

ADDIS ABABA UNIVERSITY

SCHOOL OF GRADUATE STUDIES

THE BEHAVIOUR AND DETERMINANTS OF REAL
EFFECTIVE EXCHANGE RATE IN ETHIOPIA

BY

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A Thesis Submitted to the School of Graduate Studies of Addis Ababa
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Acronyms

ADF: Augmented Dickey-Fuller
AR: Auto regression
BOP: Balance of Payment
DF: Dickey-Fuller
FDI: Foreign Direct Investment
GDP: Gross Domestic Product
IMF: International Monetary Fund
IFS: International Financial Statistics
JB: Jarque-Berra
KPSS: Kwiatkowski, Phillips, Schmidt and Shin
LM: Lagrange Multiplier
MOFED: Ministry of Finance and Economic Development
NBE: National Bank of Ethiopia
NDEV: Nominal Devaluation
NFA: Net Foreign Asset
NER: Nominal Exchange Rate
NEER: Nominal Effective Exchange Rate
NEERI: Nominal Effective Exchange Rate Index
PP: Phillips-Perron
PPP: Purchasing Power parity
RER: Real Exchange Rate
REER: Real Effective Exchange Rate
REERI: Real Effective Exchange Rate Index
RID: Real Interest Rate Differential
TGE: Transitional Government of Ethiopia
TOT: Terms of Trade
UK: United Kingdom
US: United States
VAR: Vector Auto regression
VECM: Vector Error Correction Model
VIF: Variance Inflation Factor
VMA: Vector Moving Average

Abstract

This paper adopts co-integration and vector error correction approaches to examine the behaviour, and the short run and long run determinants of the quarterly real effective exchange rate; and measure the resulting misalignment in Ethiopia during the period 1993:1 to 2008:2. The data evidence shows that both the actual and equilibrium real effective exchange rates in Ethiopia have been depreciating from 1993:1 to 2004:4. After 2004:4, while the actual value started to show significant appreciation, the equilibrium value has followed a fairly constant trend. The econometrics result reveal that government consumption spending and growth in net domestic credit depreciates the real effective exchange rate both in the short run and the long run; while the ratio of fiscal deficit to high powered money and real international price of oil both lead to currency depreciation in the short run. The real international price of oil is found to have an opposite impact in the long run. On the other hand, the degree of foreign exchange and capital controls lead to currency appreciation in the long run. Furthermore, the estimated long run equilibrium real effective exchange rate and the degree of misalignment show that in general, long run equilibrium exchange rate in Ethiopia doesn't seem to be constant and misalignment ranged from 30.7 percent to -34.3 percent. The recent increase in the actual real effective exchange rate relative to its long run equilibrium value calls for a closer attention on the side of policy makers to combat a fall in the international competitiveness and possible currency crises.

I. INTRODUCTION

1.1. Background of the Study

Exchange rates and exchange rate management are amongst the most important subjects of the recent past policy debates on economic reform especially in most developing countries. This is because exchange rate¹ in many cases has been taken to be an important relative price signaling inter-sectoral growth in the long-run, and recognized as a decisive link between the internal economy and the external world (*Aron et al., 1997; and Ghatak, 1995: 224*); and hence it can be used as an indicator of competitiveness in the foreign trade of a country (*Williamson, 2008*).

In addition, the level of exchange rate and its volatility following shocks to domestic and international economic fundamentals affects the decision to invest in a country depending on whether that country's currency is overvalued or not in comparison with the investing country (*Ruiz, 2005*); and also influences exports and private investment, and hence the international competitiveness of a country (*Caballero and Corbo, 1989; Serven and Solimano, 1991; and Kipici and Kesriyeli, 1997 for example*). In this regard, the level and behaviour of exchange rate affects the price level, interest rate, economic growth, distribution of income, and the level and variability of foreign direct investment (FDI) flows to an economy; besides the international competitiveness position of a country (*Dunn and Mutti, 2004: 378*). Moreover, since it reflects the external price of the sovereign currency, authorities attach much importance and give prestige to the stability of this rate. These aspects bring the exchange rate into the central place of the open economy macroeconomics.

Several researchers have argued that real exchange rate (RER) have important effects not only on general economic performance and international competitiveness, but also on the different sectors of the economy; foreign trade flows, balance of payments, and external debt crisis (*Hazari et al,*

¹ It refers to the real exchange rate in particular.

1992; and Haile, in Taddesse and Abdulhamid, 1994); employment, level and type of investment (Ruiz, 2005); structure of production² and consumption, and inflationary pressure. In addition, some argue that RERs are particularly important for developing economies because of their vulnerability to external shocks, where traded goods' sectors are an important share of GDP (Edwards and Savastano, 1999).

In Ethiopia, three different exchange rate policies have been pursued over the past half a century or so. The main exchange rate stories of the country include the fixing of the Birr for a very long period by the Derge in line with the principles of the so called command economic system and 'the foreign exchange market liberalization' and the maxi-devaluation³ undertaken by the transitional government, and several mini devaluations followed afterwards as one measure of economic reform and a means of stimulating the war torn economy of the country. Thus, a managed floating exchange rate policy is adopted since 1992 (Asmerom, 1999; and Derrese, 2001).

Ethiopia has issued its first legal tender currency (then called the Ethiopian dollar) in 1945, and set its official nominal bilateral exchange rate against the US dollar at 2.48, in accord with the Bretton Woods agreement of 1944 (Derrese, 2001). The Imperial government had continuously revalued the national currency (except for the slight devaluation of 1964) and finally set the exchange rate at 2.07 in 1973. The Derge government adopted this rate and maintained it for its entire life span; which in effect has resulted in an overvalued currency (similar to the Imperial Era) and to the development of the black market (Asmerom, 1999; and Derrese, 2001). There have been some attempts of foreign exchange market liberalization in the post 1991 period. In addition to the maxi devaluation of October 1992 and other measures, there were a number of mini devaluations, including the recent ones in January and July, 2009.

² Because it affects the decision of allocating resources between tradable and non-tradable goods sectors.

³ Kiguel and O'Connell, 1995 defined a maxi-devaluation as a large, one-timed devaluation of a pegged or managed exchange rate.

1.2. Statement of the Problem

There has been a tremendous growth of the literature on exchange rate in the past couple of decades where the main point of analysis has been the RER -its behaviours, determinants, and impacts on the different aspects of the economy. Some writers focused on analyzing the impact of exchange rate movements and exchange rate misalignment on the overall economic performance of an open economy (*Razin and Collins, 1997; Benigno and Thoenissen, 2003; Marca, 2004*). Others attempted to estimate the level of equilibrium RER and the degree of misalignment and, emphasized exploring the factors responsible for such movements in different countries (*Aron et al, 1997, and Takaendesa, 2006 for South Africa; Hyder and Mahboob, 2005 for Pakistan; Eita and Sichei, 2006 for Namibia, etc.*)

In case of an open economy, the RER of the domestic currency is the crucial link between the domestic economy and the external world through the goods and assets markets (*Ghatak, 1995: 224*). When a country is having a flexible exchange rate regime, the domestic economy is expected to adjust whenever RER changes. This makes the RER change very crucial for the understanding of the economy. Therefore, it can be uttered that the success or failure of an open economy depends crucially on the management of its exchange rate. Given the aforementioned facts, it is not surprising that exchange rate economics is one of the heavily researched areas in the economics literature.

The literatures give several theories that explain movements in the RER. Theory suggests that, in the medium to long-term, though not in the short term, RER changes should be at least partially determined by the interest rate and purchasing power parities (PPP). Empirical evidence, however, does not support this (*Roth, 2008; Faruqee, 1995; Carrera, and Restout, 2008*). Therefore, this study aims at identifying the major determinants of RER in Ethiopia.

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It has been found by different researchers that RER responds to different factors in different countries. In general, the country's net capital stock; technology; net international creditor position; monetary, fiscal, and trade policies; world interest rate; terms of trade; capital inflow; oil price; inflation; expectations, etc., were identified as the possible determinants of RER.

Thus, since RER represents a key relative price in the economy, and policies to change it are often the centerpiece of adjustment programs designed to improve international competitiveness and shift resources toward the production of tradable goods (*Khan and Lizondo 1987*); it is vital for policy makers to have better idea of the behaviour, magnitude, and time path of the likely response of this rate to its determinants. In other words, since the RER is a crucial variable in the macroeconomic performance of an open economy, it is very crucial to figure out its behaviour and determinants so as to help policy makers to better manage it through appropriate policies and place the economy on a path of growth and sustainable development.

However, as to my knowledge, there has not yet been a systematic empirical assessment of the determinants of the behaviour of RER in Ethiopia. There have only been few empirical studies focusing on exchange rate economics in Ethiopia and they are not recent. The most recent study that the author came across is the one conducted by Tamiru Demeke in the year 2005 entitled "The Behaviour and Dynamics of the Real Exchange Rate of the Birr after the Economic Reform". He applied a single equation modeling strategy on the quarterly data spanning from 1992:2 to 2002:1, taking for granted that the RER is a purely endogenous variable and that the fundamentals are indubitably exogenous. The present study is, therefore, intended to examine the behaviour and determinants of the RER of the Birr since 1993:1; and is expected to fill the gap by using a more recent data and methodology.

1.3. Objectives of the Study

General Objective;

The general objective of this study is to investigate the behaviour and determinants of real effective exchange rate, and measure the degree of exchange rate misalignment in Ethiopia.

Specific Objectives;

The broad objective is explored through the following specific objectives:

- To examine the behaviour of real effective exchange rate in Ethiopia.
- To identify the short run and long run determinants of real effective exchange rate.
- To investigate how the real effective exchange rate responds to shock(s) in its determinants and to determine which of the shock(s) have the most important influence.
- To measure the degree of exchange rate misalignment (if any).
- To give suggestions and policy recommendations based on the findings of the study.

1.4. Scope and Significance of the Study

The aim of this study is confined to investigating the behaviour of real effective exchange rate and identifying its short run and long run determinants in Ethiopia using a quarterly time series data extending from 1993:1 to 2008:2. It also tries to measure the degree of exchange rate misalignment (if any). The study employs co-integration and vector error correction approaches to identify the determinants of real effective exchange rate. Therefore, the result conveys some important messages about the real effective exchange rate of the Birr since the massive devaluation undertaken by the Transitional Government of Ethiopia (TGE) in October 1992 under the support and advisor-ship of the international financial institutions.

Since a sustained deviation of the actual RER from its long run equilibrium value may lead to a loss in international competitiveness and currency crises, identifying the behaviour and determinants of this rate is imperative for a country. The output of this thesis would, therefore, benefit policy makers to evaluate the behaviour of this policy variable; and take appropriate measures on the factors responsible for its movements. Moreover, it is expected to benefit students, researchers and any interested individual who may be planning to advance future study on the area of exchange rate and open economy macroeconomics in general.

1.5. Limitations of the Study

While there is a good measure of reliability of the data on most of the variables, which were obtained on quarterly basis (real effective exchange rate, nominal devaluation, oil price, parallel premium, foreign exchange reserve, and growth in net domestic credit), the quality of the entire data set may be reduced by the interpolation of GDP, government consumption spending, and tax revenue; in order to calculate the ratio of government consumption to GDP, and the ratio of fiscal deficit to high powered money. Therefore, although quarterly observations allow more degrees of freedom in estimations involving many variables and lags as in the present case, the quality of

some of the series and interpolation (three variables may be too many) might have been sources of difficulties in the estimation.

More importantly, due to the fact that agricultural production in Ethiopia takes place only in one or at best two quarters of the year and that agricultural output makes a higher share of the annual GDP, using the disaggregated GDP for such purposes may pose problems. Also the cases of spending and revenue may not be free from such limitations because it is almost customary in Ethiopia to make bulk of the spending during the budget closing season (quarter), and collect (especially agricultural) taxes mostly during some quarters of the year.

Moreover, the number of observation is not large enough when the number of variables is taken account of. Nine variables may be too many to use in a VAR with 62 observations. It would have been better had it been possible to use longer time series and high frequency data; but the study is constrained by the availability of high frequency (monthly, weekly, or daily) data on some of the variables related to or expressed as a ratio of GDP. Also it doesn't seem reasonable to include the data for the period before 1992 as the regime shift would possibly create a serious structural break in the data making it difficult for interpretation. It is also not possible to get a complete data set for the period after 2008:2.

1.6. Organization of the Study

The rest of the thesis is organized as follows. Section two reviews both the theoretical and empirical literatures related to the topic. Some background about the exchange rate policies and regimes in Ethiopia are discussed in the third section. The fourth section deals with the details of the methodology applied to attain the objectives. And section five presents the findings of the study; while the sixth section provides conclusion and policy recommendations.

II. LITERATURE REVIEW

2.1 THEORETICAL LITERATURE

2.1.1 Basic Concepts About Exchange Rate

Nominal Exchange Rate (NER)

NER is the relative price of the currencies of two countries with no reference made to what this means in terms of the purchasing power of goods or services (*Pilbeam, 1998: 11*). It is the rate that prevails at a given date at which a person can trade the currency of one country for that of another (or others). It may be expressed as domestic currency per unit of foreign currency or the reciprocal, with the choice of the two definitions determined by the purpose of analysis.

When NER is defined as the domestic currency price of a unit of foreign currency (as it is used in most cases); an increase (a decrease) in the rate is called depreciation (appreciation) of the domestic currency (*Kiguel and O'Connell, 1995*). However, the terms depreciation and appreciation are mainly used when the exchange rate is known to follow a flexible regime. When an exchange rate is pegged or managed, a discrete change in its official value is referred to as devaluation (revaluation) if the rate goes up (down).

Real Exchange Rate (RER)

Although there is no single conventional definition of RER in the literature, it can be expressed as the relative price of the goods of two countries (*Mankiw, 2000: 127-130*). It can also be defined by using the relative prices of tradables and non-tradables, to reflect resource allocation within an economy. Alternatively, RER may be defined as the NER adjusted for relative inflation differential between the countries under consideration (*Pilbeam, 1998: 11*). It measures the country's competitiveness in the international trade because it shows the rate at which a person can trade the goods and services of one country for that of another (or others). A real appreciation (depreciation) means an increase (decrease) in the purchasing power of domestic currency in

foreign markets relative to domestic markets; or in domestic traded-goods markets relative to domestic non-traded-goods markets (*Kiguel and O'Connell, 1995*).

Bilateral Vs Multilateral (Effective) Exchange Rates

It is also worth distinguishing between bilateral and multilateral exchange rates. A country may use its exchange rate to measure whether its currency is appreciating or depreciating against a single foreign currency, i.e. calculate the bilateral exchange rate. However, this rate is not a good measure of the value of a country's currency since countries may not trade only with a single country. Therefore, we must be concerned with what is happening to a country's currency against a basket of foreign currencies with whom the country trades. Thus, whether a currency is appreciating or depreciating against a weighted basket of foreign currencies is measured by effective⁴ (or multilateral) exchange rate (*Pilbeam, 1998:13-16*).

Official Vs Parallel Exchange Rates

Currency transactions may take place in an official or parallel market. Official exchange rate refers to the legal rate in a black market system or to the commercial exchange rate in a dual exchange rate system. On the other hand, parallel exchange rate refers to the black (unofficial) market rate in a black market system or to the financial rate in a dual exchange rate system (*Edwards, 1989:75; and Kiguel and O'Connell, 1995*).

A parallel foreign exchange system is one in which transactions take place at more than one exchange rate and at least one of the prevailing rates is a legal (in case of dual market) or illegal (in case of black market), freely floating, market-determined rate (the parallel exchange rate), whereas, there is a legal, officially pegged or managed exchange rate. The dual market system is one in which the government assigns an important share of current account transactions to a commercial rate (which is officially pegged or at most managed) and all remaining legal

⁴ The term effective exchange rate can also be used by exporters and importers, to represent the rate which takes into account export and import taxes for specific commodities (in order to determine the different effective prices of each commodity) (*Asuming-Prempong, 1998*). It can also be expressed as nominal or real.

transactions, including capital account transactions, to an officially floating financial exchange rate (the parallel rate). Contrarily, a black market system is one in which restrictions on transactions at the official rate may lead to the creation of an illegal market for foreign exchange.

Exchange Rate Regimes (Systems)

Fixed Exchange Rate System

This is a system or regime in which the nominal exchange rate is fixed by monetary authorities, at some desired level. Once fixed, the central bank intervenes when there is excess supply of or demand for foreign currency, by buying the excess supply or selling foreign currency to meet the excess demand (*Rivera-Batiz and Rivera-Batiz, 1994: 50; Carbough, 1995: 411; and Pilbeam, 1998: 22*). It is a rigid system in which the authorities use official reserves to create an exact match between supply and demand in the foreign exchange market to keep the exchange rate unchanged or remain within a small band.

If there are possibilities of repegging (devaluation or revaluation) of the currency in question, it is termed as a movable or adjustable peg system. Since adjustments are permitted, exchange rates although fixed are not rigidly fixed in this case. The currencies are presumably tied to a par value that changes infrequently, usually in large jumps suddenly. However, if small frequent changes are made in the par values so that they creep along slowly in response to evolving market conditions, it is said to adopt a 'crawling peg' (*Carbough, 1995: 432-433*).

Freely Flexible (Freely Floating) Exchange Rate System

Exchange rate in a free market (i.e., flexible exchange rate) is usually determined by the demand for and supply of foreign exchange. Under such system, the rate must adjust to clear the market so that the demand for and supply of foreign exchange balance in order to have equilibrium in the foreign exchange market. The level of exchange rate is left to the free play of market forces⁵ and

⁵ Such type of exchange rate is sometimes termed as clean floating exchange rate.

there is no official financing at all. In addition, such system requires that no restrictions on financial capital movement be imposed. Therefore, a current account deficit (surplus) must be financed by capital inflows (outflows).

As shown by Carbaugh (1995), exchange rate in a freely floating system depends on the relative money supplies, income levels, interest rates, prices, and other factors. Therefore, there is no need for the monetary authority to hold official reserves (what Carbaugh calls “*stabilization funds*”). Another implication of fully flexible exchange rate is that the central bank can set the money supply at will; implying that there is no link between the balance of payments and money supply, since there is no obligation for the monetary authority.

Managed (Controlled) Floating Exchange Rate system

As mentioned above, in a freely floating exchange rate system, under normal circumstances the monetary authority need not hold reserves for stabilization purposes. In a managed floating exchange rate system, however; the monetary authority occasionally intervenes to stabilize the foreign exchange market. Here, market forces basically determine the exchange rate but the central bank may intervene to buy or sell currencies or change money supply to affect exchange rate so that it moves towards a target rate deemed appropriate by the authority. In other words, a country adopting this system does not allow the value of its currency to be solely determined by the free forces of demand and supply. Rather, it attempts to combine market forces with foreign exchange market intervention in order to take advantage of the best features of both floating and fixed exchange rate systems (*Ibid: 424-425*).

Both under the freely floating and the managed floating exchange rate systems, there are rooms for market forces to play a role in determining the level of exchange rate. And both can adjust in response to market conditions, but with different levels of flexibility. Thus, both systems can be categorized under a floating exchange rate regime.

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2.1.2 Theoretical Models of the Definition and Measurement of Real Exchange Rate

As briefly defined at the beginning of this chapter, RER can be defined as the relative price of foreign goods in terms of domestic goods or the other way round. But, what domestic and foreign goods comprises of depends on the particular analytical framework being used (*Montiel, 2003: 312*). Therefore, to understand what constitute domestic goods and foreign goods in a given model, we need to know the analytical framework being used and the underlying assumption made about the production structure in that model.

Generally, there are four main modeling frameworks for the definition and measurement of the RER. These are the one-good (tradable) model, the Mundell-Flemming (complete specialization) model, the dependent-economy (Salter-Swan) model and the three-goods (Exportable-Importable-Non-tradable) model. Although measuring the RER is not the objective of this study, the dependent-economy (Salter-Swan), and the three-goods models are briefly discussed below.

2.1.2.1 Dependent-Economy (Salter-Swan) Model

Salter-Swan⁶ model is also well known as the tradable-non-tradable goods model. The model assumes that only two goods are produced in the economy; one of which is non-tradable good, while the other is tradable or foreign good. In this model, RER is defined as the number of units of the non-tradable good required to purchase a unit of the tradable good. This type of RER is sometimes referred to as the internal RER (*Ibid*). The economy is also assumed to be a small open economy that can't affect its terms of trade (TOT)⁷. Thus, TOT are exogenous and do not matter (*Hinkle and Montiel, 1999: 113-116*). A small open economy takes the prices of traded goods as given on world markets – it has little influence over the prices paid for the tradable goods. Such economy is sometimes referred to as a *dependent economy*, to emphasize the small country's inability to affect tradable goods' prices. This model seems, therefore, better applicable to

⁶ It was named so because the model was first developed by Swan and Salter in the 1950s.

⁷ Terms of trade (TOT) is defined as export price index relative to import price index.

analyzing issues for which the role of exogenous changes in the TOT are not important; in the context of most emerging economies whose TOT are exogenous (*Ibid: 116*).

This model defines the RER as;

$$RER = \frac{P_T}{P_N} = \frac{eP_T^*}{P_N} \text{----- (2:1)}$$

Where P_T^* is the foreign currency price of tradable goods; e is the nominal exchange rate expressed as units of domestic currency per unit of foreign currency; P_T is the domestic currency price of tradable goods; P_N is the domestic currency price of non-traded goods.

Hinkle and Montiel (1999) argued that although RER can be clearly defined theoretically in this model, in practice measuring it accurately in developing countries is quite difficult. This is because the model can't be used to handle changes in TOT and trade policy; and data required for computing the RER are only available on annual bases in most countries, and is difficult to disaggregate. As pointed out by these authors, the problem of measuring RER is more complicated by other factors. Unlike the industrial countries, currencies in these countries are not readily convertible for capital transaction even when they have a unified exchange rate. Moreover, many developing countries are confronted with the prevalence of other acute problems like large parallel foreign exchange market, substantial smuggling, unrecorded trade, frequent shifts in trade policies and partners, etc. This leads to the assumption that official exchange rates in such countries do not represent the market price of foreign currency; and the RER based on official measurement may be misleading as a good economic indicator.

2.1.2.2. Three-Goods (Exportable-Importable-Non-tradable) Model

This framework consists of three goods; exportable, importable, and non-tradable goods (*Hinkle and Montiel, 1999: 176-178; and Montiel, 2003: 31*). In the Salter-Swan model, the relative price of exportables to importables (the TOT) is implicitly held fixed so that the two goods may be

aggregated in to a single homogeneous tradable good (*Hinkle and Montiel, 1999: 175*). However, in the three-goods model, TOT are not exogenous and do matter.

This model suggests two RERs (exportables RER and importables RER), as well as an explicit definition for the TOT, since there are two foreign goods (*Hinkle and Montiel, 1999: 114; and Montiel, 2003: 31*). The exportables RER is given by the ratio of the domestic currency price of the exportable good to that of the non-tradable good. Similarly the importables RER is given by the ratio of the domestic currency price of the importable good to the price of the non-tradable good, while TOT is given by the ratio of the domestic currency price of the exportable good to that of the importable good.

Montiel (2003) argued that this framework is more suitable for analyzing the macroeconomic effects of TOT changes, as well as effects of changes in commercial or trade policies that affect the domestic relative prices of exportables and importables. Therefore, the model seems to be most suited for developed and giant economies that have an influence over their TOT. As noted in the previous section, the Salter-Swan framework is the most applicable, at least theoretically, to small and emerging economies which have less influence over their TOT.

2.1.3 Theoretical Models of the Determinants of the Real Exchange Rate

In addition to the four modeling frameworks used for defining and measuring the RER, there are also models used to identify its theoretical determinants. These include purchasing power parity theory, traditional flow or balance of payments approach, asset market approach (the monetary approach and the portfolio balance approach), and fundamentals models.

2.1.3.1 The Theory of Purchasing Power Parity (PPP)

As explained by Isard (1978), this theory was first formulated as an empirically testable hypothesis by Gustav Cassel in 1918. The literature, however, gives some evidence that the theory was also playing a role in the monetary view of exchange rate determination during the Bullionist

controversy in early 19th century in England and during the mid 18th century in Sweden, with the writings of Ricardo and Wheatly, respectively (*Isard, 1978; and Mark, 2000*).

In the general sense, the theory states that a unit of a given currency should be able to buy the same quantity of goods in all countries. It asserts that, a currency must have the same purchasing power in all countries and exchange rates move to ensure that (*Mankiw, 2000:138*). According to this approach, RER in the long run is defined as the value of NER corrected by the ratio of foreign price level (P^*) to domestic price level (P) (*Kipici and Kesriyeli, 1997*).

This can be shown mathematically as, $RER_{ppp} = NER \left(\frac{P^*}{P} \right)$ ----- (2.2)

Therefore, if there is a marked short run deviation of the actual RER from the PPP value, changes in the relative national price levels determine changes in NERs to take the RER back to its long run equilibrium level.

However, according to the pool of recent literature on exchange rate, PPP has mostly been argued as being only a long run theory of exchange rate determination; and is considered to be incapable of explaining short term exchange rate movements (*Gandolfo, 1995: 378*). Besides, it is not able to capture changes in the relative incentives guiding resource allocation across the tradable and non-tradable goods sectors (*Edwards, 1989: 6*).

This theory has two main variants: the absolute PPP, and the relative PPP. In its absolute version, PPP implies that equilibrium RER between the currencies of any two countries should equal the ratio of the general price levels in the two countries. It postulates that the same basket of goods should cost the same in all countries when expressed in a common measure. On the other hand, relative PPP relates changes in the RER to changes in the price ratios, so that percentage changes in the RER equal percentage changes in the ratio of price indices. A currency maintains its PPP if it depreciates by an amount equal to the excess of domestic inflation over foreign inflation or

vice-versa (*Carbaugh, 1995: 358*). But the theory has been criticized by many writers on the grounds that it does not necessarily imply that RER fluctuations are caused by relative price movements; and that its inability to explain the behaviour of relative prices makes it an incomplete model of exchange rate determination.

On the other hand, the theory is based on the assumptions of the law of one price⁸, a risk-neutral world, and absence of government intervention like Tariffs, Quotas, taxes, and other trade impediments, and absence of transport costs (*Isard, 1978; and Khan and Qayyum, 2007*). Thus, it is not a good model of exchange rate determination because many goods are not easily shipped across countries; and tradable goods are not always perfect substitutes (*Gandolfo, 1995: 379*). However, for years, PPP has been a very influential way of thinking about exchange rate.

2.1.3.2 The Traditional Flow Model

This approach is sometimes termed as the balance of payments approach to exchange rate determination (*Carbaugh, 1995: 350; and Gandolfo, 1995: 380*). It views RER as being determined by the flow of transactions in international currencies, reflecting trade in goods, services and financial assets. It is used to show how changes in the equilibrium RER are brought about by forces that affect the supply and demand for foreign exchange. It predicts RER for a country with deficit to depreciate and that with surplus to appreciate. However, since it considers flows of funds that adjust gradually over a period of time, it cannot clearly explain the short run volatility of the RER (*Carbaugh, 1995: 350-355*). In this approach the current and capital accounts, are treated symmetrically because both are seen as pure flows (*Gandolfo, 1995: 380*).

2.1.3.3 The Asset Market Approach

In the asset market approach, exchange rates are viewed as being determined within asset markets, similar to equity prices. The approach assumes instantaneous and continuous portfolio

⁸ This law asserts that in the absence of all trade restrictions, identical goods should be sold at identical prices when expressed in the same (common) currency (*Carbough: 356*).

equilibrium. It suggests that stock adjustments among financial assets are key determinants of short-run movements in RER. Within the family of asset-market models, there are two basic approaches distinguished by the underlying assumptions in the modeling framework. These are the monetary approach and the portfolio balance approach.

The Monetary Approach

The monetary approach starts from the definition of exchange rate as the relative price of two monies and attempts to model that relative price in terms of the relative supply of and demand for those monies. Exchange rate is viewed as being determined by the responses to changes in the stock or total demands and supplies of national currencies (*Carbaugh, 1995: 360*). Monetary models assume international investors that are risk-neutral. This implies that exchange rate risk is unimportant for investment choices. Consequently domestic and foreign bonds, which differ only in currency of denomination, are perfect substitutes (and are irrelevant) from an investor's viewpoint (*Gandolfo, 1995: 381*).

The traditional monetary approach is based on two foundations: the quantity theory of money and the PPP relationships. The quantity theory posits that the demand for real balances is a stable function of only a few variables in the domestic economy. Thus, any change in the nominal money stock will have a direct effect on the price level because velocity of circulation and output are assumed to be constant.

Assuming equilibriums in the money markets of two countries, and PPP to hold, exchange rate can be derived in the monetary approach as follows,

$$M = kPY \text{ ----- (2.3)}$$

$$M_f = k_f P_f Y_f, \text{ ----- (2.4)}$$

$$P = eP_f \text{ ----- (2.5)}$$

Solving for P_f in equation (2.5) and for P in equation (2.3), and substituting them into equation (2.4) subsequently and rearranging gives the following relationship,

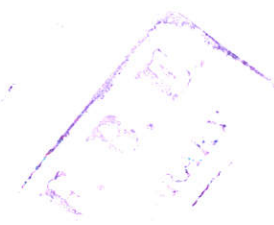
$$e = \frac{M}{M_f} * \frac{k_f Y_f}{kY} \text{----- (2.6)}$$

Where, M and M_f are the domestic and foreign money stocks, P and P_f are the domestic and foreign national price levels, Y and Y_f are exogenously given income levels of domestic and foreign countries, k and k_f are the reciprocals of the domestic and foreign income velocities of circulation, and e is the exchange rate.

The Portfolio Balance Approach

In the Portfolio-balance model, exchange rate between currencies of two countries is a function of the relative supplies of domestic and foreign assets. It assumes that there is imperfect substitutability between domestic and foreign bonds (*Gandolfo, 1995: 381*). With imperfect substitutability, demanders have preferences for distributing their portfolio over the assets of different countries due to the portfolio diversification incentives. If the supply of one country's assets increases, they will hold a greater proportion of that country's assets only if they are compensated (*Bain and Howells, 2003: 295*). This requires a premium to be paid on these assets. In general, then, portfolio balance models have risk premiums in the forward exchange rate that are a function of relative asset supplies. As the supply of one country's financial assets rises relative to that of another country's assets, there will be a higher premium paid on the first country's assets. An implication of this is that uncovered interest rate parity may not hold because risk premiums will exist in the forward market. This premium is missing in the monetary model because it is assumed that investors don't care whether they hold country X's or country Y's bonds or in what mix they are held.

Therefore, the portfolio balance model assumes that people will hold diversified portfolios of assets taking into account demand and supply equations for money and bonds in all countries. All



the markets must clear with equations setting money and bond demands equaling supplies. Thus, the exchange rate is not determined primarily by the demand for foreign currency generated by trade in goods and services, but rather by decisions on how to spread wealth over different assets. This argument holds for bonds too. Thus, the performance of the stock market may affect the value of the local currency through the changes in demand for money, with the subsequent changes in interest rates causing exchange rates to appreciate or depreciate.

2.1.3.4 The Fundamentals Models of Exchange Rate Determination

The problem with the models mentioned above is that they don't allow for a distinction to be drawn between the effects of temporary (or transitory) and permanent changes in the determinants of the RER. The only models that are helpful to identify the impacts of temporary and permanent shocks in the determinants of the RER are the fundamentals models. These are relatively newer models which synthesizes the existing literature on the determinants of the equilibrium RER. According to these models, equilibrium RER is determined only by real variables called fundamentals. There are several variants of these models, but the two most commonly used as analytical framework in empirical studies focusing on the determinants of RER and its long run equilibrium value are those developed by Edwards (1988, 1989), and Montiel (1999, and 2003). The next section briefly discusses these models with an aim of identifying the potential theoretical determinants of the RER.

Edwards' Model

Edwards' model is originally developed in an inter-temporal setting, for a country with dual NER arrangement. It is designed for analyzing how equilibrium RER responds to both the current and future period disturbances in its determinants. The equilibrium RER is defined in this model as the relative prices of tradables to non-tradables that result in the simultaneous attainment of both internal and external equilibrium for equilibrium values of the other variables. Attainment of the internal equilibrium requires the non-tradable good's market to clear both in the present and

future periods, and that unemployment is at the natural rate. External equilibrium on the other hand is attained when the inter-temporal budget constraint that states that the discounted sum of a country's current account balances, in both periods (*Edwards, 1989: 16*).

Edwards also developed a theory on how the actual RER behaves, why it differs from the equilibrium value; and how nominal devaluations may be useful in the adjustment process (i.e., to take the actual RER back to the equilibrium value). He also developed a model that can be used to analyze the behaviour of the parallel market for foreign exchange, the parallel market rate, and the determinants of the parallel premium.

Based on the theoretical model, Edwards (1989) formulated an empirical equation to estimate the equilibrium RER and its dynamics for developing countries. The model is devised particularly for a small-open economy with a dual NER system. Thus, it provides a framework to investigate the 'fundamental variables' that are associated with equilibrium RER. Moreover, the model's framework helps to capture both the short run and long run behaviours of the economy; and is useful to identify the short run and long run determinants of RER.

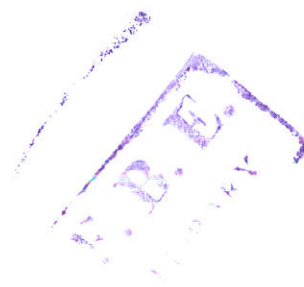
Edwards (1989) argued that long run equilibrium RER is only a function of real variables whereas in the short run nominal variables may also play a role. The real variables are classified into two: internal (domestic) fundamentals and external fundamentals. The external fundamentals include TOT, international transfers, and world real interest rates. Internal or domestic fundamentals, on the other hand, include those variables that are directly affected by the policy decisions of the country under consideration, such as import tariffs, import quotas and export taxes, capital and exchange controls, the level and composition of government expenditure, and those that are independent of policy decisions, for example technological progress. Therefore, the model is useful for analyzing the relative importance of nominal and real variables in determining the RER, both in the short run and long run. It also captures macroeconomic features of developing

economies, such as the existence of exchange controls, trade barriers and a market-determined parallel exchange rate for financial transactions.

The dual NER system assumed in the model is characterized by a fixed (predetermined) rate for commercial transactions and a market determined rate for financial transactions. The freely floating financial rate adjusts in response to the demand for and supply of foreign exchange for such transactions in order to achieve asset market equilibrium. It is also assumed that the country levies a tariff on imports. The price of exportables in terms of foreign currency is fixed since NER for commercial transactions is fixed. The model also assumes that economic agents have perfect foresight, such that they respond immediately to an unstable current account by changing their consumption and investment decisions.

Edwards derived his theoretical model starting with a portfolio decisions theory and showed how simultaneous equilibrium could be achieved by dividing the entire economy into the demand side, supply side, government sector, and the external sector. The entire derivation of the model and attainment of the simultaneous equilibrium are not shown here as it is very lengthy. Instead, it is summarized as follows. As stated earlier, long run sustainable equilibrium is attained when the internal sector and the external sector are simultaneously in equilibrium in every period. The model thus showed that for the steady state to be attained, 1) the non-tradable goods market must clear, 2) the external sector be in equilibrium, 3) government sector be in equilibrium (fiscal policy be sustainable), and 4) portfolio equilibrium holds. The RER prevailing under these steady state conditions is then called the long run equilibrium RER (*Edwards, 1989: 62-63*).

The model was extended to show how changes in the real fundamentals that disturb the stated equilibrium conditions affect the long run equilibrium RER; and what adjustments could be made to restore equilibrium. In the long run, equilibrium RER movements depend on real variables only; and that temporary and permanent changes in the fundamentals have different effects on the



equilibrium RER. Under a fixed NER regime, inconsistent macroeconomic policies could generate RER misalignment in the short run; and convergence to the long run equilibrium takes time and depends on the model's parameters and extent of capital mobility if the system is left on its own (*ibid*, 133). Moreover, the model's extension shows how nominal devaluation and monetary disturbances affect the actual RER. Edwards argued that nominal devaluations could have long lasting effect on the equilibrium RER only if undertaken from a situation of RER misalignment and accompanied by appropriate macroeconomic policies. Otherwise, nominal devaluations are argued to be neutral in the long run.

Edwards developed an empirical equation for the dynamics of the RER behaviour which captures the implications of the theoretical analysis. The mathematical model relating actual RER with its determinants is given by:

$$\Delta \log e_t = \theta(\log e_t^* - \log e_{t-1}) - \lambda\{Z_t - Z_t^*\} + \phi\{\log E_t - \log E_{t-1}\} \dots\dots\dots (2.7)$$

Where e = the actual RER; e^* = the equilibrium RER, which is in turn a function of the fundamentals; Z_t = index of macroeconomic policies, whose components are excess supply of domestic credit, ratio of fiscal deficit to high powered money, and the rate of growth of domestic credit; Z_t^* = the sustainable level of macroeconomic policies; E_t =NER and E_{t-1} is its lagged value; and θ , λ , and ϕ are positive parameters that captures the dynamic aspects of the adjustment process.

The above equation establishes how actual RER responds to three determinants. First, actual RER has an autonomous tendency of correcting the existing misalignment through the partial adjustment term $\theta(\log e_t^* - \log e_{t-1})$. θ , which theoretically depends on institutional and structural factors captures the speed of this self-adjustment to take place. The second determinant $-\lambda\{Z_t - Z_t^*\}$ states that if macroeconomic policies are unsustainable in the medium-to-long run and are inconsistent with the pegged NER, keeping other things constant, there will be real appreciation. The third determinant is related to nominal devaluations and is given by

$\phi\{\log E_t - \log E_{t-1}\}$. This term shows that nominal devaluation will have a positive impact on RER, resulting in a short run real depreciation, whose magnitude depends on ϕ .

Estimating the above equation, however, requires having data on the macroeconomic disequilibrium term ($Z_t - Z_t^*$); and the equilibrium RER, which itself has to be estimated a priori. In fact, data on the third determinant which is $\phi\{\log E_t - \log E_{t-1}\}$, may be obtained with ease.

Based on the theoretical analysis, equilibrium RER is determined by the fundamentals and should be estimated first. The most important fundamentals in Edwards' model include; terms of trade, level and composition of government consumption, capital flows, exchange and trade controls, technological progress, and capital accumulation. Thus the equation for the estimation of equilibrium RER is given as:

$$\log e_t^* = \beta_0 + \beta_1 \log(TOT)_t + \beta_2 \log(GCN)_t + \beta_3 \log(CAPCONTROLS)_t + \beta_4 \log(EXCHCONTROLS)_t + \beta_5 \log(TECHPRO)_t + \beta_6 \log(INVGDP)_t + U_t \quad \text{----- (2.8)}$$

Where TOT = terms of trade; GCN = government consumption of non-tradables; $CAPCONTROLS$ = extent of control over capital flows; $EXCHCONTROLS$ = index of the severity of trade restrictions and exchange controls; $TECHPRO$ = measure of technological progress; $INVGDP$ = ratio of investment to GDP which is proxy for capital accumulation; and U = the error term.

From the explanation of equation (2.8) above, the components of macroeconomic policy inconsistency ($Z_t - Z_t^*$) are excess supply of domestic credit ($EXCRE$)-which is equal to $(d \log(\text{domesticcredit})_t - d \log(GDP)_{t-1})$, ratio of fiscal deficit to high powered money (DEH), and rate of growth of domestic credit ($DCRE$). After substituting the variables representing the macroeconomic inconsistency term, and the right hand side of equation (2.8) for $\log e_t^*$ in equation (2.7); the model for the determinants of the actual RER is given as:

$$\log e_t = \gamma_1 \log(TOT)_t + \gamma_2 \log(GCGDP)_t + \gamma_3 \log(CAPCONTROLS)_t + \gamma_4 \log(EXCHCONTROLS)_t + \gamma_5 \log(TECHPRO)_t + \gamma_6 \log(INVGDP)_t + (1-\theta) \log e_{t-1} - \lambda_1 EXCRE_t - \lambda_2 DEH_t + \phi NOMDEV_t + U_t$$

----- (2.9)

Where GCN is replaced by $GCGDP$ (ratio of government consumption to GDP); $NOMDEV$ represents nominal devaluations; and γ s are combinations of θ and β s; and the other variables are as defined earlier.

To estimate the long run equilibrium RER, and hence measure the degree of misalignment, the monetary sector must be assumed to equilibrate as the equilibrium RER is influenced only by real fundamentals. Thus, all the monetary variables must be equal to zero. The estimate of the long run equilibrium RER ($\log e_t^*$) can be obtained, once the estimated long run coefficients ($\hat{\beta}_i$'s) are computed for the equilibrium RER equation as $\hat{\gamma}_i/(1-\theta)$. Edwards suggested the use of some kind of averaging procedure to smooth the RER fundamentals because equilibrium RER relates to the sustainable (not to the actual) values of the fundamentals. Finally, misalignment is measured as the deviation of the actual RER from the equilibrium value.

Montiel's Model

Montiel (1999, 2003) also developed a model of RER determination. This model (which apparently seems to be an extension of Edwards' model) is based on the view that RER is an endogenous variable that is determined by three classes of variables: Predetermined variables, exogenous policy variables, and other exogenous variables (*Montiel, 1999; and 2003: 316*). Predetermined variables include those endogenous variables that change slowly over time, such as the capital stock, technology, net international creditor position and nominal wage. Exogenous policy variables include fiscal, monetary and trade policies and other variables under the control of the domestic authorities. Other exogenous variables include observable variables, such as TOT, world interest rates etc., and unobservable variables.

Montiel (1999; and 2003: 316) expressed the RER in a reduced form relationship as:

$$RER(t) = F[X_1(t), X_2(t), X_3(t), B(t)] \text{-----} (2.11)$$

Where X_1 represents the current values of a set of predetermined variables; X_2 represents the current and expected future values of a set of exogenous policy variables; X_3 is the current and expected future values of a set of other exogenous variables; t indicates that expectations about future values of the variables are formed at time t ; and B represents bubble variables. Bubble variables are those that affect the economy only through their influence on sentiment; and are likely to be only transitory or short lived (Montiel, 1999; and 2003: 317).

However, equation (2.11) shows a model of the actual RER; and that long run equilibrium RER is not affected by all categories of these variables, but is affected only by the sustainable values of exogenous and policy variables called steady-state variables or long run fundamentals (Montiel, 1999). Therefore, the above equation, with the exclusion of B and t , is used as a model of short run equilibrium RER ($SRER$) which is given by,

$$SRER = F(X_1, X_2, X_3, 0) \text{-----} (2.12)$$

Where, $X_1, X_2, \text{and}, X_3$ show the current values of the variables referred to as the short run fundamentals (Montiel, 2003: 317).

According to Montiel, because the policy and other exogenous variables may deviate from their sustainable values, and even if they are at the sustainable levels, predetermined variables may not have completed their adjustment (thus forcing the short run RER to keep moving) the short run RER would not be sustainable. The predetermined variables stop moving when they reach a steady state. It must therefore, satisfy the condition of,

$$0 = H(X_1, X_2^*, X_3^*) \text{-----} (2.13)$$

He then solved for the steady state values of X_1 as $X_1^* = X_1(X_2^*, X_3^*)$. Based on this, he developed a model of the long run equilibrium RER only as a function of the steady-state values of the exogenous and policy variables or the long run fundamentals.

$$LRER = F[X_1(X_2^*, X_3^*), X_2^*, X_3^*] = G[X_2^*, X_3^*] \text{-----} (2.14)$$

Where $LRER$ represents long run equilibrium RER; and X_2^* and X_3^* represent steady-state values of exogenous and other policy variables.

Montiel defined equilibrium RER as the value of RER that is simultaneously consistent with internal and external balances, conditioned on sustainable values of exogenous and other policy variables. The model is quite detailed, but can be summarized in the form of the following two equations (as in Montiel, 2003) representing internal and external balances, respectively.

The internal balance is given by equilibrium in the market for labour and non-tradable goods as:

$$Y_N(e, \phi) = (1 - \theta)e^* PA + GovCons_N \text{-----} (2.15)$$

Where $e = e(PA, GovCons_N)$ = importables RER; Y_N = level of output of non-tradable goods in the economy; ϕ = relative price of exportables in terms of importables; PA = private absorption, measured in terms of importables; θ = share of importables in private absorption; and $GovCons_N$ = government consumption of non-tradables.

The left-hand side of the equation shows the supply of non-tradables, while the right-hand side represents the demand for such goods. The supply and private absorption of non-tradable goods are dependent on the RER as shown in the above equation.

The external balance condition requires full adjustment of the country's net creditor position, and thus sets current account deficit equal to the sustainable level of capital inflows as:

$$\pi_w f^* = \theta Y_{EX}(e, \phi) + Y_{IM}(e, \phi) + (r_w + \pi_w) f^* + t - [\tau(\pi_w) + \theta] PA - GovCons_{IM} \text{-----} (2.16)$$

Where π_w = world rate of inflation; Y_{EX} and Y_{IM} equals levels of output of exportables and importables, respectively; r_w = world real interest rate; f^* = the economy's steady-state net international creditor position; t = the value of international transfers received by the economy; and τ = cost of making consumption transactions.

Transactions costs (τ) are included in this model to show the motives of holding money. Money is held to reduce cost of making transactions and this cost, per unit of consumption, decreases with an increase in the amount of money held. Since the demand for money inversely depends on the domestic rate of inflation (equal to the world rate π_w under fixed exchange rates), transaction costs per unit of consumption are increasing in π_w . Domestic spending on tradable goods is the sum of private spending and government spending $[(\tau + \theta)PA + GovCons_{IM}]$. The domestic excess supply of tradable goods is equal to the trade balance surplus. Adding net interest receipts from abroad $(r_w + \pi_w)f^*$ and the receipt of net international transfers (t) to the trade balance yields the current account. External balance holds when the current account equals to the sustainable capital inflow, which is the amount of new borrowing required to offset the inflationary erosion of the country's net international creditor position in the presence of world inflation (Montiel, 2003:323).

Montiel's model suggests that long run equilibrium RER will be affected by changes in fiscal policy, the value of international transfers, international financial conditions, the Balassa-Samuelson effect (differential productivity growth in the tradable goods sector), TOT, and commercial policy. In this model, permanent changes in any of the fundamentals will change the long run equilibrium RER in predictable directions (Montiel, 2003: 325).

Partial Effects of the Theoretical Determinants of the Real Exchange Rate

When both Edwards' and Montiel's models are brought together, the potential determinants of RER include terms of trade, changes in fiscal, monetary, commercial, and, nominal exchange rate policies, changes in investment, changes in the value of international transfers, changes in

international financial conditions, the Balassa-Samuelson effect, changes in foreign exchange reserves and. The a priori theoretical effects of these variables on the RER under both models are discussed below.

Terms of Trade

Since TOT is the ratio of the price of exportables to that of importables, its effect operates through these price variations. The effect of TOT improvement on RER is theoretically ambiguous; and depends on the relative strengths of the income and substitution effects of changes in the prices of both imports and exports (*Edwards', 1989: 140; Mungule, 2004; and Takaendesa, 2006*). The *substitution effect* is indirect which occurs when the domestic sector shifts the production towards the tradable (exportable) goods resulting in higher wages in the tradable sector relative to the non-tradable sector, and hence in RER depreciation. The income effect occurs when the increase in the price of the country's export increases its income and in turn raises the demand for non-tradables, which results in a RER appreciation (*Montiel, 1999: 287; and Carrera and Restourt, 2008*). Therefore, if the direct income effect dominates the indirect substitution effect following an (improvement in TOT), the RER will appreciate. Conversely, if the substitution effect dominates the income effect; an improvement in the TOT may lead to RER depreciation.

The Composition of Government Spending

The impact of government consumption on RER depends on whether such spending is made mainly on tradables or non-tradables. An increase in government spending on tradables creates a trade deficit, which requires a real depreciation in order to maintain external balance. The real depreciation induces an increase in the production of tradables, allowing an increase in total spending on tradables. In contrast, an increase in government spending on non-tradables leads to an increase in their relative price in order to maintain equilibrium in the non-tradable goods market. An increase in the relative price of non-tradables, in turn, appreciates the RER (*Montiel, 1999*). Thus, the RER is a function of the composition of government spending (*Montiel, 2003:*

325); with an increase in government spending on tradables leading to depreciation, and on the non-tradables leading to an appreciation of the RER.

Capital Flows

Edwards and Montiel differ on the treatment of capital flows in their models. Edwards assumes that net capital flows are restricted to the government and are exogenous. On the other hand, Montiel assumes that the volume of capital inflows is an endogenous variable that can arise from a variety of changes in domestic and external economic conditions. However, the two are in agreement that an increase in capital inflows permits an expansion of absorption and consequently appreciates the RER (Montiel, 1999). Capital inflows can also affect RER through appreciation of the NER. Under flexible exchange rate regime, an increase in net capital inflows results in excess supply of foreign exchange leading to appreciation of both the nominal and RERs, assuming that prices are slow to respond (Mungule, 2004; and Takaendesa, 2006).

The Value of International Transfers

Montiel (1999) shows that changes in the level of international transfers (including remittances and foreign aid) received by the domestic economy have an impact on the equilibrium RER. An increase in this variable results in an addition to household incomes. Additional transfer income permits an expansion of consumption which, in turn, will raise the demand for, hence the price of non-tradables and eventually an appreciation of the RER (Montiel, 1999). But this does not seem to be a good justification as the increased transfer may also be largely spent on tradables.

International Financial Conditions

Montiel treated capital flows as endogenous since they are influenced by real interest rate differentials between the home country and the rest of the world. However, real interest rate differentials could represent several factors, including changes in aggregate demand and productivity, and persistent monetary policy. An increase in any of these factors, together with

induced capital inflows, appreciates the RER through an increase in the price of non-tradable goods (Montiel, 1999). Thus, an increase in real interest rate differential has the effect of appreciating the RER irrespective of the channel of its transmission.

Relative Productivity Growth in the Tradable Goods Sector

This is commonly known as the *Balassa-Samuelson effect*. It presupposes that productivity differences in the production of tradables across countries can introduce a bias into the overall RER, because productivity advances tend to be concentrated in the tradable sector; the possibility of such advances in the non-tradable sector is limited. If a country experiences an increase in the productivity of the tradable sector, relative to its trading partners and non-tradable sector, demand for labour in the tradable sector increases causing the non-tradable sector to release labour to the tradable sector (Montiel, 1999).

Higher wages in the tradable sector following the rise in demand pull labour out of the non-tradable sector. At a given RER, the tradable sector expands while the non-tradable sector contracts. The supply of non-tradable accordingly contracts creating excess demand in the sector and ultimately higher prices of non-tradables. This will require a real appreciation of the exchange rate in order to restore internal balance. At the same time, the increase in the production of tradables and a decline in their relative price create an incipient trade surplus, as more of the country's tradable good is demanded in the world markets. A real appreciation is required for the restoration of external balance. Thus, an increase in differential productivity growth in the tradable sector creates a real appreciation (Montiel, 1999; and Carrera and Restout, 2008).

Commercial Policy

Commercial or trade policy is another variable that affects the RER in both models. An increase, for example, in an import tariff can increase the domestic price of imports, which are part of tradables. This in turn shifts domestic demand towards non-tradables, leading to an increase in

their price beyond that in tradables, resulting in appreciation of the RER. An increase in export subsidies also creates a balance of payments surplus which requires an appreciation of the RER to correct (*Montiel, 1999*). Thus, commercial liberalization is likely to cause RER depreciation.

Monetary policy

Expansionary monetary policy, for example, represented by growth in domestic credit and money supply, exerts upward pressure on domestic prices (mostly on non-tradable goods) and hence appreciation of the RER (*Edwards, 1989: 70; and Mungule, 2004*). However, in Edwards' model, monetary variables have only short term impact on the RER.

Foreign Exchange Reserves

Improvement in the stock of foreign exchange reserve is theoretically expected to appreciate the RER, consistent with its role as a relatively liquid indicator of the stock of national wealth. Central bank reserves, in particular, indicate the capacity to defend the domestic currency and as such, an increase in reserve has an effect of appreciating the RER. Higher net foreign exchange reserves induce larger expenditure on domestic goods due to the wealth effect, thus raising the price of non-tradables relative to tradables and, in turn, appreciating the RER (*Aron et al., 1997*).

Nominal Exchange Rate Policy

This variable is included in Edwards' model to capture short term fluctuations in the RER. A nominal devaluation or depreciation (assuming that prices are slow to respond) depreciates the RER in Edwards's model. However, the ability of nominal devaluation to affect the RER may depend on the extent to which macroeconomic policies are consistent with the objective of the NER, such as inflation anchoring (i.e., domestic price stabilization) (*Mungule, 2004*).

Investment Spending

The impact of investment spending depends on factor intensities; and whether the investment spending increases took place in the tradable or non-tradable goods sectors (*Edwards, 1989: 140*).

If investment is more import intensive, an increase in the ratio of investment to GDP is expected to increase absorption, worsen the current account and lead to depreciation of the equilibrium RER (*Eita and Sichei, 2006*). When there is an increase in investment in the non-tradable sector relative to the tradable sector, there will be RER depreciation. This is because the increase in investment in the non-tradable sector increases the supply of them. Assuming that demand is not responding by the same or larger proportion, there will be a decrease in the price of such commodities which leads to RER depreciation.

2.2 EMPIRICAL LITERATURE

Following the collapse of the Bretton Woods system in early 1970s, most countries in the world abandoned the fixed exchange rate, shifting to a floating exchange rate arrangement, with different degrees of flexibility. In an attempt to avoid any possible exchange rate misalignment and hence keep the international competitive position of their economies, most of these countries have switched between fixed and floating exchange rates; and pursued a number of currency devaluations and revaluations. Literatures on exchange rate especially related to the PPP theory have been growing since the 1960s through the 1970s.

Following these benchmarks and the advancement in econometric techniques, enormous country specific and panel data studies have been undertaken both in the developed and developing countries. The following sections discuss the empirical literatures on the behaviour and determinants of the RER from developed as well as developing countries including Ethiopia.

2.2.1 Empirical Literature from Developed Countries

There are relatively fewer empirical works in the area of exchange rate in developed countries as compared to that in the developing countries. Yet it is impossible to exhaustively discuss the empirical studies from developed countries. Therefore, only the most relevant studies are reviewed in this section.

Following the launch of the Euro as a common currency in 11 European countries at the beginning of 1999, Clostermann and Schnatz (2000) initiated an empirical study to identify the forces driving the real Euro-Dollar exchange rate in the medium to long run. By using a quarterly data spanning from 1975:1 to 1998:4 and applying a co-integration approach and Vector error correction model, they found that real oil price, interest rate differential, relative prices in the tradable and non-tradable sectors, and relative fiscal position are the fundamental determinants of the Euro-Dollar RER.

Alexius (2001) applied a VAR approach to identify the sources of RER movement in four Nordic countries (Denmark, Finland, Sweden and Norway). By applying a forecast error variance decomposition analysis, he found that supply shocks are the most important sources of RER variation in all of the four countries in the long run while demand shocks have a short run impact. The study revealed that although the share of demand shocks in explaining the variation in RER in the long run is small, most of the short run variations are mainly explained by the demand shocks; and the relative importance of the supply shocks is small and increases with time.

Antonopoulos (1999) also found that an improvement in the relative productivity of export sector and capital inflows appreciates the RER. This model however, adds capital flows; and employed co-integration methodology on Greece's data covering the period 1960 – 1990. The result provided evidence supporting the view that RER movements can't be explained by PPP, that there is a strong role of the productivity of the export sector of Greece *vis-a-vis* the rest of the world, and that there is a less important role of net capital inflows in explaining the RER movement. A study by Bagchi et al. (2003) on a sample of nine small and open developed economies (most of which included those in the European Union like Finland, Portugal, Spain, Italy, etc.) also supports the other studies' findings that interest rate differential and TOT are the determinants of the long run RER.

2.2.2 Empirical Literature from Developing Countries

Edwards (1988, 1989) pioneered an empirical study of the determinants of the RER (both actual and equilibrium values), especially in developing countries- in a fundamentals model framework. Edwards (1988) carried out a study on a panel of 12 developing countries. Using instrumental variables method, he came up with the finding that only real variables (such as TOT, capital flows, and capital accumulation) are responsible for the movement in RER; and that nominal variables (like changes in monetary policy) are neutral, in the long run as suggested by the theory; while both nominal and real variables can affect the RER in the short run. The result showed that increase in TOT, government consumption of non-tradables (proxied by ratio of government consumption to GDP), and excess supply of domestic credit leads to real appreciation, whereas improvement in technology, nominal devaluation, rise in the ratio of fiscal deficit to high powered money, and unexpected growth in domestic credit leads to real depreciation; with the impact of the monetary variables limited to the short run.

The argument that the RER depends on real variables in the long run is supported by many studies both in a panel and country specific framework. Carrera and Restout (2008), for example, employed panel co-integration to identify the long run determinants of RER in a sample of 19 Latin American countries. The study found the Balassa-Samuelson effect, government spending, TOT, openness, foreign capital inflows, and NER regime as the long run determinants of RER. Their finding confirms the theoretical proposition about the links between the RER and its determinants. The study found that higher government spending to GDP, an increase in productivity differential, improvement in TOT, a surge in foreign capital flows and a higher net foreign assets result in the RER appreciation. Whereas an increase in openness was found to depreciate RER, the exchange rate regime has also been found to have a strong influence on RERs in these countries (rigid regimes exercise an upward pressure on the RER).

Drine and Rault (2005) also applied the same methodology for a panel of 45 developing countries including Ethiopia, and obtained a partly consistent result with Carrera and Restout. The later study shows that improvement in TOT, increase in per capita GDP and of capital flows entails a long-run appreciation. On the other hand, an increase in domestic investment and openness entails RER depreciation. But the effect of an increase in public spending was ambiguous.

There are also vast country specific studies supporting these findings. For example; a study by Chishti and Hasan (1993) for Pakistan shows that RER is a function of both real and monetary variables; rejecting the PPP hypothesis. According to the study, inconsistent macroeconomic policies (both fiscal and monetary) result in overvaluation of the Rupee whereas TOT, tariff, and technical progress (having only a short lived effect) appreciate the RER. Hyder and Mahboob (2005) also carried out a similar study after 12 years. The later study was a bit comprehensive in identifying the possible determinants of the RER. They found that openness, increase in current government consumption and net capital inflows depreciate the RER, while, increase in workers' remittances inflows and improvement in total factor productivity appreciates it.

Aron et al. (1997) carried out a study on the short run and long run determinants of RER for South Africa using a co-integration framework with single equation equilibrium error correction model and a quarterly data of 100 observations. The study showed that an increase in TOT, price of gold, tariffs, capital inflows, official reserves, government share in GDP, domestic credit and technological progress, all lead to an appreciation of the RER in South Africa, while an increase in openness and nominal depreciation leads to real depreciation. However, the study showed that nominal depreciation and domestic credit have only a short term impact. This is partly consistent with a study by Takaendesa (2006). Using impulse response functions and variance decomposition analyses in a VAR framework, Takaendesa (2006) found that increase in TOT, real interest differential; domestic credit and technological progress all significantly appreciate RER in the long run, while increased openness is associated with real depreciation. He found

openness as the only variable to impact RER in the short run. He also found that shocks to TOT, openness, and domestic credit have persistent effect on RER.

Mungule (2004) also employed a VAR and co-integration approach, on a quarterly data for the period 1973-1997 for Zambia. He found that the Zambian real effective exchange rate is affected by shocks to the TOT, closeness (which is the inverse of openness) of the economy and nominal devaluation; with the impact of TOT realized only in the long run. However, he found that the effect of TOT change on RER tends to be ambiguous.

Studies on Ghana also show that change in technology, growth in trade (export), improvement in TOT (*Opoku-Afari et al, 2004*), and aid inflows (*Sackey, 2001*) all depreciates the RER in the long run whereas increase in capital inflows appreciates it. An increase in export trade was found to be the only variable that leads to depreciation in the short run in Ghana (*Opoku-Afari, 2004*). Asuming-Prempong (1998) added current transfers and real money supply as the main determinants of RER in Ghana. The later study found that increase in current transfers and real money supply depreciates the RER; while the effect of TOT is insignificant.

A study on Angola, by Gelbard and Nagayasu (2004) found price of oil and foreign interest rate as the main factors behind the variation in the long run RER. They found that an increase in the price of oil appreciates while a rise in the foreign interest rate depreciates the RER. This result has indications of the importance of oil price in determining the RER of developing countries that are net importers of oil.

2.2.3 Review of the Empirical Literature on Ethiopia

Empirical research on RER behaviour and its determinants in Ethiopia are very scanty. Only two⁹ studies (*Alem Abreha, 1995; and Tamiru Demeke, 2005*) are reviewed here. Alem Abreha (1995)

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adopted the underlying balance approach to identify the determinants of RER using annual data for 1961-1991. According to the study, TOT, technical progress (proxied by growth in GDP), investment, government consumption of non-tradable goods (proxied by government consumption expenditure), and trade restrictions were found to be the main determinants of RER in Ethiopia. The study revealed that an improvement in TOT, increase in the level of investment, and tax on export leads to RER appreciation whereas technological progress and tax on imports depreciates it. On the other hand, devaluation and capital flows were found to be insignificant.

A recent study on RER behaviour in Ethiopia is that done by Tamiru Demeke (2005), entitled “The Behaviours and Dynamics of the RER of the Birr after the Economic Reform”. He applied a single equation approach to examine the behaviour and dynamics of the RER using data for the period after the maxi devaluation of October 1992 up to 2002:1. The study also attempted to identify the determinants of RER and to measure the degree of exchange rate misalignment by using the Edwards (1989) model.

Tamiru (2005) applied Engle-Granger two-step procedure and found that RER and all the macroeconomic fundamentals affecting it are co-integrated. An increase in the ratio of government consumption to GDP, ratio of investment to GDP, capital inflow, and excess supply of domestic credit all result in real depreciation whereas TOT and nominal devaluation were found to be insignificant both in the short run and long run. Moreover, increase in fiscal deficit to high powered money results in real appreciation while an increase in exchange control depreciates the RER in the short run.

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III. OVERVIEW OF THE DEVELOPMENT OF EXCHANGE RATE AND EXCHANGE RATE REGIMES IN ETHIOPIA

This part highlights the establishment and evolution of exchange rate, the determination of the nominal exchange rate, and the foreign exchange market arrangements in Ethiopia since the country introduced its own legal tender in 1945. The different exchange rate policies pursued in the country are also discussed by dividing the time into three distinct periods: *viz* the Imperial era, the Derge era and the post-1991 period.

Pre 1974 (The Imperial) Period

Ethiopia issued its first legal tender currency on 23 July 1945 through the currency proclamation of 1945. The monetary unit (the Ethiopian dollar; later renamed the Ethiopian Birr in 1976) was defined with a value of 5.52 grains (equivalent to 0.355745 grams) of fine gold (*Derrese, 2001*). The linkage with fine gold, which was in accord with the Bretton Woods Agreement of 1944, automatically established the exchange rate between the national currency and other currencies with the same arrangement during that time. Accordingly, the official exchange rate of the Ethiopian currency with the US dollar was created on July 23, 1945. The official bilateral exchange rate against the US dollar was set at a rate of 2.48 Ethiopian dollars per US dollar. This rate remained fixed for about 19 years since it was initially set before it was slightly devalued to 2.50 on January 1, 1964; and served for international transactions from 1964 up to the collapse of the Bretton Woods System in 1971. The currency was then revalued to 2.30 and 2.07 Ethiopian dollars per US dollar in December 1971 and February 1973, respectively (*ibid*).

Successive revaluations (except for the slight devaluation of 1964) against the US dollar from time to time were considered to have resulted in an overvalued national currency. However, the existence of better macroeconomic stability and a relatively liberal trade regime followed by the Imperial government had probably reduced the misalignment of the actual exchange rate from its

equilibrium (*Derrese, 2001*). It has also been explained in Derrese (2001) that except for some essential consumer items, imports were free from licensing or other quantitative restrictions while exporters were required to surrender their foreign exchange to commercial banks at the prevailing official exchange rate. Therefore, it can be stated that the Imperial government had been following a fixed exchange rate regime although it was one of a slightly adjustable type.

1974-1991 Period

During the 1974-1991 period (usually referred to as the Derge era), the Ethiopian economy was characterized by the so called socialist or command system in which the central government had put every activity including production and trade under its control. The Derge government owing to its state socialist ideology had maintained the official exchange rate of 2.07 Birr per US dollar set in 1973. This rate served for the entire period for official international transactions. Thus the Ethiopian currency was pegged at the rate of 2.07 Birr per US dollar (and left unaltered) despite the floating of the major world currencies including the US dollar (following the collapse of the Bretton Woods system). The period can thus be characterized by a rigidly or absolutely fixed exchange rate regime.

Foreign trade during this period was characterized by controlled foreign exchange allocation, import quotas, high tariffs, state owned marketing exports, export prohibitions, and export taxes. This resulted in the prevalence of a large parallel (black) market for foreign exchange and a significantly large parallel premium, and a consistently higher RER than the NER, implying an overvalued¹⁰ Birr against the US dollar (*Asmerom, 1994; 1999; and Derrese, 2001*). With an overvalued exchange rate, exports have been stagnating while imports have been rising over time since 1975/76 (*Derrese, 2001*). The overvaluation also had the potential of causing misallocation of resources in production and promoting investment of resources in rent seeking and socially

¹⁰ The Birr was then considered to become by far overvalued in terms of the US dollar as well as many other foreign currencies during the Derge period than the Imperial era (*Derrese, 2001*)

unproductive but perhaps privately profitable activities and, hence, reducing the growth rate of output. Moreover, the fixed exchange rate had also led to a rise in domestic credit, which enhanced demand for both tradable and non-tradable goods, and ended up with higher domestic prices (Asmerom, 1999). Asmerom (1999) used the phrase '*the crises period*' to emphasize the extent of severity of the foreign exchange control and other restrictions, and their consequences on the overall performance of the macro economy during the Derge period.

Asmerom (1994) used different exchange rate indices (export weighted index, import weighted index, and trade weighted index) and found that there was a continuous appreciation of the Ethiopian Birr during the Derge period; regardless of whether the nominal, real or parallel exchange rate index is used. He also found that the extent of appreciation was higher during the 1980s than the 1970s. However, the Derge regime had further tightened its control through stricter rationing of foreign exchange, by prohibiting the domestic trade of many exportables and by providing export subsidies for loss-making state-owned exporters, to reduce the falling competitiveness of legal exports and its impact on the trade balance, and to protect the development of illegal activities like smuggling (Derrese, 2001).

Therefore, it can be asserted that the official NER of the Ethiopian currency against its reference currency, the US dollar, was one of a fixed type and was determined by government decree both during the Imperial and the Derge regimes, with marginal differences in the extent of rigidity. During the Derge regime, there were two foreign exchange markets: the official and the parallel markets; where the latter was considered to be illegal, and more preferably called the black market (Derrese, 2001).

Post 1991

As explained above and confirmed by different authors, there are evidences that the Birr was overvalued throughout the entire Derge era. It has also been argued (for example in Asmerom,

1999; and Derrese, 2001) that the continuous appreciation of the RER; has resulted in deteriorating trade balance, and hence a balance of payments crises.

Realizing the negative effect of an overvaluation on the country's external balance and overall macroeconomic performance, the Transitional Government of Ethiopia (TGE) devalued the Birr by about 142%, (from 2.07 to 5.00 Birr per US dollar) (*Befekadu and Kibre, in Mekonnen and Abdulhamid, 1994*) in October, 1992 as one of the key measures of economic reform. Following this maxi devaluation there were a number of mini devaluations which altogether gradually pushed the official NER to 6.25 Birr per US dollar before the date of unification of the official and auction rates in July 1995. In an attempt to achieve the same objectives, the government has taken some measures to crack down the black market in April 2008; and even devalued the Birr against the US dollar by 5% and about 10% in January, and July 2009, respectively.

The successive devaluations were complimented by other policy measures like the introduction of a retail auction market in May 1993, the unification of the official and auction rates on July 25, 1995, and other related measures. From May 1993 up to the date of unification, there were two exchange rates: the official rate (which was the prevailing devalued rate) determined by government decree and the 'marginal' rate (determined by quasi-market forces in the auction). But in effect there were three types of exchange rates in that period; the third being the black market rate (*Deresse, 2001*).

In an attempt to further liberalize external transaction, authorized commercial banks were allowed in July 1996, to establish their own foreign exchange permit desk and FOREX bureaus, as per the directives of the national bank of Ethiopia. The commercial banks were also allowed to bid in the auction system, and the retail auction was replaced by a wholesale auction in September 1998 (*Ibid*). In 2001, commercial banks were allowed to participate in buying and selling foreign

exchange through a daily inter-bank foreign exchange market¹¹. From the date of unification up to the introduction of the daily inter-bank market, the exchange rate of the Birr against the US dollar and the resultant cross-rates had been determined only through the auction system. Since 2001, the rate determined in the daily inter-bank market for foreign exchange serves as the official exchange rate.

As it had also been the case during the Imperial and the Derge regimes, the foreign exchange system that existed prior to the introduction of the auction system in May 1993 was one of a pegged type. It can also be argued that since 1993, the country has been following a quasi-market determined or managed floating exchange rate regime.

¹¹ This discussion is partly based on the information obtained from the International Financial Statistics (IFS) world and country notes of the International Monetary Fund, version November 2008.

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IV. METHODOLOGY

Introduction

The study investigates the main determinants of RER and its dynamic adjustment in Ethiopia following shocks to those determinants. Some descriptive statistics are used to show the behaviours of the different exchange rate indices and other variables over the study period, through preliminary data exploration. The time series properties of the data are also examined through informal and formal tests. An econometric technique is employed to estimate the short run and long run parameters, following a co-integration analysis. The study also tries to measure the degree of misalignment.

Section two highlighted some of the existing theoretical as well as empirical literatures that help to understand the possible links between the RER and its potential determinants. This is considered to be a good background for the setup of this study as both Edwards' and Montiel's models are used for the identification of these determinants.

There is no fundamental difference between these two models except the way the fundamentals are classified and slight differences in the variables included. In Edwards' model, the RER is determined only by real variables in the long run whereas both real and nominal variables may be responsible for its short run movement. The real fundamentals in his model include TOT, international transfers, technological progress, world real interest rates, trade restrictions, capital and exchange controls, investment spending, and government consumption of non-tradables. Montiel, on the other hand, classified the determinants of RER into three: *Predetermined* variables (such as capital stock, technology, net international creditor position and nominal wage); *exogenous policy* variables (such as fiscal, monetary, and trade policies and other variables under the control of the domestic authorities); and *other exogenous* variables such as the TOT, world

interest rates and other unobservable variables. Both models suggest a structural equation modeling based on their theoretical explanations.

However, *Eita and Sichei (2006)* argued that although structural equation approach to time series modeling uses economic theory to model the relationship among the variables of interest; economic theory is often not rich enough to provide a dynamic specification that identifies all of these relationships. *Chishti and Hasan (1993)* also argued that the theoretical model can only guide us in identifying the relevant variables for the determination of the dynamic behaviour of the RER; leaving the correct specification and the complex interlinks it may have with different variables unclear. In addition, a theory based single equation regression approach most likely yields inefficient estimates for the parameters if there exists bidirectional causality and dynamic inter-linkages among the variables (*Bhasin, 2004*). Besides, testing for co-integration using single equation approach by itself is problematic (may give misleading results), if more than one co-integration relationship is present (*PcGive 10 Manual, page 72*). Thus, theory based structural equation approach may be appropriate when the theory is exact enough to identify the endogenous and exogenous variables and the functional form connecting them.

Therefore, it is not reasonable to ignore these facts and roughly assume that all the model's fundamentals are really exogenous. Thus, the use of a systems estimation; based on the Vector Autoregressive (VAR) approach is preferred for the present study as it does not require endogenous-exogenous division of the variables. This would solve the problem because the VAR is commonly used for forecasting systems of interrelated time series and analyzing the dynamic impact of random disturbances on the system of variables. On the other hand, a simple co-integrated VAR model (which combines co-integration analysis and VAR time series process) helps to account for spurious correlations and exo-genitive bias (*Badawi, 2005*).

The study thus employs the Johansen procedure for co-integration test. In the co-integration literature, it has been argued that the Johansen method is superior (to the single equation version of the Engle-Granger two-step procedure) in testing for co-integration. This method is preferred because of its ability to identify more than one co-integration relationships among the variables.

4.1 Descriptive Methods

Before carrying out a formal empirical analysis, the time series properties of the variables and their interrelationships are examined using some descriptive methods. These include constructing simple correlation coefficients, computing summary statistics, and graphical inspection. The correlation method is used to show the possible joint movements of the variables. It also works as a preliminary method of testing for multicollinearity. However, the severity of multicollinearity is formally tested using the variance inflation factor. Summary statistics is computed to show the means and the standard deviations (degree of variability) of the variables. On the other hand, graphical analysis is used to show the development (or trend) of the variables over time and to identify any possible shifts or breaks in the data trend.

4.1.1 Definition of Variables and Data Sources

The study employs a quarterly time series data for the period 1993:1 – 2008:2. These data are of secondary types that are obtained from Ministry of Finance and Economic Development (MOFED), National Bank of Ethiopia (NBE), the International Financial Statistics (IFS) CD-ROM of the International Monetary Fund (IMF), and the World Development Indicators (WDI) 2008 of the World Bank. Unfortunately, the data for the ratio of government consumption to GDP, and ratio of fiscal deficit to high powered money (DEH) have been obtained on annual basis, and are not compatible with the other variables for estimation. This necessitated the use of interpolation¹² to convert them into quarterly estimates.

¹² Quadratic interpolation method has been utilized to disaggregate the annual data into quarterly estimates.

This data set requires a cautionary note. In studies of such type, which uses macroeconomic variables from different sources, there is inevitably a trade-off between data availability and data comparability or consistency. To somehow reduce the potential repercussions of this, analysis is based on the series all expressed in the form of indices or ratios or growth rates.

Based on the literature covered so far, the RER can be modeled as a function of both the nominal and real variables. These variables include TOT, productivity differential (TECHPRO), real interest rate differential (RID), international transfers (including aid), trade policies proxied by economic openness (OPENNESS), capital and exchange controls proxied by the parallel premium (PREMIUM), ratio of investment spending to GDP (INVGDP), monetary policy proxied by excess supply of domestic credit (EXCRE), growth rate of net domestic credit (DCREDIT), and the ratio of fiscal deficit to high powered money (DEH), fiscal policy proxied by the ratio of government consumption spending to GDP (GCGDP), oil price (OIL), foreign exchange reserves (FOREX), and nominal exchange rate policy (NDEV).

Because of lack of data and measurement issues, some of the variables are excluded from the model. Data on variables such as openness, technological progress, and TOT couldn't be obtained for the whole period even on annual measures. In addition, since the study is interested only in the results of the RER equation from the VAR; after performing co-integration test and estimation, the RER equation is singled out and ad-hoc normalization is made for the real effective exchange rate to get an interpretable RER equation from the VECM. Therefore, the long run RER equation to be estimated looks as follows:

$$\begin{aligned}
 REERI_t = & \beta_0 + \beta_1 NDEV_t + \beta_2 GCGDP_t + \beta_3 RID_t + \beta_4 PREMIUM_t + \beta_5 OIL_t + \beta_6 DCREDIT_t \\
 & + \beta_7 DEH_t + \beta_8 FOREX_t + \beta_9 NFA_t + \varepsilon_t \text{-----} (4.1)
 \end{aligned}$$

Where, *REERI* is the real effective exchange rate index of the Birr. The NBE calculates the

REERI as: $REERI_t = \sum_i \frac{\text{currency}_i}{\text{birr}} * \frac{CPI}{CPI_i} * w_i$, w_i is the trade weight of the i^{th} partner country, and CPI

and CPI_i are the consumer price indices of Ethiopia and the i^{th} trade partner, respectively. Since REERI shows the weighted foreign currency price of a unit of domestic currency; an increase in the index shows a real appreciation.

$NDEV$ is the quarterly nominal effective devaluation of the Birr, which is calculated as,

$$NDEV = -\frac{(NEERI_t - NEERI_{t-1})}{NEERI_{t-1}} * 100 \text{ where } NEERI (NEERI = \sum_i E_i w_i).$$

The $NDEV$ variable is used in the study as proxy for the impact of nominal exchange rate policy on the real effective exchange rate. It is expected to depreciate the RER.

GCGDP is the ratio of government consumption expenditure to GDP, used as a proxy for government consumption of non-tradables. An increase in the amount of the ratio of government consumption to GDP may depreciate or appreciate the RER depending on whether these expenditures are made on tradables or non-tradables.

RID is the real interest rate differential between Ethiopia and its major trade partners. It is defined as the real interest rate of Ethiopia minus the arithmetic average of the real interest rates of the trade partners. The real interest rate is calculated as the nominal interest rate (taken as the average of the 28, 91, and 182 days' Treasury bill rates) minus the level of national inflation. An increase in RID in favor of Ethiopia is expected to lead to an appreciation of the RER since it may reflect higher capital productivity, leading to a net capital inflow.

PREMIUM is defined as the percentage by which the parallel exchange rate exceeds the official exchange rate. This variable is measured on quarterly basis, and is derived as $PREMIUM = 100 * [(parallelrate - officialrate) / officialrate]$. It enters the model to show the impact of capital and exchange controls on the RER. An increase in the capital and exchange restrictions, shown by an increase in the parallel premium, is expected to appreciate the RER.

OIL is the index for the quarterly average international price of petroleum per barrel. This is taken as the weighted average of the price indices from Dubai, UK, and West Texas, from the IFS data base. The effect of an increase in the international price of oil (OIL) on the RER is relatively straightforward. A sustainable increase in the real price of oil will have a negative effect on the current account¹³ (reducing the international competitiveness) of an oil importing country like Ethiopia. This is expected to result in RER depreciation.

DCREDIT represents the growth in net domestic credit. The growth in net domestic credit (expansionary monetary policy) is theoretically expected to increase the money stock in the economy leading to an increase in aggregate demand. This may result in a rise in the demand for non-tradables, and hence push their prices up (resulting in high domestic inflation and low or negative real interest rates). Therefore, an increase in this variable, through its impact on the prices of non-tradables, is expected to appreciate the RER.

DEH is defined as the ratio of fiscal deficit to high powered money¹⁴. An increase in this ratio is likely to lead to loss in international reserves, large current account deficits, and an increasing gap between the black and official exchange rates (*Chishti and Hasan, 1993*). Thus, it is expected to lead towards a RER appreciation.

FOREX is the stock of foreign exchange reserve available in a given period of analysis. An increase in the amount of foreign reserve caused by a rise in export earning, aid inflow, etc., is expected to lead to RER appreciation due to the increased capacity and confidence of the monetary authority to defend the national currency.

NFA is net foreign asset which is a measure of the net international creditor position of the country. An increase in the net foreign asset is expected to appreciate the RER.

¹³ Oil price rises affect macroeconomic flows: incomes, current-account balances, and saving. It may generate current account deficit for oil importing country (*Stephen S. Golub, 1983*).

¹⁴ The DEH variable shows the extent to which the government finances fiscal deficits through money printing. This study uses M2 as a proxy for high powered money.

4.1.2 Stationarity Test

Before estimating a macroeconomic time series model of the type considered in this study, it is necessary to discover the time series properties of the data. Thus, whether the variables in the model are stationary or not and their orders of integration are tested in order to avoid inappropriate model specification and misleading results (*Davidson and Mackinnon, 1999: 595*).

A series is referred as (covariance) stationary if it has constant mean, finite time-invariant variance and a covariance between any two time periods that depends only on the lag between them (*Enders, 1995:212; and Gujarati, 2003: 797*). By simple negation, we can say that a series that is not stationary is referred to as non-stationary. Non-stationarity, a property common to many macroeconomic and financial time series, means that a variable has no clear tendency to return to a constant mean or a linear trend. In the presence of non-stationary variables, there might be spurious correlation (*Granger and Newbold, 1974*). Stationarity of each series is checked using the standard Augmented Dickey-Fuller (ADF), the Phillips- Perron (PP), and the Kwiatkowski, Phillips, Schmidt and Shin (KPSS) tests¹⁵.

A time series is said to be integrated of order d , denoted $I(d)$, if it becomes stationary after being differenced a minimum of d times (*Dickey and Fuller, 1979, and 1981*). The stationarity test results may be sensitive to whether a constant and/or a time trend are/is included in the regression. Thus, prior to the formal test, graphical inspection of the individual series is performed as a preliminary step to visualize the behaviours of the series. The appropriateness of including a constant and/or a trend is checked by formally testing whether they are statistically significant in the respective stationarity test regression equations.

¹⁵ Although there are a number of methods for stationarity test, the most widely accepted and reliable methods are the ones mentioned.

Augmented Dickey-Fuller (ADF) Test

Dickey (1976), and Dickey and Fuller (1979, 1981) developed a method for testing the stationarity of a time series variable; by directly testing the null of unit root (non-stationarity). The original Dickey-Fuller (DF) test is based on a simple autoregressive of order one, AR (1) process with a white noise disturbance. However, since the DF test regression does not include values of variables beyond one lag, and the error terms may thus be serially correlated; results based on such tests may be biased and are not valid (*Davidson and Mackinnon, 1999: 610; Gujarati, 2004: 817; and Kirchgassner and Wolters, 2007: 166*). The ADF test avoids the problem because it corrects for serial correlation; by adding lagged difference terms (*Greene, 2003: 643*). The ADF test is formulated as:

$$y_t = \rho y_{t-1} + \phi_1 \Delta y_{t-1} + \phi_2 \Delta y_{t-2} + \dots + \phi_p \Delta y_{t-p} + \varphi + \psi t + \varepsilon_t \text{ ----- (4.2)}$$

Equation (4.2) can be reparameterized to give an equivalent expression of the form,

$$\Delta y_t = \rho^* y_{t-1} + \sum_{j=1}^{p-1} \pi_j \Delta y_{t-j} + \varphi + \psi t + \varepsilon_t; \varepsilon_t \sim iid(0, \sigma^2) \text{ ----- (4.3)}$$

Where, t is time trend, p is the number of lags, $\pi_j = -\sum_{k=j+1}^p \phi_k$ and $\rho^* = \sum_{i=1}^p \rho_i - 1$. The ADF tests the null hypothesis of non-stationarity, $H_0: \rho = 1$ (or $\rho^* = 0$) against the alternative of stationarity, $H_A: \rho < 1$ (or $\rho^* < 0$). However, before testing for stationarity; the appropriate number of lags to include must be determined using the standard information criteria. This is because adding too few lags may tend to overreject the null hypothesis when it is true and too many lags tends to reduce the power of the test (*Davidson and Mackinnon, 1999: 612*). The optimal lag order is allowed to be automatically determined by the Schwarz Information Criteria (SIC). However, ADF test with the appropriate lag may also be problematic with small samples; because adding the lagged values of the dependent variable reduces the power of the test due to loss of degrees of freedom (*Nkurunziza, 2002*).

Phillips-Perron Test

The other test of stationarity with the same null as ADF is the Phillips-Perron (PP). This test is argued to be more robust to serial correlation and time-dependent heteroskedasticity, (*Nandwa and Mohan, 2007*) and improves over the ADF test on the finite sample properties (*Deme, 2002*). Unlike the ADF, the PP test doesn't add lagged difference terms to take care of possible serial correlation in the error terms; it rather uses non-parametric statistical methods. Its test statistic follows the same asymptotic distribution as the ADF test statistic (*Gujarati, 2004: 819*). However, Kirchgassner and Wolters (2007:174) argued that both tests have low power if, under the alternative hypothesis, the first order autocorrelation coefficient is close to one. They noted that if the mean reverting behaviour is only weakly pronounced, very large sample sizes are necessary to reject the null hypothesis. They also argued that, with macroeconomic data, such a sample size can't be materialized, at least as long as only monthly, quarterly or even annual data are available.

The Kwiatkowski, Phillips, Schmidt and Shin (KPSS) test

All the unit root tests discussed so far tests the null hypothesis of unit root (non-stationarity). Since non-stationarity is more likely to be rejected in the ADF and PP tests (*Wang, 2004: 17*), as a mechanism of cross check or confirmation; the study used another test called the KPSS test. The KPSS test is different from other class of tests in that it reverses the null and the alternative hypotheses; and is named as a test of stationarity rather than unit root test. Under the KPSS test, the series is assumed to be (trend) stationary under the null hypothesis. The test statistic is given by a semi parametric Lagrange Multiplier (LM) statistic. The calculated LM statistic is checked against the KPSS (1992) critical values. If the LM statistic is smaller than the critical values, we fail to reject the null and conclude that the series is stationary. If instead the test rejects the null; it means that the variable is not stationary in level suggesting a test in first difference.

4.2 Econometric Method

4.2.1 Vector Autoregressive (VAR) Modeling and Co-integration Analysis

Testing for the order of integration of each series is usually followed by a test of co-integration, if the individual series are found to be non-stationary. The Granger representation theorem (*Engle and Granger, 1987*) states that even if all the variables in the model are individually non-stationary or are $I(1)$, it is possible for some of their linear combinations to be stationary or $I(0)$. In such case the variables are called co-integrated; satisfying some long run equilibrium relationships with possible short run dynamics (*Davidson and Mackinnon, 1999: 614*). In recent years co-integration test is increasingly used in economics to estimate long run linear relationships among variables in the presence of short-run deviations from the long run equilibrium. The procedure used for co-integration testing and estimation of the VAR in this study follows the methodology developed and used by Johansen (1988, 1991), and Johansen and Juselius (1990). This method is preferred to the single equation based Engle-Granger two step procedure because of the shortcomings of the Engle-Granger method.

VAR is a linear statistical model incorporating the memory and feedback effects between multiple variables. It is used to determine how each endogenous variable responds over time to a shock in that variable and in every other endogenous variable. Johansen's method allows for more than one co-integrating relationship to exist among a set of variables. Johansen (1988, 1991) has shown that the test for co-integration can be expressed as a test of reduced rank of a regression coefficient matrix. The coefficient matrix can be estimated consistently using linear regression techniques and the test statistic can be computed from the solution to an eigenvalue problem. Moreover, linear restrictions on the co-integrating parameters can be tested by computing a likelihood ratio test statistic which follows a χ^2 distribution (*Walls, 1993*). A general p^{th} -order VAR representing the interrelationships among the n variables in the model; as given in Johansen and Juselius (1990) is of the form,

$$Z_t = \Omega + \partial_1 Z_{t-1} + \partial_2 Z_{t-2} + \dots + \partial_p Z_{t-p} + \varepsilon_t = \Omega + \sum_{i=1}^p \partial_i Z_{t-i} + \varepsilon_t \quad (4.4)$$

Where, Z_t is an $(nx1)$ vector containing the n -variables (including REERI, NDEV, GCGDP, DEH, OIL, FOREX, DCREDIT, RID, PREMIUM, and NFA); ∂_i is an $(n \times n)$ matrix of coefficients; Ω is a vector of deterministic terms like trends and intercepts; and ε_t are $iid(0, \Sigma)$ vector of error terms with Σ representing the contemporaneous covariance matrix.

4.2.2 Vector Error Correction Model (VECM)

Following the Granger representation theorem, if some variables are co-integrated, the vector error correction model (VECM) representation, which incorporates the long run equilibrium relationships and short run dynamics (adjustment process), can be formulated as,

$$\Delta Z_t = \psi \Omega + \Pi Z_{t-1} + \theta_1 \Delta Z_{t-1} + \dots + \theta_p \Delta Z_{t-p} + \varepsilon_t = \psi \Omega + \Pi Z_{t-1} + \sum_{i=1}^{p-1} \theta_i \Delta Z_{t-i} + \varepsilon_t \quad (4.5)$$

Where, ΔZ_t represents the first differences of the variables; $\theta_i = -\sum_{j=i+1}^p \partial_j$ is a $(n \times n)$ coefficient matrix in the error correction term (which contains the short run parameters); and $\Pi = \sum_{i=1}^p \partial_i - I$ is $(n \times n)$ matrix of long run responses which contains information about the long-run relationships.

Further, the error terms ε_t are assumed to be Gaussian or well-behaved.

Estimation of the VECM requires the determination of the appropriate lag length; since the co-integration result may be sensitive to the number of lags included in the VAR (*Davidson and Mackinnon, 1999: 586*). Thus, we need to determine the appropriate lag length prior to co-integration testing and estimation of the VECM. This is done using the well known model selection criteria, the Akaike Information Criteria (AIC), the Final Prediction Error (FPE), the Hannan-Quinn Information Criteria (HQ), and the Schwarz (Bayesian) Information Criteria (SIC).

The next concern in co-integration analysis is the determination of the rank (r) of the long run matrix (Π). This is the same as determining the number of distinct linear combinations of the variables (or more technically the number of independent co-integrating vectors).

In general, there are three cases that may occur. The first case is when $r = 0$ in which case the short run dynamics depends only on the lagged changes in the variables; and the levels of any of the variables in vector Z have no long run relationship (i.e., there is no co-integration relation; all rows are linearly dependent, and the system is non-stationary). On the other hand, if $r = n$, the matrix is termed to have a full rank which implies that all the endogenous variables are $I(0)$, and all linear combinations would be stationary. In such case, estimating the level VAR and the VECM with unrestricted OLS will give identical results (*Davidson and Mackinnon, 1999: 630*). In addition to these two extreme cases one may find the usual intermediate case of $0 < r < n$, implying co-integration relationship. Here, the system is non-stationary but there are r co-integrating relationships that are stationary; and that Π is said to have reduced rank, and contains stationary long run equilibrium information. However, the rank determination must be supplemented by exogeneity and causality tests to get an economically interpretable linear relationship among the variables (*Badawi, 2005*).

To determine the rank of the long run matrix and hence the number of co-integrating vectors, the two likelihood ratio tests (the trace [λ_{trace}] and the maximal eigenvalue [λ_{max}] statistics) are used.

These are given by,

$$\lambda_{trace}(r) = -T \sum_{i=r+1}^n \ln(1 - \hat{\lambda}_i) \text{-----} (4.7)$$

and $\lambda_{max}(r, r+1) = -T \ln(1 - \hat{\lambda}_{r+1}) \text{-----} (4.8)$

Where r is the number of co-integrating vectors under the null; $\hat{\lambda}$ is the estimated characteristic root (eigenvalues) from the Π matrix; and T is the number of observation. The trace method tests

the hypothesis that there exist at most r co-integrating vectors against the alternative that there are n co-integrating vectors. On the other hand, the maximal eigenvalue tests the null of r co-integrating vectors against the alternative of $r+1$ co-integrating vectors. The test statistics are then compared to the critical values given by Johansen and Juselius (1990). However, these test statistics may sometimes yield conflicting results. For such cases, the trace statistic is preferred as it is more robust to skewness and kurtosis in residuals (see *PcGive10 manual page 89*).

In both of these sequential tests for the rank of the long run matrix, if the null of r co-integrating vectors ($0 < r < n$) couldn't be rejected it means that only r linear combinations of the variables are stationary. The co-integrating rank r is chosen as the smallest value among the values where the null hypothesis is not rejected. Under the null hypothesis (i.e. if the data co-integrates); Π must be of reduced rank, $r < n$ (MacDonald and Marsh, 1997). It can thus be decomposed into two ($n \times r$) matrices α (the speed of adjustment matrix) and β (the matrix of the long run coefficients) with a rank of r such that $\Pi = \alpha\beta'$.

Under such case, we can run a co-integrating regression and the co-integrated relationships from the VECM can be interpreted as long term economic steady state relationships. The VECM is used to distinguish between stationary variables with transitory (temporary) effects and non-stationary variables with permanent (persistent) effects.

After identifying the fundamental determinants of real effective exchange rate, equilibrium real effective exchange rate of the Birr is obtained to measure the degree of misalignment. This may be done in different ways. Some studies simply substitute the actual values of the fundamentals into the estimated relationship and compare the equilibrium RER thus found to the actual RER and the difference between the two indicates the extent of misalignment. MacDonald (1999) described this as a measure of *current misalignment* since equilibrium RER is calculated using the

current (actual) values of the fundamentals. Misalignment is defined as a sustained deviation of the actual exchange rate from its long run equilibrium level (*Edwards, 1988, 1989*).

The second way of calculating the equilibrium RER is by first deriving the sustainable or long run values of the fundamentals and substituting them in the long run equation of the RER. This is because of the possibility that the actual values of the economic fundamentals themselves may deviate from their sustainable or long run equilibrium levels. There are several ways of deriving the long-run values of the fundamentals such as taking moving averages as proposed by Edwards, the Hodrick-Prescott (1980) filter, the Beveridge-Nelson decomposition and the permanent equilibrium exchange rate (PEER) approach used by Montiel (1999). This study uses the second measure to estimate the equilibrium real effective exchange rate. That is by smoothing all the fundamentals using the Hodrick-Prescott (1980) filter and then substituting them into the estimated long-run relationship. This method effectively takes the cyclical (short-run) components out of the data, thus, resulting in the sustainable values of the fundamentals¹⁶. Thus, real effective exchange rate misalignment (termed *total misalignment*) in this case is given by the difference between the actual real effective exchange rate and the equilibrium rate-estimated using the sustainable or long-run values of the fundamentals.

4.2.3 Granger-Causality/Block Exogeneity Test

VAR model can be used to test Granger causality among the variables and also that an endogenous variable can be treated as exogenous. The Granger causality test is applied to investigate the direction of causality between the variables. This concept involves the effect of past values of one or more of the variables on the current value of the other. A chi-square (Wald) statistics is used to test for the joint significance of all other lagged endogenous variables in each equation of the model. The null hypothesis being tested is that for X and Y in the vector of endogenous variables of the VAR, X does not Granger cause Y; or Y does not Granger cause X.

¹⁶ The HP filter is a linear filter aimed at removing the low frequency variation from a series.

This is checked by testing whether lagged values of the variables in the unrestricted VAR are statistically significant or not.

4.2.4 Diagnostic Checks

Residual Vector Normality Test

One of the important post estimation diagnostic tests in empirical studies is the test of normality of the residuals. The study uses the multivariate extension of the Jarque-Bera (*JB*) test for residual normality. It compares the third and fourth moments of the residuals to those from the normal distribution (*EViews 5.1 user's guide*). It is a joint asymptotic test whose statistic is calculated from the skewness and kurtosis of the residuals as follows.

$$JB = \frac{T}{6} \left[S^2 + \frac{(\beta_3 - 3)^2}{4} \right] \text{-----} (4.9)$$

Where, T is the number of observation; S is the coefficient of skewness, β_3 is a measure of kurtosis; and the test statistic is χ^2 distributed. The joint test is based on the null hypothesis that the residuals are normally distributed (i.e., S = 0 and $\beta_3 = 3$). Rejection of the null hypothesis at the standard critical values indicates non-normality in the residuals.

Error Vector Autocorrelation Test

The other diagnostic test for checking the complete specification and the robustness of the results of an econometric model is the test of serial correlation in the residuals. The study uses the Breusch-Godfrey Lagrange Multiplier (LM) test; which is a multivariate test for residual serial correlation up to some specified lag order. The test statistic for the chosen lag order (L) is computed by running an auxiliary regression of the residuals (ε_t) on the original variables and the lagged residuals (ε_{t-L}).

$$LM = (T - q) R_{\varepsilon}^2 \text{-----} (4.10)$$

Where, q is the degrees of freedom and R_{ε}^2 is the coefficient of determination obtained from the auxiliary regression; and the LM test statistic is χ^2 distributed. The LM tests the null hypothesis of no serial correlation against an alternative of autocorrelated residuals.

Heteroskedacity Test

The last diagnostic test considered in this study is the test of heteroskedasticity. White's test is used to check whether the residuals are homoskedastic or not. It tests the null hypothesis that the residuals are both homoskedastic and that there is no problem of misspecification. The test regression is run by regressing each cross product of the residuals on the cross products of the regressors and testing the joint significance of the regression.

4.2.5 Impulse Response Functions and Variance Decomposition Analyses

Introduction

Tracing the response of the system to an innovation in one of the variables and decomposing the forecast error variance have become standard tools for economic analysis involving VAR (*Lutkepohl, 1990*). Impulse response analysis and variance decomposition form innovation accounting for sources of information and information transmission in a multivariate dynamic system (*Wang, 2004: 64*); and thus provide information on the dynamic behaviour of the real effective exchange rate due to innovations in the variables of the system.

Impulse Response Functions

Impulse response functions provide information to analyze the dynamic behaviour of a variable due to a random shock or innovation in other variables. The impulse response traces the cross-effect on current and future values of the endogenous variables of one standard deviation shock to the variables. The impulse response functions show the sign, magnitude, and persistence of real and nominal shocks to the RER. A shock to a variable in a VAR not only directly affects that variable, but is also transmitted to all other endogenous variables in the system through the

dynamic structure of the VAR. This is because the innovations may possibly be correlated with each other; making interpretation of the impulse responses difficult.

Consider the VAR (p) process in equation (4.4) to be stationary, so that it has a Vector moving average (VMA) representation of the form,

$$Z_t = \alpha\Omega_t + \sum_{\tau=0}^{\infty} \Phi_{\tau} \varepsilon_{t-\tau} \text{-----} (4.11)$$

$$\text{Where, } \Phi_{\tau} = \begin{bmatrix} \phi_{11} & \phi_{12} & \phi_{13} & \dots & \phi_{1j} \\ \phi_{21} & \phi_{22} & \phi_{23} & \dots & \dots \\ \dots & \dots & \dots & \dots & \dots \\ \phi_{i1} & \dots & \dots & \dots & \phi_{ij} \end{bmatrix}^{\tau+s} \text{-----} (4.12)$$

Where, Matrix Φ_{τ} is the impulse response functions, and vector ε represents innovations.

Every element $\phi_{ij}^{\tau+s}$ is interpreted as the response of the i^{th} variable at time $\tau+s$ to a one standard deviation shock in the innovation generated from the j^{th} variable τ -periods ago, provided that the effect is isolated from the influence of other shocks in the system (*Wang, 2004: 65*). There are several ways of isolating the effect of a shock on a variable of interest from the influence of all other shocks, in performing impulse response analysis, but the Cholesky orthogonalization approach (to transform the innovations such that they become uncorrelated), is preferred in this study. The dynamics of the VAR model can also be visualized from impulse response diagrams.

Variance Decomposition

Decomposing the forecast error variance also gives additional information about how the RER and its determinants are linked. It measures the proportion of forecast error variance in a variable that is explained by innovations in itself and the other variables. In other words, variance decompositions show the portion (or relative importance) of variance in the prediction for each variable in the system that is attributable to its own innovations and to shocks to other variables in the system.

V. EMPIRICAL ANALYSIS AND FINDINGS

5.1 Time Series Properties of The Data

This subsection presents the results of the descriptive analysis used to examine the data prior to making a formal parametric regression. It summarizes the data set and shows the trending and co-trending behaviours of the different variables overtime. The presence and severity of multicollinearity problem is also assessed using simple correlation and the variance inflation factor. In general, the time series properties of the variables are investigated and results are presented in this section.

Trends in Exchange Rates in Ethiopia and Their Joint Movements

Figure 1 shows that the real and nominal effective exchange rates moved closely together only during the 1997:2 to 2004:4 period. For the period after the first quarter of 2005, the real effective exchange rate showed a rapid upward movement (appreciation) with a very sharp increase after 2007:4. During the same period, the nominal effective exchange rate showed a slightly declining trend. Therefore, it seems from the graph that although the nominal exchange rate policy followed

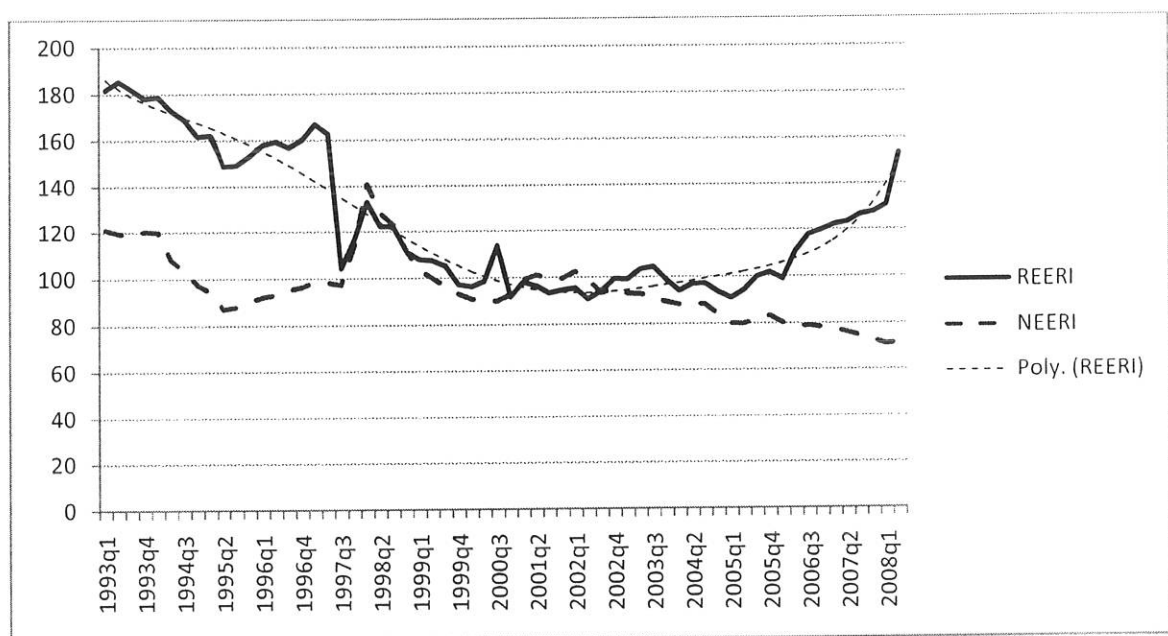


Figure 1: Trends in Nominal and Real Effective Exchange Rate Indices

since 1993 looks effective in reducing the real appreciation and hence its potential impact on the overall competitiveness of the country it doesn't seem to maintain that effectiveness after the first quarter of 2005. This may also be partly because of the soaring up of the domestic inflation since then. Overall, the graph shows that the real effective exchange rate of the Birr against Ethiopia's major trading countries' currencies has been depreciating from 1993:1 to 2005:1 followed by a continuous appreciation since 2005:1.

The correlations between pairs of some measures of exchange rate are shown in table 1 to assess their joint association. The table shows that most of the measures are fairly highly correlated. The real effective exchange rate is negatively correlated with both the official and parallel bilateral nominal exchange rates (against the US dollar); and it is positively correlated with the parallel premium and nominal effective exchange rate. The positive correlations of real effective exchange rate index (REERI) with PREMIUM (0.7935) and nominal effective exchange rate (NEERI) (0.3909), is theoretically plausible as it is natural to expect an appreciated REERI with an overvalued NEERI and a highly controlled capital and foreign exchange markets. The negative correlation of REERI with OFFICIAL (-0.8632) also makes sense as the relationship is not really negative. It rather happened so because of the way these variables are defined. It means that rising official nominal bilateral exchange rate may coexist with a depreciating real effective exchange rate. On the other hand, the official nominal bilateral exchange rate has a strong negative association with the parallel premium.

Table 1: Correlation Matrix for the Different Exchange Rate Measures in Ethiopia

	REERI	NEERI	OFFICIAL	PARALLEL PREMIUM	
REERI	1				
NEERI	0.3909	1			
OFFICIAL	-0.8632	-0.6527	1		
PARALLEL	-0.7044	-0.7408	0.9047	1	
PREMIUM	0.7935	0.381	-0.8165	-0.4991	1

Trends in the Real Exchange Rate Fundamentals

The index for international price of oil has shown an upward exponential movement with some perceived cyclical nature (Figure 2). The figure depicts that this variable has been very sharply increasing especially after the first quarter of 2007. It is a recent phenomenon that the world has experienced the highest ever nominal price for petroleum. It may also be remembered that the international nominal price for a barrel of petroleum jumped from below \$100 in the first quarter of 2008 to about \$150 only after a few months. Thus both the nominal and real prices of oil have been growing over time.

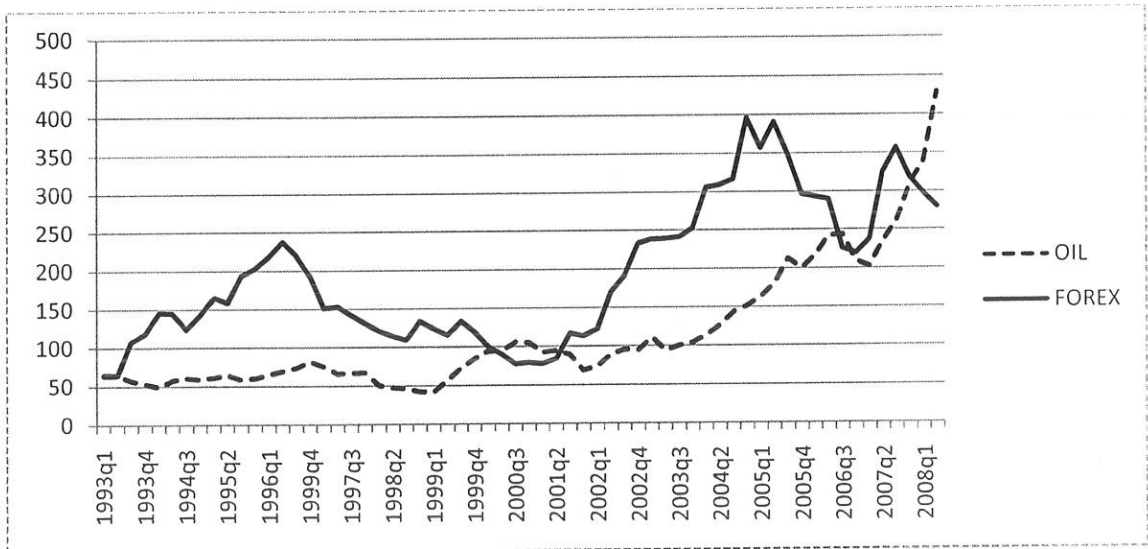


Figure 2: Trends in Indices of Foreign Exchange Reserve and Real International Price of Oil

Foreign exchange reserve also showed an average upward movement through time (with a significant variation) following a polynomial trend (Figure 2). The amount of quarterly foreign exchange reserve of the country showed an increasing trend from 1993:1 to 1995:4. It then continuously declined up to 1998:2 and reached its trough in 2000:4 after some ups and downs. As of 2001:1 it again continued to show a consistently upward movement through 2004:4 when it reached the highest ever value. After sharply declining for six quarters (from 2005:2 to 2006:4) it again showed a rising trend with slight decline very recently (after 2007:4).

One may perceive these movements to be attributable to both the economic as well as political episodes the country has experienced during the period. It seems from the graph that the aftermath of national political elections in Ethiopia, besides other factors, might have led to declines in foreign exchange reserves. This seems logical because the variable has a tendency to decline after almost each election although there were significant upward trends prior to the election periods. However, strong arguments couldn't be made in this line as the decline in foreign exchange reserve may also be caused by shocks to other (economic) factors such as rapid growth in import bills and/or declines in export earnings during the preceding quarter(s).

Premium also showed similar cyclical nature with visible peaks around 1995, 2000, and 2005¹⁷ (Figure 3). The figure shows that the parallel premium has been effectively managed to be very low during the period 2002:1 - 2005:2, and some other quarters. The above arguments may substantiate the belief that economies (especially of the developing countries) could become feeble after national political elections since international financial institutions and donor countries may cut back the amount of aid and loan they extend to those countries that in their beliefs are not promoting democracy.

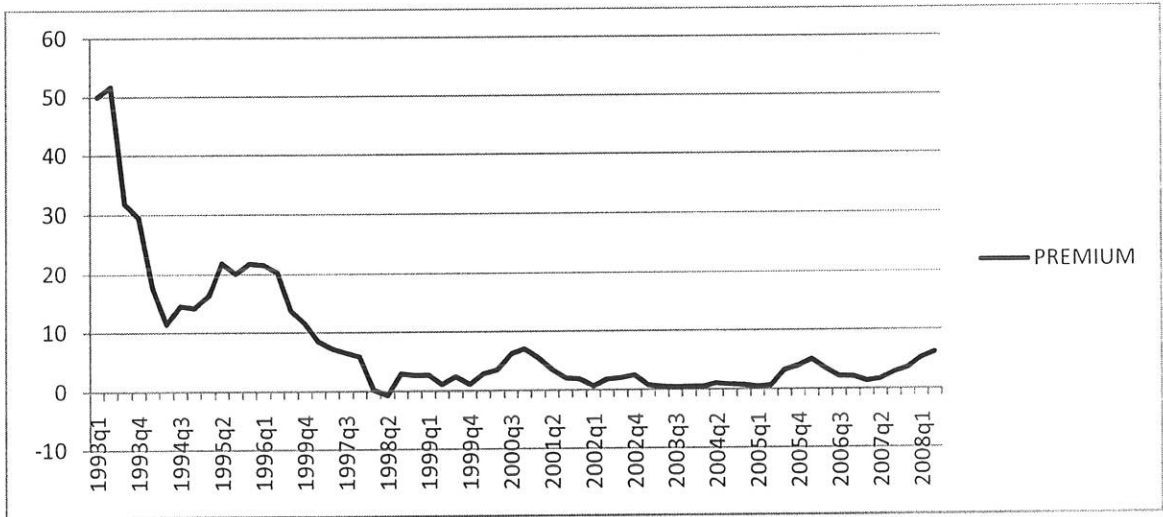


Figure 3: Trends in the Parallel Foreign Exchange Market Premium

¹⁷ It must, however, be noted that the amount of parallel premium declined from 50 in 1993:1 to 11.43 in 1994:2.

Figure 4 shows the behaviours of the ratio of government consumption to GDP (GCGDP) and ratio of fiscal deficit to high powered money (DEH). These ratios, although showed upward and downward movements (with moderately cyclical nature), look relatively stable over the period considered. The figure portrays that GCGDP ranges from 16.794 (in 1997:1) to 29.247 (in 2002:1) and DEH ranges from 6.578 (in 2006:3) to 14.815 (in 1999:3). These two ratios seem to move in the same way throughout the study period. However, since these variables are obtained by taking the ratios of interpolated variables, little could be said about the behaviours of the quarterly series.

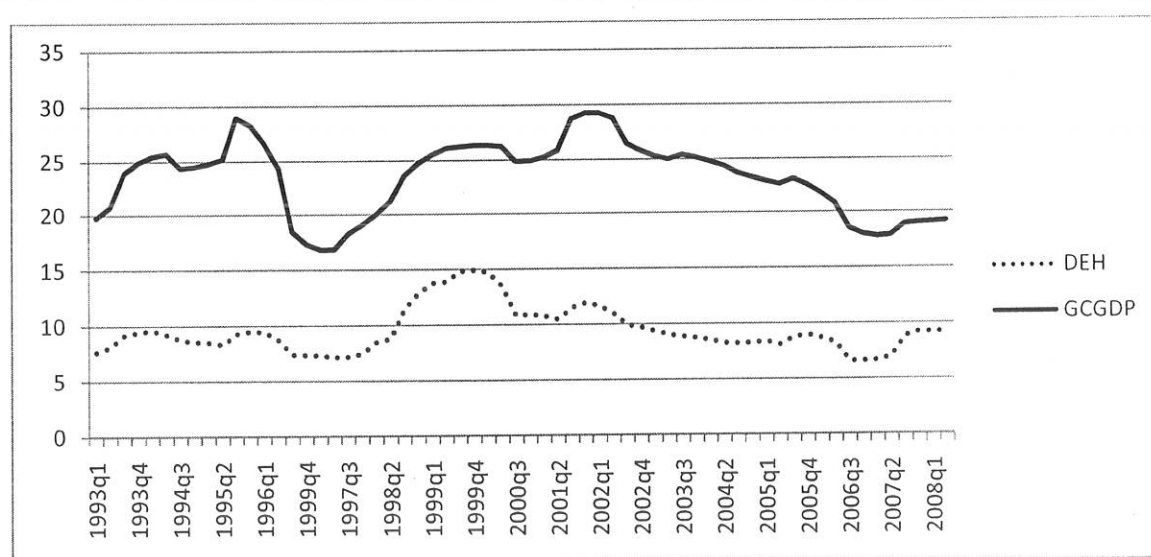


Figure 4: Ratios of Fiscal Deficit to High Powered Money and Government Consumption to GDP

Nominal devaluation (NDEV) and the real interest rate differential (RID) have shown significant fluctuations over the study period (Figure 5). The RID has followed a higher order polynomial trend during the study period with the trend slanting or bending down especially after 2002. It was swinging between -10 and 15 during 1993:1 to 2002:1. It could also be observed in the figure that although short term upward or downward movements in this variable were being compensated by reversal movements such that there have been tendencies of returning to some previous levels, this phenomenon didn't continue after 2002. It declined from 13.325 in 2001:3 to -21.758 in

2003:2. It then rose to -0.6167 in 2004:3, followed by a sustained down ward movement till recent when it registered a value of -26.5465 in 2008:2.

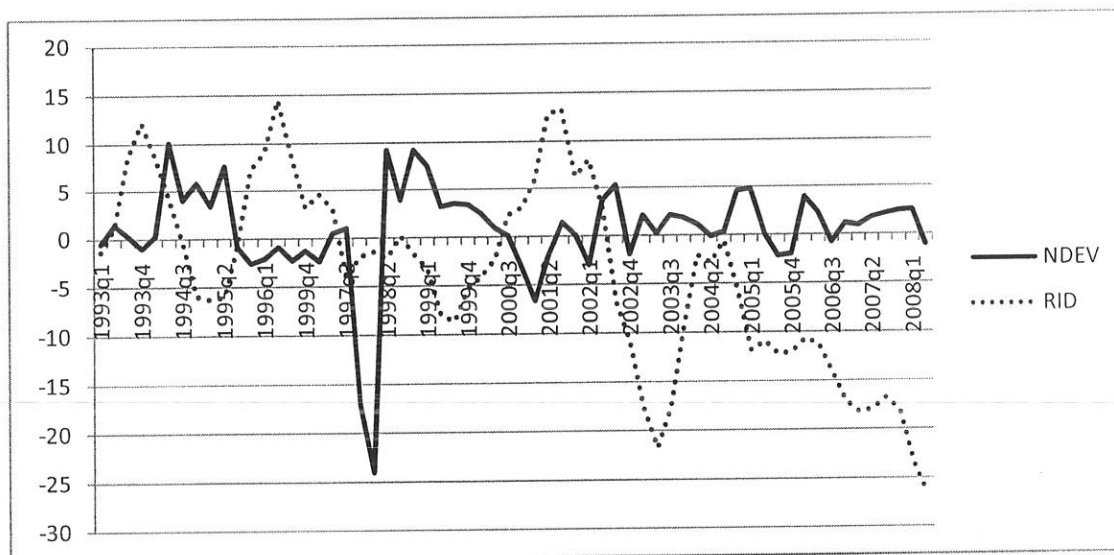


Figure 5: Trends in Nominal Effective Devaluation and Real Interest Rate Differential

The recent down ward trend in RID could in fact be justified by the rise in the rate of domestic general prices¹⁸. During post 2005, inflation did not cross a value of 4% in most of the major trading partners' economies; and has been consistently negative or at most less than one in some of them (Japan for example). Nominal interest rate is also found to be very low in Japan compared to that of the other partners. Therefore, the recent large negative interest rate differential between Ethiopia and its major trading partners' average could be attributable largely to the relatively faster growth in general prices in the domestic economy.

Finally, figure 6 show that the growth in net domestic credit has a frequently changing rate. Net domestic credit showed a very volatile growth which in fact didn't exceed a 10% level. On the other hand, there were also periods during which it has shown negative growth rates (of up to -12.79% in 1993:2, for example).

¹⁸ The CPI based inflation in Ethiopia rose from a value of 5.77 in 2004:4 to 11.67 in 2005:1, and continued to grow afterwards with only small declines in some quarters.

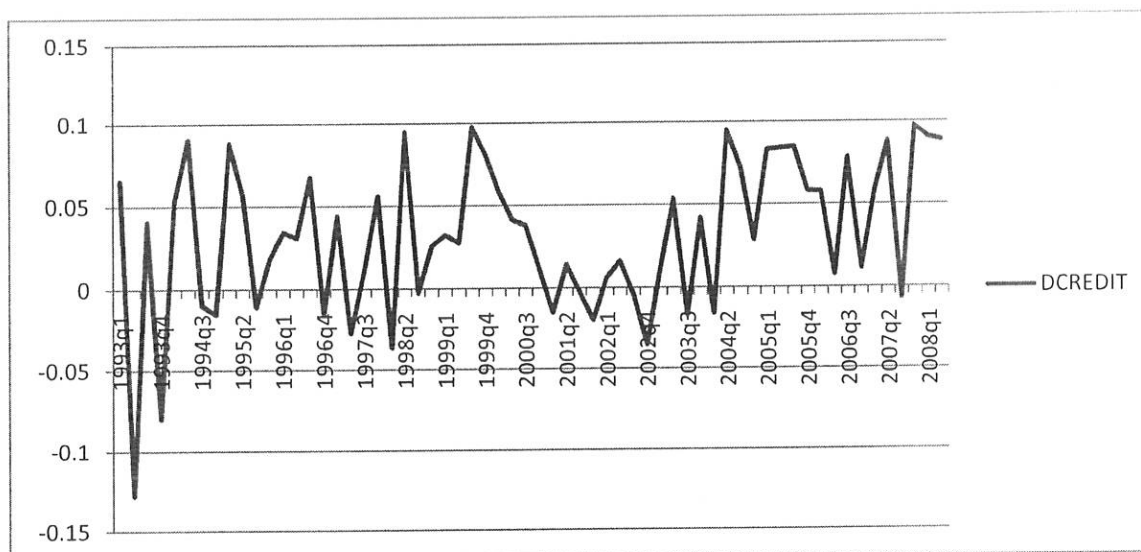


Figure 6: Behaviour of the Growth in Net Domestic Credit

Summary Result

Table 2 gives the summary statistics showing mainly the mean values and the standard deviations of the variables. The table shows that all the variables except the real interest rate differential have positive mean values. It is also apparent from the table that most of the variables show significant variations. The ratio of fiscal deficit to high powered money, ratio of government consumption to GDP, parallel premium, nominal effective devaluation, growth in net domestic credit, and real interest rate differential were found to have low standard errors. Contrarily, the FOREX and NFA

Table 2: Summary Statistics

Variable	Observation	Mean	Std.Dev.	Minimum	Maximum
REERI	62	123.9387	30.19959	90.8	185.5
DEH	62	6.000144	1.701232	2.88067	9.91012
GCGDP	62	23.3549	3.481266	16.794	29.247
OIL	62	116.0126	80.99586	41.24	428.96
PREMIUM	62	8.037049	11.05441	-0.7	51.72
NDEV	62	0.783871	5.556806	-27.3	12.9
NFA	62	7893.816	3896.479	171.6	14108.4
DCREDIT	62	0.0314095	0.046448	-0.12799	0.09741
FOREX	59	707.5142	335.08	241	1485.11
RID	62	-3.889594	9.808488	-26.5465	14.5067

variables have recorded large standard errors, with the latter being overly exaggerated. This may imply the presence of outliers in these variables (especially the NFA) that may affect the results if included (without transformation) in the model.

Test of Multicollinearity

One of the pre-estimation diagnostic tests in empirical analysis is a test of multicollinearity. When the explanatory variables are very highly correlated (they are “multicollinear”) then data cannot tell, with the desired precision, if the movements in the dependent variable was due to movements in one or the other explanatory variables. This means that the point estimates might fluctuate wildly over subsamples and it is often the case that individual coefficients are insignificant even though the overall fit may be high and the joint significance of the coefficients is also high. However, the estimators can still be consistent and asymptotically normally distributed (*Greene, 2003: 56-59*).

Table 3: Correlation Matrix for the Real Exchange Rate Fundamentals in Ethiopia

	NDEV	GCGDP	RID	PREMIUM	OIL	DCREDIT	DEH	FOREX	NFA
NDEV	1.0000								
GCGDP	0.2132	1.0000							
RID	-0.1758	0.2960	1.0000						
PREMIUM	-0.0179	-0.0570	0.4005	1.0000					
OIL	0.0210	-0.3911	-0.6195	-0.3614	1.0000				
DCREDIT	0.2057	-0.0749	-0.2588	-0.2848	0.2574	1.0000			
DEH	0.2131	0.6753	0.1928	-0.2145	-0.3579	0.0145	1.0000		
FOREX	0.0847	-0.2179	-0.5283	-0.3527	0.7123	0.2948	-0.4485	1.0000	
NFA	0.0727	-0.1801	-0.6904	-0.6118	0.7924	0.2748	-0.3270	0.8927	1.0000

As a preliminary step for checking the presence of high multicollinearity among the variables, simple correlations between the pairs of variables have been calculated and the results are presented in table 3. Although the presence of high pair-wise correlations among pairs of variables may not necessarily imply that there is multicollinearity problem; it would warn the analyst to be cautious about it and perform formal tests so as to check the severity of the

problem¹⁹. The result shows that most of these correlations are less than 0.6. It is the NFA variable that has high correlation with four variables. Therefore, it is suspected that the use of NFA in the regression model may create multicollinearity problem.

There are several classical tests for diagnosing collinearity problems to augment the results from the simple pair-wise correlation matrix, but this study focuses on only one—the variance inflation factor (VIF) - perhaps the simplest and most commonly used test. Using the VIF and its reciprocal- the Tolerance, it is found that including NFA generates a VIF of 23.92 (first column of table 4) with a very less tolerance (0.0418) for the problem. Eventhough, the test by itself is not free from limitations, as a rule of thumb the VIF must be less than 5. When the NFA variable is excluded, the highest VIF value is 3.15 (for FOREX) with a mean value of only 2.19. This may suggest that the problem caused by high multicollinearity is less tolerable when NFA is used together with the other variables, and hence the estimates are less precise and the results so obtained would be less reliable. Thus, NFA is excluded from the econometric analysis.

Table 4: Variance Inflation Factor for the Test of Multicollinearity

With NFA			Without NFA		
Variable	VIF	Tolerance	Variable	VIF	Tolerance
NFA	23.92	0.041804			
FOREX	9.13	0.109558	FOREX	3.15	0.317322
PREMIUM	4.13	0.242313	DEH	3.13	0.319508
OIL	3.90	0.256194	OIL	2.75	0.364266
DEH	3.76	0.266145	GCGDP	2.43	0.410774
GCGDP	3.04	0.328961	RID	1.91	0.522263
RID	2.80	0.357401	PREMIUM	1.67	0.598672
DCREDIT	1.29	0.775249	NDEV	1.23	0.815788
NDEV	1.23	0.815732	DCREDIT	1.22	0.821814
<i>Mean VIF</i>	<i>5.91</i>		<i>Mean VIF</i>	<i>2.19</i>	

¹⁹ Multicollinearity inflates the standard errors, making it impossible to determine the relative importance of the predictors. Thus, the coefficients will be unreliable. However, it does not affect the efficiency of the estimators.

Stationarity Test Result

Before making formal test of stationarity, a graphical sketch of each of the variables over time has been done. This helps to (informally) identify the presence of any trending behaviour for the variables at hand. The graphical plots in figures 2 through 6 showed that none of the variables have clear upward or downward linear trend. It seems from the drawing that PREMIUM is trending downward and OIL is trending upward. However, these seemingly trends don't look like linear. They are rather rectangular hyperbolic and exponential, respectively. On the other hand, the FOREX and RID variables seem to trend upward and downward, respectively. These also look like higher order polynomials instead of linear. Nonetheless, this visual inspection may only help us to have a rough idea about the behaviours of the variables; but it will not give us a complete answer as to whether these variables are stationary or not.

Therefore, as explained in the methodology, formal testing for stationarity and the order of integration of each variable are undertaken mainly using three different methods (ADF, Phillips-Perron, and KPSS). The tests with the ADF and PP methods are done under the different trend assumptions (only intercept, both linear trend and intercept, and no intercept and no trend). After performing the tests under all the three alternatives, whether the trend and intercept or both are significant has been identified. This helps to choose the right trend assumption under which to perform the test, and hence augment the rough suggestions of the graphical plots.

The results from the stationarity test equations under the ADF (table 5) shows that only an intercept must be included in three of the variables (OIL, GCGDP and DEH) in testing for stationarity, while the remaining six variables are tested without trend and intercept. On the other hand, a linear trend is found to be insignificant in all of the test equations. This also supports the results from the graphical plots that none of the variables have clear linear trend. The numbers in bold in table 5 shows the statistic with the respective trend assumption.

The table shows that seven out of the nine variables are non-stationary at level, while all are difference stationary. Thus, the ADF identified two level stationary variables (PREMIUM, and NDEV). The result for DCREDIT is found to be sensitive to the trend assumption and the other results are found to be stable and consistent in all the cases.

Table 5: Augmented Dickey-Fuller Stationarity Test Result

Variable	Test Statistic Under Different Assumptions			Order of Integration
	Intercept	Trend and Intercept	No Trend No Intercept	
REERI	-1.8732	-0.6536	-0.7788	I(1)
D(REERI)	-8.1184***	-7.8282***	-8.1628***	
PREMIUM	-4.8668***	-3.9557**	-5.0102***	I(0)
OIL	4.7147	2.6488	4.9553	I(1)
D(OIL)	-3.0621**	-3.9620**	-2.6380***	
FOREX	-0.8673	-1.4505	0.8574	I(1)
D(FOREX)	-6.3557***	-6.3074***	-6.2277**	
RID	-0.7050	-3.8206**	-0.2054	I(1)
D(RID)	-5.6575***	-5.6980***	-5.5529***	
DEH	-2.3805	-2.4072	-0.3982	I(1)
D(DEH)	-4.8945***	-4.8575***	-4.9359***	
GCGDP	-2.1295	-2.1917	-0.6496	I(1)
D(GCGDP)	-2.6855**	-2.6935*	-2.6491***	
NDEV	-5.4209***	-5.3740***	-5.3867***	I(0)
DCREDIT	-4.2344***	-4.6202***	-1.2095	I(1)
D(DCREDIT)			-10.2712***	

Note: MacKinnon (1996) one-sided critical values for rejection of a unit root depend on the optimal lag length. *, **, and *** shows significance at the 10%, 5%, and 1%, respectively.

The Phillips-Perron test (table 6) gives a result that is fairly consistent with and supports the results of the ADF. The only differences are that DCREDIT is level stationary under the PP test and difference stationary under the ADF and the significance of a constant is maintained only for OIL. In addition, in PP test equation, only the constant is significant for GCGDP variable. It is theoretically expected for variables like NDEV, PREMIUM, and DCREDIT to be level stationary since some differencing operations have been performed in the steps to derive them. Therefore, both the ADF and PP results are consistent with each other and seem to be plausible.

Table 6: Phillips-Perron Stationarity Test Result

Variable	Test Statistic Under Different Assumptions			Order of Integration
	Intercept	Trend and Intercept	No Trend, No Intercept	
REERI	-1.7818	0.4092	-0.8259	I(1)
D(REERI)	-8.1906***	-10.8336***	-8.2333***	
PREMIUM	-4.7616***	-3.9180**	-4.8331***	I(0)
OIL	4.0159	2.0235	3.9092	I(1)
D(OIL)	-2.8639**	-3.9451**	-2.3220	
FOREX	-1.1611	-1.8394	0.5477	I(1)
D(FOREX)	-6.4477***	-6.4010***	-6.3223**	
RID	-1.6053	-2.9654	-1.3103	I(1)
D(RID)	-4.9053***	-4.9267***	-4.9650***	
DEH	-2.1225	-2.1572	-0.2577	I(1)
D(DEH)	-4.9062***	-4.8734***	-4.9466***	
GCGDP	-2.1343	-2.3188	-0.3467	I(1)
D(GCGDP)	-4.7134***	-4.7421***	-4.7524***	
NDEV	-5.3041***	-5.2534***	-5.3161***	I(0)
DCREDIT	-7.9229***	-8.6807***	-6.3645***	I(0)

Note: MacKinnon (1996) one-sided critical values for rejection of a unit root depend on the optimal lag length. *, **, and *** shows significance at 10%, 5%, and 1%, respectively.

Unfortunately, the KPSS results (in appendix 1) are not consistent with both the ADF and PP test results for some of the variables. This may be because of the fact that the KPSS cannot perform the stationarity test under the no constant and no trend assumption in EViews. But, it has been shown that intercept and trend are insignificant in the ADF and PP test equations for most of the variables.

5.2. Econometric Analysis

5.2.1 Results for Co-integration Test And Vector Error Correction Model

5.2.1.1. Co-integration Test Result

Lag Order Selection for Endogenous Variables

The Johansen co-integration test results could be highly sensitive to the number of lags included for the endogenous variables in the estimation of the VAR; which necessitates the determination of an optimal lag order prior to the test of co-integration. The optimal lag order is determined partly by using the sequential modified Likelihood Ratio test statistics [LR], the Final Prediction

Error [FPE], the Akaike Information Criterion [AIC], the Schwarz Information Criterion [SIC], and the Hannan-Quinn Information Criterion [HQ]) and partly by taking the size of the data into consideration.

Considering the potential small sample problems of the data, we chose to refrain from basing the analysis on the larger lags. Therefore, the third lag is chosen to be the maximum lag. As shown in table 7, all the LR, FPE, AIC, SIC, and HQ suggest an optimal lag of one when a maximum lag of three is included; all at the 5% level of significance²⁰.

Table 7: Optimal Lag Order Selection Criteria

Endogenous variables: REERI DEH1 RID DCREDIT PREMIUM NDEV OIL FOREX GCGDP
Sample: 1993:1 2008:2; included observations: 58; exogenous variables: C

Lag	Log-likelihood	LR	FPE	AIC	SIC	HQ
0	-1760.541	NA	2.26e+16	63.19791	63.52341	63.32411
1	-1333.236	702.0023**	9.95e-10**	50.82985**	54.08488**	52.09182**
2	-1264.094	91.36650	1.89e-11	51.25334	57.43790	53.65108
3	-1171.861	92.23221	2.39e-11	50.85219	59.96627	54.38570

** indicates lag order selected by the criterion (each test at 5% level).

LR: sequential modified LR test statistic; FPE: Final Prediction Error; AIC: Akaike Information Criterion; SIC: Schwarz Information Criterion; and HQ: Hannan-Quinn Information Criterion.

Lag Exclusion Test

It may also be possible for some of the lags (of some endogenous variables) that are chosen as optimal to have insignificant contribution in causing movements in the real effective exchange rate, individually as well as jointly. Therefore, it should be checked whether the first lags (chosen as optimal) of all variables are individually and jointly important and be included in the testing for co-integration and estimation of the VECM. This was done using the Wald form of lag exclusion test (which is asymptotically chi-square distributed). Table 8 shows that the first lags of all endogenous variables are significant both individually and jointly. This suggests that the use of the first lags of the variables in the model is valid.

²⁰ This is because the model passes most of the diagnostic checks under this case; and including higher order lags may reduce the degrees of freedom, and hence affects the robustness of the model as it would be forced to estimate too many parameters per each equation using only sixty two observations while there are nine variables.

Table 8: VAR Wald Lag Exclusion Test

Lag	Equation									
	REERI	NDEV	GCGDP	RID	PREMIUM	OIL	DCREDIT	DEH	FOREX	JOINT
1	620.79 (0.000)	32.62 (0.001)	470.37 (0.000)	332.87 (0.000)	974.33 (0.000)	1935.39 (0.000)	41.40 (0.000)	472.95 (0.000)	650.21 (0.000)	6230.74 (0.000)
DF	9	9	9	9	9	9	9	9	9	81

*Chi-squared test statistics (with the respective p-values in parenthesis) is used.

Granger Causality/Block Exogeneity Test

In addition to the lag exclusion test, the study performed granger causality test to examine the presence of bidirectional causality in the sense of Granger. Table 9 shows, that the parallel

Table 9: Result for the Granger Causality/Block Exogeneity Wald Tests

Equation	REERI	NDEV	GCGDP	RID	PREMIUM	DCREDIT	OIL	DEH	FOREX
Excluded									
REERI		15.834 (0.000)	4.152 (0.042)	2.557 (0.109)	0.657 (0.418)	5.868 (0.015)	0.011 (0.916)	2.237 (0.135)	0.591 (0.442)
NDEV	0.453 (0.501)		0.977 (0.323)	2.511 (0.113)	0.568 (0.451)	0.840 (0.359)	0.111 (0.739)	1.310 (0.252)	0.616 (0.432)
GCGDP	0.288 (0.591)	1.518 (0.218)		0.474 (0.491)	7.088 (0.008)	0.762 (0.383)	0.661 (0.416)	2.668 (0.102)	4.807 (0.028)
RID	0.147 (0.702)	0.751 (0.386)	3.919 (0.048)		2.606 (0.106)	0.569 (0.450)	0.196 (0.658)	0.455 (0.499)	0.898 (0.343)
PREMIUM	7.038 (0.008)	7.481 (0.006)	1.593 (0.207)	9.200 (0.002)		4.849 (0.028)	0.187 (0.665)	0.473 (0.491)	0.039 (0.842)
DCREDIT	1.842 (0.175)	1.253 (0.263)	8.4e-05 (0.993)	1.805 (0.179)	23.074 (0.000)		0.157 (0.692)	0.834 (0.361)	0.259 (0.610)
OIL	0.084 (0.772)	1.714 (0.191)	2.469 (0.104)	0.633 (0.426)	0.118 (0.731)	0.044 (0.834)		4.305 (0.038)	0.014 (0.906)
DEH	0.305 (0.581)	4.329 (0.038)	2.126 (0.145)	0.201 (0.654)	4.066 (0.044)	11.369 (0.001)	4.688 (0.030)		6.812 (0.009)
FOREX	0.001 (0.983)	0.816 (0.366)	8.172 (0.004)	1.449 (0.229)	3.279 (0.070)	14.596 (0.000)	1.688 (0.001)	0.707 (0.400)	
Joint	10.490 (0.232)	18.555 (0.017)	24.377 (0.002)	19.366 (0.013)	35.226 (0.000)	33.992 (0.000)	18.905 (0.015)	11.503 (0.175)	10.516 (0.231)

NB: The numbers in parenthesis show the P-values for the corresponding Chi-square statistics.

premium granger causes real effective exchange rate, and real effective exchange rate granger causes nominal devaluation, ratio of government consumption to GDP and growth in net domestic credit. On the other hand, foreign exchange reserve and ratio of government consumption to GDP; oil price and ratio of fiscal deficit to high powered money; and parallel premium and growth in net domestic credit are found to granger cause each other. This implies that the lagged values of some of the variables have significant roles in explaining the current and future values of some other variables and this effect runs both ways in some of the cases. Thus, due to the implied dynamic interaction among the variables, it might not be legitimate to consider the real effective exchange rate in Ethiopia as purely endogenous and the other variables as exogenous. This in turn confirms the legitimacy of using the VAR model and the Johansen Procedure as opposed to the single equation approach of Engel and Granger.

The Johansen Co-integration Test Result

The different stationarity test results (in section 5.1) show that not all the variables are level stationary. This suggests that regression with the level variables may produce an unreliable outcome. However, the Granger representation theorem states that it is possible for non-stationary variables to produce a stationary relationship if they are co-integrated. Thus, the presence and the number of such co-integrating relationships are checked using the trace and the maximum eigenvalue. It may also be possible to use the Engle-Granger two-step procedure to test for co-integration. But the Engle-Granger method tests the presence of only one co-integrating relationship; and doesn't tell whether there may be other such relationships.

The results from the Johansen method of co-integration rank test may also be sensitive to the deterministic trend assumption (in addition to the number of lags of the endogenous variables) in the underlying VAR structure. Since the results may vary with the alternatives, a decision must be made as to which one to choose for the purpose of further analysis. Following EViews' (*EViews 5.1 User's Guide*, page 739) rough guide, case 2 is chosen as appropriate for this case since none

of the series appear to have a linear trend²¹. The VECM is estimated based on the number of co-integration rank obtained from case 2.

Table 10: Unrestricted Co-integration Rank Test

Included observations: 59 after adjustments

Trend assumption: No deterministic trend (restricted constant)

Series: REERI DEH1 RID DCREDIT PREMIUM NDEV OIL FOREX GCGDP

Lags interval (in first differences): 1 to 1

Hypothesized No. of CEs	Eigenvalue	Maximal Eigenvalue		Trace	
		Statistic	p-value	Statistic	p-value
None	0.742227	77.27363***	0.0004	277.6656***	0.0000
At most 1	0.620938	55.29320**	0.0300	200.3920***	0.0004
At most 2	0.576840	49.02034**	0.0305	145.0988**	0.0105
At most 3	0.437763	32.82241	0.3051	96.07843	0.1462
At most 4	0.340139	23.69640	0.5449	63.25602	0.3480
At most 5	0.263280	17.41618	0.6255	39.55962	0.4927
At most 6	0.190465	12.04384	0.6505	22.14344	0.5858
At most 7	0.095993	5.752317	0.8150	10.09960	0.6301
At most 8	0.073432	4.347284	0.3629	4.347284	0.3629

Both the Trace and the Max-eigenvalue tests indicate 3 co-integrating eqn(s) at the 0.05 level. MacKinnon-Haug-Michelis (1999) p-values are used.

*** , and *** denotes rejection of the hypothesis at the 0.05, and 0.01 levels, respectively.*

Under the intercept and no trend assumption in the underlying VAR, both the trace and the maximal eigenvalue tests identified three co-integrating relationships at the 5% level of significance (table 10). To see the robustness of these tests under the five deterministic trend assumptions, the test is performed for all the five alternative cases and the summary result is presented in appendix 2. Both tests are found to give robust results under the first three deterministic trend assumptions. The results of the two statistics differ from each other only under the fourth and fifth cases. These results also legitimize the use of the VAR and the Johansen method instead of the single equation based Engle-Granger two-step procedure.

²¹ Case 2 assumes intercept (no trend) in co-integration equation and no intercept in VAR. It should also be noted that such pre-tests and justifications would increase the credibility of the results.

Model Stability Test

The stability of the VAR model and the results of the post estimation diagnostics could affect the validity and robustness of the results of the impulse response functions and other diagnostics, and thus should be tested prior to further analysis. The companion matrix showing the roots of the characteristic polynomial and the corresponding modulus is presented in appendix 3. Appendix 3 shows that all the modulus for the characteristic roots are less than unity. This can also be visualized from the graph of the inverse roots of AR characteristic polynomial (figure 7). The figure portrays that all the modulus lie inside the unit circle. Therefore, the results suggest that the VAR model satisfies the stability condition.

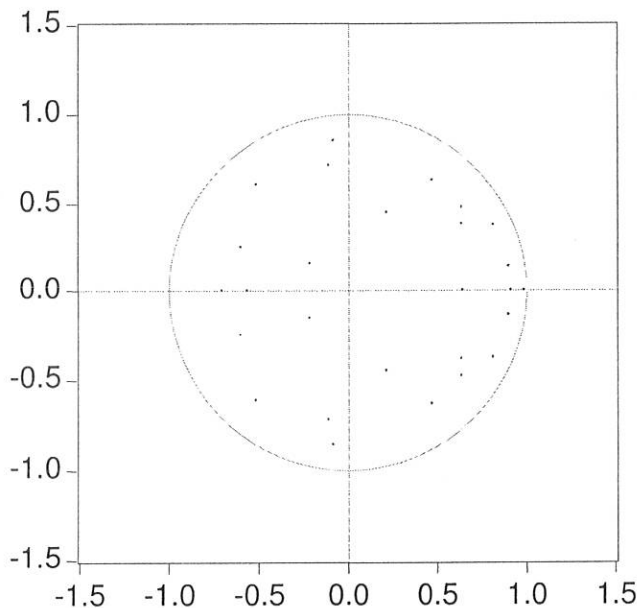


Figure 7: Inverse Roots of AR Characteristic Polynomial

5.2.1.2. Vector Error Correction Model (VECM)

After the vector autoregressive model is estimated with a maximum lag of three, an optimal lag of one is chosen based on the results of the information criteria; and the VECM is estimated by making use of these and the results of the Johansen co-integration test. The VECM consists of two

parts: the matrix of long run co-integrating coefficients (used to derive the long run co-integrating relationship), and the short run coefficients (for the short run analysis).

Long run Relationship

It is explained in the previous part that there are more than one co-integrating relationships among the real effective exchange rate and its potential determinants included in the model. This suggests that there would be a (n x r) matrix of unrestricted long run coefficients from which r possible long run equations can be derived. Since this study aims at examining the behaviour and determinants of the real effective exchange rate, only the real effective exchange rate equation is solved for through ad-hoc normalization on the REERI variable; and the result, after eliminating the insignificant variables, looks the following.

$$\begin{aligned}
 (REERI_t - 245.023 + 4.371GCGDP_t - 3.7965PREMIUM_t + 0.138OIL_t + 2.1038DCREDIT_t) = 0 \text{ ----} \\
 \text{stan.error} \quad (23.6730) \quad (1.1713) \quad (0.3076) \quad (0.0614) \quad (0.9263)
 \end{aligned}$$

----- (5.1)

This is the long run equation of real effective exchange rate that relates the real effective exchange rate with its long run determinants, and upon which the long run analysis is based. This result shows that in the long run, real effective exchange rate in Ethiopia is determined by composition of government spending in terms of tradables and non- tradables, extent of capital and foreign exchange restrictions (proxied by the parallel market Premium), real international price of oil, and rate of growth in net domestic credit. The study found no statistical significance for the long run impact of the other variables of the model like nominal effective devaluation, real interest rate differential, ratio of fiscal deficit to high powered money, and foreign exchange reserve. Overall, most of the results are in line with the theory. Especially the results on nominal devaluation and ratio of fiscal deficit to high powered money are consistent with Edwards' proposition about the long run impact of nominal variables. The interpretation of the entire result, however, depends on the way these variables are defined.

The long run impact of the ratio of government consumption spending to GDP on the real effective exchange rate is found to be negative and statistically significant. Specifically, an increase in the ratio of government spending to GDP is likely to depreciate the real effective exchange rate in Ethiopia. Theoretically, the ratio of government spending to GDP may depreciate or appreciate the RER depending on whether this spending is made largely on tradable goods or non-tradable goods. If a larger proportion of the spending is made on non-tradable goods, an increase in government consumption spending increases their demand in the market. In response to the rise in demand, there could be a natural tendency for their prices to increase relative to that of tradable goods. This would increase the price of non-tradable to tradable goods ratio, leading to real effective appreciation. However, if instead government purchases are mostly composed of tradable goods, an increase in such spending leads to higher demand for tradable goods relative to that of the non-tradable goods. This may tend to push tradable goods' prices up; and results in a real depreciation in the exchange rate. Therefore, the realized negative relationship between the ratio of government consumption spending to GDP and the real effective exchange rate could imply that an increase in this ratio statistically significantly depreciates the real effective exchange rate in the long run. This could also suggest that a bulk of the government spending in Ethiopia is more likely to fall on the tradable goods.

On the other hand, the statistically significant positive coefficient on PREMIUM may suggest that strict capital and exchange controls could lead to real effective exchange rate appreciation in Ethiopia. This result is sound, consistent with the theory and other empirical findings. One of the mechanisms through which an increase in such controls may lead to real appreciation could be the following.

First, it makes sense to say that stringent capital and foreign exchange controls tend to reduce the volume of goods crossing borders. Specifically, it would reduce the volume of imports. If these restrictions persist, there could be a rise in domestic demand for non-tradable goods that puts an

upward pressure on their prices. The effect would be more serious in the case of Ethiopia if there is a reduction in export volume owing to such controls because the domestic price of goods produced for export may fall as they usually have less demand in the domestic economy. Second, a reduction in import volume owing to increased foreign exchange restriction (which is reflected on a rise in the parallel premium) may increase the demand for non-tradable goods causing an upward pressure on their prices. Therefore, a reduction in the volume of tradable goods resulting from stringent controls on exchange and capital would cause real effective appreciation by increasing the ratio of non-tradable goods' price to tradable goods' price.

The impact of an increase in the real international price of oil is negative and statistically significant in the long run which means that a rise in the real oil price in the international market could lead to real effective exchange rate depreciation. This is in line with what is theoretically predicted. Since oil takes the lion's share of the country's import demand and is a tradable good, a sustained rise in the price of this crucial import, therefore, means that there is a rise in the price of tradable goods' basket. The final result is real effective exchange rate depreciation due to the possible decrease in the ratio of prices of non-tradable goods to that of the tradable goods.

The long run impact of the growth in net domestic credit is also found to be negative and is statistically significant. This is in contradiction with what has been hypothesized. Theoretically, a rise in the growth rate of domestic credit is expected to increase aggregate demand which may push the prices of non-tradable goods upward relative to that of the tradable goods' prices, leading to a real appreciation. This contradiction may, however, be resolved by making two arguments. The first argument has something to do with the natural assumption about the consumption behaviour of the people. A rise in the domestic credit may of course increase aggregate demand; however, as money income rises people may change their consumption behaviour by shifting most of their purchases from the non-tradable goods towards the tradable goods, especially to imported or export standard goods. Put differently, people may have a tendency to consider the

non-tradable goods as inferior. Thus, they may want to fill their consumption basket mostly with tradable goods. This in turn would raise their prices relative to that of the non-tradable goods because of the increased demand for the tradable goods. The second argument can be made in relation to the realized impact of an increase in government spending on the real effective exchange rate. Since an increase in government spending is found to depreciate the real effective exchange rate; which suggests that most of this spending is likely to fall on tradable goods that raise their prices, the rise in people's money income due to credit expansion could fuel up the competition in the tradable goods' market. Thus, a credit expansion would depreciate the real effective exchange rate through its tendency of increasing the relative prices of tradable goods as the pressure on prices is higher in the tradable goods' market.

Short run Relationship

Table 11 shows the results of the D(REERI) equation in the error correction model from which the short run movements of the real effective exchange rate of the Birr can be analyzed. The coefficients of the one- period lagged differences in the table can be interpreted as the short run parameters representing the short run determinants of real effective exchange rate. The table revealed that real effective exchange rate in Ethiopia depends only on four variables in the short run. The results show that the ratio of government consumption spending to GDP and growth in net domestic credit are both likely to depreciate the real effective exchange rate. On the other hand, an increase in the international price of oil and the ratio of fiscal deficit to high powered money leads to real appreciation in the effective exchange rate. It is also apparent from the result that the real international price of oil and growth in net domestic credit are significant only at the 10% level; and their impact is not statistically strong. The other variables including nominal effective devaluation are found to have no significant role in the short run.

The short run impact of the growth in net domestic credit is also found to be negative similar to the long run case and is only marginally significant. It means that although the relationship is

relatively weak, an increase in the growth of net domestic credit could lead to real effective depreciation in the short run. This result could be explained by making similar arguments as given for the long run case. The relative strength of the long run effect of domestic credit compared to the short run effect may be due to the fact that some people might stick to the traditional way of life to which they have been accustomed and take some time to change their consumption behaviour. Some may even stick to the non-tradable goods for longer periods until they see what their neighbors consume; but finally increase the consumption of tradable goods due to what is called 'demonstration effect'. Therefore, an increase in the growth rate of net domestic credit is likely to lead to real depreciation, both in the short run and the long run.

A rise in the international price of oil is found to appreciate the real effective exchange rate in the short run. This also seems to be against the theoretical expectation. But the result may still be accepted as possible to happen since most of the Ethiopian manufacturing and service sectors are structurally dependent on oil; and a bulk of the goods and services they produce or render are mostly non-tradable. Moreover, some of these firms are structurally rigid as it requires long period to change their factories or machines to those using alternative sources of energy. Thus, an increase in the real international price of oil is more likely to increase the cost of production for such goods and services in the short run which may lead to a rise in their prices by larger proportion than the possible rise in the prices of the tradable goods, and hence appreciates the real effective exchange rate.

The short run impact of an increase in the ratio of fiscal deficit to high powered money on the real effective exchange rate is consistent with the theoretical prediction but the impact is significant only in the short run. This is again consistent with what Edwards' suggested about the impact of nominal variables. The positive coefficient here suggests that a rise in this ratio could lead to real effective appreciation, and the effect is statistically significant. On the other hand, the ratio of

government spending to GDP has a statistically significant depreciating impact on the real effective exchange rate in the short run, similar to its long run effect.

Table 11: Short Run Coefficients

Error Correction	Dependent Variable: D(REERI)		
	Coefficient	Standard error	t-value
Coint.Eq1	-0.321470	(0.14197)	[-2.26437]**
D(REERI(-1))	-0.185513	(0.22094)	[-0.83965]
D(NDEV(-1))	0.732829	(0.66597)	[1.10040]
D(GCGDP(-1))	-4.459983	(1.90394)	[-2.34250]**
D(RID(-1))	-0.069572	(0.43511)	[-0.15989]
D(PREMIUM(-1))	-1.127927	(0.79257)	[-1.42313]
D(OIL(-1))	0.312089	(0.16725)	[1.86595]*
D(DCREDIT(-1))	-2.168154	(1.26503)	[-1.71391]*
D(DEH1(-1))	8.649976	(3.89659)	[2.21988]**
D(FOREXI(-1))	0.151110	(0.11028)	[1.37029]
R-squared	0.654425		
Adj. R-squared	0.270454		
Sum sq. resids	2157.577		
S.E. equation	8.939253		
F-statistic	1.704358		
Log likelihood	-187.1711		
Akaike AIC	7.523140		
Schwarz SC	8.624412		

**, and ** denotes rejection of the null at the 10% and 5% levels of significance, respectively.*

The other result that deserves explanation is the coefficient of the error correction term in the real effective exchange rate equation. This coefficient would help to determine whether the long run equilibrium real effective exchange rate equation is stable and thus convergence to that equilibrium could be attained at a reasonable period of time, depending on its sign and statistical significance. From the table, it can be observed that this coefficient has a negative sign, which is less than one in absolute value, and is statistically significant. It shows the rate at which the real effective exchange rate adjusts to any previous shock, suggesting a stable co-integrating relationship. This guarantees that although the actual real effective exchange rate may temporarily deviate from its long run equilibrium value, it would gradually converge to that equilibrium. The error correction term of -0.32147 shows that 32.147 percent of the deviation of the actual real

effective exchange rate from its equilibrium value is eliminated every quarter; and hence, full adjustment would take a period of less than 10 months. This speed of adjustment is comparable to 11 months obtained by Mathisen (2003) for Malawi. But it is much faster than the adjustment speed of 2.5 years obtained by Eita and Sichei (2006) for Namibia. The error correction coefficient is also in the range of values obtained by Hyder and Mahboob (2005) for Pakistan and Takaendesa (2006) for South Africa. The basic observation made here is that the adjustment period could depend on the unit of time measure, and not only on the error correction coefficient.

5.2.1.3. Post-Estimation Diagnostics

The study performed different post estimation diagnostic tests that guarantee that the residuals from the model are Gaussian and that the assumptions are not violated and the estimation results and inferences are trustworthy. The diagnostic test results could also be used as indicators of the validity to employ impulse response functions and variance decomposition analyses.

Residual Vector Serial Correlation LM Test

Table 12 shows that there is no evidence that reveals the presence of autocorrelation at the first through the third lags. The large p-values imply that the chi-squared statistics at all lags are not large enough to help reject the null of no autocorrelation at any of the usual critical values. Thus, the study could not find any evidence of autocorrelation problem in the residuals.

Residual Vector Normality Test

Normality is checked mainly by using the Jarque-Bera test. The result (in table 12) shows that the null of joint normality in the residuals of the VECM is rejected at the 5 percent level but could not be rejected at the 10 percent level of significance. Therefore, the residual vector of the model is found to be jointly normal only at the 10% level. However, since normality is an asymptotic or large sample property, it may be expected that the residual normality could asymptotically be improved if the sample size could be increased. Unfortunately, the sample size could not be

(lasts for long or is transitory). Since our main interest is to see what determines the real effective exchange rate, we restrict ourselves to the analysis of the responses of real effective exchange rate to the different shocks based on the results shown in figure 8.

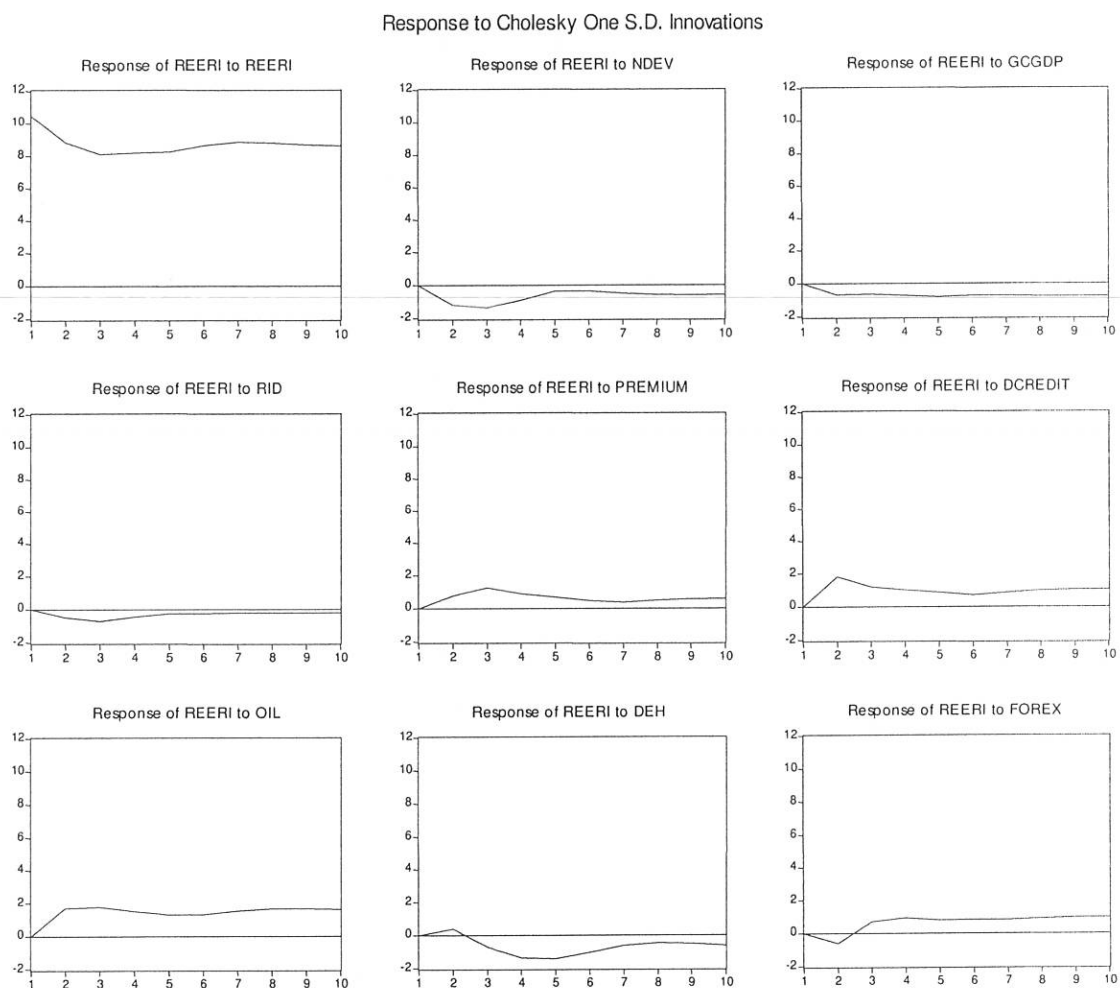


Figure 8: Impulse Responses of Real Effective Exchange Rate to Different Shocks.

It is apparent from the figure that the response of the real effective exchange rate to innovations arising from some of the variables looks sound in terms of direction; and magnitude. The impulse response function graphs shows that shocks in the nominal devaluation, premium, and domestic credit are found to have a declining impact after the fourth quarter and hence can be considered as transitory. On the other hand, the responses of the real effective exchange rate arising from shocks in the real interest rate differential and ratio of government spending to GDP are insignificant. In

general, all the variables in the list except for the international price of oil do not show persistence in affecting the real effective exchange rate. In addition, the result for the growth in net domestic credit is found to contradict (in terms of direction) what the empirical model has suggested. This together with the result of the response of the real effective exchange rate to a shock in itself shows that the real effective exchange rate in Ethiopia is likely to respond largely to innovations arising from itself.

Variance Decomposition Analysis

The variance decomposition result is also reported only for the real effective exchange rate; to show the relative importance of each of its determinants in explaining variations in it. The result shows that in the first quarter, all of the variation in the real effective exchange rate is explained by its own innovations. For a two period ahead forecast error variance, the real effective exchange rate explains about 95 percent of its own variation, and only 5 percent is explained by the variations in the other variables. If we consider a longer forecast period of up to eight quarters, the share of the other variables rise only to about 8 percent out of which growth in net domestic credit and real international price of oil comprises about 4 percent.

Table 13: Variance Decomposition of Real Effective Exchange Rate

Period	Reeri	Ndev	Gcgdp	Rid	Premiu m	Dcredit	Oil	Deh	Forex
1	100.000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2	95.1573	0.7258	0.2218	0.1175	0.3041	1.7030	1.5053	0.0774	0.1874
3	92.8415	1.1929	0.3029	0.2703	0.8055	1.7608	2.2716	0.2389	0.3151
4	91.9913	1.1599	0.3822	0.2708	0.8554	1.6652	2.4430	0.7343	0.4974
5	91.8718	0.9856	0.4645	0.2396	0.8176	1.5444	2.4268	1.0890	0.5602
6	92.1844	0.8537	0.4980	0.2155	0.7285	1.3936	2.3929	1.1293	0.6037
7	92.4355	0.7719	0.5194	0.1940	0.6469	1.3193	2.4495	1.0335	0.6295
8	92.4868	0.7254	0.5404	0.1775	0.5998	1.2987	2.5611	0.9379	0.6719
9	92.4576	0.6947	0.5582	0.1648	0.5742	1.2963	2.6564	0.8712	0.7262
10	92.4271	0.6673	0.5722	0.1548	0.5583	1.2995	2.7172	0.8331	0.7700

Cholesky Ordering: REERI NDEV GCGDP RID PREMIUM DCREDIT OIL DEH FOREX

Therefore, similar to the results of the impulse response functions, the variance decomposition suggests that most of the variation in the real effective exchange rate in Ethiopia is attributable to innovations arising from itself and the impact of the other variables is less significant. Both results reveal that variations in the real international price of oil and the growth in net domestic credit have relatively important influences on the real effective exchange rate, next to the variation in the real effective exchange rate itself. However, these results shall be taken very cautiously as the case might have been different had the ordering for cholesky been changed. In general, it seems that these results are not much interesting in explaining the interactions among the variables; which would have supported the result of the short run analysis in the empirical model. Finally, the result on (joint) normality of the residuals might also have to some extent affected the results.

5.2.2 Real Effective Exchange Rate Misalignment

One of the specific objectives of this study was to check whether there is a sustained deviation of the real effective exchange rate from its long run equilibrium level that is consistent with the long run values of the fundamentals (technically known as misalignment) and measure its extent. As explained in section four, there is lack of consensus on the methods of measuring the equilibrium real exchange rate. This may result in contradicting or at least inconsistent outcomes for the measurement of misalignment; which in turn could end up with inappropriate policy prescriptions. Equilibrium real effective exchange rate is derived in this study by first deriving the sustainable values of the long run fundamentals of the real effective exchange rate using the Hodrick-Prescott filter, and substituting them in the long run equation. Then, misalignment is measured as the percentage deviation of the actual (current) real effective exchange rate from its long run equilibrium value. The results for the equilibrium real effective exchange rate and the degree of misalignment are presented in figure 9.

The dotted line in the figure shows that the equilibrium real effective exchange rate has been continuously depreciating since 1993:1. However, the degree of this depreciation has become

weakened after 2000:1 and the line is flattened towards the end of the study period. The actual rate has never been above its equilibrium value until 2006:3. It is clear from the figure that there have been sustained deviations of the actual rate from the equilibrium value for most part of the study period. Percentage misalignment is below zero from 1993:1 up to 2006:3 although it declined to -0.3 in 1997:1. As of 2006:4, the gap has turned to be positive and been widening over time. The actual real effective exchange rate is larger than the equilibrium value by 30.7 percent in 2008:2.

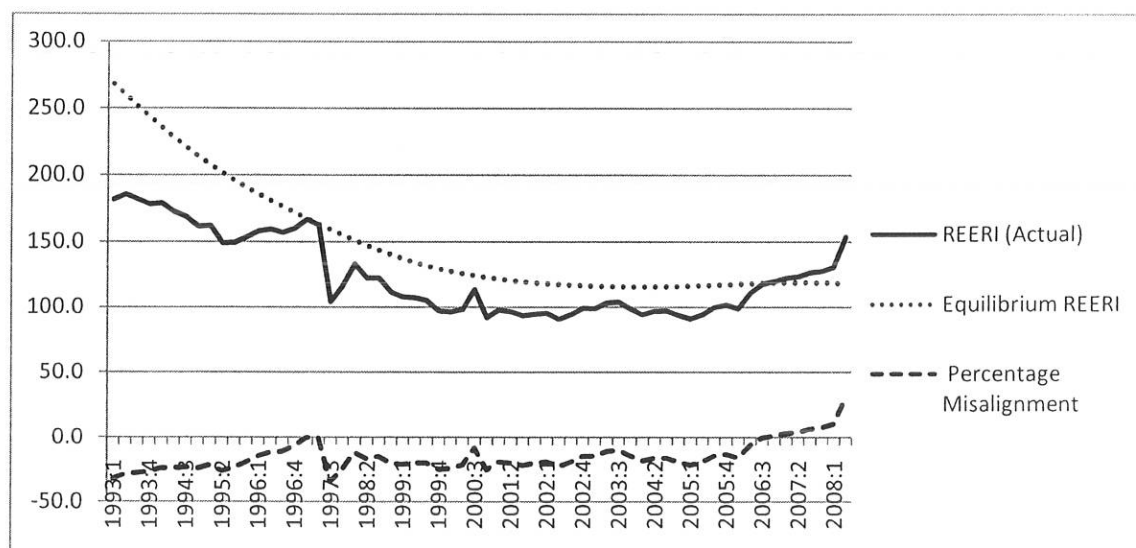


Figure 9: Total Real Effective Exchange Rate Misalignment.

Therefore, as depicted by the figure, the actual real effective exchange rate of the Birr against the currencies of the major trade partners of Ethiopia has been undervalued for the period 1993:1 to 2006:3 with varying degrees followed by a continuous overvaluation since 2006:4. It has been explained in the background of this study that currency misalignment has an impact on the allocation of resources and the international competitiveness of the goods of a country. Therefore, given the limitations of this study with regards to variable selection and time dimension, the result obtained here has some important message for the monetary authority. Especially, the recent overvaluation of the Birr deserves closer attention.

VI. CONCLUSION AND RECOMMENDATIONS

6.1 CONCLUSION

This study mainly aimed at identifying the determinants of the real effective exchange rate of the Birr, and measuring the existence and degree of exchange rate misalignment in Ethiopia since the first quarter of 1993. Co-integration and Vector Error Correction approaches have been applied for the identification of the short run and long run determinants of the real effective exchange rate. The study also employed innovation accounting to analyze the response of the real effective exchange rate to an impulse or a shock arising from its determinants; and examine the relative importance of these shocks. Based on the findings of the study both from the descriptive and econometric results, the following conclusion is derived.

On average, both the actual and the long run equilibrium real effective exchange rates in Ethiopia have been depreciating over the period 1993:1 to 2004:1 followed by a continuous appreciation of the actual rate; while the long run equilibrium exchange rate is found to be stable, since then. The degree of appreciation in the actual rate has been increasing since the first quarter of 2007. This may be attributable to the inauspicious global economic conditions that might have reduced the international competitiveness, and brought about some macroeconomic instability in the country. The rise in the international price of oil followed by a gloomy international business might also have impacted the performance of Ethiopia's foreign sector. In addition, the rising tendency of the parallel premium might be the major factor behind the recent appreciation.

The study found that the real effective exchange rate in Ethiopia is significantly explained by the real international price of oil, the growth rate of net domestic credit, ratios of government consumption to GDP and fiscal deficit to high powered money in the short run; and by real international price of oil, the parallel premium, ratio of government consumption to GDP, and the ratio of fiscal deficit to high powered money in the long run. The ratio of government

consumption to GDP, and the growth in net domestic credit have depreciating impact both in the short run and long run whereas the ratio of fiscal deficit to high powered money has only short run impact (of appreciation). On the other hand, real international price of oil has opposite effects in the short run and long run. It has an appreciating impact in the short run and the opposite effect in the long run. While the parallel premium appreciates the real effective exchange rate in the long run; with no significant role in the short run.

On the other hand, real effective exchange rate is found to be misaligned for the major part of the study period. It has been undervalued over the period 1993:1 to 2006:3, with a declining tendency for the degree of misalignment; and has shown a continuous and an increasing degree of overvaluation since 2006:4. In general, real effective exchange rate misalignment was between 30.7 percent and -34.3 percent during the study period. This, together with the error correction coefficient shows that any temporary deviation of the real effective exchange rate can be corrected, or there is a zero mean reversion of the misalignment.

Therefore, real effective exchange rate in Ethiopia forms co-integration relationship with four fundamentals (ratio of government consumption to GDP, real international price of oil, the parallel premium, and growth in net domestic credit); and responds to both real and monetary variables, both in the short run and the long run. Unfortunately, nominal effective devaluation is found to have insignificant role in affecting the real effective exchange rate (*consistent with Alem, 1995; and Tamiru, 2005*) even in the short run. Thus, the use of nominal devaluation as an exchange rate policy tool doesn't seem to be effective.

After the short run and long run determinants of the real effective exchange rate of the Birr are identified; and the degree of misalignment is measured, the following recommendations are forwarded.

6.2 RECOMMENDATIONS

- The long run effect of the parallel premium calls for a need to further liberalize the foreign exchange and 'capital' markets. Relaxing the degree of foreign exchange and capital controls could be one of the possible remedies to curb the recent appreciation of the real effective exchange rate beyond its long run equilibrium value. This could reduce the degree of misalignment, and its likely impact on the international competitiveness of the country.
- As Ethiopia is a net importer of Petroleum and that the real international price of oil significantly affects its exchange rate both in the short run and long run, which also lead to current account deficit by depleting the foreign reserve; new energy policy shall be designed to solve or at least minimize the problem. This may be achieved by initiating policies that encourage national and international corporations to undertake exploration of petroleum; and developing the culture and capacity of using renewable sources of energy (like solar, biogas, etc) (at least for household consumption), to reduce the amount of petroleum import.
- The respective authorities shall practice prudent macroeconomic policies. The measure of monetary policy stance in this study is the growth in net domestic credit (with a negative impact on the real effective exchange rate). In addition, the ratio of fiscal deficit to high powered money depreciates real effective exchange rate in the short run. This calls for a careful management of fiscal and monetary policy variables. Therefore, the authorities shall pursue macroeconomic policies consistent with the economic conditions.
- Although the study successfully achieved its objectives, the unavailability of data on some actual variables suggested by the theoretical models and the inability of obtaining the most recent information on many of the variables seems to leave some important gaps that require further research. For example, the impact of the current global trend on the real effective exchange rate probably through its effect on net capital inflow (aid and remittances) could be an interesting area of future research.

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APPENDICES

Appendix 1: KPSS Stationarity Test Result

Variable	Test Statistic		Order of Integration
	With Constant	With Trend and Constant	
REERI	0.6258**	0.2439***	I(1)
PREMIUM	0.7864***	0.2372***	I(1)
OIL	0.8093***	0.2632***	I(1)
FOREX	0.5411**	0.1402*	I(1)
RID	0.7471***	0.170273**	I(1)
DEH	0.1635	0.1535**	
GCGDP	0.1816	0.1477**	
NDEV	0.0603	0.0557	I(0)
DCREDIT	0.4354*	0.0937	

Note. *, **, and *** shows significance at 10%, 5%, and 1%, respectively

Appendix 2: Summary of the Number of Co-integrating Rank by Model Under all Deterministic Trend Assumptions

Sample: 1993:1 2008:2

Series: REERI NDEV GCGDP RID PREMIUM DCREDIT OIL DEH FOREX

Lag interval: 1 to 1

Data Trend		None	None	Linear	Linear	Quadratic
Test Type	Critical Value	No Intercept No Trend	Intercept No Trend	Intercept No Trend	Intercept Trend	Intercept Trend
Trace	5%	2	3	3	4	4
Max.eigen	5%	2	3	3	1	1

Critical values are based on MacKinnon-Haug-Michelis (1999) p-values

Appendix 3: Roots of Polynomial Characteristics

Sample: 1993:1 2008:2

Series: REERI NDEV GCGDP RID PREMIUM DCREDIT OIL DEH FOREX

Lag interval: 1 to 1

Root	Modulus	Root	Modulus
0.985460	0.985460	0.638387+/-0.383035i	0.744482
0.913100	0.913100	-0.108298+/-0.717212i	0.725342
0.901397+/-0.138263i	0.911940	-0.702490	0.702490
0.815526+/-0.376655i	0.898304	-0.59936+/-0.250042i	0.649425
-0.083189+/-0.856017i	0.860049	0.644242	0.644242
0.638182+/-0.47021i	0.797359	-0.562504	0.562504
-0.512733+/-0.609249i	0.796291	0.214477+/-0.448663i	0.497291
0.471654+/-0.632388i	0.788906	-0.215482+0.154800i	0.265322

Appendix 4: Quadratic Interpolation

The annual data for some variables are disaggregated using quadratic interpolation. Cubic and higher order methods could have also been used for a better approximation. However, this method is chosen because of its manageability. It is similar to the Newton's divided difference polynomial method, and the method developed by Goldestein and Khan (1976).

Given three consecutively measured series X_{t-1} , X_t and X_{t+1} being flow variable can be put in a quadratic function. The quadratic function passing through the three points is, say, $at^2 + bt + c$.

Then we can represent the three points by the area under the function as:

$$\int_0^1 (at^2 + bt + c)dt = X_{t-1} \dots\dots\dots (1)$$

$$\int_1^2 (at^2 + bt + c)dt = X_t \dots\dots\dots (2)$$

$$\int_2^3 (at^2 + bt + c)dt = X_{t+1} \dots\dots\dots (3)$$

Taking the definite integrals of equations 1, 2, and 3 gives:

$$\left[\frac{at^3}{3} + \frac{bt^2}{2} + ct \right]_0^1 = X_{t-1} \dots\dots\dots (4)$$

$$\left[\frac{at^3}{3} + \frac{bt^2}{2} + ct \right]_1^2 = X_t \dots\dots\dots (5)$$

$$\left[\frac{at^3}{3} + \frac{bt^2}{2} + ct \right]_2^3 = X_{t+1} \dots\dots\dots (6)$$

These parameters themselves are functions of X_{t-1}, X_t, X_{t+1} . The equivalent expressions for the three parameters (a, b and c) can be derived by first solving each of equations (4), (5), and (6) at the indicated limits of integration, and solving them simultaneously.

$$a = 0.5X_{t-1} - X_t + 0.5X_{t+1} \dots\dots\dots (7)$$

$$b = -2X_{t-1} + 3X_t - X_{t+1} \dots\dots\dots (8)$$

$$c = 1.833X_{t-1} - 1.166X_t + 0.33X_{t+1} \dots\dots\dots (9)$$

The four quarterly series from the yearly aggregate data can then be estimated as follows;

First quarter:

$$\int_1^{1.25} (at^2 + bt + c)dt = 0.0548X_{t-1} + 0.2343X_t - 0.039X_{t+1} \dots\dots\dots (10)$$

Second quarter:

$$\int_{1.25}^{1.5} (at^2 + bt + c)dt = 0.0078X_{t-1} + 0.2657X_t - 0.02355X_{t+1} \dots\dots\dots (11)$$

Third quarter:

$$\int_{1.5}^{1.75} (at^2 + bt + c)dt = -0.02355X_{t-1} + 0.2657X_t + 0.0078X_{t+1} \dots\dots\dots (12)$$

Fourth quarter:

$$\int_{1.75}^2 (at^2 + bt + c)dt = -0.039X_{t-1} + 0.2343X_t + 0.0548X_{t+1} \dots\dots\dots (13)$$

NB. We should not totally perceive the result as if it were the actual (realistic) value since it is only an approximation of it.

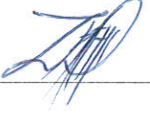
Declaration

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 source of materials used for the thesis have been duly acknowledged.

The examiners' comments have been duly incorporated.

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