AN ANALYSIS OF THE EFFECTS OF PUBLIC DEBT ON EXCHANGE RATE VOLATILITY IN UGANDA FOR A PERIOD OF 53 YEARS 1970-2023

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UGANDA CHRISTIAN UNIVERSITY

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DECLARATION.

I BIDALI BOSCO registration number S21B34/023 declare that this research paper on the analysis of the effects of public debt on exchange rate volatility in Uganda from 1970 to 2023, is my original work and it has not been submitted to any academic institute for any accreditation. Any secondary information used has been duly cited and referenced.

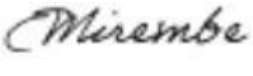
Signature……

Date……4/09/2024……

Bidali Bosco

APPROVAL

This research report entitled "an analysis of the effects of public debt on exchange rate volatility in Uganda from 1970 to 2023" has been carefully examined and endorsed by the undersigned.

Signature 

Date: 05/09/2014

Mrs. Elsie Nsiyona Mirembe

DEDICATION

I dedicate this study report to my extended family, particularly my grandfather, whose continuous support and encouragement have served as a guiding light throughout this academic journey. I would like to offer my heartfelt gratitude to my supervisor, Mrs. Elsie Nsiyona Mirembe, for your expertise and mentorship. Your advice has been invaluable. I also dedicate my work to the people of Uganda, for whom economic well-being is the ultimate purpose of this research. May the study's findings help policy marker make informed policy decisions that promote economic stability and development. May this research serve as a springboard to a brighter future for all Uganda.

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ACRONYMS

UGX- Ugandan shillings

FAO- Food Agriculture Organization of the United State

UNECA- United Nations Economic Commission for Africa

GDP- Gross Domestic Product

IMF- International Monetary Fund

AFDB- African Development Bank

DTC- Debt Trap Countries

NDTC- Non-Debt Trap Countries

OLS- Ordinary Least Square

ARDL-ECM- Autoregressive Distributed Lag Error Correction Model

VIF- Variance Inflation Factor

TOL- Tolerances

ADF- Augmented Dickey-Fuller

AIC- Akaike Information Criterion

SIC- Schwarz Bayesian Information Criterion

PIC- Hannan-Quinn Information Criterion

HIPC- Heavily Indebted Poor Countries

ABSTRACT

Uganda, like other developing countries, has been experiencing a rising trend in public debt, raising concerns among the public about its implications on economic variables influencing economic welfare. Notably, Uganda's exchange rate has exhibited a depreciating and volatile trend since 1970 to date, detrimental to economic growth. This study empirically investigates the effects of public debt on exchange rate volatility in Uganda from the period 1970 to 2023. This study examines the short run and long run relationship between external debt, debt servicing non external debt, foreign reserves, and exchange rates using an ARDL-ECM model. The findings disclose that external debt has an insignificant positive effect in the short run and an insignificant negative effect in the long run. In contrast, external debt service has an insignificant positive effect in the long run, meanwhile foreign reserves have a significant negative effect in the long run and a positive relationship in the short run. Based on these findings, the government should prioritize maintaining stable foreign reserves to mitigate exchange rate volatility in the short and long run. Additionally, prudent debt management and investing public debt in high-multiplier projects can enhance Uganda's capacity to repay debts and interest charges. Furthermore, concessional loans are more suitable for developing economies like Uganda.

CHAPTER ONE: INTRODUCTION

1.0 Introduction

This slice gives the provenance of the study, the statement of the problem, the objectives of the study, the research questions, the significance of the study, the scope of the study, and the justification of the study.

1.1.0 Provenance of the study

The global debt landscape is witnessing an unprecedented ballooning of debt stocks across developed and emerging economies, with indebtedness reaching a critical mass that defies historical precedent (Nsubuga, 2019; M. Kose, 2021). This spike is primarily driven by increasing public expenditure and persistent budget deficits in both wealthy and emerging nations, coupled with a reliance on foreign aid and loans due to insufficient local revenue, leading to a debt cycle. M. Gazali. 2020. Meanwhile the need for development necessitates borrowing, this has led to widening debt-to-GDP ratios, economic stagnation, reduced investment, and higher borrowing costs, exacerbating financial vulnerability and hindering growth in different emerging economies (Naseem, 2014, Nonso et al 2023). Nevertheless, a well-structured sovereign debt management framework is essential for nations to secure sustainable financing options, bolster economic resilience, and reduce financial exposure. Proactive debt management approaches can avert fiscal crises and their devastating repercussions Misztal, (2021). while strong economic fundamentals or high-quality earnings can enhance creditworthiness and facilitate access to long-term financing opportunities.

Public debt, especially external debt, serves as a vital bridge in the development process, addressing two critical financing gaps. First it helps alleviate the foreign exchange shortfall which occurs when a country's export earnings are insufficient to meet its international obligations, and second the investment gap, where domestic resources fall short of meeting investment needs (Ezenwa, 2012, Lola & Oni 2022). However, the dramatic slump in global Commodity price trends of the 1980s, particularly for primary agricultural products and crude oil, had a devastating impact on foreign exchange revenues in developing countries, which heavily rely on these exports. This led to a significant challenge in financing external payments, necessitating external borrowing to supplement domestic savings. Consequently, public borrowing became an essential tool for

bridging the financing gaps and fostering economic growth (Adamu, 2016; Miečinskienė & Lapinskaitė, 2014).

Uganda's public debt has surged to a historic high of UGX 96.1 trillion ($25.3 billion), equivalent to 52% of GDP, as of June 2023 Bank of Uganda (2024). The debt composition reveals a split between domestic (UGX 44.6 trillion) and foreign sources (UGX 52.8 trillion). The accumulation of such debt is primarily attributed to government initiatives aimed at transforming Uganda from a peasant-oriented to a modern economy by 2040 (Bulime, Mukisa & Bbaale, et al 2021). Moreover, throughout the 19th century, the government initiated socioeconomic development programs. The Buganda Agreement (1900) and Uganda Protectorate (1894) introduced modern infrastructure, education, and healthcare. Post-independence, programs like the Five-Year Plans, SAPs (1987), PMA (2000), and PEAP (2004) followed, funded through donor aid and government borrowing, including concessionary loans, to drive industrialization, agricultural growth, and social services expansion, fostering sustainable development and economic prosperity. Meanwhile, in recent years, the government's efforts to address infrastructure constraints and convert Uganda from a peasant to a modern and prosperous nation Vision40 have resulted in increased public investment. However, the decline in coffee prices as Uganda's principal agricultural export, has had an impact on foreign exchange income (FAO, 2020). Furthermore, the COVID-19 pandemic and the Russia-Ukraine conflict have exacerbated state debt by increasing government spending. The situation is further worsened by a decline in aid, budget support, and development assistance from development partners, exemplified by the reduction in aid from UGX 2.781 trillion to UGX28.94 billion following the passage of the anti-gay law in the country (Amos, 2024).

In developing economies, governments often rely on public borrowing to bridge the significant Imbalance in fiscal inflows and outflows. To address this shortfall, they seek funding from international sources, including loans, grants, and donations from multilateral and bilateral institutions (UNECA, 2019). Domestically, they issue Treasury bills, and bonds, and tap into central bank financing and sovereign wealth funds (World Bank, 2023). While this approach increases resource availability, it creates contractual liabilities that must be repaid (IMF, 2022). External borrowing from diverse sources adds to the complexity of managing public debt.

1.1.1 The Structure and Magnitude of Uganda’s Public Debt.

Public debt embodies the fiscal legacy of bygone eras, cumulatively aggregating past financial deficits born from deliberate political decisions. This comprehensive liability inventory encompasses both domestic and foreign currency-denominated obligations, tantamount to a nation's total indebtedness. In essence, public debt reflects the aggregate amount a country owes to a diverse array of lenders, including individuals, corporations, and fellow governments, both within and beyond its borders. According to Alagia (1990), external debt specifically pertains to financial obligations owed to non-resident creditors, denominated in foreign currencies, goods, or services, which can exert profound economic influence and dependence on debtor nations, particularly in the developing world. Conversely, domestic debt represents the quantity of funds borrowed by the government from its citizens in local currency, including bank and non-bank borrowing (Public Debt Portfolio Analysis, 2022). Notably, Uganda's debt profile has sparked consternation due to its elevated debt-to-GDP ratio, surpassing the IMF threshold, and escalating debt servicing expenses in foreign currency.

Uganda, upon gaining independence from colonial rule in 1962, inherited a considerable fiscal burden, dubbed 'the legacy of subjugation, which comprised a substantial debt portfolio accumulated during the colonial era, posing significant challenges to the newly liberated nation's economic sovereignty and development aspirations Okoth (1992). Since then, Uganda's debt stock has risen to high levels, this worsened between 1986 to 2006. In one instance in 1992, the debt to GDP ratio increased to 109% from 31% in 1987. This is caused by rapid debt buildup, inefficient debt utilization, and an increasing share of interest payments in the national budget (Ndejjo, Musinguzi, Nuwaha, 2020). Following the Heavily Indebted Poor Countries (HIPC) initiative, Uganda's debt burden was lowered to $1.6 billion after receiving $650 million in debt relief and 100% debt forgiveness under Multilateral Debt Relief Initiative in 2006. However, despite the rollover and relief given to Uganda, debt figures have risen to record heights over the last two decades as a result of the economy's declining foreign exchange earning potential. (Barungi & Atingi, 2000), reducing the country's debt-service capacity.

Uganda's public debt has reached alarming levels, skyrocketing to UGX 96.1 trillion ($25.3 billion) with an additional UGX 7 trillion awaiting approval, up from UGX 86.8 trillion ($23.66 billion) in FY 2022/2023. As a percentage of GDP, the debt has surged from 34.6% in FY2018-2019 to 52.8% in FY2023-2024, exceeding the IMF's recommended threshold of 50% for low-

income countries, with a forecasted increase to 53% in FY2024/2025. A staggering 32% of every shilling collected goes towards servicing debt, equivalent to UGX 2.5 million per citizen, shared among the population of 45 million Amos (2024). This unsustainable trajectory, combined with stagnant domestic revenue, dwindling export earnings, and soaring debt servicing costs, pushes Uganda to the brink of debt distress, heightening the risk of a full-blown debt crisis and economic stagnation.

1.1.2 External long and short-term debt and external debt servicing

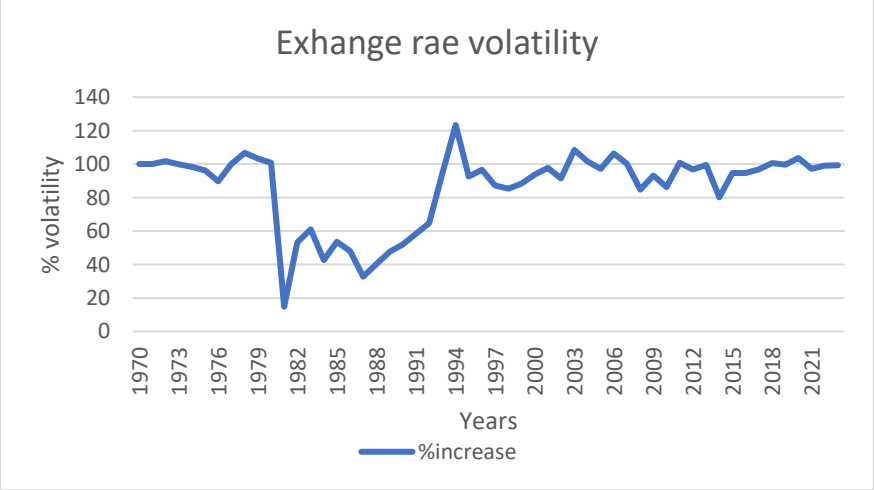
External debt as a composition of public debt has exhibited a relentless upward trajectory, surging from $13.97 billion in 2019 to $19.49 billion in 2022, with a striking escalation to $23.22 billion in the 2022/23 financial year. This burgeoning external debt, encompassing both long-term and short-term liabilities, now constitutes a substantial 28.2% of GDP. The country's external debt servicing obligations have also experienced a precipitous rise, imposing a formidable burden on Uganda's finances, with payments skyrocketing from $197 million in 2019 to $443 million in 2022, and projected to reach a staggering $633 million in 2024 World bank (2024). This rising debt service load portends a diversion of key resources away from critical public services and development efforts, thereby compromising Uganda's economic stability and developmental progress and threatening to trap the country in a vicious circle of debt dependency.

1.1.3 Foreign reserves in Uganda

Uganda's foreign exchange reserves decreased by 12% from $4.07 billion in June 2023 to $3.58 billion in January 2024, compared to an 18% drop in 2022. This equates to 3.4 months of import cover due to external debt payments and the central bank's inability to purchase foreign currency amid a weakening shilling. This decline in reserves is a concern, as the Bank of Uganda aims to maintain a minimum of 4 months of import cover to ensure economic stability and support growth. The drop in reserves is attributed to Uganda's rising public debt, which has increased to $24.7 billion, with 60% being external debt, and is eating into revenues, impacting spending priorities like education and health.

1.1.4 Exchange rate

The Ugandan shilling (UGX) averagely traded 3752.48 per US Dollar (USD) in 2023 compared to 3689.8173 in 2022, representing a slight increase in exchange rate World Bank, (2023). Exchange rate is the price of one country's currency in terms of another country's currency, signifying the rate at which one currency can be exchanged for another. It is expressed as a quotation, such as USD/UGX in nominal terms. Exchange rate volatility, on the other hand, refers to the unpredictable and rapid fluctuations in the value of one currency relative to another; it measures the degree of variation in exchange rates over a given period, capturing the frequency, magnitude, and unpredictability of exchange rate changes (Lubinga and Kiiza, 2013; Oskooee and Hegerty, 2007). Debt servicing in foreign reserves may put the country at risk of exchange rate volatility, as principal and interest payments in foreign currencies can affect exchange rates. However, the shillings remarkable fell by 85% in 1981 and then by 67.4% in 1987 followed by a low rate until 1994 where it appreciated by 23% against the US dollar, Notably, as depicted by figure 1 below, exchange rate exhibited a significant fluctuation showing various depreciation and appreciation of Ugandan shillings against the dollar.



1.2 Statement of the Problem.

Uganda's public debt has grown dramatically in the past few decades. Concerns have been raised concerning the effect it has on the economy, particularly on indicators of macroeconomic performance. The country's debt-to-GDP ratio increased from 25.9% in 2015 to 52% in 2023 and is expected to climb to 53% in FY2024/2025 (World Bank, 2024), surpassing the International

Monetary Fund's (IMF) suggested threshold of 50% for developing countries. Moreover, external debt has climbed to $19.49 billion, with servicing payments expected to reach $633 million by 2024, straining finances and threatening economic stability. According to Bank of Uganda state of economy report 2024, Uganda's foreign exchange reserves reduced by 12%, to $3.58 billion from 4.074 billion in the previous year, jeopardizing its capacity to maintain a stable exchange rate and fund crucial public services. Concerns have been raised regarding the effects of rapid debt buildup on the exchange rate, which is a crucial determinant of trade competitiveness, inflation, and economic growth (Krugman & Obstfeld, 2009).

Recent studies in various countries have revealed that high levels of public debt, specifically external debt and debt servicing, have had an effect on volatility in exchange rates (Nwame & Onyekachi 2015, Adhiambo 2015, Reinhart & Rogoff, 2010, Saheed, Sani & Idakwoji, 2015, Nwikina & Naakuu, 2023, Moazzam, 2022, Obwogi 2019), reduced foreign exchange reserves (Aizenman & Marion, 2004), and increased inflation Fischer (2013). In Uganda, the rapid depreciation and appreciation of the Ugandan shilling against the US dollar in recent years has raised concerns about the economic consequences of rising government debt (Bank of Uganda, 2022).

Given the significance of this issue, there has been little research into the specific effects of public debt on Ugandan exchange rates. The majority of prior research has concentrated on advanced economies or regional analysis, ignoring the unique context and constraints that low-income nations like Uganda face. As a result, the purpose of this study is to look into the effects of externa public debt on Ugandan exchange rate volatility between 1970 and 2023. This paper attempts to contribute to the current knowledge by studying the relationship between external debt, debt service on external debt, foreign reserves, and exchange rates in Uganda and providing policy recommendations for managing public debt and fostering exchange rate stability in low-income countries.

1.3 General Objective of the Study

The goal of this study is to investigate the impacts of public debt on Uganda's exchange rate volatility, with a focus on understanding the relationships between external debt, debt servicing on external debt, foreign reserves, and exchange rate volatility in both short and long-term scenarios.

1.4 Specific Objectives of the Study

1. To examine the relationship between external debt and exchange rate volatility in the short and long run in Uganda.
2. To study examine the effects of debt service on exchange rate volatility in the short and long term from 1970 to 2023.
3. To Analyze the effects of foreign reserve on Ugandan currency rate volatility.

1.5.Research Questions

1. To what extend does external debt contribute to exchange rate volatility in Uganda and how does these relationships differ in the long and short run?
2. How does debt service on external debt impact exchange rate in Uganda, and how these effects vary in the short run versus the long run over the period 1970-2023?
3. To what extent do foreign reserve contribute to exchange rate volatility in Uganda, and what are the implications for macroeconomic stability?

1.6 Justification of the Study

This study is motivated by the urgent need to understand the impacts of Uganda's fast expanding public external debt on the economy, which has climbed from UGX 13.4 trillion in 2010 to UGX 73.8 trillion and is now at UGX 96.1 trillion (Bank of Uganda, 2022). With public external debt increasing at an alarming rate, it is necessary to explore its implications on exchange rates, which are an important determinant of trade competitiveness, inflation, and economic growth (Kumar & Kumar, 2017). Uganda's economy is strongly reliant on imports; therefore, a falling exchange rate can intensify inflationary pressures, weaken trade competitiveness, and stymie economic growth (IMF, 2023) Although the relevance of this problem, past research has disregarded the Ugandan context, leaving a knowledge gap that this study tries to fill. This study aims to provide valuable insights and recommendations that will inform policy decisions and promote long-term economic growth and macroeconomic stability as Uganda strives to achieve Vision 2040. The purpose of this study is to investigate the effects of public external debt on Ugandan exchange rate volatility and foreign reserve in order to identify policy measures that can mitigate the negative economic

consequences of debt. Rising government debt has an influence on the economy as indicated by various studies.

1.7 Scope of study.

This study covers the years 1970 through 2023. This is due to the numerous fiscal measures the government has taken to preserve and restore the economic order and fiscal discipline, which were jeopardized, particularly between 1970 and 2023. Furthermore, Uganda has accrued a substantial amount of external and domestic public debt to fulfill its enormous financial demands throughout this time. As a result, this time frame is crucial for evaluating budgetary measures in light of the nation's mounting debt on exchange rates.

1.8 Significance of the Study

This study is essential because it explores the critical relationship between Uganda's governmental debt and exchange rates, providing useful insights into the economic repercussions of debt accumulation, which has increased from 14.6% of GDP in 2010 to 52% in 2024 (World Bank, 2022). By investigating this complex link, the study adds to the existing literature and increases our understanding of the impact of public debt on exchange rates in developing countries where debt sustainability is a serious concern (IMF, 2022). The findings and recommendations will guide policy decisions in Uganda, promoting long-term economic growth and development as the country works toward Vision 2040 (Government of Uganda, 2013). Furthermore, the framework used in the study to analyze the effects of public external debt on exchange rates can be applied to other developing countries, improving understanding of macroeconomic implications and informing debt management and economic policy-making strategies, ultimately promoting regional economic stability and prosperity (AFDB, 2022).

1.9 Conceptual Framework

This study uses the Input-Process-Output framework to look at the impact of foreign debt on Uganda's exchange rate. External debt, debt service payments, foreign reserves, and currency rate are among the variables utilized as inputs. The study investigates the empirical connections between these variables and calculates their statistical significance. Diagnostic tests are subsequently carried out to confirm that the generated regression model is trustworthy. The result

provides insights into the interaction of the dependent and independent variables, allowing the researcher to draw conclusions and make suggestions for educated policy decisions on exchange rate management and its relationships with external debt and other aspects

CHAPTEER FOUR: LITERATURE REVIEW

2.0 Introduction

This section summarizes the theoretical, empirical, and conceptual literature on the connection between external debt and exchange rate volatility, with a focus on debt payment, external debt, short-term foreign debt, foreign reserve and the exchange rate. The empirical review focuses on previous investigations, whereas the theoretical framework investigates current theories to support the study.

2.1 Theoretical framework

The currency rate serves an important role in facilitating international trade by allowing cross-country price comparisons. Amollo (2023). Following the transition to floating exchange rates, research interest has shifted to understanding the determinants of exchange rates (Menya, 2021), with a focus on forecasting and explaining exchange rate changes. To further understand these processes, this study used foundational principles from the Classical and Keynesian Schools of Ideas, as well as the Debt Overhang Theory. Furthermore, in studying the relationship between public spending and exchange rates, this study draws on Ricardo's theory of public debt, which provides a core framework for understanding the impact of state debt on exchange rates.

2.1.1 Classical economist debt theory

The classical theory of debt posits that government borrowing is detrimental to the economy. Hume et al, (1752) warned that public debt could destroy a nation, while Adam Smith (1776) believed it led to wasteful spending and burdensome taxes. Baptist, (1832) distinguished between private and public debt, arguing that the latter creates barren production and consumption. Ricardo advocated for a one-time capital levy to redeem debt, while Malthus recognized the evils of public debt but disagreed with Ricardo's solution. John Stuart Mill, (1848) believed public borrowing destroyed capital that could be used productively. In contrast, this was refined by classical theory, that public debt's impact depends on how the government employs the loan proceeds (Cark,1887,

Bastable, 1892 and Leroy-Beaulieu, 1883). Overall, classical economists viewed public debt as a hindrance to economic progress, emphasizing the importance of prudent fiscal management.

2.1.2 The Keynesian thought of public debt

Keynesian economists, on the other hand generally view government borrowing as a stimulus to an economy, particularly during recessions. They argue that borrowing absorbs excess savings, boosts aggregate demand, and finances productive investments, thereby reinvigorating the economy Hicks, (1939). While some, like McCord and Seymour, advocate for cyclical deficit spending, others, like Clark and Moulton, are skeptical of Lerner's functional finance. However, most Keynesians believe that public debt has no adverse consequences on economic variables, as fresh investments enabled by borrowing can drive growth (Keynes, 1936; Samuelson, 1954; Krugman, 2012). This optimism is rooted in the idea that government borrowing can bridge the savings-investment gap, fostering economic expansion (Musgrave, 1959; Hansen, 1962).

2.1.3 The Debt overhang theory

A paradigm for understanding the effect of state debt on currency rates. According to the Debt Overhang Theory, excessive amounts of external debt can discourage investment by reducing the possibility of debt payback. Krugman, (1989). This hypothesis says that when a country's repayment ability is questionable, investors become reluctant of investing in the domestic economy, since they fear that profits on their investments will be punished by current foreign creditors. Sachs (1989). Debt overhang can have far-reaching consequences for exchange rates, as it discourages investment in physical capital, human capital, and technological innovation. Easterly (2001).

The need to service a large amount of external debt can lead to a crowding-out effect, where high real interest rates worsen macroeconomic conditions and limit access to foreign credit markets World Bank, (2020). This can result in a decline in private investment, as investors seek more secure opportunities elsewhere Sachs, (1989). Policymakers must consider the effects of debt overhang on private investment and economic growth, and implement strategies to reduce the debt burden and improve macroeconomic conditions IMF, (2022).

2.1.4 Ricardo’s theory of public debt and exchange rate

David Ricardo's theoretical theory of public debt posits that the primary burden on the community arises from the wasteful nature of public expenditure itself, rather than the methods used to finance it. Additionally, Richardo believes that supporting public expenditure entails extracting cash from the community's liquid resources, and it makes no difference whether these amounts are generated through taxes or loans Roberts, (1942). . Public debt, on the other hand, refers to cash raised through loans. If drawn from an external source, it entails debt servicing, which normally demands payment in foreign currency, influencing the foreign reserve and potentially affecting the exchange rate (Alagidede & Ibrahim, 2017). This emphasizes the significance of examining the impact of public debt on the economy and exchange rate.

However, the monetary framework of exchange rate determination, developed by scholars such as Mussa (1976, 1984), states that the current exchange rate is determined by the current stocks of domestic and foreign money, as well as the demands for these monies, which include domestic and foreign income and interest rates. This approach, also known as the monetary approach to international capital movements, contends that changes in a country's foreign currency reserves and money supply are important drivers of its external position, resulting in balance-of-payments surpluses or deficits and subsequent exchange rate fluctuations (Frenkel, Johnson, & Mussa, 1976; Sobersten & Reed, 1994). Understanding the variables influencing currency rates and foreign capital movements allows policymakers to better manage their country's external position and foster economic stability.

2.2 Empirical framework.

This section includes an explanation of relevant previous studies on the relationship between state debt and currency rates.

Research has investigated the link between external debt and exchange rates, yielding insightful findings. In developing countries, excessive debt accumulation tends to lead to long-term appreciation of real exchange rates Sene, (2004). In some instances, debt servicing, external debt, and foreign reserves have been identified as significant factors influencing exchange rate fluctuations, with service payments on external debt have the strongest impact on exchange rate volatility Sami, et at, (2015). This is mostly due to the need for foreign currency. Furthermore, a study in Croatia revealed that exchange rate depreciation increased the country's external debt load

because the majority of the country's external liabilities were held in foreign currency Palić et al., (2018), meaning debt if not properly managed can influence the exchange rate which intern affects countries debt burdens These studies underscore the importance of prudent debt management in maintaining economic stability.

Meanwhile, Kouladoum, (2018) examined this dynamic of debt and exchange rate in Chad over 39 years. The study revealed a positive and statistically significant correlation at the 5% level between the level of foreign debt and Chad's real exchange rate. This suggests that initially, higher debt levels might lead to a stronger real exchange rate, possibly due to increased foreign investment associated with the debt. However, the study also found a negative and significant relationship of debt servicing on the real exchange rate. Repaying the debt involves outflows of domestic currency, which can weaken its value.

In contrast, other researchers (Mongardini, 1998; Sekkat & Varoudaki, 1998; Milesi-Ferreti & Lane, 2000) have focused on a broader trend. Their studies suggest that the significant accumulation of external debt in sub-Saharan African countries contributes to real exchange rate misalignments. This implies that the exchange rate may deviate from its ideal equilibrium level, becoming either overvalued or undervalued. Additionally, these studies highlight a potential disparity between creditor and debtor nations. They propose that creditor countries tend to experience appreciating real exchange rates (stronger currency) as a result of their lending position while borrowing nations like Chad see depreciating real exchange rates (weaker currency).

Furthermore, Alam and Taib (2013) conducted an empirical analysis of panels from six Debt Trap Countries (DTC) and Non-Debt Trap Countries (NDTC) in Asia's Pacific development region to investigate the relationship between external debts, budget deficit, current account deficit, and exchange rate depreciation. The data suggested a positive link between external debt, budget deficit, current account deficit, and exchange rate depreciation. However, a stronger coefficient is observed in debt-trap countries compared to the non-debt-trap countries. According to Aliyu (2011), an appreciation of the currency rate generates an increase in imports and a decrease in exports, whereas depreciation promotes an expansion in exports and a contraction in imports. similarly, depreciation of the exchange rate is likely to result in a shift from foreign goods to domestic goods; as a result, income is diverted from importing countries to exporting countries

via a shift in terms of trade, affecting the economic growth of both exporting and importing countries.

Aderemi (2019) found no significant inverse relationship between exchange rate volatility and external debt in Nigeria using the DOLS method. Research on the correlation between external debt and currency rate movements in Nigeria is underway, although there are no conclusive conclusions. This study aims to contribute to the literature on the relationship between public debt and exchange rate volatility, which is currently unclear.

Mendoza (2022) conducted an empirical study to determine the impact of external debt buildup on the Philippine exchange rate. Using correlational time series analysis, the researcher investigated the links between external debt, debt servicing obligations, foreign reserves, and the Philippine currency rate from 1980 to 2019. The data revealed that external debt and debt servicing are positively correlated with the exchange rate, whereas foreign reserves are negatively correlated. The regression coefficients show that changes in the independent variables cause noteworthy but moderate exchange rate variations, emphasizing the importance of these factors in determining the value of the Philippine peso.

A study carried out by Menya (2021) employed OLS analysis to investigate the effects of external debt service, money supply, terms of trade, and balance of trade on exchange rate fluctuations between 1990 and 2019. The study revealed that external debt service had a detrimental impact on the exchange rate. Conversely, Ssempala et al. (2020) used ARDL analysis to show that while total debt service had a negative impact, gross debt as a share of GDP positively affected Uganda's economy, with public debt hindering short-term economic growth but stimulating long-term growth. Similarly, Fagbola et al. (2020) found that external debt negatively impacted economic growth in Nigeria from 1981 to 2018. Studies conducted by Were (2001) and Babu et al. (2014) has consistently shown that excessive foreign debt accumulation slows economic growth, underlining the importance of prudent debt management for long-term economic success in emerging countries.

2.3 Overview of the literature

External debt is inextricably linked to currency rates (Cavallo et al., 2005; Ezirim and Muoghalu, 2006; Siregar and Pontines, 2005). High levels of foreign debt have resulted in exchange rate

overshooting (Gressani, 1998) and local currency depreciation, which can exacerbate foreign indebtedness (Awan et al., 2011; Bunescu, 2014). External debt and currency rates have a complicated relationship, with some studies finding it less significant (Ajayi, 1992; Ezirim & Muoghalu, 2006) and others finding it significant (Cavallo et al., 2005; Draz & Ahmad, 2015; Siregar & Pontines, 2005). In addition, external debt has been found to have a negative impact on exchange rate volatility in underdeveloped nations (Devereux & Lane, 2003; Osifalujo et al,2022). Furthermore, studies have shown that external debt can cause currency crises (Milesi-Ferreti & Lane, 2000) and have an impact on economic growth (Ngangnchi et al, 2022).

Public debt-specific external debt is linked to exchange rates, with excessive debt levels causing currency volatility. While the magnitude of this relationship is debatable, research indicates that external debt has a payback in currency crises and influences economic development. Furthermore, external debt has a detrimental impact on exchange rate volatility in emerging countries. Understanding this relationship is critical for policymakers as they control foreign debt and foster economic stability. This conflicting evidence emphasizes the need for more research to fully understand the complex interplay between debt exchange rates in emerging economies. These links are likely to be influenced by each nation's unique economic circumstances, the sort of debt incurred, and other external factors.

CHAPTER THREE: METHODOLOGY

3.0. Introduction

This section summarizes the methodology employed to attain the study objectives, providing a comprehensive account of the research process. Methodology refers to the systematic and structured style used to conduct research, encompassing the research design, data source, quality and reliability test, processing, and analysis technique Sekaran & Bougie, (2022). By detailing the methodology, this chapter ensures transparency and replicability of the study.

3.1 Research Design

This study employs a quantitative research method, focusing on secondary time series data on state debt, such as external debt, debt repayment requirements on external debt, foreign currency reserves, and corresponding annual exchange rates in dollars. The main purpose is to investigate the relationship between government debt and exchange rate volatility, with a particular emphasis on Uganda's economic landscape. The null hypothesis (H0: $\beta = 0$) suggests that there is no significant correlation between public debt and exchange rate volatility. The alternative hypothesis (H1: $\beta \neq 0$) suggests that public external debt has a significant impact on exchange rate volatility, potentially harming Uganda's exchange rate stability during the study period.

3.2 Data source

This study analyzes secondary data covering 54 years (1970-2023) to investigate the effects of governmental debt on Ugandan exchange rate volatility. Time series data on external debt, debt servicing on external debt, and foreign reserves, as well as corresponding yearly exchange rates in dollars, were obtained from reputable sources, including the World Bank's Global Economic Monitor, International Financial Statistics, and Data file, the Bank of Uganda, Ministry of Finance and Economic Planning and the International Monetary Fund (2023).

3.3 Theoretical and empirical frame

Based on the study objectives, this study applied the Autoregressive Distributed Lag Error Correction Model (ARDL-ECM) to empirically test the short run and long run relationship between the variables. The ARDL-ECM model consists of two parts: ARDL, also known as the

Bounds Test, was first developed by Charemza and Deadman (1992) and then enhanced by Pesaran, Smith, and Shin (2001). It is a statistical approach used to detect cointegration and estimate long-run correlations between variables in the presence of short-run dynamics. And ECM to identify long-run relationships between series, detect and correct for short-term deviations from equilibrium, and model the dynamics of variable adjustments, thus providing a comprehensive framework for analyzing and understanding the complex interactions between time series data, enabling researchers to discern stable relationships, address temporary fluctuations, and capture the adaptive processes that guide variable changes over time Engle and Granger. 1987. Nonetheless, the ARDL-ECM model is the focus of this study because to its ability to deal with variable endogeneity. Furthermore, it has the ability to estimate long-run and short-run impacts while accepting variables with differing integration qualities such as I (0) and I (1). This makes it a reliable instrument for empirical study. The ARDL-ECM approach is a two-step process that begins with comparing the F-statistic from the ARDL-ECM to specified constraints to determine the presence of a long-run equilibrium relationship among the variables.

3.4.1 Estimation procedures

In line with the work of Sani and Idakwoji (2015) in Nigeria and Adhimbo (2015), this study uses the ARDL-ECM model to evaluate the consequences of public debt on exchange rate volatility in Uganda. A variety of diagnostic tests are run to ensure the model's validity, including checks for multicollinearity, unit root, cointegration, and model specifications. These experiments provide a detailed evaluation of the model's performance and provide a solid framework for investigating the relationship between public debt and exchange rate volatility.

3.4.2 Test 1

A single prevalent challenge in the analysis of relationships is multicollinearity, which if not addressed can lead to unstable coefficient estimations (Gujarati, 2004, p. 348). Several tests have been created by different researchers to discover multicollinearity, including the Variance Inflation Factor (VIF) (Kutner et al., 2005), tolerance (Menard, 1995), correlation matrix (Cohen et al., 2013), and condition index (Belsley et al., 1980). For this investigation, the VIF, tolerance, and correlation matrix are used to assess the strength of the association between the treatment variables under consideration.

$$VIF = \frac{1}{1-r2} \quad (1)$$

$$TOLj = \frac{1}{\text{VIF}} = (1 - R2) \quad (2)$$

The VIF and tolerance indicate that a value greater than 10 and less than 0.1 indicates a high correlation, whereas the correlation matrix measures the strength of the relationship between the variables and a value greater than 0.8 indicates a high correlation.

3.4.3 Test2

The unit root test, this is carried out to ascertain the properties of stationarity. In line with this study, the Dickey-Fuller (DF) and Augmented Dickey-Fuller (ADF) are employed to test for a unit root in the data (Granger, 2004 Pesaran, 2007; Enders, 2014). However, Granger (1974), stated that, if a variable for example integrated of order d, I(d), requires differencing d times to achieve stationarity, I (0), then it is considered a non-stationary variable of order d. The ADF and Phillips-Perron tests, are commonly used to determine whether a variable is stationary or not Seddighi et al, (2015). As noted by Pesaran, (2007), the ADF and PP tests work similarly for uncorrelated error terms and the DF test is used for corrected error terms. By applying these tests,

Correlated error

$$\Delta Yt = \beta 1 + \delta Yt - 1 + \varepsilon t \quad (3)$$

Uncorrelated error

$$\Delta Yt = \beta 1 + \beta 2t + \delta Yt - 1 + \sum_{i=1}^{m} \alpha i \Delta \gamma t - i + \varepsilon t. \quad (4)$$

Equation (3) tests the Ho $\delta = 0$ against Ha $\delta \neq 0$ while equation (4) specifies a null hypothesis of non-stationarity H0: $\gamma = \beta = \theta = 0$, while the alternative hypothesis is H1: $\gamma \neq 0$ or $\beta \neq 0$ or $\theta \neq 0$and the t-statistics are computed and compared with critical value from tau statistic distribution at 5% level of significance.

However, in the case of this study, the t-value of the coefficient of logext_debt, logdebt_serv,logfor_res, and logex_rate2 are calculated and compared to critical values from the tau statistic distribution obtained through Monte Carlo simulations Dickey & Fuller, (1979). If the

t-value is less than the critical value at 5% levels, the null hypothesis is rejected, indicating stationarity. Otherwise, the time series is considered non-stationary.

3.4.4 Step 3

Choosing the proper lag length is critical when creating a time series model. Typically, three criteria are employed. The Akaike Information Criterion (AIC), Schwarz Bayesian Information Criterion (SIC), and Hannan-Quinn Information Criterion (PIC). The best lag length is determined by the lowest value of these criteria. Brock et al. (2019). AIC, SIC, and PIC evaluate model fit and complexity, with lower values indicating a better trade-off (Burnham & Anderson, 2002). This is to ensure a compact model that prevents overfitting Lütkepohl, (2014).

3.4.5 Test 4

The limits test is a technique for detecting the presence of a long-term link between variables in a multivariate system. It is employed when some variables are integrated into order I (1) while others are integrated into order I (0). The test is carried out by determining the best lag for each variable and then analyzing the F-statistic value to see if it exceeds the upper bound critical value for I(1) variables or falls below the lower bound critical value for I(0) variables.

The null hypothesis of no cointegration is contrasted with the alternative hypothesis of cointegration. If the F-statistic value exceeds the upper bound critical value, the null hypothesis is rejected, indicating cointegration (Engle & Granger, 1987). In contrast, if the F-statistic value is less than the critical value for the lower bound, there is no cointegration but only a short-run relationship (Granger, 1981).

In the event of cointegration, the error correction model (ECM) is estimated to capture the long-run relationship. The ECM represents the deviation from the long-run equilibrium and adjusts for short-term deviations (Engle & Granger, 1987).

On the other hand, if there is no cointegration, the ARDL model is estimated to capture the short-run relationship. The ARDL model examines the relationships between the variables without assuming cointegration Shin, (2001)

3.5.1 Model Specification

This paper investigates the shot-run and long-run relationship between each of the independent variables and the dependent variable. To achieve the study's objectives, the Autoregressive Distributed Lag - Error Correction Model (ARDL-ECM) is employed. The model is transformed using logarithms to stabilize variance, normalize data, and linearize relationships between variables, enabling a more accurate analysis of the relationships between the variables.

In the traditional model as dictated by the variables ER- exchange rate, EDT- external debt, DSEDT- debt service on external debt, and FR- foreign reserve,

$$ER = F(ER, EDT, DSEDT, FR) \quad (5)$$

Where;

ER = Exchange Rate

EDT = External Debt

DSEDT = Debt Service on External Debt

FR = Foreign Reserve.

Equation 1 illustrates a relationship in the variables under study. However, the study employed the robust ARDL of cointegration due to the nature of the variable under study.

$$\Delta \log ERt = \mu + \sum_{i=1}^{m} \gamma i \Delta \log ERTt - i + \sum_{i=1}^{m} \beta i \Delta \log EDTt - i + \sum_{i=1}^{m} \alpha i \Delta \log DSEDTt - i + \sum_{i=1}^{m} \theta i \Delta \log FRT - i + \delta 0 \log ERt + \delta 1 \log EDTt + \delta 2 \log DSEDTt + \delta 3 \log FRt + \varepsilon t \quad (6)$$

The terms ΔlogER, logEDT, logDSEDT, and logFR in equation 6 are the transformed operator in their natural log.

δ0, δ1,δ2 and δ3 are the coefficients for long-run relationships in the variables.

γi, βi , αi , θi are the coefficients for short-run relationships among variables.

μ is the constant term of the model,

εt is the white noise error component.

m- represent the appropriate number of lags

In the context of the ECM the appropriate equation for the study below to capture short-term dynamics

$$\Delta \log ERt = \mu + \sum_{i=1}^{m} \gamma \Delta \log ERTt - i + \sum_{i=1}^{m} \beta \Delta \log EDTt - i + \sum_{i=1}^{m} \alpha \Delta \log DSEDTt - i + \sum_{i=1}^{m} \theta \Delta \log FRT - i + \varphi ECMt - 1 + \varepsilon t \quad (7)$$

α, β, γ, and θ are short-run dynamic multipliers and represent the speed of adjustment to long-run equilibrium

3.6.1 Model Significance.

To assess the overall performance of the ARDL-ECM, the residuals for normality, homoscedasticity, and serial correlation will be employed for model fit. Additionally, the F-statistical analysis, which involves R-squared and adjusted R-squared values, will be examined to evaluate the goodness of fit and predictive power of the model. This step will ensure that the model effectively captures the relationships between the variables under investigation

3.6.2 Variable Significance Test

To determine the significance of each explanatory variables in explaining the dependent variable, the t-statistics and t-scores calculated entail to accomplish this purpose. The null hypothesis will be tested using a one-sided test, with a 5% level of significance, based on prior knowledge and review Kennedy, (1992). The critical t-value will be obtained from the distribution table, and the decision to reject or accept the null hypothesis will be made by comparing the calculated t-value with the critical t-value. This process will enable the identification of the most significant predictors of the dependent variable, providing valuable insights for the research.

CHAPTER FOUR: DATA ANALYSIS AND DISCUSSIONS

4.0 Introduction

The next section presents the findings of the data analysis, combining descriptive and inferential statistical approaches to create a comprehensive picture. The findings are systematically analyzed, with each outcome exposed to a detailed discussion that reveals its significance and meaning. The chapter uses a dual method to give a nuanced exploration of the data, exposing patterns, trends, and linkages that contribute to a better understanding of the research objectives.

4.1. Summary of Descriptive Statistics.

This section gives an overview on mean deviation, skewness and range of Uganda's external debt, debt service on external debt, foreign reserves, and exchange rate from 1970 to 2023, further highlighting major trends and patterns in each.

Table 1. Summary of Descriptive Statistics.

Variables	EDT	DSEDT	FR	ER
Mean	4.52e+09	2.15e+08	1.27e+09	3.078345
Std.Dev	5.30e+09	3.90e+08	1.46e+09	5.640743
Min	1.52e+08	9039289	3000000	0.0002683
Max	2.07e+10	2.03e+09	4.43e+09	14.25659
Variance	2.81e+19	1.52e+17	2.13e+18	31.81798
Skewness	1.752625	3.66362	0.7541448	1.339163
Kurtosis	5.177281	16.43139	1.972279	2.827077
Observation	54	54	54	54

Based on table 1, the external debt profile of Uganda, reveals a mean debt of $4.52 billion, accompanied by a significant standard deviation of $5.30 billion, underlining the enormous variations in debt levels. The data reveals a remarkable range, from a low of $152 million to a high of $20.7 billion external debt levels, highlighting the country's varying external debt obligations over the years. Furthermore, the variation of $2.81 trillion indicates a large deviation from the mean, while the skewness of 1.752625 suggests a moderate asymmetry, with a trend toward higher debt levels. The kurtosis of 5.177281 indicates a leptokurtic distribution with extreme values and probable outliers, implying a more complex debt profile than a normal distribution would suggest.

Debt service on external debt, on the other hand, has a mean payment of $215 million and a standard deviation of $390 million, indicating considerable annual payment swings. However, the range of payments is wide, ranging from a low of $9.04 million to a breathtaking high of $2.03 billion, demonstrating the country's changing ability to manage external debt. Furthermore, the variance of $1.52 trillion indicates considerable departures from the mean, but the skewness of 3.66362 indicates a highly asymmetrical distribution with a strong tilt toward extreme values. The kurtosis of 16.43139 highlights the occurrence of outliers, implying that Uganda's foreign debt service payments are marked by sporadic but considerable increases.

Foreign reserves have a mean value of $1.27 billion, with a huge standard deviation of $1.46 billion, highlighting the significant range in reserve levels. The range in reserves is significant, ranging from $3 million to $4.43 billion, highlighting the country's fluctuating ability to maintain foreign exchange buffers. Furthermore, the variance of $2.13 trillion indicates a significant deviation from the mean, but the skewness of 0.754 indicates substantial asymmetry with a minor tilt toward greater reserve amounts. The kurtosis of 1.972 underlines the occurrence of outliers, demonstrating that Uganda's foreign reserves fluctuate sporadically yet significantly.

In addition, exchange rate movements reflect a complicated terrain, with a mean rate of 3.078345 and a standard deviation of 5.64073, indicating high volatility. The exchange rate varies from a low of $0.00027 to a high of $14.2569 per shilling, demonstrating the wide variety of values. The variance of 31.81798 highlights the significant variations from the mean, while the skewness of 1.339163 indicates a considerable asymmetry with a minor bias toward higher exchange rates. The kurtosis of 2.827077 underlines the prevalence of extreme values, demonstrating that Uganda's currency rates fluctuate sporadically yet significantly.

4.2. Step 2 Diagnostic Tests

4.3.1 Test 1

Table 2a: Correlation Matrix

	lnER	lnEDT	lnDSEDT	lnFR
lnER	1.0000			
lnEDT	-0.9042* 0.0000	1.0000		
lnDSEDT	-0.6949* 0.0000	0.8701* 0.0000	1.0000	
lnFR	-0.8534* 0.0000	0.7954* 0.0000	0.5460* 0.0000	1.0000

Table 2 reveals the strength of correlation among the independent variables of external debt, debt serves on external debt and foreign reserve. The results indicate a significant interrelationship among predictor variables. However, a correction among the independent variables exceeding the 0.8 might pose a challenge in explaining the results (Gujarati, 2003; Belsley, 1984; Kennedy, 2003). Notably, the correlation between external debt and debt serves on external debt indicate a high correlation of 0.8701 among the independent variables, meanwhile external debt and foreign reserves show high correlation of 0.7954 not surpassing the 0.8 threshold and on another hand, debt serves on external debt and foreign reserve indicate a moderate correlation of 0.5460. Therefore, due to the high correlation, this study purposely employed the ARDL-ECM to take in to consideration the high correlation in some of the variables.

Table 2b: VIF and TOL Test of Multicollinearity

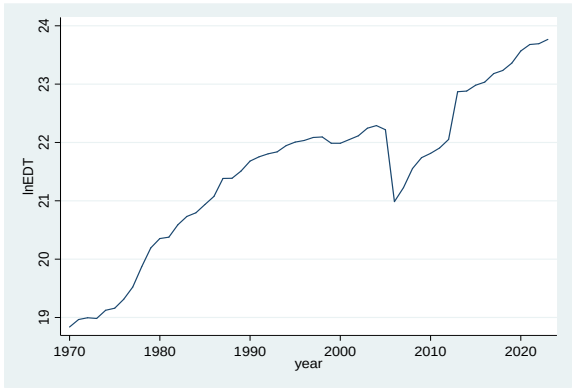
```
. vif

    Variable |       VIF       1/VIF
-------------+----------------------
       lnEDT |     10.34    0.096741
     lnDSEDT |      5.41    0.184824
        lnFR |      3.58    0.279543
-------------+----------------------
    Mean VIF |      6.44
```

The table 2b shows the VIF and TOL results indicating a mean VIF of 6.44, this is less than 10 suggesting that multicollinearity among independent variables is not a concern. Furthermore, all Tolerance TOL values are below 1, indicating that the variables have low correlation, which strengthens the model's reliability and accuracy.

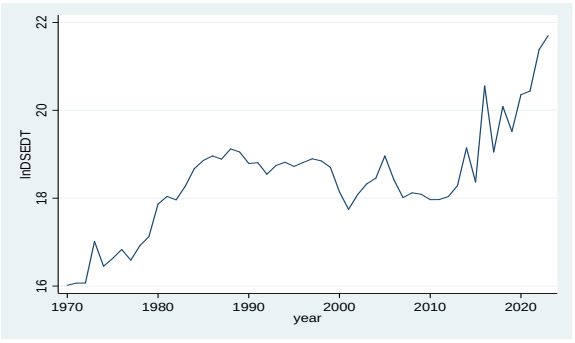
4.3.2 Test 2

Table 3a: Variables at level

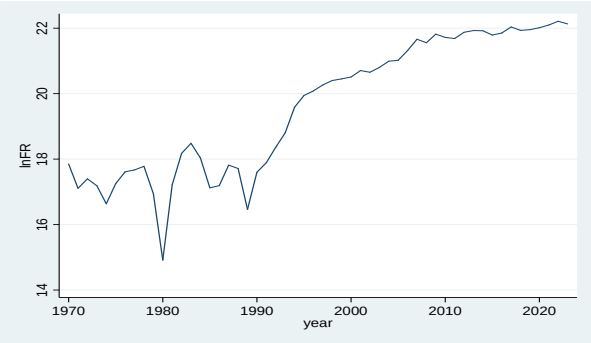
LnEDT



LnDSEDT



LnFR



LnER

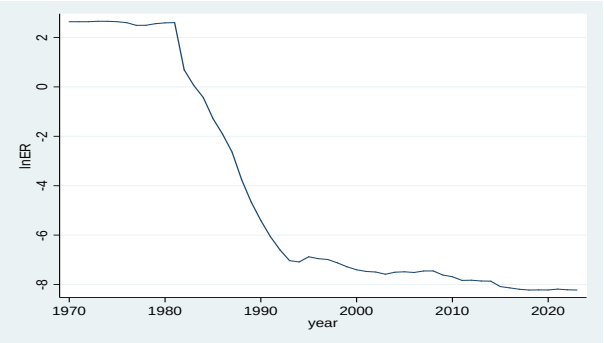


Table 3a provides a graphical representation of each variable's trend. Notably, external debt rises gradually from 1970 to a dramatic fall in 2005, prompted by the HIPC effort, followed by a fast climb. Similarly, debt service is reasonably stable until 2014, when it becomes a source of concern for policy experts, and then exhibits shifting tendencies, alternating between increases and decreases. In contrast, foreign reserves increased significantly in 1987, followed by a sequence of rising and dropping trends. Meanwhile, the exchange rate reveals a depreciating, with a dramatic decrease in the 1980s, and then fluctuates against the dollar.

Table 3b: Unit root test at Level.

Variables	t-statistics	1%critical level	5%critical level	10% critical level
lnER	-0.833	-4.146	-3.498	-3.179
lnEDT	-1.944	-4.146	-3.498	-3.179
lnDSEDT	-0.671	-4.146	-3.498	-3.179
lnFR	-3.127	-4.146	-3.498	-3.179

The Augmented Dickey-Fuller test results in Table 3a reveal that all the variables under investigation exhibit unit root at the 5% level of significance. Specifically, the t-statistics are lnER (0.833), lnEDT (1.944), lnDSEDT (0.671), and lnFR (3.127), which fall short of the critical value

(3.498) in absolute terms. This leads to the acceptance of the null hypothesis of a unit root suggesting that each of the series contains a stochastic trend, rendering them non-stationary. The presence of non-stationarity implies that the variable's mean and variance evolve over time, ARDL-ECM requires that all variables should be integrated in the following orders I (0) or I (1) Granger and Engle (1985). Therefore, to ensure the validity and reliability of the subsequent analysis, this study will proceed with differencing of the series to reveal their order of integration.

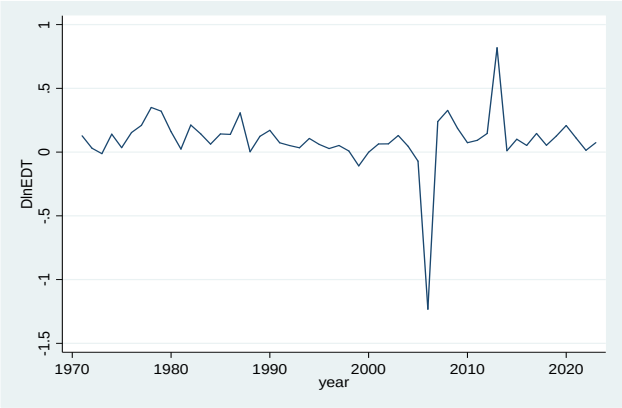
Table 4a: Unit Root Test at 1st and 2nd Difference.

Variables	t-statistics	1% critical value	5%critical value	10% critical value
2nd D lnER	-7.772	-4.150	-3.500	-3.180
1st D lnEDT	-5.079	- 4.148	-3.499	-3.179
1st D lnDSEDT	-4.374	- 4.148	-3.499	-3.179
1st D lnFR	-6.683	- 4.148	-3.499	-3.179

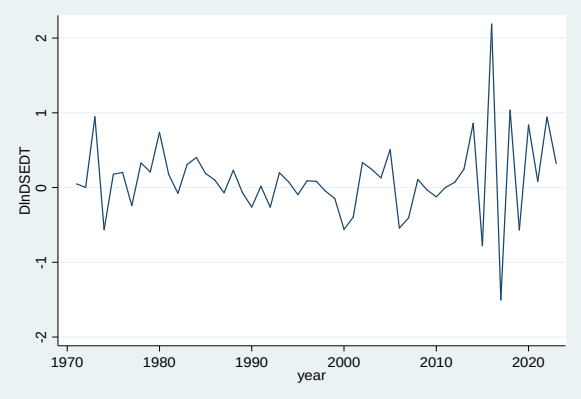
The Augmented Dickey-Fuller test results presented in Table 4b indicate that the series lnEDT, lnDSEDT, and lnFR are stationary at first difference meaning their mean and variance become constant after 1st difference. Therefore, series lnEDT, lnDSEDT, and lnFR are integrated into order one (I (1)). Meanwhile, series lnER is stationary at the 2nd difference indicating that it's integrated of order two (I (2)) in absolute terms. Which for this study, the first difference is obtained and used in the analysis.

Table 4b: Stationarity at 1st and 2nd Difference

1st D lnEDT



1st D lnDSEDT



1st D lnFR

2nd D lnER

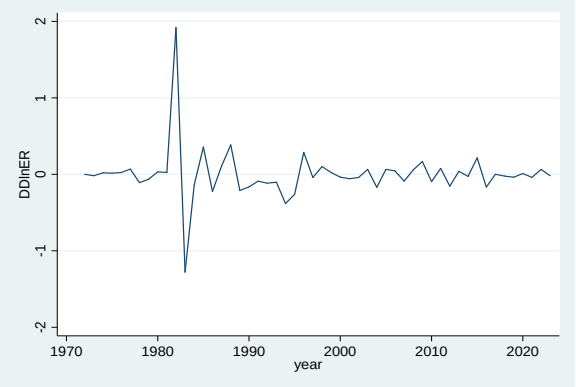


Table 4c displays the stationary series, confirming that differencing has achieved stationarity. A visual inspection reveals diverse volatility patterns across the series, with some exhibiting consistent fluctuations, while others show intermittent spikes or gradual changes, indicating unique underlying dynamics in each variable. From 1980 to 2000, the exchange rate and foreign reserves were highly volatile. The currency rate fell rapidly in 1980, rebounded moderately until 1985, and then fluctuated dramatically, including a precipitous plunge in 1986 and a big recovery in 1994. Foreign reserves increased dramatically in 1980, followed by a slow fall until 1985, a precipitous dip in 1986, and a big increase in 1987. Throughout the 1990s, both variables experienced volatile

oscillations, with occasional spikes and quick changes, including a rapid depreciation of the exchange rate and a severe decrease in foreign reserves in 1998, which was followed by stabilization by 2000.

In contrast, external debt and debt service on external debt have shown increased volatility in recent years, notably between 2005-2020 and 2010-2023. Interestingly, debt service follows a distinct pattern, with a brief burst of volatility in the late 1970s, followed by a rather steady era, before seeing another rise in volatility between 2010 and 2023. These observations reveal that the variables have undergone considerable changes over time, with different periods distinguished by distinct economic situations. This indicates the increasing debt and interest charges on the debt in recent years, creating concerns among policymakers.

4.3 Step 3 Optima lag Selection

Table 5: Optima lag Selection

```
varsoc lnER lnEDT lnDSEDT lnFR

 Selection-order criteria
 Sample:  1974 - 2023                        Number of obs      =        50
```

lag	LL	LR	df	p	FPE	AIC	HQIC	SBIC
0	-294.374				1.79227	11.935	11.9932	12.0879
1	-75.7416	437.27	16	0.000	.000543	3.82967	4.12091	4.59447*
2	-46.7885	57.906	16	0.000	.000327*	3.31154*	3.83578*	4.6882
3	-31.989	29.599*	16	0.020	.000355	3.35956	4.11679	5.34806
4	-22.6451	18.688	16	0.285	.000494	3.6258	4.61603	6.22615

```
 Endogenous:  lnER lnEDT lnDSEDT lnFR
  Exogenous:  _cons
```

Table 5 presents the results of the optimal lag length selection for the series, employing three prominent information criteria: Akaike Information Criterion (AIC), Schwarz Bayesian Information Criterion (SBIC), and Hannan-Quinn Information Criterion (HQIC). Each criterion suggests four potential lags, but the decision hinges on selecting the criterion with the lowest value. Upon examining the results in Table 5, it is evident that the Akaike Information Criterion (AIC) exhibits the lowest value, specifically 3.31154*. This outcome indicates that AIC is the most

suitable criterion for determining the optimal lag length. Consequently, AIC identifies two lags as the optimal choice, signifying that incorporating two lagged values of the variables will achieve an optimal balance between model fit and parsimony. This result suggests that a two-lag specification will effectively capture the underlying dynamics of the data, striking a balance between model complexity and simplicity.

4.4 Test 4 Bound test of cointegration.

As indicated by the results of the unit root test, all variables have a unit root, suggesting that they are integrated with order one, I (1). This implies that the variables are not stationary and follow stochastic trends. As a result, more study is required to assess whether the variables have a long-run equilibrium connection. To overcome this, the bound test of cointegration is used, which is appropriate for modeling variables that show a consistent trend and pattern.

Table6: Summary of Bound Test of Cointegration

Pesaran/Shin/Smith (2001) ARDL Bounds Test

H0: no levels relationship — **F = 9.743**, **t = -6.176**

Critical Values (0.1-0.01), **F-statistic**, Case 3

	[I_0] L_1	[I_1] L_1	[I_0] L_05	[I_1] L_05	[I_0] L_025	[I_1] L_025	[I_0] L_01	[I_1] L_01
k_3	**2.72**	**3.77**	**3.23**	**4.35**	**3.69**	**4.89**	**4.29**	**5.61**

accept if F < critical value for I(0) regressors
reject if F > critical value for I(1) regressors

Critical Values (0.1-0.01), **t-statistic**, Case 3

	[I_0] L_1	[I_1] L_1	[I_0] L_05	[I_1] L_05	[I_0] L_025	[I_1] L_025	[I_0] L_01	[I_1] L_01
k_3	**-2.57**	**-3.46**	**-2.86**	**-3.78**	**-3.13**	**-4.05**	**-3.43**	**-4.37**

accept if t > critical value for I(0) regressors
reject if t < critical value for I(1) regressors

k: # of non-deterministic regressors in long-run relationship
Critical values from Pesaran/Shin/Smith (2001)

The test of cointegration yields a significant result, indicating a long-run equilibrium relationship between the variables. The F-statistic of f = 9.743 exceeds upper bound critical values of 3.77, 4.35, 4.89, 5.61 respectively, for the (0.1- 0.01) significance levels. This suggests that the null

hypothesis of no cointegration is to be rejected indicating the presence of cointegration. Furthermore, the F-statistic surpasses the lower bound critical values of 2.72, 3.23, 3.69 and 4.29 respectively, providing strong evidence of cointegration. The results imply that a linear combination of the variables is stationary, confirming the presence of a stable long-run relationship. This finding supports the use of error correction models to capture the dynamic interactions between the variables, enabling reliable forecasting and policy analysis.

Meanwhile, the t-statistic result indicates a significant deviation from the null hypothesis. With a calculated t-statistic value of t = -6.176, which is less than the lower and upper critical values (-2.57, -2.86, -3.13, -3.43) (-3.46, -3.78, -4.05, -4.37) respectively. The criteria are to reject the null hypothesis of no cointegration. This suggests that the variables are cointegrated, implying a stable long-run equilibrium relationship. The significant t-statistic value of t = -6.176, confirms the presence of cointegration, supporting the use of error correction models for analysis.

4.5.1 Statistical Model

The diagnostic tests conducted on the variables confirm the suitability of the ARDL-ECM model in examining the short-run and long-run relationships between the exchange rate and the independent variables: external debt, debt service on external debt, and foreign reserves. However, the Akaike Information Criterion (AIC) suggests that the optimal number of lags is two, indicating that the model considers up to the second lag of the variables to explain how public debt, debt service, and foreign reserves impact the exchange rate.

4.5.2 Summary of the model

The results show that F = 8.97 with a matching p-value of 0.0000. The R-squared value of 0.5934 indicates that the lag values of exchange rate, external debt, debt service, and foreign reserves account for approximately 59% of the volatility in the exchange rate. The adjusted R-squared value of 0.5272 accounts for the model's number of parameters, offering a more cautious assessment of the model's explanatory power. The log-likelihood value (-0.26943715) reflects the model's goodness of fit, and the root mean squared error (RMSE) of 0.2649 quantifies the average difference between predicted and actual values, indicating the model's accuracy (Appendix 5).

The error correction model ARDL-ECM exhibits a moderate level of explanatory power, with R-squared value of 0.5203, indicating that approximately 52% of the fluctuation in the exchange rate is being explained by the predictor variables and lag values of the exchange rate. The adjusted R-squared value of 0.4440 provides a more conservative estimate, taking into account the number of parameters in the model. The log-likelihood of 0.1299298 indicates that the model is a good fit for the data. The root mean squared error (RMSE) of 0.2624 represents the average magnitude of the mistakes and serves as a measure of the model's precision. Overall, these findings show that the ECM model is an acceptable description of the variables' interactions, accounting for almost half of the variation in the dependent variable. This establishes a good platform for studying the long-run and short-run dynamics of exchange rate volatility.

Table 7: Summary of the long run and short regression

ARDL(1,0,1,2) regression

Sample:	1972 -	2023		Number of obs	=	52
				R-squared	=	0.5203
				Adj R-squared	=	0.4440
Log likelihood =	.1299298			Root MSE	=	0.2624

D.DlnER	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
ADJ						
DlnER						
L1.	-.7285406	.1179546	-6.18	0.000	-.9662625	-.4908186
LR						
lnEDT	.0660904	.1289161	0.51	0.611	-.1937229	.3259036
lnDSEDT	.1237996	.1080967	1.15	0.258	-.0940549	.3416542
lnFR	-.16871	.048398	-3.49	0.001	-.2662498	-.0711702
SR						
lnDSEDT						
D1.	-.108477	.0797249	-1.36	0.181	-.2691519	.0521979
lnFR						
D1.	.1074713	.0659188	1.63	0.110	-.0253793	.2403218
LD.	.2633726	.0639903	4.12	0.000	.1344085	.3923366
_cons	-.1596403	.6771561	-0.24	0.815	-1.524359	1.205078

4.6 Discussion of Results

Based on Table 7, the lagged exchange rate exhibits a statistically significant negative coefficient of -0.7285406, with a p-value of 0.000. This indicates that past exchange rate movements have a strong influence on current exchange rate volatility. Specifically, a percentage change in the previous period's exchange rate leads to a 72.8% depreciation in exchange rate holding other variables constant. This suggests that exchange rate shocks persist over time, contributing to ongoing volatility. The significant lagged effect underscores the speculative effects of trades it incorporates the forces of demand and supply in explaining exchange rate volatility.

Meanwhile, external debt reveals limited insignificant dynamics, in the long run, a one percent change in external debt leads to a 6.6% increase in exchange rate holding other variables constant, but this effect is statistically insignificant with a p-value = 0.611. Similarly, in the short run, a percentage change in external debt leads to a 10.8% depreciation of the exchange rate holding other variables constant, but again, this effect is statistically insignificant with a p-value = 0.181. This result also shows that a percentage change in eternal debt leads to an appreciation in Ugandans exchange rate. However, these findings suggest that external debt has an insignificant influence on the exchange rate volatility both in the long run and short with p values exceeding the 0.05 level of significance, indicating that other factors other than external debt affect exchange rate volatility in Uganda.

Similarly, debt service on external debt has a statistically insignificant relationship with exchange rate both in the short run and long run. Based on table7, a percentage change in debt service on external debt leads to a 12.37996% appreciation in the exchange rate holding other variables constant, but this effect is statistically insignificant (p-value = 0.258). This suggests that the cost of servicing external debt does not have a significant impact on the exchange rate fluctuation both in the long run and short run.

On the other hand, the relationship between foreign reserve and the exchange rate is multifaceted revealing a statistically significant relationship in the long run and the second lag in the short run. In the long run, a percentage change in foreign reserves exhibits a 16.871% depreciation in the exchange rate holding other variable constant, indicating that accumulating foreign reserves can help stabilize the value of Ugandan shilling. However, in the short run, the impact of foreign

reserves on the exchange rate is more complex. For example, a percentage change in foreign reserves leads to a 10.74713% appreciation in exchange rate after one period holding other variables content, but a 26.33726% appreciation in the exchange rate after two periods holding other variables constant. Overall, the dynamics between foreign reserves and the exchange rate underscore the importance of considering both short-run and long-run effects.

4.7. Summary of Findings

The research reveals an intricate structure of linkages between the exchange rate, external debt, debt service on external debt, and foreign reserves. Notably, the prior exchange rate value has a considerable impact on exchange rate volatility, showing the persistence of exchange rate shocks. Similarly, foreign reserves have a significant association with Ugandan exchange rate volatility from 1970 to 2023, showing their critical statistical significance in long-term currency stability and a delayed favorable influence in the near run.

External debt and debt service on external debt, on the other hand, have a statistically insignificant relationship with exchange rate movements in both the short and long run. Overall, the data indicate that exchange rate volatility is predominantly influenced by prior exchange rate values, foreign reserves, and other controlled variables not included in the analysis, rather than external debt or debt service on external debt. These findings can help policymakers make judgments on how to mitigate exchange rate swings.

CHAPTER FIVE: CONCLUSION AND RECOMMENDATION

5.0 Introduction

This chapter summarizes the study by providing a summary, policy recommendations, constraints, and suggestions for further research. in a better understanding of exchange rate volatility not only in Uganda, but also in other developing nations.

5.1 Summary of the Study

The study investigated the swings in Uganda's currency exchange rates rate in reaction to changes in the volume of external debt, debt service on external debt, and foreign reserves. Exchange rate management in developing countries has been one of the challenging issue due to the need of reserves of foreign countries faced by the various governments in history and this has raised a lot of concerns within policy makers and economists. Volatility in exchange rate has various consequences, including a significant increase in external debt burdens, higher import costs fueling inflation, reduced foreign investment due to uncertainty, and decreased economic competitiveness impacting exports. These impacts further hinder economic growth Duru et al (2024), affecting living standards and undermining the country's economic stability.

This study examined the exchange rate's behavior and its relationships with global debt commitments and corresponding repayment schedules, and foreign reserves over the short to long term horizon. The importance of a stable exchange rate was also discussed, drawing on insights from various scholars in the literature, with relevance to both developed and developing economies. Following an extensive literature review on exchange rate volatility, an analysis of Uganda's exchange rate system, and consideration of data availability, an empirical model was specified to link the exchange rate to the predictor variables under investigation, thereby achieving the study's objectives.

To uncover the dynamic relationship between exchange rate and its determinants, the ARDL-ECM was employed, capitalizing on the cointegration among variables revealed by the cointegration test. The methodological approach commenced with an in-depth analysis of each variable's behavior, followed by an examination of the time series properties, including unit root tests, bound tests of cointegration, and overall model significance assessments. The results revealed a notable

degree of collinearity among variables, with most exhibiting integration of order one, whereas the exchange rate displayed integration of order two. Furthermore, the overall significance tests, comprising F-tests and adjusted R-squared values, provided compelling evidence that the explanatory variables collectively had a significant impact explaining about 52% of the variability, thereby confirming a well-fitting model.

These findings, therefore, depict that exchange rate is closely tied to fluctuation as a result of changes in the volume of foreign reserve in Uganda both in the long run and short. This means that an increase or decrease in volume of foreign reserve is associated with fluctuation in the exchange rate in Uganda. Meanwhile external debt and debt service has an insignificant impact on exchange rate fluctuation in Uganda for the period of study this means that public debt and debt service on external debt has no potential impact on exchange rate volatility in Uganda for the period of investigation. To a greater extent, the previous lags of exchange rate impact exchange rate volatility this is more of the speculative forces driven by market force of demand and supply of the domestic and foreign currency.

5. 2 Policy Recommendations.

The study's findings showed that foreign debt and debt servicing had no substantial influence on Uganda's exchange rate volatility since 1970 to 2023. However, the recent increase in public debt has sparked worries among the public about its possible impactions on macroeconomic indicators like exchange rate, economic growth, inflation among other variables in Uganda. Notably, the rising debt burden has revealed that every Ugandan is indebted to UGX 2.5 million Amos (2024). This worrying trend may force Uganda into debt difficulties, potentially raising the cost of living as the government resorts to taxing to service the debt, putting strain on the economy.

To unlock Uganda's growth potential and close the revenue gap, the government should take a more cautious borrowing approach, prioritizing investments in high-yielding projects that stimulate economic growth, such as infrastructure development, agriculture, and manufacturing, which can generate additional revenue streams to repay debts. This necessitates putting in place a thorough project evaluation process, strengthening public-private collaborations, and improving debt management capacities. Furthermore, to reduce the danger of short-term insolvency, more emphasis should be placed on concessional borrowing alternatives, reasonable loan terms,

diversification of funding sources, and the creation of a strong foreign exchange reserve buffer to mitigate macroeconomic instability.

Foreign reserves, on the other hand, have demonstrated an important influence in influencing exchange rate variations in both the short and long term. As a result, authorities should emphasize maintaining a stable level of foreign reserves in order to mitigate the economic impact of currency fluctuation. This can be accomplished by the implementation of policies that encourage foreign exchange inflows, such as export promotion. Uganda's extremely productive agricultural area holds the key to feeding a large population of 200 million people with nutritious food while also providing fresh water for fishing in East Africa and across Africa. Notably, the Food and Agriculture Organization (2023) reports that 45% of arable land remains uncultivated. However, the government should prioritize agricultural output, value addition, and exports. Given the relative advantage in arable land. For example, with coffee being Uganda's largest export, maize may add additional value to boost its competitiveness in the global market. More importantly, the oil experts are compelled to boast the country's foreign reserves. Furthermore, promoting foreign direct investment and maintaining a stable macroeconomic environment are critical to reducing Uganda's exchange rate volatility.

To summarize, in the long run, policymakers should prioritize the development of a strong foreign reserve buffer to protect the economy against exchange rate fluctuations. This is achievable through the implementation of structural changes that encourage economic diversification, enhance trade balances, and minimize reliance on foreign debt. Furthermore, investing in home companies with export potential can boost foreign exchange profits while relieving strain on foreign reserves. Uganda can lessen its exposure to exchange rate volatility, promote economic stability and growth, and secure a more sustainable economic future by implementing these policies.

5.3 Limitation of the Study

This analysis admits a large gap in data consistency across Ugandan sources, including the Bank of Uganda, the Ministry of Finance and Economic Planning, and international organizations such as the IMF and the World Bank. To address this issue, the research used only World Bank data for analysis, ensuring consistency and trustworthiness. However, this method may not fully reflect the

complexities of Uganda's economic situation, as domestic sources may provide more precise information. Future research should aim to reconcile these disparities and investigate strategies to combine multiple data sources, thereby improving the accuracy and comprehensiveness of economic analysis in Uganda.

Another notable disadvantage of this study is the limited scope of real effective exchange rate estimation, which relied entirely on the US dollar as the reference currency. This strategy ignores exchange rate changes with other important trading partners, notably emerging nations, which make for a sizable share of Uganda's trade activity (89%). The lack of data for these countries hampered the investigation, perhaps obscuring crucial exchange rate implications. Future research should try to encompass a more comprehensive range of trading partners to provide a more accurate portrayal of Uganda's exchange rate landscape.

A further drawback of this study is that it only examines the relationship between exchange rate volatility and external public debt, ignoring the potential impact of domestic debt on exchange rate changes. Notably, Uganda has recently turned its focus to domestic public borrowing, which might have a considerable impact on exchange rate volatility. The exclusion of domestic debt from this approach may leave out a critical component impacting exchange rate movements, potentially leading to an insufficient understanding of the underlying relationships. Future research could investigate including domestic debt in the analysis to acquire a better understanding of the complex factors impacting Ugandan exchange rate swings.

5.4 Suggestions for areas further research

Prior to this study's findings, future research should focus on the effects of public debt on exchange rate volatility using the real exchange rate, which may provide a more realistic depiction of competitiveness and terms of trade between countries. A quarterly investigation of the effects of public debt on exchange rate volatility would also provide useful insights into the short-term dynamics of the exchange rate-public debt relationship. Incorporating other debt sustainability metrics as regressors, such as the external debt-to-exports ratio, debt service-to-exports ratio, and governmental debt-to-GDP ratio, would also provide a broader understanding of the variables affecting exchange rate volatility. Investigating the non-linear influence of governmental debt on exchange rate volatility and examining the role of institutional economic indicators, such as

monetary policy frameworks and fiscal governance, would also be valuable extensions of this research. Future research on these topics can offer additional light on Uganda's complicated exchange rate volatility, ultimately informing policy decisions that support economic stability and prosperity.

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APPENDICES

Appendix 1: series in dollars from 1970nto 2023

year	EDT	DSEDT	FR	ER (UGX)	ER
1970	151676389	9039288.9	56650000	0.07143	13.99972
1971	172358506	9496535.8	26922886.93	0.07143	13.99972
1972	177715261	9517049.9	35952613.88	0.07143	13.99972
1973	175538182	24524860.9	29113281.88	0.07014	14.25659
1974	202067895	13951504	16758479.85	0.07021	14.24207
1975	209213939	16677183.6	31022694.39	0.07136	14.01355
1976	243891749	20414116.4	44534030.05	0.07422	13.47359
1977	300756081	16025295.4	47205471.07	0.08266	12.09751
1978	426836504	22260349	52700057.35	0.08259	12.10800
1979	588284931	27422149.6	22839243.34	0.07736	12.92713
1980	690503151	57385845.9	3000000	0.07483	13.36392
1981	707175105	68312117.1	30003003.01	0.07417	13.48254
1982	874408803	63194083.8	78324323.54	0.50052	1.99791
1983	1009041290	86049747.5	106496136.7	0.94047	1.06330
1984	1074247779	128659523.6	67907171.22	1.53862	0.64993
1985	1238566867	155204150.9	27288400.7	3.59702	0.27801
1986	1422906332	171614275	29205652.39	6.72020	0.14881
1987	1935609125	159895955.6	54600000	14.00000	0.07143
1988	1940761841	201546173.6	49300000	42.84127	0.02334
1989	2196167748	187810127.1	14100000	106.13583	0.00942
1990	2605823364	144658327	43986075.03	223.09161	0.00448
1991	2803285021	147232340.5	58913407.43	428.85467	0.00233
1992	2951348323	113228781.5	94420033.83	734.00992	0.00136
1993	3052849509	138033224.5	146356315.9	1133.83433	0.00088
1994	3397572159	148739837.6	321367624.5	1195.01675	0.00084

1995	3608776798	135286342.2	458850278.6	968.91667	0.00103
1996	3710237065	148114789	528370205.3	1046.08475	0.00096
1997	3907829290	160916270.5	633473685.8	1083.00867	0.00092
1998	3941902487	153312447	725384316	1240.30583	0.00081
1999	3537939247	132373223.3	763115699.8	1454.82717	0.00069
2000	3535147375	75655758.9	808042388.8	1644.47533	0.00061
2001	3768195791	50948574.8	983357419	1755.65875	0.00057
2002	4019812753	71247923.4	934009575.9	1797.55050	0.00056
2003	4577712718	90865322.4	1080256630	1963.72008	0.00051
2004	4789438348	103413639.4	1308101595	1810.30471	0.00055
2005	4460499217	171761252.5	1344201157	1780.54026	0.00056
2006	1300697180	99854589.4	1810879486	1831.45185	0.00055
2007	1653066727	66620884.9	2559789964	1723.49159	0.00058
2008	2292861399	74201276.7	2300539405	1720.44388	0.00058
2009	2763176528	71828186.1	2994459465	2030.48807	0.00049
2010	2974602245	63490401.6	2706005010	2177.55751	0.00046
2011	3262582094	63627429	2617450463	2522.80203	0.00040
2012	3776131388	68204397.2	3167158060	2504.56308	0.00040
2013	8559917108	87342189.3	3337539363	2586.88957	0.00039
2014	8651413818	206376623.3	3316363815	2599.78820	0.00038
2015	9570705818	94794213.8	2908876773	3240.64542	0.00031
2016	10086179673	844447261.9	3097848070	3420.09801	0.00029
2017	11672672164	187852374.5	3720863721	3611.22446	0.00028
2018	12315104976	529039203.1	3358514650	3727.06899	0.00027
2019	13971124696	299858749.6	3433819444	3704.04907	0.00027
2020	17207223253	692525367.8	3637819444	3718.24892	0.00027
2021	19217000098	751596373.8	3953819444	3587.05171	0.00028
2022	19488352675	1928561409	4431819444	3689.81739	0.00027
2023	20700000000	2031000000	4074000000	3726.10000	0.00027

Appendix3a Descriptive Statistics

```
. summarize EDT DSEDT FR ER
```

Variable	Obs	Mean	Std. Dev.	Min	Max
EDT	54	4.52e+09	5.30e+09	1.52e+08	2.07e+10
DSEDT	54	2.15e+08	3.90e+08	9039289	2.03e+09
FR	54	1.27e+09	1.46e+09	3000000	4.43e+09
ER	54	3.078345	5.640743	.0002683	14.25659

```
. summarize EDT DSEDT FR ER, detail
```

Appendix3b Descriptive Statistics

EDT

	Percentiles	Smallest		
1%	1.52e+08	1.52e+08		
5%	1.76e+08	1.72e+08		
10%	2.09e+08	1.76e+08	Obs	54
25%	1.01e+09	1.78e+08	Sum of Wgt.	54
50%	2.96e+09		Mean	4.52e+09
		Largest	Std. Dev.	5.30e+09
75%	4.46e+09	1.72e+10		
90%	1.23e+10	1.92e+10	Variance	2.81e+19
95%	1.92e+10	1.95e+10	Skewness	1.752625
99%	2.07e+10	2.07e+10	Kurtosis	5.177281

DSEDT

	Percentiles	Smallest		
1%	9039289	9039289		
5%	9517050	9496536		
10%	1.67e+07	9517050	Obs	54
25%	6.35e+07	1.40e+07	Sum of Wgt.	54
50%	1.02e+08		Mean	2.15e+08
		Largest	Std. Dev.	3.90e+08
75%	1.61e+08	7.52e+08		
90%	5.29e+08	8.44e+08	Variance	1.52e+17
95%	8.44e+08	1.93e+09	Skewness	3.66362
99%	2.03e+09	2.03e+09	Kurtosis	16.43139

FR

	Percentiles	Smallest		
1%	3000000	3000000		
5%	1.68e+07	1.41e+07		
10%	2.73e+07	1.68e+07	Obs	54
25%	4.72e+07	2.28e+07	Sum of Wgt.	54
50%	5.81e+08		Mean	1.27e+09
		Largest	Std. Dev.	1.46e+09
75%	2.71e+09	3.72e+09		
90%	3.43e+09	3.95e+09	Variance	2.13e+18
95%	3.95e+09	4.07e+09	Skewness	.7533879
99%	4.43e+09	4.43e+09	Kurtosis	1.970158

ER

	Percentiles	Smallest		
1%	.0002683	.0002683		
5%	.0002689	.0002684		
10%	.0002769	.0002689	Obs	54
25%	.0004592	.00027	Sum of Wgt.	54
50%	.0008594		Mean	3.078345
		Largest	Std. Dev.	5.640743
75%	1.063302	13.99972		
90%	13.99972	14.01355	Variance	31.81798
95%	14.01355	14.24207	Skewness	1.339163
99%	14.25659	14.25659	Kurtosis	2.827077

Appendix 5: ARDL model short run.

```
. ardl DlnER lnEDT lnDSEDT lnFR, max(2)aic

ARDL(1,0,1,2) regression

Sample:       1973 -       2023                 Number of obs     =         51
                                                  F(   7,     43)  =       8.97
                                                  Prob > F          =     0.0000
                                                  R-squared         =     0.5934
                                                  Adj R-squared     =     0.5272
Log likelihood = -.26943715                       Root MSE          =     0.2649

------------------------------------------------------------------------------
       DlnER |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
       DlnER |
         L1. |   .2713835   .1190887     2.28   0.028     .0312182    .5115488
             |
       lnEDT |   .0519432   .0958928     0.54   0.591     -.141443    .2453294
             |
     lnDSEDT |
         --. |  -.0173624   .0803802    -0.22   0.830    -.1794645    .1447398
         L1. |   .1097169   .0805488     1.36   0.180    -.0527252    .2721589
             |
        lnFR |
         --. |  -.0174589   .0672045    -0.26   0.796    -.1529897    .1180718
         L1. |    .161579   .0879442     1.84   0.073    -.0157774    .3389354
         L2. |  -.2685147   .0658262    -4.08   0.000    -.4012659   -.1357634
             |
       _cons |  -.2549514   .7225652    -0.35   0.726    -1.712143     1.20224
------------------------------------------------------------------------------
```