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Real Effective Exchange Rate Misalignment and Monetary Policy in Developing Countries: The Case of Uganda[2]

by

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Abstract

This paper estimated the equilibrium real exchange rate for the Uganda shilling, assessed the extent of its misalignment and the implication of monetary policy on exchange rate misalignment. Based on the ARDL cointegration approach and the Behavioral Equilibrium Exchange Rate (BEER) framework on data spanning 1990-2021, the study showed that, on average the shilling was slightly overvalued over the considered sample period. It is estimated that correction of any misalignment takes about one and half years. In addition, REER misalignment episodes appear to be linked with policy shifts and macroeconomic shocks and are characterized by both abrupt and at times extreme movements as well as long swings. The paper also provides evidence on the relationship between monetary policy and REER misalignment. Specifically, tight monetary policy appears to be linked to an increase in REER misalignment.

JEL Classification Code: F31, F33, E52,
Keywords: Real Effective Exchange Rate; Misalignment; ARDL; Monetary policy

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I. Introduction

The subject of real effective exchange rate (REER) misalignment continues to generate wide interest and debate from policymakers, market participants and academicians alike due to the increase in real exchange rate distortions occasioned by globalization and openness, whereby the exchange rate deviates from its long run equilibrium level resulting in either an over or undervaluation of the domestic currency. There is a vast literature on the determination of the equilibrium level of exchange rates and its misalignment both in developed and developing country contexts that employ various exchange rate models, data sets, and estimation strategy with mixed results. In general, real exchange rate misalignment is considered costly and a key indicator of a country's economic vulnerability. However existing evidence on the impact of REER on macroeconomic performance is mixed. For instance, while the general consensus is that real exchange rate matters for economic growth, existing evidence on exchange rate misalignments in the form of undervaluation is linked to both positive and adverse growth effects, suggesting moderating region and country specific factors may be important (Ghura & Grennes, 1993; Haddad & Pancaro, 2010; Karadam & Özmen, 2021; Berg & Miao, 2010; Ribeiro et al., 2020).

In the era of increasing globalization, the close link between REER misalignment and economic crises makes the issue of optimal currency value a concern for academics and policymakers. Indeed, several studies are devoted to investigating the link between REER misalignment and crises (Heriqbaldi et al., 2020; Holtemöller & Mallick, 2013; Kemme & Roy, 2006; Stein & Paladino, 1999). For policymakers, exchange rate misalignments constitute a serious problem because they may highlight a country's economic vulnerability that signals domestic policy inconsistency or adverse macroeconomic shocks. As such, an understanding of equilibrium exchange rates and their misalignment is crucial information for the effective deployment of corrective action and contributes to central banks' objectives of maintaining price stability and a sound financial system.

The present study therefore estimates the equilibrium REER and examines its misalignment for Uganda in line with the popular Behavioral Equilibrium Exchange Rate (BEER) approach. In addition, the study investigates the potential relationship between real exchange rate misalignment and monetary policy. To the best of the authors' knowledge, this is the first study investigating the relationship between monetary policy and REER misalignment in Uganda.

The rest of paper is structured as follows. The evolution of Uganda's exchange rate policy is described in section 2, section 3 presents a review of the literature on real equilibrium exchange rates while section 4 discusses the methodology applied in this study. The empirical results and discussion of the findings are presented in section 5 while the conclusions are reported in section 6.

II. Evolution of Uganda's Exchange Rate Policy

The exchange rate and its evolution are essential macroeconomic indicators in a small open economy like Uganda. Uganda's foreign exchange market has undergone significant reform and transformation, moving from systems of controls in the early 70's to an open and liberalized market. The inception of the Ugandan foreign exchange market date back to the period following independence, when the Government of the newly created Republic of Uganda began establishing institutions through Acts of Parliament including the Bank of Uganda Act of 1966 as well as the Exchange Control Act (1969). The Uganda foreign exchange market was charged with the responsibility of among other things maintaining external reserves in order to safeguard the international value of the currency and manage the exchange rate. Exchange rate management during this period was guided by the Treaty for East African Co-operation, which came into force in December 1967 and required central bank governors to meet at least four times a year to consult and co-ordinate their monetary, balance of payments, and interest rate policies. However, in the 1970s, gross economic mismanagement and artificial shortages created by fixed exchange rate regimes led to deterioration of the economy and the emergence of a parallel market leading to overvaluation of the shilling. The resultant balance of payments deficit was caused by dwindling foreign exchange earnings as the shilling overvaluation imposed an implicit tax on the export sector while at the same time granting a subsidy on imports. By the 1980s, the parallel foreign exchange market premium had risen dramatically such that the official shilling rate in 1980 stood at 7.5 per US dollar while the black-market rate was 30 times higher.

In 1981, a financial program with the IMF partly aimed at correcting the exchange rate distortion was launched during which the shilling was un-pegged and substituted by a managed float that resulted in extensive devaluation of the shilling. The managed float was maintained up to August 1982 and replaced by a dual exchange rate regime characterized by a two-window system. The first window (Window I) handled priority transactions including exports of coffee, tea, tobacco and cotton; imports of petroleum; aid-financed projects; official loan and grant inflows; and the servicing of debts and arrears at the official exchange rate while other transactions were handled through the auction system under Window II. In June 1984, the two windows were merged just before the collapse of the adjustment program. The dual exchange rate regime was re-introduced briefly in May 1986 before a fixed rate system was re-established at the end of 1986 that further aggravated the external disequilibria in the economy. Thus, a currency reform was undertaken in May 1987 to address external imbalances which reduced the parallel market premium substantially. From October 1989 to July 1990, the government adopted a more active stance on the management of the official exchange rate. The aim was to assist in dampening the disruptive effects of discrete devaluations and the erosion of the exchange rate in real terms. As such the policy of maintaining the real effective exchange rate constant (a 'crawling peg' system) was introduced in October 1989 and the parallel market legalized in July 1991, leading to the

establishment of foreign exchange bureaus which were licensed to engage in spot transactions at freely determined rates.

In a further move towards a market-based exchange rate regime, a foreign exchange auction system for import support funds was introduced in January 1992. Eligibility of imports was based on a short "negative" list of goods jointly set by the Government, the donor community and commercial banks, and later foreign exchange bureaus were permitted to bid in the auction, provided they were in a good financial footing with the Bank of Uganda. This marked the end of administered exchange rates although the foreign exchange market remained segmented until November 1993 when the current account was liberalized and inter-bank foreign exchange trading system was launched. Following the liberalization of the current account, Bank of Uganda adopted a flexible exchange rate policy regime and on fifth April 1994, the government accepted the obligations of Article VIII, Sections 2, 3 and 4 of the IMF's Articles of Agreement. Accordingly, since then, the Ugandan shilling's exchange rate is determined by market forces and BOU intervention in the foreign exchange market is limited to occasional purchase or sale of foreign currency aimed at dampening excessive volatility in the exchange rate and building foreign exchange reserves. Following on the reforms, the capital account was opened up in 1997, marking the last reform in the liberalization of the foreign exchange market.

III. Overview of the Literature

The major challenge in investigating REER misalignment analysis is the construction of a suitable benchmark or yardstick against which to appraise a country's price-competitiveness performance in a theoretically defensible and empirically accurate manner. This section provides an overview of the theoretical and empirical literature, highlighting the differences in alternative approaches to measuring equilibrium exchange rates and misalignments. Much of the voluminous theoretical and empirical literature on the equilibrium exchange rates has been captured in detailed and extensive theoretical and empirical discussions found in (Demir & Razmi, 2022; MacDonald, 2007; Sarno & Taylor, 2002; Siregar, 2011) among others and thus this section only provides a brief overview.

3.1 Theoretical Review

The equilibrium REER is generally defined as the rate that is consistent with the internal and external balance of the economy and is characterized by high economic growth, low levels of inflation and current account sustainability. Thus, effective exchange rate misalignment is defined as the deviation of the real effective exchange rate from its equilibrium level. Any analysis of REER misalignment depends upon the measurement of the equilibrium REER and thus requires the derivation of a measure of the equilibrium REER, otherwise the notion of currency under or

overvaluation is meaningless. Although there is still no consensus on the precise calculation of the equilibrium REER, several methodologies exist in the literature with varying strengths and weaknesses. Siregar, (2011) suggest that, when choosing between different equilibrium concepts and the models used to represent them, their relevance to the question at hand is important.

The Purchasing Power Parity (PPP) approach is the earliest theory and has been subjected to numerous theoretical reviews and econometric tests (Frait et al., 2008; MacDonald, 2007; Sarno & Taylor, 2002; Stein & Paladino, 1999). The theory of PPP posits that the exchange rate between two countries will be determined by the ratio of their general price level. The theory assumes that monetary policy does not influence the real exchange rate in the long run, implying that countries with different inflation rates should expect their bilateral exchange rates to adjust to offset these differences over the long run. However, despite its simplicity and limited data requirements, there is a strong consensus in the literature that PPP is not an appropriate measure for the developing economies (Frait et al., 2008; Stein & Paladino, 1999).

In order to address the shortcomings of the PPP approach and contribute meaningfully to policy analysis, subsequent equilibrium real exchange rate theories and approaches determine the equilibrium REER based on economic fundamentals that have an impact on the value of the equilibrium exchange rate. Among these theoretical streams is the Fundamental Equilibrium Exchange Rate (FEER) developed by Williamson (1994). FEER defines the equilibrium exchange rate as the REER that satisfies internal and external balance simultaneously and was widely used by the IMF despite relying on normative judgement to determine the size of long-term capital flows. Moreover, determination of the equilibrium FEER is based on largescale macro econometric models or partial trade blocks of a given economy which the macroeconomic balance (MB) approach to equilibrium REER determination, also used widely used by the IMF, attempts to circumvent by directly estimating the sustainable level of current account deficits (surpluses) based on the saving and investment balance (Frait et al., 2008). The main limitation of the fundamental equilibrium exchange rate approach is that the equilibrium level of the exchange rate is highly influenced by the normative assumptions around the internal and external balance positions. The Natural Real Exchange Rate (NATREX) model developed by Stein & Allen (1997) and Stein & Clark (1995) is also based on the concept of internal and external balances, although unlike the FEER, it considers both the medium term and long run horizon when capital stock and foreign debt are assumed to converge to their long-run steady state. The NATREX is the rate that generates a current account balance that corresponds to the equilibrium between the optimal investment and savings while the unemployment rate is at its natural level and contrary to the FEER model, does not necessitate defining a sustainable external balance.

The Behavioural Equilibrium Exchange Rate (BEER) approach by MacDonald (1997) and MacDonald & Clark (1998) uses real interest parity to connect the real exchange rate to macroeconomic fundamentals and as such the choice of the fundamentals is more ad hoc than

based on a theory according to Frait et al. (2008). The popularity of the BEER stems from its flexibility in allowing the equilibrium REER to vary and respond to the economy's fundamentals and macroeconomic conditions as well as its ability to explain REER movements even when estimated in a reduced form (Maeso–Fernandez et al., 2002). The BEER approach eschews internal and external equilibria perspective and directly estimates the structural or long-run relationship between relevant economic fundamentals and the real equilibrium exchange rate which is considered the equilibrium relationship. The BEER approach is considered more suitable for developing economies and is widely used due to its attractive features including its applicability to country-specific circumstances, the rigorousness of statistical estimation and limited scope for normative elements. Understandably, the choice of long run macroeconomic determinants for the equilibrium REER vary in the empirical literature, although the most plausible choice of fundamentals can be gleaned from comprehensive literature reviews such as Égert (2004) and Fidora et al. (2021). Among the popular explanatory variables used to explain equilibrium REER are per-capita GDP or (GDP), net foreign assets (NFA), terms of trade (TOT), foreign real interest rate or real interest rate differential, foreign debt, foreign direct investment and trade openness.

The literature also has variants of the BEER approach such as the permanent equilibrium exchange rate (PEER) developed by Gonzalo & Granger (1995) that aims to decompose the long-term co-integration vector into a permanent and transitory component and the capital enhanced equilibrium exchange rate (CHEER) that focuses on the interaction between the real exchange rate and the capital account items to the exclusion of other real determinants such as relative output and captures the basic Casselian view of PPP based on the assumption that the exchange rate may be away from its PPP determined rate because of non-zero interest rate differentials (Frait et al., 2008; MacDonald, 1997; Maeso–Fernandez et al., 2002).

3.2 Empirical Review

The past decades have seen many developing countries shift from fixed to flexible exchange rates as part of a cocktail of measures to deliver macroeconomic growth and stability. Notwithstanding, real exchange rate misalignment may occur under fixed, flexible or hybrid exchange rates regimes, although the intensity of REER misalignment across regimes remains contentious. For instance, according to Dubas, (2009), flexible exchange rates are prone to more misalignment which is even more pronounced in the case of developing countries while Coudert & Couharde (2009) and Holtemöller & Mallick (2013) show that fixed exchange rates induce more misalignment than the floating exchange rate regimes. Recently, Mahraddika (2020) examined the association between real exchange rate (RER) misalignments, exchange rate flexibility, and capital account openness using a panel dataset for 60 developing countries over the period 1980 to 2014. The study showed that the exchange rate regime and capital account policy are significantly related to the degree of

persistence and the magnitude of RER misalignments, with a more flexible exchange rate and liberal capital account contributing significantly to limiting the persistence of RER misalignment. However, the divergence in results may be due to differences in econometric methodology and data samples. There is a lot of empirical research on exchange rate modeling and REER misalignment across countries, however among the popular approaches is the BEER approach which has been widely used for developing countries. One of the early studies in the context of developing countries was Edwards (1988) who develops a BEER type dynamic model of real exchange rate (RER) behavior using data from 12 developing countries over the period 1962–84. Ghura & Grennes (1993) indicated that the Edwards model of REER determination performs well for the Sub-Saharan Africa (SSA) region and higher levels of misalignment are accompanied by higher levels of macroeconomic instability. In addition, the study confirms the negative relationship between the real exchange rate (RER) misalignment and economic performance is robust for 33 countries in Sub-Saharan Africa (SSA).

Recent country specific studies within the African context include Iimi (2006) who investigates the behavior of Botswana's real exchange rate for the period 1985-2004 following concerns that the country's exchange rate might have been misaligned with its economic fundamentals due to successive devaluations of its currency and the move from a fixed to a crawling peg exchange rate regime. Using the BEER approach, the study found Botswana's pula to be undervalued in the late 1980s and overvalued by 5 to 10 percent in subsequent years, though the misalignment in the 1990s seems to have been very marginal. Masunda (2012) found that real exchange rate misalignment in Zimbabwe was attributed to pressures exerted by government consumption, openness, excess credit, technical progress, and capital flows. Using annual data from 1980 to 2006, the study also found evidence that real exchange rate misalignment in the form of an overvaluation contributed to the currency crisis. Ndhlela (2012) found that keeping the RER at levels close to, or below, equilibrium and avoiding protracted periods of RER overvaluation will promote economic growth in a study that analyzed the relationship between real gross domestic product growth and real exchange rate misalignment for Zimbabwe using the BEER approach and monthly data for the period 1985-2004.

For Morocco, Lebdaoui (2013) employed the BEER technique to estimate the equilibrium real exchange rate of the Moroccan Dirham using quarterly data that spanned from 1980Q1 to 2012Q4 and finds misalignment from the equilibrium level requires from five to six years to correct. In addition, the study identifies three periods of under or overvaluation ranging from 2.80 percent under to 2.16 percent over equilibrium level while the variables used to determine the behavior of the equilibrium real exchange rate in Morocco include the terms of trade, government spending, relative productivity, net capital flows in real terms, foreign reserves, trade openness and a monetary policy index. The results indicate that except for the statistically insignificant net capital flows variable, both government spending and trade openness have a depreciating effect on the Moroccan Dirham exchange rate, while the rest of variables have an appreciating effect on it.

In a study to examine the dynamics of Nigerian real exchange rate, Ibrahim (2014) used the BEER technique to estimate the equilibrium real exchange rate for Nigeria and a single equation cointegration approach to determine the effect of exchange rate misalignment on trade flows. The study found that between 1960 and 1985 Nigeria's real effective exchange rate appreciated relative to its long run level in most periods between 1960 and 1985 and depreciated relative to its long run level in most periods between 1986 and 2013. In addition, real exchange misalignment had no significant effect on volume of export, but it had a negative effect on import and trade balance in the country. In contrast, Essien et al. (2017) examined the dynamics of Nigerian real exchange rate and its misalignment over the period 2000Q1 to 2016Q1 and found that real exchange rate misalignment averaged 0.15 per cent during the sample period. Generally, the period 2001Q2 to 2016Q1 was characterized by 43 episodes of overvaluation and 21 episodes of undervaluation, suggesting a tolerance for real exchange rate overvaluation than undervaluation. The study which adopts the BEER approach, incorporating structural breaks and the Balassa Samuelson effect proxied by GNP per capita as well as other determinants including the nominal exchange rate, total government expenditure and the interest rate differential, also highlights the relationship between exchange rate misalignment and exchange rate policies.

Interestingly, Amoah (2017) also investigates the behavior of the Ghanaian cedi for the period 1980Q1 to 2013Q4 using the BEER approach and the Johansen cointegration and error correction modelling framework and find significant misalignment of the real effective exchange rate characterized by undervaluation before the redenomination in 2007 and overvaluation thereafter. In view of the significant overvaluation, the study recommends a one-off devaluation of a minimum of 20% to bring the exchange rate close to its equilibrium. This is consistent with Akosah et al. (2018) who examine the degree of real exchange rate misalignment and its macroeconomic implications in Ghana using quarterly data over the period 2000Q1-2015Q3 and found evidence of misalignment throughout the sample period although the REER was close to its equilibrium level at the end of 2012. In addition, overvaluation was observed to exert disinflationary pressures, while undervaluation tends to increase inflationary pressures in Ghana and concludes that the use of REER undervaluation as a deliberate industrial policy instrument for sustained economic growth may be counterproductive in the context of Ghana, potentially undermining the price stability objective of the central bank.

In a different country context, Gachoki et al. (2019) investigates real exchange rate misalignment in Kenya using quarterly data for the 2000 to 2016 and the BEER approach and found that the REER was on average undervalued. Although the magnitude of misalignment varies across the sample period, the exchange rate is overvalued to a maximum of 5.9 percent and undervalued up to 5.2 percent. In addition, the results show that Kenya's long-run real exchange rate is driven by economic fundamentals namely; net foreign assets, productivity, world oil prices, trade openness and terms of trade.

Recently, Hosni (2021) investigates the behavior of the real exchange rate in Egypt over the period 1965–2018 using a BEER approach and found that the Egyptian pound was misaligned from its equilibrium value during most of the examined period. The main determinants of real exchange rate misalignment in Egypt are terms of trade, degree of openness, investment ratio and government consumption variables. The domestic currency experienced a phase of overvaluation that started in 2009 until the free float of the local currency in November 2016, following which the Egyptian pound was found to have experienced a new phase of undervaluation till the end of the sample period. Moreover, the results support the importance of both economic fundamentals and short run shocks in impacting currency misalignment in Egypt.

Among the few studies that investigate the Ugandan context is Atingi-Ego and Sebudde (2004) whose study focused on determining the equilibrium exchange rate path, degree of misalignment and its impact on the performance of nontraditional exports. The study found that the magnitude of misalignment greatly reduced during the period 1991 to1999 following the liberalization of the exchange and payments system. In addition, overvaluation of the exchange rate in excess of 15 percent hampers non-traditional export performance. Another study by Kihangire et al. (2005) investigated Uganda's equilibrium real exchange rate (EREER) during 1993M1 to 2004M12 and found that not only is Uganda's REER overvalued over the period 2003-2004 but also the macroeconomic and financial costs of this overvaluation were quite high for the economy. The analysis was based on ARDL approach to cointegration and the long-run relationship between Uganda's REER and its determinants, driven largely by trade balance, openness, fiscal deficits, and capacity utilization.

As demonstrated in the preceding empirical studies, there is significant variation in macroeconomic fundamentals that drive the exchange rate in the long run across countries suggesting that this may be dependent on domestic country conditions. Indeed Schröder (2013) finds that when homogeneity assumptions on cross-country long-run real exchange rate behavior are appropriately addressed by estimating the misalignment of the real exchange rate for each of the 63 developing countries over the period 1970–2007 individually, REER misalignment in the form of either an overvaluation or undervaluation reduces growth. In summary, the numerous empirical studies suggest real exchange behavior is somewhat heterogeneous across countries and over time albeit broadly consistent with macroeconomic fundamentals.

IV. Methodology

The theoretical foundation of the BEER approach popularized by Clark & MacDonald, (1998) derives from the risk-adjusted uncovered interest parity (UIP) condition depicted below:

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

Where s_t denotes the price of a unit of foreign currency, i_t is the nominal interest rate, and c_t is the risk premium, Δ is the first difference operator, E_t is conditional expectations operator, t+k is the maturity horizon of the asset (bonds), * denotes foreign variables. Equation (1) can be converted from nominal to real by deducting the expected inflation differential from both sides of the equation, giving:

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

where $r_t = i_t - E_t[\Delta p_{t+k}]$ and $r_t^* = i_t^* - E_t[\Delta p_{t+k}^*]$ which depict domestic and foreign real interest rates, respectively and q_t is the real exchange rate. Equation (2) expresses the real exchange rate as a function of the expected future real exchange rate, real interest rate differential and the risk premium, on the assumption that the unobservable expected future real exchange rate, $E_t[q_{t+k}]$ is determined by long run macroeconomic fundamentals, Z_t, such that the equilibrium real exchange rate is equal to $E_t[q_{t+k}] = E_t[\beta' Z_t]$.

In line with the theoretical underpinnings of the BEER model and the ARDL approach to cointegration, the specified empirical equilibrium REER model for the Ugandan economy is as follows:

$$\Delta lREER_t = \beta_0 + \sum_{k=1}^{n1} \beta_{1k} \Delta lREER_{t-k} + \sum_{k=1}^{n2} \beta_{2k} \Delta lRGDP_{t-k} + \sum_{k=1}^{n3} \beta_{3k} \Delta lTOT_{t-k} + \sum_{k=1}^{n4} \beta_{4k} \Delta lOPEN_{t-k} + \sum_{k=1}^{n5} \beta_{5k} \Delta lNFA_{t-k} + COVID19_{t-k} + \gamma_0 lREER_{t-1} + \gamma_1 lRGDP_{t-1} + \gamma_2 lTOT_{t-1} + \gamma_3 lOPEN_{t-1} + \gamma_4 lNFA_{t-1} + \varepsilon_t \quad (3)$$

where Δ is a difference operator, l is natural logarithm, β_{ik} represents the short-run effect and γ_{ik} represents the long-run effect, which are normalized by β_0. In Equation 3, RGDP denotes productivity and is derived as real GDP per capita, while REER, TOT, OPEN and NFA denote the real effective exchange rate, terms of trade, trade openness and net foreign assets respectively. COVID19 denotes a Dummy for the Covid19 pandemic crisis which takes on the value of 1 during the COVID 19 pandemic crisis (2020 to 2021) and 0 otherwise. This study applies the ARDL estimation technique.

The a priori expected signs are indeterminate for TOT and OPEN because the effect of TOT on the REER occurs through the income and substitution effects, with the net impact depending on their relative strength since they work in opposite directions and as such while theoretically important as a determinant of the REER, the direction of its impact remains largely unclear. In addition, while trade restrictions negatively affect the REER, the direction of influence of trade openness on REER is inconclusive in the empirical literature and largely depends on the weight of imports versus exports in the domestic economy. Further, the expected sign for RGDP is theoretically positive but a negative sign may occur due to imperfect substitution between tradable and non-tradable sectors as well as imperfect competition while the expected positive theoretical

sign for NFA sign could become negative due to sustained foreign direct investment which results in deterioration of a country's NFA position and appreciation of its currency.

The ARDL approach was proposed by Pesaran and Shin (1999) and Pesaran et al. (2001) and, has multiple advantages in contrast with other co-integration techniques. These include the fact that it does not require unit root pretesting for the incorporated variables in the model, allows for the inclusion of variables that are integrated of different orders such as (I(0), I(1) or a combination of both, accounts for endogeneity, providing unbiased estimates and valid t-statistics, irrespective of the endogeneity of some regressors, and is considered to be statistically robust in the case of small sample size modelling (Harris & Sollis, 2003; Narayan, 2005; Pesaran et al., 2001; Pesaran & Shin, 1998, 1999). The tests for the existence of a long run relationship among the variables of interest is carried out using the ARDL Bounds test for cointegration by Pesaran et al. (2001). The null hypothesis of no cointegration is tested using the joint F-statistic as follows:

$$H_0: \gamma_0 = \gamma_1 = \gamma_2 = \gamma_3 = \gamma_4 = 0 \quad (4a)$$
$$H_1: \gamma_0 \neq \gamma_1 \neq \gamma_2 \neq \gamma_3 \neq \gamma_4 \neq 0 \quad (4a)$$

If the calculated F-statistics exceeds the upper level of the bound, the null hypothesis is rejected, implying that there is cointegration. However, the null hypothesis cannot be rejected, indicating lack of cointegration, if the computed F-statistic is below the lower bound and the test result is inconclusive if the calculated F-statistics falls within the upper and lower bounds.

4.1 Data Sources

The data used for analysis are compiled from the World Bank and the Bank of Uganda (BOU), while the variables that enter the model were selected based on economic theory, the empirical literature, and data availability. The analysis is based on annual data for the period 1990–2021, and details of the data and a summary of descriptive statistics are summarized in table 1.

Table 1: Descriptive Statistics

Variable	Description	Mean	Maximum	Minimum	Std. Dev.	Obs
REER	Real effective exchange rate	81.56	103.86	52.53	15.70	32
TOT	Terms of trade	-115.73	1229.10	-3166.52	969.39	32
OPEN	Natural log of Trade Openness	3.60	4.03	3.28	0.16	32
NFA	Net Foreign Assets (Shs billion)	-13.65	16.99	-270.70	64.57	32
RGDP	Natural Log of GDP per capita (constant 2015 US$)	6.43	6.80	5.93	0.30	32

Notes: RGDP, TOT and OPEN data was compiled from the World Bank database on World development indicators while data on REER, and NFA were compiled from Bank of Uganda Database.

V. Empirical Results and Discussion

5.1 Cointegration Tests Results

The unit root test in Annex 1 indicate that all the variables are either I(0) or I(1) validating the appropriateness of using ARDL technique. Consistent with previous studies that used annual data and for the sake of parsimony, a maximum lag length of 2 lags is adopted for each variable of the ARDL model, (Narayan, 2005; Pesaran and Shin, 1999).[3] After determining the optimal number of lags, we apply ARDL bounds test approach to test for the presence of long-run relationship among the variables of interest. The result of the bounds test given in table 2 is above the upper bound critical value suggested by Narayan (2005) using a small sample size between 30 and 80 at the 5 percent level of significance. Thus, the null hypothesis of no cointegration between the REER and the explanatory variables is rejected.

Table 2: ARDL Bounds Cointegration Test Results

Dependent variable [a]	F-Statistic for Case III Intercept no Trend [b]	Conclusion
	MODEL 1	
REER	6.070	Cointegration
LRGDP	3.257	No cointegration
LOPEN	4.510	No cointegration

NOTES: [a] The cointegrating vector includes the Real effective exchange rate (REER), Natural log of Trade Openness (LOPEN), and Natural Log of GDP per capita (LRGDP), while Terms of trade adjustment (TOT), Net Foreign Assets (NFA), and the Covid-19 pandemic crisis (COVID19) are excluded from the cointegrating vector but included in the short run dynamics. The F-test indicates which variable should be normalized when a long-run relationship exists between the lagged level variables in the cointegrating vector. If the F-statistic lies between the bounds, the test is inconclusive. If it is above the upper bound, the null hypothesis of no cointegration is rejected. If it is below the lower bound, the null hypothesis of no cointegration can't be rejected. [b] The relevant critical values are obtained from Case III: Intercept no Trend when k = 2. For small sample sizes ranging from 30 to 80 observations, Narayan (2005) provides a set of critical values, which are 4.27 and 5.47 for the lower and upper bound respectively at 95 percent significance level.

5.2 Discussion of Results

Given the conclusive evidence of cointegration, we proceed to estimate the long run and short run models. The long run and short run results are presented in table 3. In the long run the significant

[3] The lags must be long enough to render εt serially uncorrelated and not too long as to lead to an over parameterization (Narayan, 2005; Pesaran, 2001). The conducted tests indicated that the optimal lag length is one and the selected ARDL representation for the model is ARDL (1, 0, 0). Additionally, as a precaution we apply the Heteroscedasticity and Autocorrelation Consistent Covariance (HAC) estimators in the ARDL model estimation to ensure that our results are robust in the presence of heteroscedasticity and serial correlation. Note that the HAC approach alters the estimates of the coefficient standard errors of an equation but not the point estimates themselves.

variables which appear to affect the REER are LRGDP, NFA, TOT and COVID19 while in the short run only NFA and TOT were found to statistically significantly affect the REER. Importantly, the study also finds the COVID19 pandemic statistically significantly affects the REER, resulting in a 10.8-unit appreciation. Strikingly an increase in the productivity proxy LRGDP resulting in a 51.8-unit depreciation of the REER in the long run, which implies that in the long run, REER was largely determined by LRGDP in Uganda. An increase in TOT and NFA appreciate the real effective exchange rate. Interestingly, despite the negative coefficient, the study finds that OPEN does not significantly affect the REER at both the short and long run horizons.

The coefficient of the error correction term (ECT) is significant at the 1 percent level with the expected sign giving further support of a long run level relationship between the REER and the long run variables in the ARDL model. The coefficient estimates of -0.60 implies that the speed of adjustment to equilibrium after a shock is high with approximately 60 percent of disequilibria from the previous year's shock converging back to the long-run equilibrium in the current year. The results satisfy all the diagnostic tests reported in Annex 2.

Table 3: ARDL Model Results

Regressors	ARDL (1,0,0)	LONG RUN	SHORT RUN
Intercept	-132.084		-139.879
	(-4.06) ***		-4.09***
LREER1(-1)	0.432		
	(3.53) ***		
LRGDP	29.420	51.827	
	(4.61) ***	(6.16) ***	
Δ LRGDP			53.373
			(1.25)
LOPEN	-2.957	-5.209	
	(-0.68)	(-0.72)	
Δ LOPEN			-2.374
			(-0.29)
NFA	-0.057	-0.100	
	(-4.51) ***	(-3.17) ***	
Δ NFA			-0.049**
			(-2.75)
TOT	-0.003	-0.005	
	(-2.38) **	(-2.56) **	
Δ TOT			-0.003
			(-3.62) ***
COVID19	-6.119	-10.780	
	(-3.32) ***	(-2.65) ***	
Δ COVID19			-6.950
			(-1.41)
ECT(-1)			-0.598
			(-4.13) ***

Notes: The values in parentheses are t-ratios. The asterisks *, ** and *** denote statistical significance at 10 percent, 5 percent and 1 percent significance levels.

5.3 Estimates of REER Misalignment

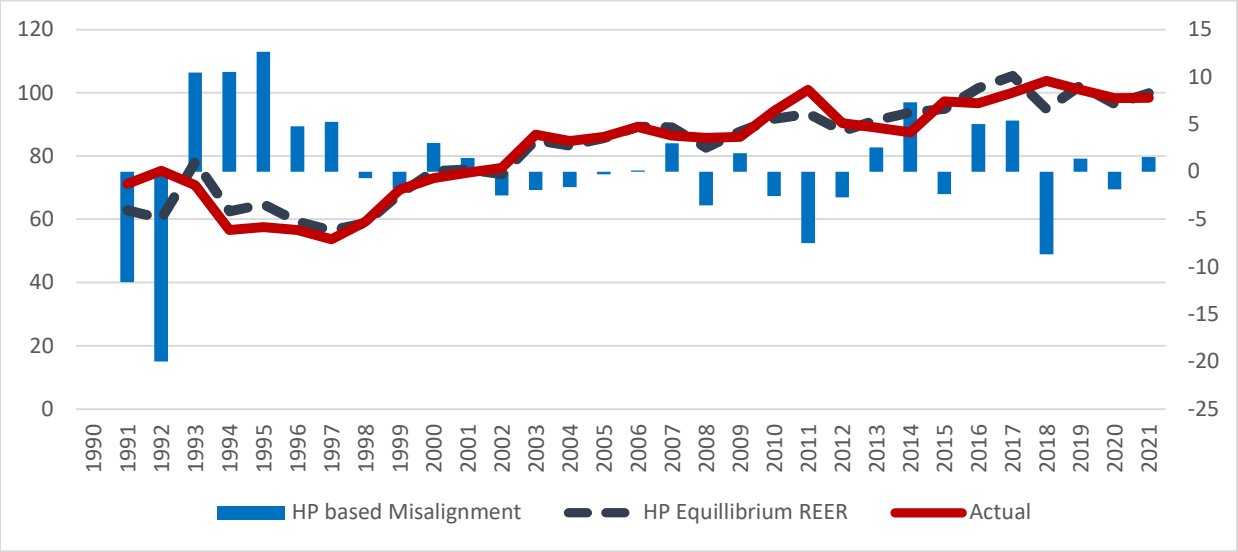
Since the principal concern of the study is to assess the extent of REER misalignment, we apply the estimated ARDL based error correction model to obtain the equilibrium REER and thereafter compute the extent of misalignment associated with the real effective exchange rate. The difference between the estimated equilibrium real effective exchange rate and the actual real effective exchange rate was computed as follows to arrive at the degree of (short-run) misalignment:

$$misalignment = \frac{\widehat{REER} - REER}{REER} * 100 \quad (5)$$

where $\widehat{REER}$ is the estimated equilibrium REER from the ARDL model. The evolution of the misalignment indicator is compared to the zero value such that when the curve is above zero, it is overvaluation and if not, it is undervaluation. The degree of misalignment, is measured first by estimating the equilibrium REER based on the ARDL model which is then subtracted from the actual REER to obtain the misalignment series. However, since the macroeconomic variables that enter the long-run ARDL model are not themselves at their equilibrium levels, we use the Hodrick-Prescott (HP) filter to obtain the permanent value of the fundamental variables which are then included in the ARDL long run model in line with practice in the empirical literature (see Gan et al., 2013) so as to derive the equilibrium values of the REER from which a REER misalignment measure is derived.

A depiction of actual REER versus the equilibrium measure of the REER (EREER) over the period 1990 to 2021, and the extent of misalignment (expressed as the percentage deviation of the actual REER from the estimated EREER) is presented in figure 1, which confirms that the exchange rate deviates from its equilibrium level over time. The plot also shows the presence of abrupt changes or shifts in the direction of misalignment and long swings in the deviation of the REER from its equilibrium level. For example, following a 20 percent undervaluation in 1992, the exchange rate moved quickly into a 10 percent overvaluation in 1993. Similarly, from an overvaluation of 3.0 percent in 2007, the global financial crisis caused a 3.5 percent undervaluation in the currency in 2008 which was followed by a 2.0 percent overvaluation in 2009. An analysis of the misalignment series indicates that the exchange rate has been on average close to equilibrium by an average overvaluation of 0.2 percent during the study period, with 15 cases of undervaluation and 16 cases of overvaluation. In addition, periods of significant misalignment appear to be linked with policy shifts and macroeconomic shocks. For instance, the largest degree of over and under valuation during the period of estimation was recorded in in the early 1990s a period characterized by policy transition from a system of market controls to market based policies including the adoption of a flexible exchange rate regime in 1993.

Figure 1: Actual Versus Equilibrium REER and Misalignment



The estimates of the computed REER misalignment as summarised in table 4 show that during 2001-2005 and 2006–2010, the REER was largely in line with the levels implied by fundamentals, with the REER being slightly undervalued by an average of 0.96 percent and 0.19 percent respectively over these periods. The periods 2011-2015 and 2016-2020 while indicating low levels of REER misalignment on average, also have higher levels of uncertainty associated with them.

Table 4: Average Real Effective Exchange Rate Misalignment

	HP based Misalignment			
Period	Average	minimum	Maximum	std. dev.
1991-1995	0.401	-20.019	12.683	15.138
1996-2000	2.137	-1.774	5.272	3.197
2001-2005	-0.961	-2.478	1.479	1.586
2006-2010	-0.191	-3.548	3.009	2.819
2011-2015	-0.526	-7.499	7.320	5.650
2016-2020	0.257	-8.685	5.396	5.807

VI. Conclusions

This study investigated the determinants of the real effective exchange rates (REER) in Uganda using the ARDL cointegration technique and annual data for the period 1990 to 2021. In addition, we computed the deviations of the REER from its equilibrium levels with a view to gaining insight into the extent of REER misalignment during the sample period. The long-run model showed that real GDP, net foreign assets, terms of trade and COVID19 were statistically significant determinants of the REER while only net foreign assets and terms of trade were found to statistically significantly affect the REER in the short run. The results showed that approximately

60 percent of disequilibria from the previous year's shock is corrected in the current year. On the average, the Uganda shilling REER was overvalued by about 0.2 percent over the period 1990-2021. The results also show that most REER misalignment episodes appear to be linked with policy shifts and macroeconomic shocks. Further, REER misalignments during the period under study were characterized by both abrupt and at times extreme movements with a quick correction as well as long swings.

The study also assessed the implications of REER misalignment for monetary policy implementation. Consistent with the existing literature, we find that tight monetary policy appears to increase REER misalignment which may be explained by the fragility of the economy and vulnerability of the banking sector particularly during the early 1990s which evidenced the greatest magnitudes of REER misalignment.

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Annexes

Annex 1: Unit Root Tests Results

Variables	Augmented Dicky Fuller (ADF) test		Phillips-Peron(PP) test		Kwiatkowski-Phillips-Schmidt-Shin	
	Level	First Difference	Level	First Difference	Level	First Difference
Real effective exchange rate	-1.683	-5.487***	-1.688	-5.566***	0.675	0.304***
Terms of trade adjustment	-3.059**		-3.233**		0.513	0.105***
Natural log of Trade Openness	-2.536	-6.364***	-2.454	-9.693***	0.429**	
Net Foreign Assets (Shs billion)	-45.578***		-2.508	-6.750***	0.448**	
Natural Log of GDP per capita (constant 2015 US$)	-2.081	-3.852***	-1.901	-3.898***	0.733	0.354**
Asymptotic critical values						
Significance level	ADF		PP		KPSS	
1%	-3.66		-3.66		0.739	
5%	-2.96		-2.96		0.463	
10%	-2.62		-2.62		0.347	

Notes: The figures in this table are unit-root test statistics. The asterisks ***, ** and * denote significance at the 1%, 5% and 10% level, respectively.

Annex 2: ARDL Model Diagnostic Tests

Model Diagnostics	ARDL (1,0,0)
Adjusted R-squared	0.90
S.E. of regression	4.69
Schwarz Bayesian Criterion	6.45
DW-statistic	1.63
Residual Diagnostics	
Serial Correlation[1]	1.70 [0.207]
F-statistic[2]	47.30 [0.000]
Heteroscedasticity[3]	0.95 [0.339]
Functional Form[4]	3.59 [0.002]
Normality[5]	0.41 [0.815]

Notes:

[1] Breusch-Godfrey Lagrange multiplier test of residual serial correlation

[2]F-statistic

[3] ARCH test for Heteroskedasticity based on the regression of squared residuals on squared fitted values

[4] Ramsey's RESET test for omitted Variables/Functional form

[5] Jarque-Bera Normality test based on a test of skewness and kurtosis of residuals

The values in brackets are probabilities.

The asterisks *, ** and *** denote statistical significance at 10 percent, 5 percent and 1 percent significance levels, respectively.

Annex 3: Bivariate Tests between Monetary Policy and REER Misalignment

This study tested the null hypothesis that monetary policy has no effect on REER misalignment against the alternative that it does by estimating the following equation:

$$misalignment_t = \alpha_0 + \propto_1 91day_t + \propto_2 91day_{t-1} + \propto_3 91day_{t-2} + \propto_4 IT + \varepsilon_t \qquad (6)$$

where $misalignment$ denotes the measure of REER misalignment generated under section 5.4. When the actual RER is more appreciated than the estimated equilibrium rate, the actual REER is considered to be overvalued and $misalignment > 0$, otherwise the REER is undervalued and $misalignment < 0$. In addition, $91day$ represents the 91 day Treasury bill interest rate, a proxy for monetary policy implementation and IT denotes inflation targeting a dummy variable to capture the effect of monetary policy regime that assumes the value of unity during the inflation targeting regime and zero otherwise. The 91-day Treasury bill interest rate was used as a proxy for monetary policy because it played a pivotal role in interest rate transmission in Uganda prior to the introduction of inflation targeting in 2011 and represents the best measure of the monetary policy stance in view of data availability limitations. The expectation is that $\propto < 0 \; or \; > 0 \; and \; \propto < 0$. The theoretical and empirical work on the impact of tight monetary policy on exchange rates misalignment remains inconclusive and as such remains an empirical issue, particularly in post-crisis situations (Montiel, 2003). The study also investigates the effect of REER misalignment on monetary policy implementation by estimating the following equations:

$$91day_t = \propto_0 + \propto_1 misalignment_t + \varepsilon_t \qquad (7)$$

$$\text{inflation}_t = \propto_0 + \propto_1 misalignment_t + \varepsilon_t \qquad (8)$$

Annex 3a: Unit Root Tests

	Augmented Dicky Fuller (ADF) test		Phillips-Peron(PP) test		Kwiatkowski-Phillips-Schmidt-Shin (KPSS)	
Variables	**Level**	**First Difference**	**Level**	**First Difference**	**Level**	**First Difference**
Misalignment	-3.762		-3.705		0.348	
91 Day interest rate	-5.423		-5.423		0.091	
Inflation	-5.330		-5.330		0.112	
Asymptotic critical values						
Significance level	ADF		PP		KPSS	
1%	-3.66		-3.66		0.739	
5%	-2.96		-2.96		0.463	
10%	-2.62		-2.62		0.347	

Notes: The figures in this table are unit-root test statistics. The asterisks ***, ** and * denote significance at the 1%,

where $misalignment$ denotes the measure of REER misalignment computed in section 5, $91day$ represents the 91-day Treasury bill interest rate, a proxy for monetary policy implementation and $inflation$ denotes the domestic inflation rate. We expect $\propto > 0\ and\ \propto > 0$. Equations 6, 7 and 8 was estimated with annual data for the period 1993-2021 due to limitation of data availability. The results for unit root tests for variables in equations 6-7 are reported in annex 3a.

The results from the estimations of equations 6, 7 and 8 are reported as Model 2, model 3 and model 4, respectively in annex 3b. In annex 3b, the study finds that monetary policy implementation does affect REER misalignment. While the impact is correctly signed for the Inflation targeting regime, suggesting that adoption of inflation targeting regime contribute to reduction in misalignment, and an appreciation of the REER and correction of the REER undervaluation, this effect is not statistically significant. In contrast, the monetary policy tightening in the form of an increase in the 91 day interest rate results in an increase in misalignment in the form of a depreciation of the REER and undervaluation of the exchange rate. However, this effect is statistically significant only for lags one and two. This result is consistent with Montiel (2003) who in a review of the theoretical and empirical literature concludes that a positive effect of tight monetary policy on REER misalignment is plausible particularly during crisis periods and periods where the economy and banking system are vulnerable.

Annex 3b: REER Misalignment and Monetary Policy

Regressors	**MODEL 2**	**MODEL 3**	**MODEL 4**
Intercept	-11.637	9.762	10.599
	(-2.41) **	(10.72) ***	(2.65) ***
misalignment		0.189	0.340
		(1.35)	(0.55)
91day	0.206		
	(0.73)		
91day(-1)	0.472		
	(1.78) *		
91day(-2)	0.545		
	(2.41) **		
IT	-2.459	1.865	-6.136
	(-1.36)	(1.31)	(-0.98)
Inflation	0.037		
	(0.71)		
Model and Residual Diagnostics			
Serial Correlation[1]	0.118[0.943]	3.737 [0.154]	0.189 [0.909]
Heteroscedasticity[2]	0.607 [0.436]	0.158 [0.691]	0.061 [0.805]
Normality[3]	1.772[0.412]	5.644 [0.060]	413.699[0.000]
Adjusted R squared	0.176	0.032	-0.016

Notes:

[1] Breusch-Godfrey Lagrange multiplier test of residual serial correlation

[2] ARCH test for Heteroskedasticity based on the regression of squared residuals on squared fitted values

[3] Jarque-Bera Normality test based on a test of skewness and kurtosis of residuals

The values in parentheses are t-ratios while probabilities are brackets.

The asterisks *, ** and *** denote statistical significance at 10 percent, 5 percent and 1 percent significance levels.

This views is also supported by Baig & Goldfajn (2002) who found that in some countries, there was need to reverse overly depreciated currencies through firmer monetary policy . In addition, this study highlights the limitations of cost associated with high interest rates to stabilize the currency which can be overwhelming if the banking sector is fragile. Further support is provided by Goldfajn & Gupta (2002) who found that for undervaluation in many countries in the aftermath of currency crises, tight monetary policy substantially increased the probability of reversing the exchange rate trend while opposite was true when the country was facing a banking crisis and tight monetary policy decreased the probability of a reversal. Thus, in the case of Uganda, the fragility of the economy and vulnerability of the banking sector during the early 1990s characterized by the greatest magnitudes of REER misalignment may account for our result.