:

$$MIS_{it} = RER_{it} - RER_{it}^{*} \qquad (3.14)$$

If $RER_{it}^{*} > RER_{it}$, the model would suggest that the currency is undervalued. Conversely, if $RER_{it}^{*} < RER_{it}$, the model would indicate that the domestic currency is overvalued.

3.3 Panel Unit Root, Panel Cointegration test, and Panel Cointegration Estimation

Recent advances in time series econometrics and panel data analysis have focused attention on unit root and cointegration properties of variables observed over a relatively long span of time across a large number of cross section units, such as countries in our case.

According to Villavicencio (2006), and Breitung, J., and H. Pesaran (2005), there are several reasons that justify the use of panel data unit root and cointegration techniques. First of all, it is well known that time series unit root and cointegration tests have limited power for finite samples against alternative hypotheses with highly persistent deviations from equilibrium. Thus, the use of panel data is usually seen as a way to generate more powerful tests. Second, countries may share common similarities usually lost in time series analysis. For instance, non stationarity appears more as a general feature for macroeconomic series, characterizing an important number of developed and developing countries. Hence, it is interesting to test the homogeneity of the unit root in a panel framework. In addition, a panel data framework not only allows taking into account the international dimension and the similarities of a group of countries, also some specifications consider possible cross-sectional dependence among them. Finally, a major advantage of panel cointegration techniques is that they allow to selectively pooling the long run information contained in the panel while permitting the short-run dynamics to vary and heterogeneity among different members.

Under this sub-section, we will first evaluate whether all variables, in equation 3.11, are stationery or not. That is, we will test for unit root for each variable. Moreover, we will test for cointegration between the real exchange rate and the underlying macroeconomic fundamentals. Finally, we shall estimate the long-run parameters that we later use for computing the equilibrium real exchange rates (ERER) and the misalignments.

3.3.1 Panel unit root tests

Before proceeding to cointegration techniques, we need to verify that all variables are integrated to the same order. This can be done by using panel unit root test for panel data sets.

Bangake and Eggoh (2006) and, Villavicencio (2006) has classified unit root tests into two groups depending on whether they allow for structural breaks and cross sectional correlation, which are features very often found in time series and panel data models. The Levin, Lin, and Chu (LLC), Breitung, and Hadri panel unit root tests employ the assumption of the persistence of parameters across cross-sections (or countries in our case) are common or homogeneous (i.e. $\rho_{i=}\rho$). In contrast, Im, Pesaran, and Shin (IPS), and Fisher-ADF and Fisher-PP unit root tests allow the parameters to vary freely across cross-sections (heterogeneous). In other words, Levin, Lin and Chu (1992, 1993), Breitung (2000) and Hadri (2000) tests are based on a common unit root process and with serial correlation where these problems are resolved by Im etal. (2003) (hereafter IPS) who proposed a test that allows for residual correlation, and heterogeneity of the autoregressive root and error variance across individual members of the panel (Sallenave, 2010).

Because of its superiority, we will employ IPS unit root test in our study. The basic equation for the panel unit root tests for IPS, as illustrated in Baltagi (2005), is as follows:

$$\Delta Y_{it} = \alpha_i + \rho_i Y_{i,t-1} + \sum_{j=1}^{p} \emptyset_{ij}\, \Delta Y_{i,t\_1} + \varepsilon_{it} \;;\; i=1,2,\ldots, N;\; t=1,2,\ldots,T \quad \ldots\ldots\ldots\ldots(3.15)$$

Where Y_{it} stands for each variable under consideration in our model, α_i is the individual fixed effect and ρ_i is selected to make the residuals uncorrelated over time by using the differenced lag of the variables under consideration.

The null hypothesis is that $\rho_i = 0$ for all i versus the alternative hypothesis is that $\rho_i < 0$ for some i= 1,.., N_1 and $\rho_i = 0$ for $i = N_1 + 1, \ldots, N$. The IPS t-bar statistic is based on averaging individual ADF statistics and can be written as follows:

$$\bar{t} = 1/N \sum_{i=t}^{N} (t_{iT}), \quad \ldots\ldots\ldots\ldots(3.16)$$

Where t_{iT} is the ADF t-static for country i based on the country –specific ADF regression.

Even though the IPS test is the most significant one for our work, we will also utilize various panel unit root tests, such as Levin, Lin and Chu (LLC), Breitung, Fisher-ADF, Fisher-PP, and Hadri panel unit root tests, for the purpose of comparison.

3.3.2 Panel cointegration test

Once the order of stationary has been defined, we should proceed to the test for co-integration. Cointegration refers to the possibility that two or more non-stationary variables may have a linear combination that is stationary, which implies a long run equilibrium relationship between variables to which they converge over time. Cointegrating variables move together overtime so that any short run deviation from the long-term trend will be corrected.

Cointegration in panel setting can be tested using Pedroni (1999), Pedroni (2004), Kao (1999), a Fisher-type test using an underlying Johansen methodology (Maddala and Wu, 1999) and others. In this paper we will follow the methodology proposed by Pedroni (2004), which has the advantage over others as it allows for considerable heterogeneous variances across countries at each point in time (Villavicencio, 2006; Saayman A, 2010) and take in to account heterogeneity by using specific parameters which are allowed to vary across individual members of the sample (Bangake and Eggoh, 2006). Taking in to account such heterogeneity constitutes an advantage because it is unrealistic to assume that vectors of cointegration are identical from one individual to the other for the panel.

The implementation of pedroni's cointegration test requires estimating first the following long-run relationship:

$$y_{it} = \alpha_i + \delta t + \beta_{1i} x_{1i,t} + \beta_{2i} x_{2i,t} + \ldots + \beta_{mi} x_{mi,t} + \varepsilon_{i,t} \quad \text{……………………………………..…………..(3.17)}$$

For t = 1,…,T; i = 1,…,N; m = 1,…,M; where M is the number of exogenous variables, and y and x_s are assumed to be integrated of order one. α_i and δ_i are parameters of individual and trend effects which can be set to zero if desired.

Under the null hypothesis of no cointegration, the residuals $\varepsilon_{i,t}$ will be I(1). The general approach is to obtain residuals from Equation (3.17) and then to test whether residuals are I(1) by running the panel counterpart of the DF or ADF test on the residual.

In Pedroni's panel cointegration tests, the null hypothesis is taken to be that for each member of the panel the variables of interest are not co-integrated. The alternative hypothesis is taken to be that for each member of the panel there exists a single co integrating vector, although this co integrating vector does not need to be the same between each member (Sallenave, 2010).

3.3.3 Panel Cointegration Estimation

Although Pedron's panel cointegration test allows us to test for the presence of cointegration, it is well-known that the ordinary least squares estimation (static OLS) of the cointegrating vector in equation (3.11) is biased and inefficient. The most important shortcomings of static OLS (SOLS) are the estimates have an asymptotic distribution that is generally non-Gaussian (for instance non-zero mean), exhibit biased asymptotic distribution, asymmetry, and are dependent on nuisance parameters associated with strong autocorrelations in the estimated residuals (Balgati, 2005; Benassy-Quere A. etal, 2010, Dufrenot G. and Yehoue E., 2005). So it is generally not recommended to conduct inference on such kind of cointegrating vector.

For panel frame work, in the presence of cointegration, various efficient estimation procedures are proposed. The most efficient estimation methods proposed by the econometrics literature are the Fully-Modified OLS (FM-OLS) method originated by Phillips and Hansen (1990), and the

Dynamic OLS (DOLS) method developed by Kao and Chiang (2000) in the context of panel cointegration. These estimation methods not only deal with the endogeneity bias correction, but also correct nuisance parameters that appear in SOLS and serial correlation in the data (Dufrenot G. and Yehoue E., 2005; Kao and Chiang (2000)).

In this study, we will apply the panel DOLS procedure. As to the simulation made by Kao and Chiang, (2000), this estimator has the same asymptotic distribution as the FM-OLS one, but has smallest sample bias, and the DOLS estimator appears to outperform the other estimators.

From now on, we will briefly describe the panel DOLS Estimation of Cointegrating Relationship which has been derived from time-series application of DOLS. Let the panel cointegrating relationship be given as:

$$y_{it} = \alpha_i + X_{it}^{'}\beta + u_{it}, \quad \ldots (3.18)$$

Where, y_{it} is the RER exchange rate, x_{it} is the vector of RER fundamentals, α_i is the unobserved country-specific constants and u_{it} is the error term of the RER equation. And if $x_{it} = x_{i,t-1} + \varepsilon_{it}$, then the cointegration of y and x implies that u_{it} and ε_{it} are correlated and hence u_{it} and x_{it} are correlated. This will make the least square estimator of the panel cointegration asymptotically inefficient (Aguirre and Calderon, 2006). The DOLS modifies the OLS estimator to derive asymptotically efficient estimator as shown below. Assume u_{it} is correlated with at most k leads and lags of ε_{it}.

$$u_{it} = \sum_{K=-p}^{p} \delta_{ik}\varepsilon_{i,t-k} + \upsilon_{it} \quad \ldots (3.19)$$

Where, δ_{ik} is a coefficient vector, $\pm$P is the lead and lag level respectively, and ε_{is} is uncorrelated with υ_{it} (and independent across i). Where, t$\pm$p is given by s. From $x_{it} = x_{i,t-1} + \varepsilon_{it}$, we can find:

$$\varepsilon_{it} = x_{it} - x_{i,t-1} = \Delta x_{it} \quad \text{……(3.20)}$$

Substituting equation (3.20) in to equation (3.19) we can get the following equality:

$$u_{it} = \sum_{K=-p}^{p} \delta_{ik} \Delta x_{it-k} + \upsilon_{it} \quad \text{……(3.21)}$$

Note that υ_{it} and Δx_{it} are orthogonal by construction. Substituting equation (3.21) in to (3.18):

$$y_{it} = \alpha_i + X_{it}^{'} \beta + \sum_{K=-p}^{p} \delta_{ik} \Delta x_{it-k} + \upsilon_{it} \quad \text{……(3.22)}$$

Equation (3.22) is asymptotically efficient DOLS estimator of the cointegrating relationship in equation (3.18). The inclusion of the leads and lags in the above panel DOLS cointegration model help to correct the nuisance parameters that would have been occur in SOLS, and in order to obtain coefficient estimates with nice limiting distribution properties. By the stationarity of υ_{it}, one would expect that the values of Δx_{it-k} would have negligible impact on Y_{it} in the very remote past and very remote future and can therefore be ignored (Aguirre and Calderon, 2005; Kao C., Chiang M. and Chen B., 1999).

3.4 Theoretical and Econometric Growth Models

3.4.1 The Theoretical Growth Models

Having introduced the various panel data tests and estimation techniques to calculate real exchange rate and misalignments, we are now in position to investigate the impact of real exchange rate misalignments on the economic performance. For this purpose, we will add misalignments among the explanatory variables in the theoretical growth regression equation. We consider a growth model of the following form that is adopted from Béreau etal (2009) and rely on the neoclassical growth theory as:

$$y_{it} = \beta_1 y_{it-1} + \beta_2 Mis_{it} + X'_{it}\beta + \nu_i + \varepsilon_{it} \quad (3.23)$$

Where ν_i represents unobserved country-specific factors and ε_{it} is the error term of the dynamic panel regression model. The dependent variable, y_{it}, is the growth rate of real GDP per capita.

Turning to the growth determinants, the model includes one period lagged value of real GDP per capita, real exchange rate misalignment and all the other determinants that are represented by a vector of X_{it} (i.e. trade openness, Terms of trade, government expenditure as a ratio of GDP, population growth, and gross capital formation as a ratio of GDP). The one period lagged value of GDP per capita proxies for conditional convergence. We expect, according to the theory, the sign of this variable to be negative. The dependent and all the explanatory variables will be in terms of logarithms.

To investigate the link between RER misalignment variability and economic growth, we will also estimate the following growth regression model:

$$y_{it} = \beta_1 y_{it-1} + \beta_2 MisVariability_{it} + X'_{it}\beta + \nu_i + \varepsilon_{it} \quad (3.24)$$

Except our substitution of RER misalignment by its variability, all the independent variables and the dependent variable in equation 3.24 are alike to equation 3.23. We have computed RER misalignment variability by the five year standard deviation of RER misalignment for the sample countries under contemplation.

Moreover, by splitting the real exchange rate undervaluation into a dummy of low undervaluation and higher undervaluation indicator, we will re-estimate growth regression models using the following specifications:

$$y_{it} = \beta_1 y_{it-1} + \beta_2 low\text{-}undervaluation_{it} + X'_{it}\beta + \nu_i + \varepsilon_{it} \quad \text{...........(3.25)}$$

$$y_{it} = \beta_1 y_{it-1} + \beta_2 high\text{-}undervaluation_{it} + X'_{it}\beta + \nu_i + \varepsilon_{it} \quad \text{...........(3.26)}$$

Where, *low-undervaluation* reflects the degree of undervaluation greater than negative six (undervaluation near zero). It will be entered as one if it is greater than negative six and zero other wise. *High-undervaluation,* on the other hand, measures the average degree of undervaluation of a certain currency which is less than negative six. It will be written as one if it is less than negative six, zero other wise. This technique is employed from Nouira R. and Sekkat K., (2010) and Collins M., Ofair R. S. (1997).

3.4.2 The Econometric Estimation of Growth Models

As to Baltagi (2005), panel data methodology, which we will employ, gives more informative, and more variability in data since large numbers of data points are available. These special features lead less collinearity among variables, more degrees of freedom and more efficiency. Furthermore, panel data better controls the heterogeneity among economic variables and allow us to construct and test more complicated behavioral models than pure cross-section and time series data.

However, looking at our growth models above (from 3.23 to 3.26); we have included the lagged dependent variable as a regressor. From these growth equations, the unobservable country specific effect (ν_i) affects the dependent variable (y_{it}). Due to this relationship, y_{it-1} is a function of ν_i. This creates a positive correlation between the explanatory variable (y_{it-1}) and the error term. This econometric problem accompanied with the omitted variable bias, the measurement error, and the endogeneity of other regressors, which are common problems in panel data models (Hoeffler, 2002), leads to inefficient estimates by standard econometric techniques (like OLS, 2 stage least square, IV, fixed effect etc.). The GMM method provides a solution to these problems as well as yielding estimates of unobserved country-specific effects and dummy coefficients for which the usual methods would be inappropriate given the dynamic nature of the regression (see Calderon et al. 2006). There are two types of GMM estimators based on the assumption made and resulting moment restriction, and thus variables used as instruments in the estimation process: the first-difference GMM and the system GMM.

The first difference GMM estimator (DGMM) for dynamic panels was introduced by Holtz-Eakin, Newey and Rosen (1988), Arellano and Bond (1991), and Arellano and Bover (1995). It is based on first differencing the series to eliminate unobserved country specific effects and it uses lagged explanatory and dependent variables as instruments, called "internal" instruments to avoid autocorrelation problem.

If our dependent variable is given by Y_{it}, which is the growth of per capita GDP, and if the set of all explanatory variables are represented by vector X_{it}, we rewrite equation (3.23) as follows:

$$Y_{it} = \alpha\, Y_{i,t-1} + X'_{it}\beta + \eta_i + \varepsilon_{it} \qquad (3.27)$$

In order to eliminate the country-specific effect, we take the first-differences of equation (3.27),

$$(Y_{it} - Y_{i,t-1}) = \alpha\, (Y_{i,t-1} - Y_{i,t-2}) + (X_{it} - X_{i,t-1})'\beta + (\varepsilon_{it} - \varepsilon_{i,t-1}) \qquad (3.28)$$

The use of instruments is required to deal with the likely endogeneity of the explanatory variables and to deal with the correlation of the new error term, $(\varepsilon_{it} - \varepsilon_{i,t-1})$ with the lagged dependent variable, $(y_{i,t-1} - y_{i,t-2})$. As to Arellanno and Bond (1991), the instruments consist of previous observations of the explanatory and previous observations the lagged independent variable.

Based on the assumptions that the error term (ε) is not serially correlated, and the explanatory variables, X, are weakly exogenous (i. e., they are uncorrelated with future realisations of the error term), the DGMM Dynamic panel estimator uses the following moment conditions:

$E[Y_{i,t-s} . (\varepsilon_{it} - \varepsilon_{i,t-1})] = 0$ for $s \geq 2; t = s....T$ ……………………………………………...…(3.29)

$E[X_{i,t-s} . (\varepsilon_{it} - \varepsilon_{i,t-1})] = 0$ for $s \geq 2; t = s....T$ ………………………………...…………….(3.30)

In spite of its advantages with respect to simpler panel data estimators, the difference GMM has statistical shortcomings. Alonso- Borrego and Arellano (1999) and Blundell and Bond (1998) showed that when the explanatory variables are persistent over time, lagged levels of these variables are weak instruments for the regression equation in differences. Instrument weakness influences the asymptotic and small sample performance of the difference estimator. Asymptotically, the variance of the coefficients rises in small samples. In addition, the Monte Carlo experiments show that the weakness of the instruments can produce biased coefficients.

To decrease the potential biases and imprecision associated with the usual difference estimator, Arellano and Bover (1995), and Blundell and Bond (1998), propose the system-GMM (SGMM) estimator that combines the regression in differences with the regression in levels. The instruments for the regression in levels are the lagged differences[16] of the corresponding variables. These are appropriate instruments under the following additional assumptions: although there may be correlation between the levels of the right-hand side variables and the country-specific effect in equation (3.28), there is no correlation between the differences of these

[16] Arellano and Bover (1995) and Roodman (2007), claim that the instruments in the system GMM should account only the most recent lagged differences. Using other lagged differences as instruments would result in redundant moment conditions.

variables and the country-specific effects. In precise, the moment condition for the regression in levels is assumed to fulfill the following property:

$E[(Y_{i,t-1} - Y_{i,t-2}). (\eta_i + \varepsilon_{it})] = 0$ …………………………………………………….……….. (3.31)

$E[(X_{i,t-1} - X_{i,t-2}). (\eta_i + \varepsilon_{it})] = 0$ ………………………………………………………..…(3.32)

The empirical literatures use the moment conditions given by equations (3.29), (3.30), (3.31), and (3.32) to employ a GMM procedure that could generate consistent and efficient parameter estimates. The use of the SGMM estimator in empirical growth research is strongly recommended by Bond et al (2001), Nouira R. and Sekkat K., (2010), Roodman (2007) and Elbadawi I., et al (2008). Hence, we will employ a SGMM procedure to generate consistent and efficient estimates of the parameters of equation 3.23 - 3.26.

The consistency of the SGMM estimator is assessed by Sargan test of over identifying restrictions tests suggested by Arellano and Bond (1991). The Sargan test of over identifying restrictions tests the overall validity of the instruments. Failure to reject the null hypothesis gives support to the model.

3.5 Data Sources and Description

This sub-section provides the description and sources of the data that will be used in our empirical analysis. In this respect, we first describe the data on the real exchange rate and its fundamentals used for the estimation of the long run real exchange rate equation. More specifically, we will elaborate and describe the real exchange rate and its determinants: the net foreign asset (NFA), the terms of trade (TOT), government expenditure as ratio of GDP (G), trade openness (Open) and the level of productivity (Prod). Moreover, we shall explain the exact sources where these long-time series data are extracted. Next we will illustrate the definition and sources of the data for the growth regression variables that have not been illustrated in the long-run exchange rate equation.

As we have mentioned in the previous parts of the study, the data set in this investigation comprises a set of twenty nine sub-Saharan African countries[17]. Almost alike the empirical analyses of MacDonald R. and Vieira F., (2010), and Nouira R. and Sekkat K., (2010), the time series dimensions of our data set ranges from 1980 to 2007. The sample is selected based on the availability of data.

3.5.1 Variables under the Long-Run Real Exchange Rate Regression Equation

To determine the extent of misalignment, we first need to establish the long-run relationship between the real exchange rate and its determinants. The logarithm of actual Real exchange rate (the dependent variable) and the fundamental determinants (the independent variables), that will be used in this empirical evaluation, are defined, calculated as well as proxied as follows:

The real exchange rate for each time period can be defined as the nominal exchange rate adjusted for price differences between countries in the same time period. Various price indices have been used to adjust the nominal exchange rate, including the consumer price index, the whole price index and unit labour cost indices (see Edward, 1989). In this research, we will compute the real exchange rate as:

$$\mathrm{RER_{it}} = \frac{\mathrm{PN_{it}}}{\mathrm{E_{it}}\,(PT)^*_{it}} \qquad (3.33)$$

[17] Botswana, Burkina Faso , Burundi, Cameron, Central Africa Republic, Chad, Congo Dem. R., Congo Republic, Cote Devoir, Ethiopia, Gabon, Gambia The, Ghana, Kenya, Lesotho, Madagascar, Malawi, Mauritius, Mali, Niger, Nigeria, Rwanda, Senegal, Seychelles, South Africa, Swaziland, Togo, Zambia, Zimbabwe.

Where E_{it} is the official nominal exchange rate measured as the amount of domestic currency per unit of foreign currency, and $(PT)^{*}_{it}$ is the foreign currency price of tradable, PN_{it} is the domestic price index of nontradables at each specific time (t) for each individual country (i). As quite a lot of economists have used [18], the U.S. wholesale price index (WPI_{US}) is used as a proxy for $(PT)^{*}_{it}$ and the domestic Consumer price index (CPI) is employed as proxy for PN_{it}. Following this principle, an increase in the bilateral RER represents a real appreciation of the currency and vice versa. Nominal exchange rate and WPI_{US} data will be extracted from World Development Indicator (WDI) version 2010. Moreover, CPI is taken from IMF's world economic outlook data base 2010. RER is used in our regression after we conduct logarithmic transformation on it.

Following the literature, we use a number of fundamentals as a determinant for the equilibrium exchange rate, as it is explained in sub-section 3.1. The fundamental determinant variables include the terms of trade (TOT), the degree of openness of the economy captured by trade openness (Open), the technological progress (Prod), government consumption as a ratio of GDP (G) and net foreign asset position (NFA).

In our empirical implementation, the terms of trade is defined as the ratio of export price to import price. Data on this variable will be drawn from the African Development Indicator-2010.

The second fundamental—the extent of trade openness—is computed as the ratio of the sum of export and import to the gross domestic product (GDP). Data for this variable is supposed to be used from WDI-2010.

[18] Aguirrea A., Calderón C. (2006), Edwards S., (1989), Ghura D., Grennes T.J. (1993) and others have adopted this definition as well as the above mentioned proxies for P^{*}_{T} and P_N in their empirical study.

Given the difficulty in measuring technological progress, different authors have used different proxies for relative productivity. In Cottani et al. (1990) and Ghura and Grennes (1993), the effect of technological progress is captured in a very simple way by use of a time trend in their regression equation. Razin and Collins (1997) used GDP per worker to capture the effect of productivity growth. Kubota M., (2009), Agguirre and Calderon (2005) and Toulaboe D., (2000) on the other hand, used the rate of growth of real GDP as a proxy for technological progress. As the case of Japan, Korea, and Singapore illustrates, there is strong evidence that rapid economic growth is associated with technological improvement and real exchange rate appreciation. In line with this literature, technological progress variable (prod) is proxied by the growth rate of real GDP in this investigation. The data for growth rate of real GDP will be taken from WDI (2010).

With regard to net foreign assets, we will use simply the data on the net foreign asset (NFA) from the updated and extended version of the External Wealth of Nations Mark II database developed by Lane and Milesi-Ferretti (2007).

As government shocks can generate deviations from the equilibrium levels, we are also interested in measuring how government spending will affect the equilibrium real exchange especially in this new empirical implementation. We will extract data on general government final consumption expenditure from the WDI (2010). It will be incorporated in our regression as a ratio of GDP.

Some of the fundamental determinants clarified above: such as terms of trade, openness, and general government final consumption expenditure will be used in the RER regression after a logarithmic transformation.

3.5.2 Variables under the Growth Regression Equation

Despite the availability of voluminous research on growth, there is no consensus on the major determinate factors of economic growth. Most empirical investigations are conducted by employing core explanatory variables. Likewise, we will employ the core explanatory variables of economic growth proposed by Béreau & al. (2009). These are the initial value of GDP per capita, Gross capital formation as a ratio of GDP, RER misalignment, Population growth rate, government expenditure as a ratio of GDP, TOT, and trade Openness.

Business cycle effects are not taken in to account in most regression models. Averaging data is undertaken to eliminate business cycle effects (Bond et al, 2001). Even though the duration of one business cycle differs from one country to other, the traditional methodology in most empirical literatures is averaging over different non-overlapping five years. Consequently, we will employ this traditional averaging methodology in our growth regressions.

Our dependent variable is the growth rate in real output per capita. Our measure of output per capita is proxied by the ratio of total GDP to total population, extracted from WDI version 2010.

The initial value of the GDP per capita is used as a proxy for the initial output per capita that indicates for conditional convergence in the literature. On the other hand, Gross Capital Formation as a ratio of GDP will be used as a basic determinant of the growth rate in real GDP per capita. Further more, growth rate of population will be taken as a determinant of the dependent variable. Our source of data for these variables will be WDI (2010).

The other explanatory variables of growth such as TOT, Openness, G and misalignment will be used as expressed in the RER equation, above. All the growth regression variables, except growth rate of per capita GDP and misalignment indicator, will be transformed in to natural logarithms before the econometric estimation is held.

Chapter Four

Data Analysis, Regression Results and Discussion

Under this section, which is the heart of the investigation, we will present all the statistical and econometric results of the study accompanied with their interpretations so as to achieve the main and specific objectives discussed in the first chapter.

The section will have two broad sub-sections. The first broad sub-section discusses about the descriptive statistics and econometric results of the ERER model. This sub-section will further contain two specific sub-topics. The first specific sub-topic deals about the central tendency, the dispersion, normality test, the correlation matrix and graphical association of the variables in the ERER regression model. In the second specific sub-topic, which is allotted to analyze the basic econometric results, we will briefly observe the panel unit root test, the panel cointegration test and the Dynamic panel OLS regression estimation result of the ERER equation.

In the second sub-section, alike the first one, we will first view the fundamental descriptive statistics, normality test and the graphical as well as the correlation matrix results of the long-run Dynamic GMM growth variables. The graphical and correlation matrix outputs assist to acquire preliminary information about the association between the Dynamic GMM growth dependent and independent variables. Eventually we will discuss the findings of the two step Dynamic system GMM results of the diverse growth regression models specified in chapter three.

4.1 Descriptive and Econometric Analysis of RER Model

4.1.1 Descriptive Analysis

As it can be looked at in table 4.1 below, the overall average actual RER registered by the 29 sample of sub-Saharan African countries is 0.33 with a standard deviation of 2.425 under the period taken into account. There is also a relatively huge gap between the maximum and minimum values of the ARER in the overall of the data as well as in the between and within dimension of the data. The highest and lowest levels of ARER are recorded by Ghana and Zambia in the year 1982 and 1987, respectively. The substantial appreciation of ARER revealed in Ghana is attributed to the expansive and unsustainable macroeconomic policies of 1979-82 that finally led to considerable deterioration in Ghanaians economic performance. In particular, the period 1981-82 witnessed a collapse in cocoa prices, leading to the reversal of earlier policy reforms. This in turns led to the substantial overvaluation mentioned earlier (Dufrenot G. and Yehoue E. (2005)). The lowest depreciation of ARER in Zambia in the year 1987, on the other hand, is due to the reversal of the policy package towards free market oriented auction exchange rate transactions in the 1985-87. This extreme depreciation of the Zambian currency results surges in consumer prices (Robert H. Bates and Paul Collier, 1994).

With respect to the net barter terms of trade, which is another significant determinant of real exchange rate, the sample countries have registered an overall average of 111.9255 with 47.338 standard deviations. The maximum ratio of export price and import price, TOT, has been scored by Gabon in the year 1981. This considerably large amount of price ratio exhibits that Gabon has been selling her products at a relatively higher export price. Such kind of achievement might be due to the good performance of exporting manufactured products to foreign buyers since the price of primary agricultural commodities are stagnant and deteriorating from time to time. In contrast to the above, the lowest amount of TOT (which is 15.4) has been observed in Ethiopia in 1991. During this period, the country was experiencing the pick point of the long lasting civil strife. At this moment, not only TOT but also the other major macroeconomic variables have also reached at their lowest point.

Table 4.1 Summary Statistics of the Variables Used for Real Exchange Rate equation Estimation

Variable		Mean	Std. Dev.	Min	Max	Observations	
arer	overall	.3306624	2.425163	.0001695	43.41866	N =	812
	between		1.457713	.0004171	7.895995	n =	29
	within		1.956331	-5.389027	35.85333	T =	28
tot	overall	111.9255	47.33898	15.4	357.5757	N =	812
	between		33.09753	35.54107	191.958	n =	29
	within		34.38026	3.597483	301.0525	T =	28
gdp_gr	overall	3.087489	5.685358	-50.24807	35.22408	N =	812
	between		1.660911	-.4244083	7.686253	n =	29
	within		5.445779	-51.04075	34.4314	T =	28
nfa	overall	-4148.238	7370.648	-71731.84	28762.21	N =	812
	between		6095.939	-24122.44	2801.99	n =	29
	within		4289.887	-53581.7	48736.42	T =	28
g	overall	15.80318	6.878565	2.650635	54.51542	N =	812
	between		5.511241	8.40774	31.31442	n =	29
	within		4.236991	2.285221	50.66586	T =	28
open	overall	73.31105	39.48453	6.320343	224.6584	N =	812
	between		36.70838	27.1002	160.0189	n =	29
	within		16.01199	21.35498	153.7081	T =	28

As far as the proxy of productivity is concerned, the GDP of SSA countries has on average grown by 3.087 percent under the period taken into consideration. Compared to their economic status and living condition, this growth rate of GDP would have been very high. When we explore the smallest and the greatest growth rates realized, surprisingly the Republic of Rwanda has registered both the maximum and minimum GDP growth values of -50.248 and 35.224 in the consecutive years of 1994 and 1995. In 1994, the then genocide has extremely hindered the growth of GDP. However, after one year the favorable political, social and economic conditions assisted the nation to significantly increase and manage to achieve the highest level of GDP growth not only in Africa but also in the world.

Considering the remaining variables, the subcontinent exhibited an average of -4148.238 net foreign asset flows along with a sizeable standard deviation of -71731.84. The value of net foreign asset which is the difference between total asset and total liabilities is found out to be negative for the majority of sample countries. It ranges from -71731.84 in South Africa (in 2007) to 28762.21 in Nigeria (2006). Likewise the average government expenditure (as ratio of GDP) demonstrated by the 29 sub-Saharan African countries was 15.83 with a slightly smaller standard deviations of 6.87 and a maximum value of 54.5 in Gambia (in the year 1984) and a minimum record of 2.65 in Central Africa Republic. Table 4.1 also presents the degree of openness which varies from as low as of 6.32 in Ghana (1982) to as high as of 224.66 in Seychelles (2007). However, the overall mean of the sample is 73.31 within the given time frame.

We have also computed the summary statistics for the logarithmic transformed magnitudes of the above discussed fundamental variables. However, to avoid redundancy we have simply presented it in Appendix A.1 without further discussion.

4.1.2 The Correlation between Variables under RER models

Before we explore the econometric regression results of equation 3.11, we have to analyze the correlation, graphical association and normality of the earlier summarized economic variables.

Observing the correlation matrix in Appendix A.2, we can infer that the highest level of collinearity is found to be 0.3965. This outcome confirms the nonexistence of the problem multicollinearity among variables. Regarding the sign of individual correlation, the log of ARER is only negatively related with LOGTOT. Meaning there is a negative linear relationship between LOGARER and LOGTOT. A positive linear relationship is documented between actual real exchange rate and the remaining independent variables.

In order to derive introduction information, we have also presented the graphical association between actual real exchange rate and its fundamentals in Appendix A.3. The graphical depictions reveal mixed results. Actual RER and Terms of trade are found to have an indirect association in the sample under review. Alike the correlation matrix outcome, the remaining three fundamentals (i.e. Growth rate of GDP, Government expenditure and Trade openness) have displayed a positive association with actual real exchange rate. The Net Foreign Asset, on the other hand, has no any form of linear relationship with actual RER.

Table 4.2 gives information about the skewness and kurtosis magnitudes to test the normality of the data. The test statistics of normality is constructed by combining the skewness and kurtosis values of each observation. As it can be looked at from the table, we fail to reject the null hypothesis of normality for all variables except the logarithm of government expenditure. Regarding the logarithm of government expenditure, the problem was more serious in levels. The logarithmic transformation has slightly improved the normality of the variable.

Table 4.2 Tests of Normality for Variables in RER Model

Skewness/Kurtosis tests for Normality

Variable	Pr(Skewness)	Pr(Kurtosis)	joint chi2(2)	joint Prob>chi2
logarer	0.000	0.026	61.76	0.0000
logtot	0.000	0.000	97.88	0.0000
logg	0.767	0.125	2.44	0.2948
loggdp_gr	0.000	0.000	198.29	0.0000
logopen	0.017	0.869	5.77	0.0559
nfa	0.000	0.000	576.26	0.0000

Although graphical figures and correlation matrix indicate the observed linear relationships, they neither express the strength of the correlation nor exhibit the linear association when other variables enter simultaneously. They merely serve to generate preliminary acquaintance about the data before we conduct the major regression estimation.

4.1.3 Estimation results for Panel Unit roots, Cointegration and Panel DOLS

In this section, we will first present the various panel unit root tests to ascertain the presence of stationarity. After checking the stationarity of the process, we shall investigate the existence of long-run relationship using Pedroni panel cointegration test. Ultimately the efficient long run regression parameters will be estimated by implementing Panel Dynamic Ordinary Least Squares (panel DOLS) of Kao and Chiang (2000).

4.1.3.1 Panel Unit Root Tests

In order to determine the stationarity process we have performed different panel unit root tests. We have conducted unit root tests when the exogenous regressors are of two types. At the outset stationary tests are carried out when individual fixed effect and time trend are employed as exogenous regressors (table 4.3). Secondly, the unit root test is accomplished when we do have only one exogenous regressor which is the individual intercept (table 4.4).

Besides the above distinction, two sets of unit root tests can be witnessed from the two tables. The columns labeled individual unit root tests report the computed test statistics and probability values of the Im, Pesaran and Shin (2003) individual unit root process. As we have tried to mention in the previous chapter, the IPS unit root test is better than the others in a sense that it allows heterogeneity of the autoregressive process. The columns labeled Summary Panel unit root tests, in contrast, present the test statistics and probability values of the Levin, Lin and Chu (LLC), Breitung, Fisher-ADF, Fisher-PP, and Hadri panel unit root tests which are employed for the purpose of comparison.

As far as the IPS panel unit root test is concerned, the output result with both a constant and a trend regressors indicates that the null hypothesis of the unit root for the (log) panel data of real exchange rate, terms of trade, openness and GDP growth series is reject at 5% significance level. These results strongly indicate the real exchange rate, terms of trade, openness and GDP growth series are stationary at (log) levels. However, NFA is stationary at its first difference.

In an attempt to check the robustness of the IPS unit root test results, we have applied the formerly mentioned summary panel unit root tests. As it could be deduced from the executed outcomes, most of the summary unit root outcomes justified the IPS unit root results. All the variables are stationary at (log) level except NFA. We also noted that for real exchange rate there is wider contradiction among the unit root tests as some claim non-stationary while others claim stationarity at level.

The Breitung test illustrates non-stationarity of terms of trade, openness, GDP growth and net foreign asset (both at level and at first difference). However, since it allows common coefficient for the autoregressive process, which is not convincing for our sample, we fail to accept the power of the test results.

Table 4.3 Panel Unit Root Test result with individual effects and individual linear trends exogenous variables

Type of the Panel Unit Root	**(IPS)Individual unit root tests (1)**		**Summary Panel unit root tests (2)**							
Variables	Im, Pesaran and Shin W-stat		Levin, Lin & Chu test		Breitung t-stat		ADF - Fisher Chi-square		PP - Fisher Chi-square	
	Static	Prob.	Static	Prob.	Static	Prob.	Static	Prob.	Static	Prob.
LOGARER	-1.7346	0.041	0.6567	0.7443	-3.8451	0.0001	61.517	0.1273	50.925	0.437
NFA	6.8743	1.000	7.6639	1.0000	1.6467	0.9502	44.507	0.6927	27.690	0.995
DNFA	-13.556	0.000	-3.4754	0.0003	4.8867	1.0000	176.21	0.000	229.87	0.000
LOGTOT	-2.1559	0.016	0.1049	0.5418	-0.9553	0.1697	87.377	0.0004	65.962	0.044
LOGOPEN	-3.9536	0.000	-3.0155	0.0013	1.3005	0.9033	88.521	0.0006	80.708	0.004
LOGG	-3.8275	0.000	-2.0669	0.0194	-3.7738	0.000	49.4831	0.0140	37.300	0.1686
LOGGDP_GR	5.22054	0.000	-3.1583	0.0008	-0.042	0.4833	48.5748	0.0000	52.958	0.0000

Regarding the individual effect exogenous variable IPS panel unit root and Summary panel unit root tests, both of them have confirmed that real exchange rate, terms of trade, openness, government expenditure and GDP growth are found to be stationery at levels. These results are more preferable than the former outcomes due to the fact that nearly all of the variables are stationery at 5% significance level.

4.4 Panel Unit Root Test result when individual effect is the only exogenous variable

Type of the Panel Unit Root	**Individual Unit Root Process: IPS (1)**		**Panel unit root: Summary (2)**					
Variables	Im, Pesaran and Shin W-stat		Levin, Lin & Chu t*		ADF - Fisher Chi-square		PP - Fisher Chi-square	
	Static	Prob.	Static	Prob.	Static	Prob.	Static	Prob.
LOGARER	-3.88260	0.0001	-1.37	0.0867	76.5775	0.0054	75.0564	0.0075
NFA	4.84933	1.0000	2.90276	0.1346	47.6973	0.1346	29.5952	0.8335
DNFA	-13.2289	0.0000	-5.23850	0.0000	182.764	0.0000	243.947	0.0000
LOGTOT	-3.24257	0.0006	-0.20595	0.4184	39.5205	0.0123	41.4961	0.0072
LOGOPEN	-3.43498	0.0003	-4.21970	0.0000	50.0289	0.0001	31.0808	0.0282
LOGG	-2.81944	0.0024	-2.49198	0.0064	70.6052	0.0185	87.4864	0.0004
LOGGDP_GR	3.65841	0.0001	-3.06961	0.0011	28.0570	0.0018	49.8640	0.0000

The IPS test results in table 4.3 and 4.4 are almost identical with Dufrenot G. and Yehoue E. (2005) computed unit root results. Dufrenot G. and Yehoue E. (2005) found that LOGRER, LOGTOT, LOGOPEN, LOGG, NFA and LOGGDP_GR variables are stationary at level. In contrast to their result, NFA was not I(0) in this investigation.

4.1.3.2 Panel Cointegration Tests

In this section using Pedroni panel cointegration test, we will check the cointegration between the real exchange rate and the underlying macroeconomic fundamentals.

We consider here the seven tests proposed by Pedroni (1999, 2004). These tests are based on the null hypothesis of no cointegration. As it is described in the preceding chapter, among the seven Pedroni's tests, four are based on the within dimension (i.e. panel cointegration tests) and three are based on the between dimension (i.e. group mean panel cointegration tests). Group mean panel cointegration test statistics are more general since the autoregressive coefficients are allowed to vary across individual members of the panel.

Pedroni (2004) explored the finite sample performances of the seven statistics. He showed that in terms of power all the proposed statistics do fairly well for T > 90. Likewise Pedroni's (1997) simulations showed that for small time span (T < 20), the between group parametric-t statistic is the most powerful. In particular, the group-adf statistics plays a pivotal role among the between group parametric t-statistic in the case of small samples (Drine I.and Rault C., 2003).

In a similar fashion, Sallenave A (2010) and Saayman A., (2010), has also expressed that particular attention should be paid to the group parametric-t statistic (where the ADF and Phillips–Peron (PP) statistic are more reliable than the panel rho statistic) for smaller sample sizes in order to test panel cointegration. Based on these propositions, we will pay vital attention on the group mean panel cointegration test since our sample is a relatively short time span (T = 28). The result of panel cointegration tests are displayed in appendix A.4.

Similar to the results in the majority of the empirical investigations[19], our Pedroni's group mean panel cointegration test results are mixed. As can be seen in appendix A.4, except the Group rho-Statistic, both the Group PP-Statistic and Group ADF-Statistic validated the presence of long-run relationship since the null hypothesis of no cointegration is easily rejected at 1% significance level. The rho statistic, which is trivial for small time span, indicates that the null hypothesis of no co-integration can not be rejected.

[19] See Benassy-Quere A., Bereau S.and Mignon V., (2009), Nouira R. and Sekkat K., (2010), Saayman A., (2010), Sallenave A., (2010) and others for similar pedroni cointegration test results.

4.1.3.3 Panel Cointegration Estimation

Having found that there exists for a cointegrating link between real exchange rate and the macroeconomic fundamentals, in this sub-section we will discuss the panel dynamic OLS estimation results of the long-run real exchange rate equation stated in 3.11.

We have estimated the panel DOLS regression of the real exchange rate equation with 2 lags and 4 leads of the underlined fundamentals along with their levels. The number of lags and leads in the panel DOLS are selected based the value of the coefficient of determination (R^2) and Wald test. The highest level of R^2 (which is .9607) is found when we include 2 lags and 4 leads in the regression equation. Moreover, at the specified number of leads and lags the joint significance of the coefficients (which is measured by Wald test) becomes good enough.

When we come to the estimation results, consistent with the literature the computed regression coefficients are with the expected sign. The econometric outcome is reported in table 4.5, below.

Table 4.5 Panel Cointegration Estimation output of Panel DOLS

DOLS Hom. Panel data Coint. Estimation results						
Group variable: country						
Wald chi2(5) = 89.72						
Prob > chi2 = 0.000						
			R-squared = 0.9607			
			Adj R-squared = 0.7041			
logarer	Coef.	Std. Err.	t	P>t	[95% Conf. Interval]	
Loggdp_gr	.0172714	.7225432	0.71	0.255	-.1762269	.2107697
Logopen	-.1947447	4.128822	-1.40	0.110	-1.30045	.9109609
logtot	.9494639	5.379483	5.24	0.002	-.491171	2.390099
logg	.0346472	3.434405	0.30	0.388	-.8850924	.9543868
nfa	.0000572	.0002775	6.12	0.001	-.0000171	.0001315

As it can be noticed from the table, the terms of trade has a strong and positive effect on real exchange rate. Intuitively, an increase in terms of trade leads to a negative substitution and a positive income effect. The negative substitution effect happens when domestic consumers substitute the expensive domestic products to the foreign cheap products. On the other hand, the positive income effect occurs when higher income is generated from the increased price of exported commodities. The impact of terms of trade on real exchange rate depends on which effect outweighs. If the income effect is grater than the substitution effect, terms of trade improvement will appreciate the real exchange rate. The opposite also holds valid. In our case, since the income effect out weighs the negative substitution effect, a 1% rise in terms of trade on average consequences a 0.95% increase (i.e. appreciation) of the real exchange rate. Hence, the predominant income effect leads to a significant positive effect for sub-Saharan countries.

Regarding the degree of openness of the SSA economy, it has a negative but insignificant effect on real exchange rate. Holding other variables constant, a one percent rise in the degree of openness will on average result in 0.195 percent depreciation in the level of real exchange rate. This result conforms with the theoretical illustrations discussed in chapter three in that a more liberalized and open trade regime will lead to a more depreciated equilibrium real currency value. This finding has a significant importance for SSA policymakers, as it points out trade liberalization in the form of reduction in tariff rates, eliminating quota and exchange rate controls can lead to real currency depreciation which is intern helpful for export lead growth and development.

Concerning the effect of productivity on real exchange rate, we can realize from the regression outcome that productivity has a positive and insignificant impact on real exchange rate. The possible justification for the insignificant effect of productivity on real exchange rate for SSA may be due to the absence of the assumption of perfect labor market. As we stated before, productivity growth in the tradable sector is assumed to lead a wage rise in the non-tradable sectors due to wage equalization in perfectly competitive labour market. But government's intensive intervention in the functioning of the market may result in labour market disequilibrium in SSA. In this case, wage equalization can not be achieved between the tradable and non-tradable sectors. This finally can result in the poor performance of the productivity effect on real exchange rate in least developing countries, such as SSA.

Another fundamental of interest for this analysis is government consumption. Comparable to the degree of openness and technological progress, government consumption has a positive but insignificant impact on the dependent variable. A 1% increase in government expenditure will, on average, result in a .035% appreciation of the currency. This result is consistent with the theoretical predictions as well as the explored empirical findings.

The fundamental assumption on the effect of government consumption on real exchange rate is that government mainly spends on non-traded goods. Accordingly, a surge in government consumption will favorably affect the demand of the non-traded sector, thus raised its price and generating a real exchange rate appreciation. However, African governments, predominantly sub-Saharan African governments, expend their substantial resources on tradable goods. Consequently the rise in non-traded goods in SSA can not be as equal as those of developed economies. That is why the impact of government expenditure turns out to be insignificant.

As far as the impact of net foreign asset variable concerned, holding other variables constant a 1% boost in NFA on average results a 0.0000572% significant appreciation of real exchange rate. The result of NFA confirms our conjecture that higher net foreign asset payments from abroad would lead to higher capital inflows (mainly in the form of foreign aid) and high demand to domestic currency, leading to an upward pressure on the exchange rate. This empirical finding is in line with Elbadawi etal's (2008) clarification in that scaling up of net foreign asset in SSA, particularly in the form of foreign aid, can result an overvaluation of real exchange rate.

Using the estimated coefficients and the permanent values of the fundamentals, we can construct the real exchange rate misalignment indicator. In the next section, we will analyze the misalignment index in SSA countries and explore its impact on economic growth.

4.2 Descriptive and Econometric Analysis of Growth Models

4.2.1 Descriptive Analysis

Before we conduct the GMM regressions of economic growth, we shall examine the summary statistics, the overtime average trend, intensity of collinearity, the degree of graphical association, and the extent of normality for the economic growth variables.

Appendix B.1, reports the summary statistics for the dependent and independent variables of the specified growth model. Except the misalignment index, all variables have a positive mean value in the period under consideration. Looking at the misalignment index deeply, the sample countries registered an average misalignment of -7.798 with the highest undervaluation of -12.86 in Zambia (1986) and with the lowest undervaluation of -0.234 in Ghana (1982). There is a slight variation in the degree of misalignment among sub-Saharan African countries. What is most surprising regarding the computed misalignment indicator is that, there is no any overvalued currency compared with equilibrium value for the sample at hand. All the currencies elucidate real exchange rate misalignment in the form of undervaluation with varying degree. This computational result is inline with the earlier empirical findings of Elbadawi etal (2008) and Greens and Ghura (1993).

Appendix B.1 also presents the average value of per capita GDP and growth rate of per capita GDP for SSA. Concerning per capita GDP, SSA has an average of 987.6 dollar with significant variation. The highest Per capita GDP (i.e. 8349.8$) is documented in Seychelles by the year 2007. In contrast, the lowest level of per capita GDP (which is 80.6$) is registered by Congo Democratic Republic by 2001. With an average of 0.467, both the minimum (-46.89) and the maximum (37.8386) GDP per capita growth is attained by Rwanda in the year 1994 and 1995 respectively. The summary statistics table also presents an average of 19.8 gross capital formation (as a ratio of GDP) and an average of 2.57 population growth rate with small variation.

- **Normality Test result**

As we have described in the real exchange rate model, apart from the other pre-estimation test, the normality of the economic variables should be examined in order to conduct the major econometric regression. As it is evidently illustrated on table 4.6, the logarithmic transformation of gross capital formation, terms of trade, and growth rate of per capita income are found to be normally distributed at 1% significance level. Moreover, population growth rate and misalignment indicator are normally distributed with 1% significance level. As far as government expenditure and openness to trade are concerned, we have found a moderately better normal distribution than the distributions of the variables that they exhibit at levels.

Table 4.6 Normality Measurement for Variables in the Economic Growth Equation

Skewness/Kurtosis tests for Normality

Variable	Pr(Skewness)	Pr(Kurtosis)	joint chi2(2)	joint Prob>chi2
logg	0.767	0.125	2.44	0.2948
loggcf	0.000	0.000	125.45	0.0000
logopen	0.659	0.162	2.15	0.3410
logtot	0.000	0.000	99.07	0.0000
pop_gr	0.000	0.000	459.09	0.0000
misalt	0.000	0.000	86.09	0.0000
growth	0.000	0.000	340.79	0.0000

In a nut shell, we can carry out the major econometric estimation as most of the variables are normally distributed.

- **Measurement of multicollinearity**

The dynamic GMM estimation method can solve the problems of endogeneity, omitted variable bias, serial correlation and heteroskedasticity. However, one crucial pre-estimation test that should be done is the test of the approximate linear relationship among the explanatory variables (i.e. multicollinearity).

Pair-wise correlation between regressors is one of the most commonly employed detection method to measure the problem of multicollinearity. The correlation matrix reported in Appendix B.2 measures the severity of linear relationship among the economic growth explanatory variables. In a nut shell, the reported outcome reveals the absence of the problem of multicollinearity. The highest pair-wise correlation occurred between gross capital formation and government expenditure, 0.41, is very small compared to correlation values of 0.8 and above which are commonly taken as a rule of thumb to conclude the presence of multicollinearity problem.

- **The mean trend values of some variables overtime**

Under appendix B.3 we have depicted the graphs of averaged trends of actual real exchange rate, ERER, exchange rate misalignment, GDP per capita, and growth of GDP per capita for SSA under the period in contemplation. The average values of each variable are generated and depicted for every specific year.

The mean ERER and Actual RER had continuously depreciated up to the year 2002. But, the increase in the graphs of ERER and ARER after 2002 reveals the presence of a slight overvaluation of the average values of the currencies. The trend of exchange rate misalignment for SSA, which is our core variable, has shown an irregular movement. Although the average misalignment indicator had continually declined (undervalued) from 1980-1985, it has on average overvalued from 1986-1994. The disequilibrium, finally, exhibit an average depreciation until the year 2007.

Looking at the remaining variables of interest, we can infer a continuous up-ward rise for the average GDP per capita of SSA. In sharp contrast, the trend of average GDP per capita growth rate is unstable. The depicted values explain rapid ups and downs from time to time. However, the GDP per capita growth rate has shown an approximate improvement.

- **A simple correlation between economic growth and its determinants**

Prior to dealing with the major problem at hand by using econometric estimation, it is indispensable to explore the association between GDP per capita growth and its individual determinants. As it can be seen from appendix B.4, an average positive association can be observed between GDP per capita growth, and gross capital formation, trade openness, exchange rate misalignment as well as government expenditure in order of there degree of strength. On the contrary, a negative association can be deduced between GDP per capita, and terms of trade as well as population growth rate.

Although the above graphical relationships portray the individual association between per capita GDP and its determinants, it neither expose the statistical significance of the relationship nor guarantees whether this relationship can be maintained when other explanatory variables simultaneously included. The most dependable and sophisticated econometric analysis will be undertaken in the following subsection.

4.2.2 System GMM Econometric Analysis

In this section we shall investigate the impact of exchange rate misalignment on economic growth using more advanced econometric estimation techniques. In particular, we will focus on the effect of real exchange rate misalignment, variability of real exchange rate misalignment, low undervaluation and high undervaluation on economic growth of SSA, as provided in the previous sections.

4.2.2.1 Exchange rate misalignment and economic performance

To study the link between RER misalignment and economic growth, we will estimate the previously specified growth model that nests the different strands of the growth literature. In table 4.7, below, we report our regression estimates using the two step system GMM estimation technique.

Table 4.7 The impact of exchange rate misalignment on per capita GDP growth: 2 step System GMM regression outcome

Variable	Coefficient	Std. Error	t-Statistic	Prob.
GROWTHLAG	-0.218428	0.033768	-6.468550	0.0000***
POP_GR	0.000320	0.006368	0.050316	0.9600
MISALT	-0.035868	0.011847	-3.027634	0.0031***
LOGTOT	0.048367	0.016083	3.007378	0.0033***
LOGOPEN	0.041786	0.019672	2.124194	0.0360**
LOGGCF	0.095123	0.022128	4.298732	0.0000***
LOGG	-0.041048	0.026635	-1.541140	0.1263

Effects Specification

Cross-section fixed (orthogonal deviations)
Period fixed (dummy variables)

Mean dependent var	-0.036851	S.D. dependent var	0.095764
S.E. of regression	0.081007	Sum squared resid	0.689031
J-statistic	51.27971	Instrument rank	64

Note:

1. *The dependent variable is the growth of per capita GDP. Growth lag is the first lag of the log of per capita GDP.*
2. *We have included period specific effects to account the unobserved time specific effects.*
3. *We have used "white diagonal" GMM weights and "white diagonal standard errors & covariance" Coefficient covariance methods to compute standard errors that are robust to serial correlation and standard errors which are corrected for heteroskedasticity.*
4. *We have also test the sargan test of over identification using the J-statistic, the number coefficients estimated and the instrument rank. Since the calculated probability of the test is 0.7 we fail to reject the null hypothesis of the over-identifying restrictions are valid.*
5. *On the table ***, **, * indicates the test is significant at 1%, 5% and 10% respectively.*
6. *The lags of the dependent and independent variables are used as an instrument.*
7. *We have employed E-views (version 7) to estimate the dynamic system growth GMM regression equation.*

From the above regression result, we find evidence for presence of conditional convergence in sub-Saharan countries. Since the coefficient of the first lag of per capita GDP is negative and significance at 1%, it confirms that countries with lower per capita income grows faster than countries with higher per capita income. Our result is inline with the theoretical prediction that we have dealt in the previous chapter as well as the empirical investigations of Aguirre & Calderon (2005), Toulaboe D., 2000, Sallenave A., 2010 and others.

The estimated coefficient for the growth of population is found to have a very small and statistically insignificant effect on the growth of per capita income. A 1% increase in population growth, holding other factors constant, results on average a 0.00032% rise in growth of per capita income. This finding contradicts with the theoretical predictions of Solow model: population growth has a negative and significant consequence on growth. In sub-Saharan Africa due to the presence of higher dependency ratio and the unproductiveness of the man power, population growth does not have any positive contribution to the growth process.

The terms of trade which captures both the change in international demand for a country's export and the cost of production, have a positive and statistically significant effect on per capita income growth. In fact, there is no consensus on the impact of terms of trade and its volatility on growth in the theoretical literature. If the income effect outweighs the substitution effect, an increase in terms of trade, will help to foster economic growth. The above GMM output elucidates a 1% increase in terms of trade will lead to a 0.048% long-run significant rise in the growth of SSA economies. This evidence supports our argument that the income effect is greater than the substitution effect in the case of sub-Saharan Africa. This result conforms to the empirical result of Collins M., and Ofair R. S. (1997) that identified the raising of terms of trade is helpful for economic growth.

When we see the elasticity of openness to international trade, we have found a 1% increase in the level of openness leads to (on average) a 0.0417% boost in the per capita income, citrus paribus. Thus, the more SSA countries are outward-oriented the more this contributes favorably to economic growth. This result suggests, sub-Saharan African countries should minimize and/or abolish the level of trade taxes, quota, exchange controls and other restrictions which are against trade liberalization. The executed elasticity of openness for SSA is inline with the theoretical predictions as well as the empirical results of Elbadawi etal (2008), Sallenave A., 2010, Aguirrea A., Calderón C. (2006) and others.

The estimated elasticity of gross capital formation has the theoretical signs predicted by the Solow growth model. The coefficient of gross capital formation (as a percentage of GDP) variable is positive and significant (at 1%), reflecting the importance of capital accumulation for developing countries such as SSA. Citrus paribus, a 1% adjustment in the level of gross capital formation results a 0.095% change in the growth rate of per capita GDP. This result is inline with the vast empirical outcomes of growth models such as Nouira R. and Sekkat K., (2010).

Regarding the elasticity of government expenditure, the result indicates that fiscal policy matters for economic growth. The fiscal policy variable, proxied by government consumption as a percentage of GDP, has a negative coefficient although it is insignificant. Even though sound government policy is crucial for sustainable economic advancement, excessive government participation in an economy can hinder economic growth, especially in developing countries. The strong involvement of government in the economy may weaken the private sector through excessive taxation. In addition, higher government expenditure (which is mainly achieved by public borrowing), may crowd out private investment which was a vital engine for economic acceleration. Elbadawi etal (2008), Toulaboe D., (2000), Ghura D. and Greenes T.J. (1993) and others have obtained a similar estimation outcome.

Turning our attention to the main investigation at hand, the relationship between RER misalignment and economic growth is explored. From table 4.7, it is clear that other factors remaining constant the 5 year average exchange rate misalignments are negatively associated with economic growth. The coefficient of the misalignment variable is negative and statistically large at 1% level of significance. This result implies, holding other factors fixed, (on average) a 1% increase in the misalignment of RER will result in a 0.036% decline in the growth of per capita income. The results, therefore, confirms how much real exchange rate misalignment hampers the economic performance (proxied by economic growth) for the sub-region. Alike the previous empirical investigations (demonstrated under the review literature), the current study lends the fact that exchange rate policy plays a pivotal role in the growth endeavor of sub-Saharan African countries. Countries that pursue major and appropriate exchange rate reforms to eliminate RER misalignment are very likely to record gains in real per capita GDP.

As illustrated in chapter three, the Sargan test of over identifying restriction tests whether the instruments applied for the system GMM growth regressions are not correlated with the error terms. Hence the validity of the system GMM growth regression result can be measured by the sargan test value. The sargan test of over-identifying restriction, as we pointed out earlier, supports the correctness of the estimated system GMM growth model. Furthermore, the Wald test provided in appendix B.5 indicates the regression coefficients are not jointly zero. This is due to the fact that we fail to reject the null hypothesis which hypothesizes the regression coefficients are not jointly zero.

As a final remark, since we have employed the “white diagonal” GMM weights and the “white diagonal” coefficient covariance methods, all the standard errors presented for the above system GMM estimates are robust to heteroskedasticity and autocorrelation of arbitrary form.

4.2.2.2 Variability of exchange rate misalignment and economic performance

The next mission is to estimate the probable effect of exchange rate misalignment variability on economic growth. Table 4.8, below, exhibits the impact of misalignment variability on economic growth. As illustrated in the methodology part, all the independent variables of misalignment and economic growth are maintained in this growth regression. We have only replaced exchange rate misalignment by its variability.

Like the former 2 step system GMM, we have employed the sargan test of over identifying restriction to understand whether the instruments are correlated with residual or not. Since the probability value of the test is 0.72, it strongly supports the validity of the instruments (they do not correlate with the residuals).

Table 4.8 The impact of the volatility of exchange rate misalignment on per capita GDP growth: 2 step System GMM regression outcome

Variable	Coefficient	Std. Error	t-Statistic	Prob.
GROWTHLAG	-0.203990	0.029604	-6.890532	0.00***
VOLATILITY_OF_MISAL	-0.322776	0.030505	-10.58107	0.00***
POP_GR	0.003936	0.004293	0.916977	0.36
LOGTOT	0.049674	0.013092	3.794305	0.00***
LOGOPEN	0.031387	0.016544	1.897140	0.06*
LOGGCF	0.110923	0.015169	7.312623	0.00***
LOGG	0.015234	0.016777	0.908069	0.36

Effects Specification

Cross-section fixed (orthogonal deviations)
Period fixed (dummy variables)

Mean dependent var	-0.036851	S.D. dependent var	0.095764
S.E. of regression	0.075488	Sum squared resid	0.598331
J-statistic	55.25246	Instrument rank	73

Note:

1. *The dependent variable is the growth of per capita GDP. Growth lag is the first lag of the log of per capita GDP.*
2. *We have included period specific effects to account the unobserved time specific effects.*
3. *We have used "white diagonal" GMM weights and "white diagonal standard errors & covariance" Coefficient covariance methods to compute standard errors that are robust to serial correlation and standard errors which are corrected for heteroskedasticity.*
4. *We have also test the sargan test of over identification using the J-statistic, the number coefficients estimated and the instrument rank. Since the calculated probability of the test is 0.72 we fail to reject the null hypothesis of the over-identifying restrictions are valid.*
5. *On the table ***, **, * indicates the test is significant at 1%, 5% and 10% respectively.*
6. *The lags of the dependent and independent variables are used as an instrument.*
7. *We have employed E-views (version 7) to estimate the two step dynamic system growth GMM regression equation.*

As it is shown in the above table, real exchange rate variability has a negative significant effect at one percent level of significance. Holding other growth determinants constant, a 1% increase in the volatility of misalignment leads (on average) a 0.323% decrease in the growth of per capita GDP. The adverse effect of exchange rate volatility is found to be higher than the negative effect of exchange rate disequilibrium. This result confirms the argument that misalignment volatility will result in instability on the general economic environment.

This econometric finding is consistent with previous empirical findings of Ghura D., and Grennes T.J. (1993), Toulaboe D., (2000), and Aguirrea A., Calderón C. (2006). Many Sub-Saharan African economies have maintained what are essentially called managed floating exchange rate systems. Due to this reason the actual exchange rate is relatively inflexible. However, the equilibrium exchange rate, which is mainly affected by terms of trade and net foreign asset, quickly fluctuates. This ultimately brings excessively volatile exchange rate misalignment that largely hinders the economic progress of SSA.

When we observe the elasticity of the remaining growth determinants, we have found a similar effect as the earlier two- step GMM regression result. The computed standard errors in table 4.8 are also robust to serial correlation and heteroskedasticity problems. The Wald test statistics in appendix B.6 verified the overall significant of the coefficients of the above two-stem system GMM regression result.

4.2.2.3 Low undervaluation, high undervaluation and economic performance

The other direction in which the effect of exchange rate misalignment can be seen is by sub-dividing the undervaluation episodes into two distinct categories. All values of exchange rate misalignment higher than -6 are taken as “lower-undervaluation”. While all values of exchange rate misalignment lower than -6 are labeled as “higher-undervaluation”. By applying this technique we can test the possible existence of a nonlinear relationship between growth and RER misalignments.

The results on table 4.9 and 4.10 show the effect of lower and higher undervaluation on economic growth respectively. The sargan tests, for the two results, prove the absence of the problem of collinearity between the instruments and the error term. The estimation methodology employed is identically similar to the previous two system GMM results.

Table 4.9 The impact of low undervaluation on per capita GDP growth: 2 step System GMM regression outcome

Variable	Coefficient	Std. Error	t-Statistic	Prob.
GROWTHLAG	-0.255408	0.035768	-7.140716	0.0000***
LOW_UNDERVALUATION	0.082676	0.039880	2.073095	0.0406**
POP_GR	0.002469	0.005679	0.434795	0.6646
LOGTOT	0.089590	0.009846	9.099085	0.0000***
LOGOPEN	0.019497	0.015679	1.243466	0.2165
LOGGCF	0.109317	0.023940	4.566370	0.0000***
LOGG	0.033301	0.023852	1.396107	0.1656
	Effects Specification			
Cross-section fixed (orthogonal deviations)				
Period fixed (dummy variables)				
Mean dependent var	-0.036851	S.D. dependent var		0.095764
S.E. of regression	0.081666	Sum squared resid		0.700286
J-statistic	47.72342	Instrument rank		63

Note:

1. *The dependent variable is the growth of per capita GDP. Growth lag is the first lag of the log of per capita GDP.*
2. *We have included period specific effects to account the unobserved time specific effects.*
3. *We have used "white diagonal" GMM weights and "white diagonal standard errors & covariance" Coefficient covariance methods to compute standard errors that are robust to serial correlation and standard errors which are corrected for heteroskedasticity.*
4. *We have also test the sargan test of over identification using the J-statistic, the number coefficients estimated and the instrument rank. Since the calculated probability of the test is 0.64 we fail to reject the null hypothesis of the over-identifying restrictions are valid.*
5. *On the table ***, **, * indicates the test is significant at 1%, 5% and 10% respectively.*
6. *The lags of the dependent and independent variables are used as an instrument.*
7. *We have employed E-views (version 7) to estimate the two step dynamic system growth GMM regression equation.*

The above two step GMM growth regression output disentangle the positive and significant effect of smaller undervaluation on the growth of per capita GDP, at 5% significance level. This result shows the benefit of lower-undervaluation on the economic progress of SSA.

In contrast, table 4.10 reports the system GMM regression outcome of the effect of higher undervaluation on economic growth. As it can be looked out from the table, higher-undervaluation has a negative and significant effect on economic growth rate. Holding other determinants constant, a one unit enhancement in the level of higher-undervaluation will result 0.083% decline in the growth of per capita income.

Table 4.10 The impact of higher undervaluation on per capita GDP growth: 2 step System GMM regression outcome

Variable	Coefficient	Std. Error	t-Statistic	Prob.
GROWTHLAG	-0.255408	0.035768	-7.140716	0.0000***
HIGH_UNDERVALUATION	-0.082676	0.039880	-2.073095	0.0406**
POP_GR	0.002469	0.005679	0.434795	0.6646
LOGTOT	0.089590	0.009846	9.099085	0.0000***
LOGOPEN	0.019497	0.015679	1.243466	0.2165
LOGGCF	0.109317	0.023940	4.566370	0.0000***
LOGG	0.033301	0.023852	1.396107	0.1656
Effects Specification				
Cross-section fixed (orthogonal deviations)				
Period fixed (dummy variables)				
Mean dependent var	-0.036851	S.D. dependent var		0.095764
S.E. of regression	0.081666	Sum squared resid		0.700286
J-statistic	47.72342	Instrument rank		63

Note:

1. *The dependent variable is the growth of per capita GDP. Growth lag is the first lag of the log of per capita GDP.*
2. *We have included period specific effects to account the unobserved time specific effects.*
3. *We have used "white diagonal" GMM weights and "white diagonal standard errors & covariance" Coefficient covariance methods to compute standard errors that are robust to serial correlation and standard errors which are corrected for heteroskedasticity.*
4. *We have also test the sargan test of over identification using the J-statistic, the number coefficients estimated and the instrument rank. Since the calculated probability of the test is 0.65 we fail to reject the null hypothesis of the over-identifying restrictions are valid.*
5. *On the table ***, **, * indicates the test is significant at 1%, 5% and 10% respectively.*
6. *The lags of the dependent and independent variables are used as an instrument.*
7. *We have employed E-views (version 7) to estimate the two step dynamic system growth GMM regression equation.*

The results confirm the existence of non-linearity in the relationships of exchange rate misalignment and economic growth. Even though, higher undervaluation is deleterious for economic progress, smaller undervaluation is identified to be crucial to stimulate economic growth. Consequently, this result yields a similar conclusion to the empirical findings of Nouira R. and Sekkat K., (2010), Aguirre, A. and Calderon, C. (2005), and Razin, O. and Collins, S.M. (1997. The Wald test reported on Appendix B.7 and Appendix B.8 also reflects the rejection of the null hypothesis that states all the coefficients are jointly zero.

Chapter Five

Conclusions and Recommendations

Academicians and policy makers have arrived at a consensus on the deleterious effect of real exchange rate misalignment on the economic performance of most countries. Different theoretical models and empirical investigations have demonstrated how exchange rate misalignment can generate incorrect signals to economic agents and thereby results distortion in resource allocation, significant loss of welfare, severe loss of efficiency, greater economic instability and poor economic performance.

For this reason, real exchange rate issues have been given greater emphasis by the academic community and policy formulators in developed countries. Despite the vital function of the issue in the current globalized world, adequate and careful investigations have not been conducted in sub-Saharan Africa. There are almost no researches that have been carried out using exclusive data on sub-Saharan countries accompanied with appropriate econometric methodologies.

In this study, we have explored the impact of sustained real exchange rate misalignment and its volatility on the economic growth of African countries located south of the Saharan desert. By employing a panel data set of 29 sub-Saharan African countries from the period 1980 to 2007, we have estimated four kinds of econometric models.

In the first model, we have estimated the reduced single ERER equation of SSA by utilizing the panel DOLS cointegration estimation technique. From the result real exchange rate appreciation has been found when there is an increase in terms of trade, capital flow, productivity and government expenditure. In contrast, the more open the SSA economy the more depreciated the real exchange rate. Particularly terms of trade and capital flow have significant effect on ERER.

The second part of the econometric regression starts by exploring the relationship between RER misalignment and economic growth. The result indicates that average exchange rate misalignment have detrimental effect on economic growth. The more overvalued (undervalued) the RER, the lower (the higher) the per capita growth rate is. The result also shows, inappropriate exchange rate policies in SSA that generally lead to high disequilibrium RER appreciation, may explain, at least partially, the poor economic performance that these regions experience.

The third estimation output finds a negative and significant relationship between economic growth and the variability of exchange rate misalignment. This result agrees with both the theoretical models as well as the former empirical investigations.

Ultimately, two estimations are undertaken to explore the existence of non-linear relationship between RER misalignment and economic growth. Alike the previous empirical investigations, the impact of undervalued misalignment on economic growth depends on its size. The larger the size of undervaluation the higher the adverse impact it has on growth. On the other hand, lower undervaluation is conducive to growth.

To avert the undesirable consequence of high disequilibrium RER appreciation and variability of misalignment on the welfare, growth, and development prospect of sub-Saharan African countries, policy makers of governments are recommended to devise prudent and appropriate macroeconomic policies to keep the RER at a competitive depreciated level. Government bodies must carry out direct devaluation of the nominal exchange rate; undertake a careful adjustment of ERER fundamentals (such as reducing foreign aid inflow, taxing socially undesirable imports like alcohols, harmful drugs and cigarettes); adopt appropriate fiscal and monetary policy changes (such as reducing unproductive government expenditures and plummeting money supply through reduction of governments' Seignorage or inflation tax); and making disinflation measures to control domestic price hike in order to achieve a moderately depreciated RER of the SSA currencies.

Eventually, we point out the following research areas as potential topics for further investigations in African countries:

1. Future research should focus on indentifying and expanding the set of economic fundamentals (as dependable data become available) to empirically determine the link between these fundamentals and the real exchange rate.
2. Generate productive outcomes by assessing the direct impact of exchange rate misalignment on the individual determinants of economic growth such as investment, agricultural output, import, export and private saving.
3. Derive relatively better exchange rate misalignment indicator by employing real effective exchange rate instead of real exchange rate of a currency.
4. Broaden the sample by incorporating North African countries to investigate the poisonous effect exchange rate misalignment on the economic growth of Africa.

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APPENDICES

Appendix A: Summary Statistics, Unit Root Test and Cointegration Test for Real Exchange Rate Model

Appendix A.1: Summary Statistics for Logarithimic variables of RER equation

Variable		Mean	Std. Dev.	Min	Max	Observations
logarer	overall	-4.342979	2.301665	-8.682796	3.770889	N = 812
	between		2.321622	-7.82179	1.591368	n = 29
	within		.2952516	-5.203985	-2.163458	T = 28
logtot	overall	4.636635	.4119481	2.734367	5.879347	N = 812
	between		.310443	3.530179	5.160223	n = 29
	within		.2766495	3.265334	5.475378	T = 28
logg	overall	2.673683	.4164062	.9747992	3.998484	N = 812
	between		.3340091	2.071549	3.409884	n = 29
	within		.25602	1.075776	3.794764	T = 28
loggdp~r	overall	1.337905	.9238792	-4.029294	3.56173	N = 627
	between		.3061711	.5224489	1.89103	n = 29
	within		.875863	-3.636346	3.222471	T-bar = 21.6207
logopen	overall	4.151849	.5460577	1.843773	5.414581	N = 812
	between		.4872793	3.208508	5.065571	n = 29
	within		.2619979	2.148608	5.058842	T = 28
nfa	overall	-4148.238	7370.648	-71731.84	28762.21	N = 812
	between		6095.939	-24122.44	2801.99	n = 29
	within		4289.887	-53581.7	48736.42	T = 28

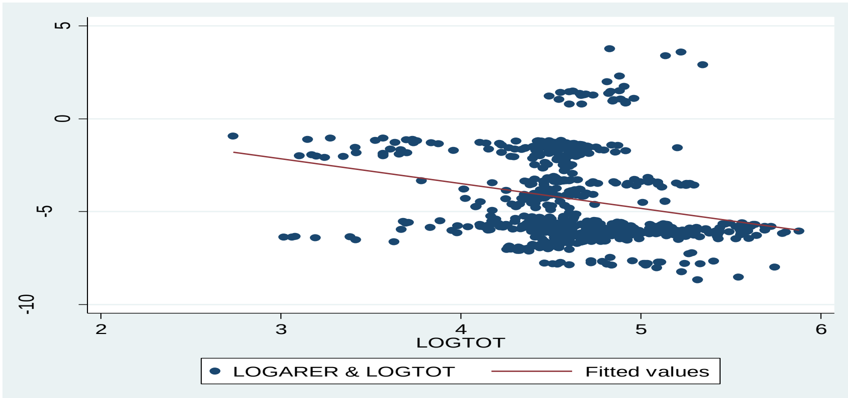
.

Appendix A.2: Correlation matrix among variables in RER model

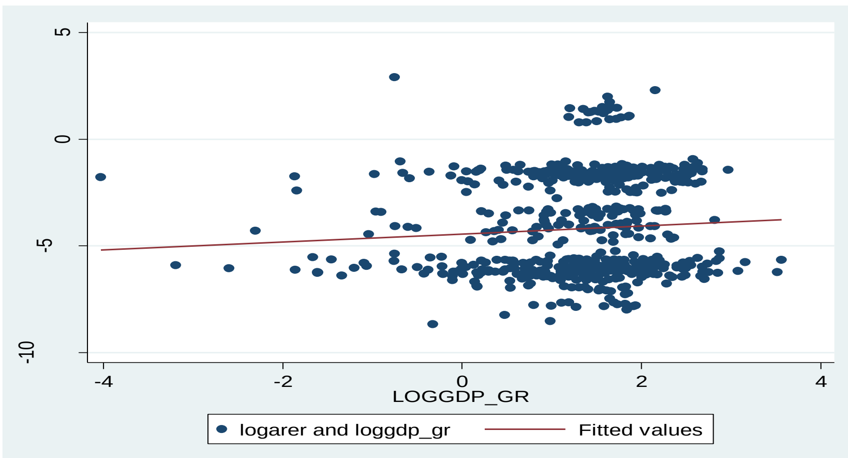
	logarer	logtot	loggdp~r	logg	logopen	nfa
logarer	1.0000					
logtot	-0.2324	1.0000				
loggdp_gr	0.0743	-0.0698	1.0000			
logg	0.3672	0.0560	0.0091	1.0000		
logopen	0.2882	0.0390	0.0559	0.3965	1.0000	
nfa	0.0102	0.1035	0.1052	0.0789	0.0755	1.0000

Appendix A.3: Graphical relationship between Actual Real Exchange Rate and its determinants

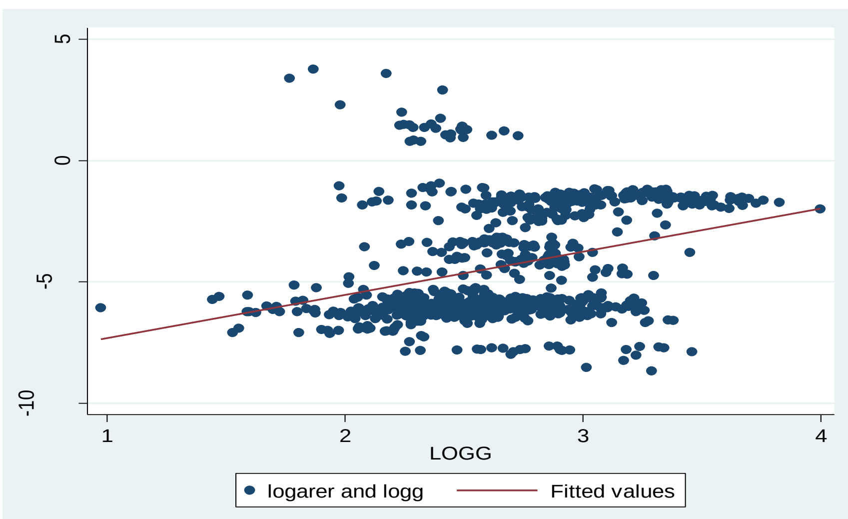
a. Real exchange rate versus terms of trade



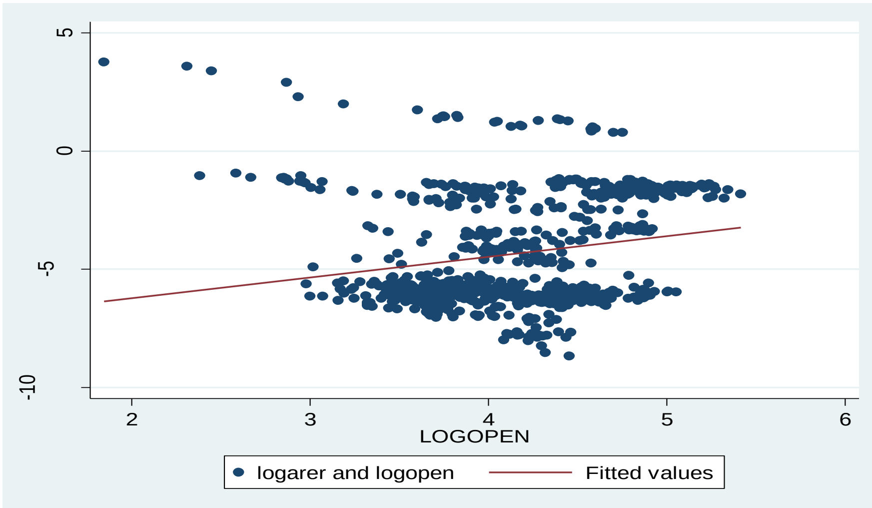
b. Real exchange rate versus growth of GDP



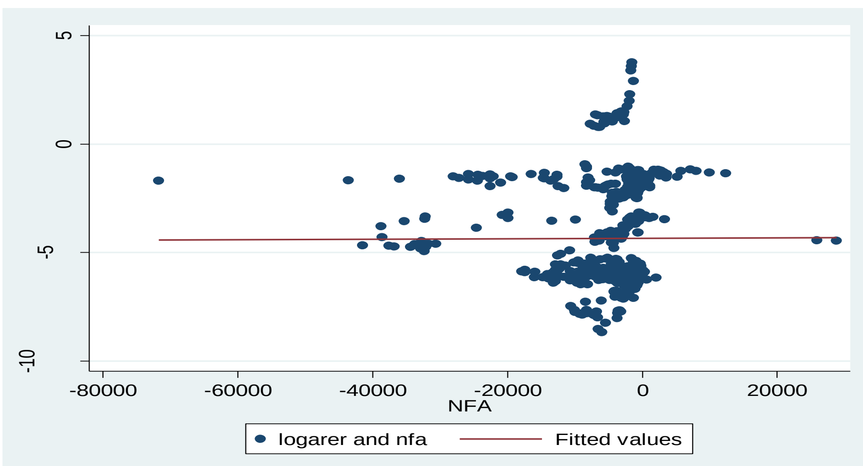
c. Real exchange rate versus government expenditure



d. Real exchange rate versus openness



e. Real exchange rate versus net foreign asset



Appendix A.4: Pedroni Panel residual cointegration test of real exchange rate model

Series: LOGARER LOGG LOGGDP_GR LOGOPEN LOGTOT NFA
Null Hypothesis: No cointegration
Trend assumption: Deterministic intercept and trend
Automatic lag length selection based on SIC with a max lag of 5
Newey-West automatic bandwidth selection and Bartlett kernel

Alternative hypothesis: common AR coefs. (within-dimension)

	Statistic	Prob.
Panel v-Statistic	-269.0648	1.0000
Panel rho-Statistic	2.589631	0.9952
Panel PP-Statistic	-1.973922	0.0242
Panel ADF-Statistic	3.656976	0.0999

Alternative hypothesis: individual AR coefs. (between-dimension)

	Statistic	Prob.
Group rho-Statistic	4.414001	1.0000
Group PP-Statistic	-4.408772	0.0000
Group ADF-Statistic	-3.926030	0.0000

Appendix B: summary statistics, correlation matrix and graphical relationships in the economic growth model

Appendix B.1 summary statistics for variables in growth regression

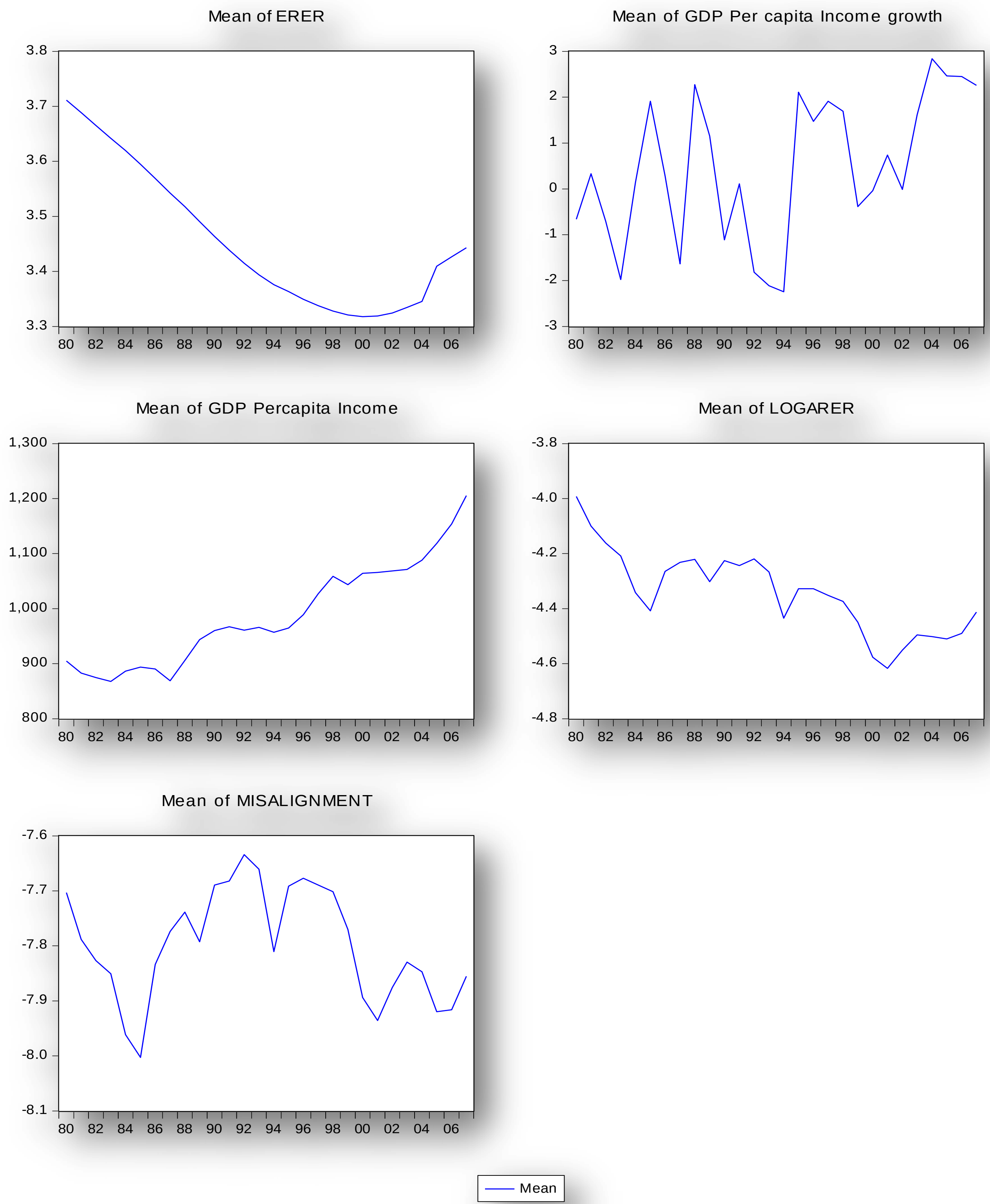
Variable		Mean	Std. Dev.	Min	Max	Observations
open	overall	75.48488	40.67628	14.78415	237.0127	N = 812
	between		36.70463	25.91677	168.1813	n = 29
	within		18.76652	17.14429	213.5311	T = 28
tot	overall	112.1871	47.11124	15.4	357.5758	N = 812
	between		32.49672	43.12798	191.958	n = 29
	within		34.62066	3.8591	301.3142	T = 28
g	overall	15.80318	6.878565	2.650635	54.51542	N = 812
	between		5.511241	8.40774	31.31442	n = 29
	within		4.236992	2.285226	50.66586	T = 28
gcf	overall	19.80846	9.571858	1.763038	76.69449	N = 812
	between		7.233713	10.09675	46.40225	n = 29
	within		6.405929	-.8593229	64.39273	T = 28
gdp__p~r	overall	.4659743	5.524571	-46.89249	37.83861	N = 812
	between		1.803046	-3.432751	5.056867	n = 29
	within		5.232412	-47.84436	36.88674	T = 28
gdp_pc	overall	987.5914	1483.33	80.62465	8349.811	N = 811
	between		1462.892	129.9816	5976.485	n = 29
	within		360.2951	-1065.852	3360.917	T-bar = 27.9655
pop_gr	overall	2.570646	1.173079	-8.271369	10.04283	N = 812
	between		.6053339	1.005219	3.565706	n = 29
	within		1.010882	-7.955596	10.3586	T = 28
misalt	overall	-7.798231	2.479124	-12.86569	-.234091	N = 812
	between		2.48951	-11.65987	-1.998274	n = 29
	within		.3933588	-10.60072	-5.946792	T = 28

.

Appendix B.2 Correlation Matrix among Economic Growth variables

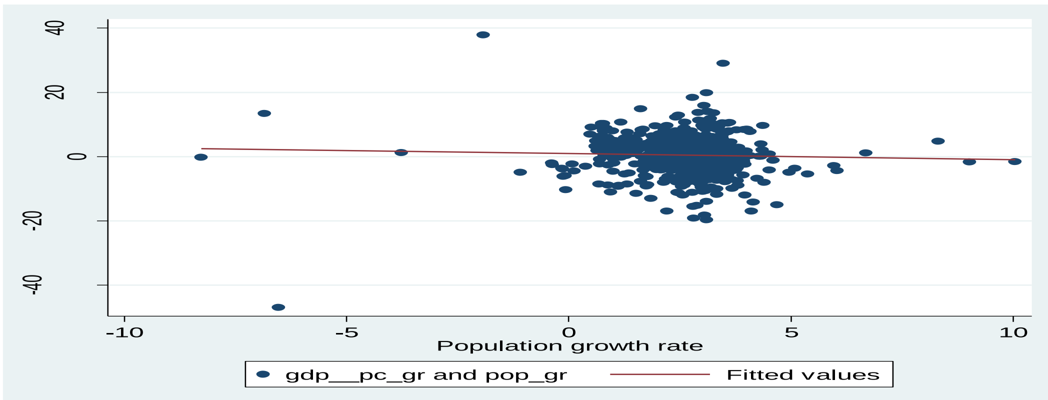
	logg	loggcf	logopen	logtot	pop_gr	misalt	growth
logg	1.0000						
loggcf	0.4054	1.0000					
logopen	0.1929	0.3923	1.0000				
logtot	0.0706	-0.1115	-0.0498	1.0000			
pop_gr	-0.1553	-0.0922	-0.2304	0.1028	1.0000		
misalt	0.2759	0.2542	0.3670	-0.3654	-0.1574	1.0000	
growth	0.0139	0.1037	0.0383	0.0062	-0.0078	0.0065	1.0000

Appendix B.3 the overtime mean trend values of the various variants of RER and GDP per capita income for SSA

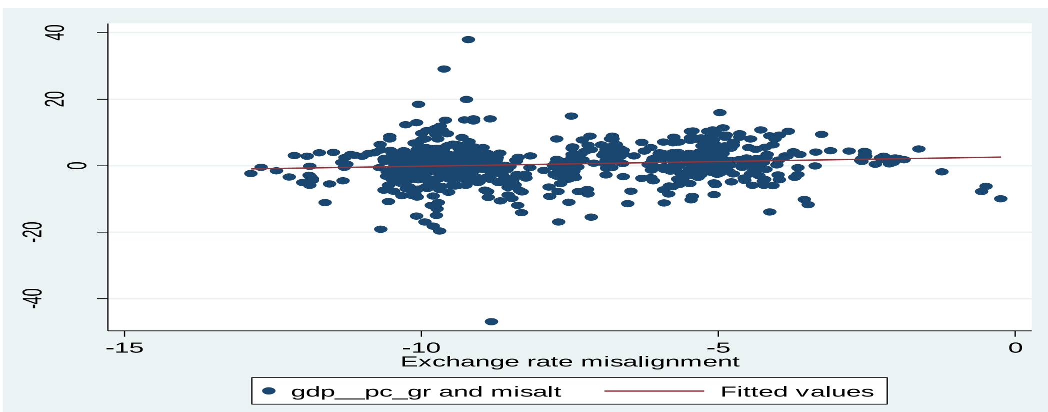


Appendix B.4 Graphical Relationship between GDP Per Capita Growth and Its Determinants

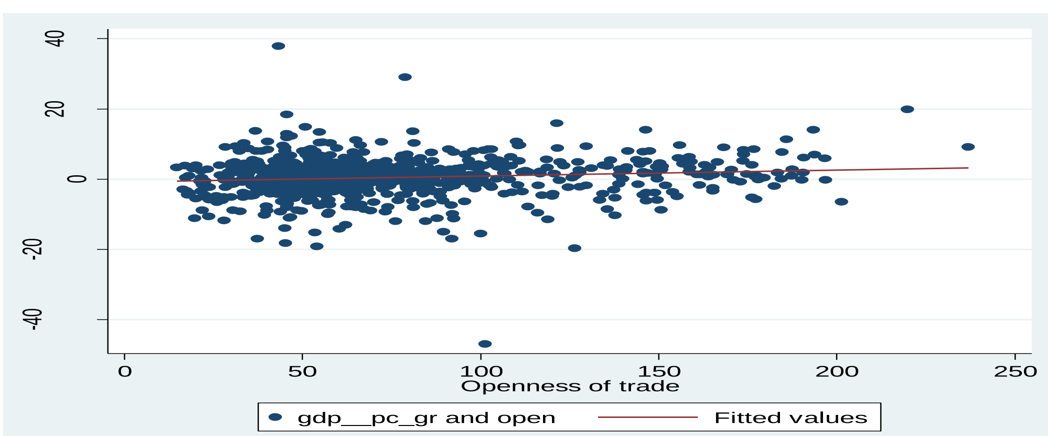
1) Growth rate of GDP per capita versus population growth



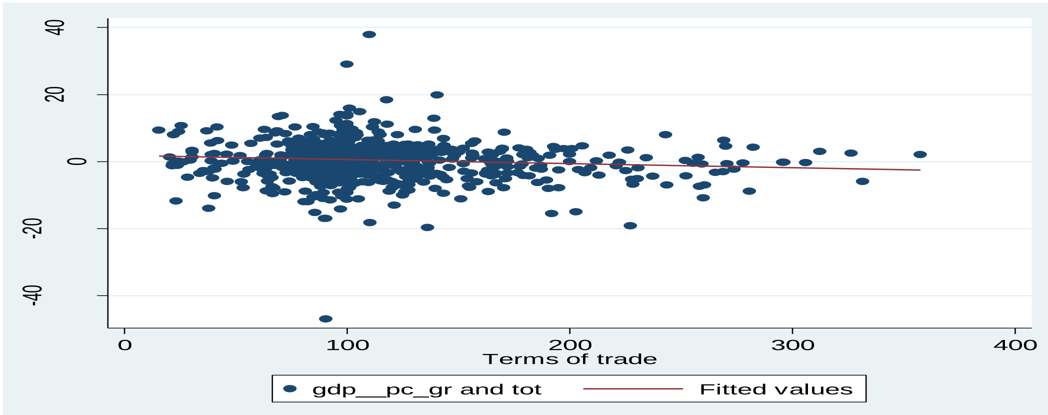
2) Growth rate of GDP per capita versus exchange rate misalignment



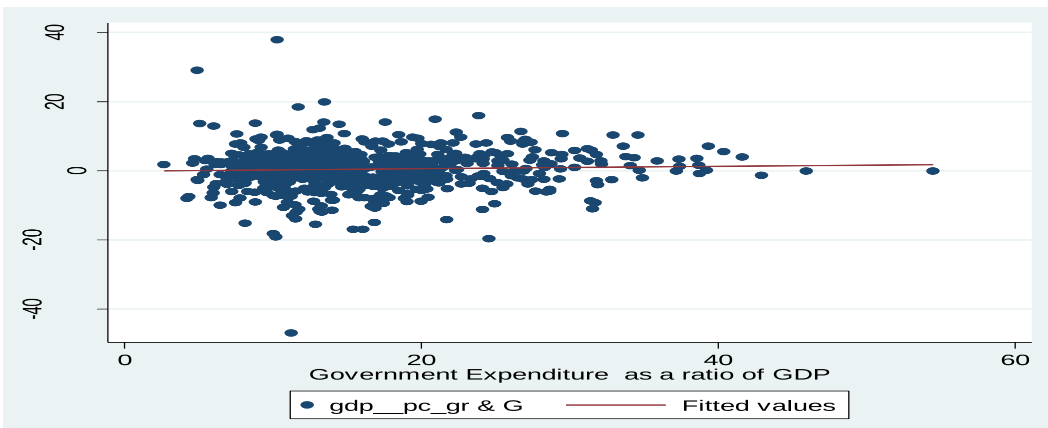
3) Growth rate of GDP per capita versus openness



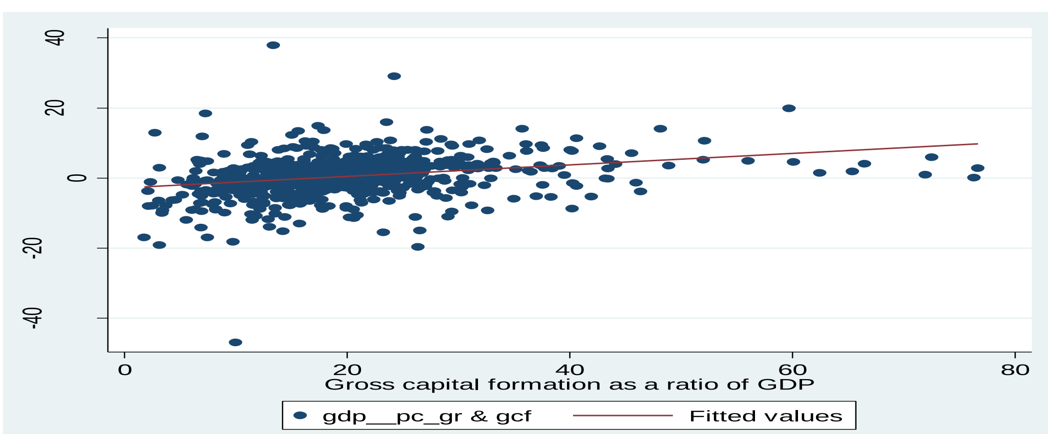
4) Growth rate of GDP per capita versus terms of trade



5) Growth rate of GDP per capita versus government expenditure



6) Growth rate of GDP per capita versus gross capital formation



Appendix B.5: Wald test result for misalignment and economic growth

Equation: Panel GMM regression result for the impact of real exchange rate misalignment on economic growth

Test Statistic	Value	df	Probability
F-statistic	49.62897	(7, 105)	0.0000
Chi-square	347.4028	7	0.0000

Null Hypothesis: C(1)=0, C(2)=0, C(3)=0, C(4)=0, C(5)=0, C(6)=0, C(7)=0
Null Hypothesis Summary:

Normalized Restriction (= 0)	Value	Std. Err.
C(1)	-0.192912	0.034787
C(2)	0.002111	0.004977
C(3)	-0.020676	0.010928
C(4)	0.064635	0.013407
C(5)	0.024229	0.013467
C(6)	0.102234	0.017457
C(7)	-0.012016	0.025315

Restrictions are linear in coefficients.

Appendix B.6: Wald test result for misalignment variability and growth

Equation: Panel GMM regression result for the impact of real exchange rate misalignment on economic growth

Test Statistic	Value	df	Probability
F-statistic	71.28299	(7, 105)	0.0000
Chi-square	498.9809	7	0.0000

Null Hypothesis: C(1)=0, C(2)=0, C(3)=0, C(4)=0, C(5)=0, C(6)=0, C(7)=0
Null Hypothesis Summary:

Normalized Restriction (= 0)	Value	Std. Err.
C(1)	-0.203990	0.029604
C(2)	-0.322776	0.030505
C(3)	0.003936	0.004293
C(4)	0.049674	0.013092
C(5)	0.031387	0.016544
C(6)	0.110923	0.015169
C(7)	0.015234	0.016777

Restrictions are linear in coefficients.

Appendix B.7: Wald test result for low undervaluation and economic growth

Equation: Panel GMM regression result for the impact of low undervaluation on economic growth

Test Statistic	Value	df	Probability
F-statistic	22.68863	(7, 105)	0.0000
Chi-square	158.8204	7	0.0000

Null Hypothesis: C(1)=0, C(2)=0, C(3)=0, C(4)=0, C(5)=0, C(6)=0, C(7)=0

Null Hypothesis Summary:

Normalized Restriction (= 0)	Value	Std. Err.
C(1)	-0.193098	0.041478
C(2)	0.087564	0.050583
C(3)	-0.002990	0.007473
C(4)	0.087404	0.016026
C(5)	0.011114	0.023348
C(6)	0.120541	0.020499
C(7)	0.053042	0.028323

Restrictions are linear in coefficients.

Appendix B.8: Wald test result for high undervaluation and economic growth

Equation: Panel GMM regression result for the impact of high undervaluation on economic growth

Test Statistic	Value	df	Probability
F-statistic	22.68863	(7, 105)	0.0000
Chi-square	158.8204	7	0.0000

Null Hypothesis: C(1)=0, C(2)=0, C(3)=0, C(4)=0, C(5)=0, C(6)=0, C(7)=0

Null Hypothesis Summary:

Normalized Restriction (= 0)	Value	Std. Err.
C(1)	-0.193098	0.041478
C(2)	-0.087564	0.050583
C(3)	-0.002990	0.007473
C(4)	0.087404	0.016026
C(5)	0.011114	0.023348
C(6)	0.120541	0.020499
C(7)	0.053042	0.028323

Restrictions are linear in coefficients.

DECLARATION

I, the undersigned, declare that this thesis is my original work and has not been presented for a degree in any other university, and that all sorts of materials used for this thesis have been duly acknowledged.

The examiners' comments have been duly incorporated.

Declared by:

Name: Dessie Tarko Ambaw

Signature: __________

Date: 30/06/2011

Confirmed by Advisor:

Name: Fantu Guta (Dr.)

Signature: __________

Date: 30/06/2011

Place and date of submission: Addis Ababa University, 30/06/2011