Addis Ababa University
School of Graduate Studies

The effect of exchange rate, interest rate, & inflation on economic growth: evidence from the Ethiopian economy

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Addis Ababa, Ethiopia

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A thesis submitted to the Department of Economics in Partial fulfillment of the requirements for the Degree of Master Science in Financial Economics.

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DECLARATION

Candidate's Declaration

I hereby declare that this dissertation is the result of my own original research and that no part of it has been presented for another degree in this university or elsewhere.

Candidate's Signature……..Date……

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This is to certify that the thesis prepared by **Kiros Seyoum Abreham**, entitled: **The effect of exchange rate, interest rate, & inflation on economic growth: evidence from the Ethiopian economy (1982 - 2021)** and submitted in partial fulfillment of the requirements for the Degree of Master of Science in Economics (Financial Economics) complies with the regulations of the University and meets the accepted standards with respect to originality and quality.

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Abstract

The research investigated the effect of exchange rate, lending interest rate, and inflation on the economic growth of Ethiopia, using data from 1982 to 2021. The independent variables included exchange rate, lending interest rate, inflation rate, government expenditure, gross capital formation, and foreign direct investment, with economic growth functioning as the dependent variable. Integration levels in the time series were determined through the Philips-Perron (PP) and Augmented Dickey-Fuller (ADF) unit root tests. The Autoregressive Distributed Lag (ARDL) and its Error Correction Model (ECM) were applied to discern long run and short-run relationships. The study identified both long run and short-run relationships within the assessed model. It revealed that over time, the exchange rate has a considerably positive influence on economic growth. In contrast, to initial years in the short run, the exchange rate exhibits a negative and significant effect at both lag 1 and lag 2. Regarding inflation, its effect on economic growth is not significant in the long run. However, in the short run, it has a significant and negative effect, particularly with a one-period time delay (lag1). Lastly, lending interest rates have a negative and significant effect on economic growth in both the short and long run. In addition, the research investigated whether there is a statistically significant threshold level of inflation that influences growth in Ethiopia differently, based on whether it falls below or above this level. The study used time series data from 1982 to 2021 and the Ordinary Least Squares (OLS) technique to analyze this. The findings confirmed a maximum threshold of 7 percent for a positive relationship between the two variables. However, when inflation rates exceed 7 percent, the relationship turns negative. The research findings indicate that for promoting economic growth in Ethiopia, it is essential for the Ministry of Finance (MOF) and National Bank of Ethiopia (NBE) the to adopt policy suggestions such as ensuring a stable exchange rate, controlling lending interest rates, and targeting inflation rates below 7%. It is advised that monetary and fiscal policy creators pay attention to the insights offered, which would assist them in formulating efficient strategies to manage these microeconomic indicators effectively, ultimately contributing to the country's economic growth. By adopting a coordinated strategy that integrates these policies, Ethiopia can attain sustainable growth. To ensure the effectiveness of these measures, continual evaluation and adjustments are essential.

KEY WORDS

Autoregressive distributed lag

Economic Growth

Error correction term

Exchange Rate

Inflation

Lending Interest Rate

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LIST OF ACRONYMS/ABBREVIATIONS

2SLS	Two Stage Least Squares
AD	Aggregate Demand
AS	Aggregate Supply
AIC	Akaike information criterion
APR	Annual Percentage Rate
ADF	Augmented Dickey-Fuller
ARCH	Autoregressive Conditional Heteroskedasticity
ARDL	Autoregressive distributive lag
CUMSUMSQ	Cumulative Sum Squares Stability Test
CUSUM	Cumulative Sum Test
CPI	Consumer price index
BKW	Belsley, Kuh and Welsch
DOLS	Dynamic Ordinary Least Square
DPAs	Social Overhead Capital
ETB	Ethiopian Birr
ECT	Error Correction Term
FDI	Foreign Direct Investment
FX	Foreign Exchange
GCF	Gross Capital Formation
GGCF	Growth of Gross Capital Formation
GE	Government Expenditure
GM2	Growth of Money Supply

GDP	Gross Domestic Product
GLS	Generalized Least Square
IJBGM	International Journal of Business and General Management
IMF	International Monetary Fund
INF	Inflation
MOF	Ministry of Finance
NBE	National Bank of Ethiopia
LCU	Constant Local Currency Unit
LM	Liquidity Money
LIR	Lending Interest Rate
OLS	Ordinary least square
OPEN	Trade Openness
PP	Phillips-Perron tests
PPP	Purchasing Power Parity
RGDP	Real Gross Domestic Product
REER	Real effective exchange rate
RLS	Robust Least Square
SBC	Schwarz Bayesian Criterion
SOCs	Directly productive activities
UNCTAD	United Nations Conference on Trade and Development
VAR	Vector autoregressive
VECM	Vector Error Correction Model
WB	The World Ban

Chapter One

1 Introduction

1.1 Background of the study

The increase in a country's Gross Domestic Product (GDP) serves as a crucial measure of its development (Mendoza, 1995). To achieve higher growth rates, both developed and advancing countries are modifying the policies they have implemented. Global growth performance is consistently improving over time. However, various debates offer substantial theories regarding the trend shift and identification of macro and micro variables that influence economic growth. Fischer (1993) asserts that the primary factors that can destabilize an economy are exchange rates, inflation rates, and interest rates. This is due to the high volatility of these variables, which, if left uncontrolled, can result in economic instability.

It is widely agreed upon that the three essential macroeconomic foundations for a country's economy are exchange rate, interest rates, and inflation (Savaş Kaptan, 2019). Collectively, they serve as the macroeconomic indicators at the center of the economy, sending messages about the macroeconomic well-being of the system. They are the primary macroeconomic policy variables of an economy, even in concrete terms, and they performance a significant part in determining and affecting the real and nominal economies. Hence, a diverse range of societal interests - including policymakers, academic economists, investors, businesses, and households - consistently focus on the possible presence of a long-run relationship between them (Şen, H., Kaya, A., Kaptan, S., & Cömert, M. (2019)).

This appeal has gotten more complex in today's globally interconnected world. The alterations in the macroeconomic policy environment adopted by nations with global integration as a result of globalization may be the tenable justification for this. Understanding their connection serves as a foundation for creating effective macroeconomic policy management. In recent decades, several nations have implemented a variety of macroeconomic policies, including exchange rate, monetary, and fiscal, policies, that are in line with their economic goals (Savaş Kaptan, 2019).

Ethiopia, a developing country with a population of 117 million (2021) according to the World Bank (WB, 2022), is working to increase its growth rate through policies that target GDP growth, economic stability, poverty reduction, and reduced inequality. Despite setbacks in the 1990s, since the late 1980s, Ethiopia has witnessed favorable trends in GDP growth, with an average growth rate of 5.1% in the 1980s, -1.4% in the 1990s, -3.3% in 1995, 9.84% from 2000-2010, and 7.13% from 2011-2013(National

Bank of Ethiopia, 2020/2021). As the fastest-growing economy in Africa, Ethiopia achieved a growth rate of 6.3% in FY2020/21. However, it continues to be among the most impoverished countries in the area, having a per capita gross national income of $960. To achieve lower-middle-income status by 2025, Ethiopia must enhance its macroeconomic framework to maintain growth rates, create jobs, reduce poverty, and address inequalities.

In Ethiopia, macroeconomic instability is influenced by factors such as exchange rate volatility, inflationary pressures, and elevated interest rates, which may result in an uncertain business landscape, diminished investment, and decreased economic expansion. Variability in exchange rates can generate an unpredictable business climate, effecting trade, investment, and resource distribution while also affecting external sector stability and inciting inflation. Persistent elevated inflation in Ethiopia undermines purchasing power, disrupts macroeconomic fundamentals, and fosters uncertainty, with both demand and supply factors contributing to this issue. Additionally, high-interest rates in the country contribute to instability by raising borrowing costs, discouraging investment and consumption, and potentially prompting capital flight and hindered economic growth. The connection between exchange rate, interest rate, and inflation and their influence on Ethiopia's GDP underscores the significance of tackling these elements in sustaining a stable macroeconomic climate.

The current study is motivated by several factors, including the importance of exchange rate, interest rates, and inflation as dynamic macroeconomic variables in a booming economy. Ethiopia has been successful in attracting foreign direct investment (FDI), as evidenced by the World Bank Report indicating its leading position in East Africa. However, there is still vast potential for FDI, and no existing study explores the relationships between these four main variables in Ethiopia between 1982-1921. Additionally, the country's exposure to international economic and political changes can effect these variables, partially due to its economic and political structure and integration with the global economy. Lastly, Ethiopia has implemented various policy arrangements to boost economic growth, such as attracting FDI through exchange rate devaluation. The IMF (2022) highlights that Ethiopia's progress in foreign exchange (FX) reforms and modernizing monetary policy should help address FX shortages and reduce inflation.

Therefore, the major aim of this paper is to examine the effects, and contributions of the real effective exchange rate, lending interest rate, and inflation to the economy during the period of 1982-2021.

1.2 Statement of the problem

Ethiopia's monetary and fiscal policies seek to maintain high rates of GDP growth while reducing inflation by promoting price stability. Ethiopia sets a single-digit inflation target each year. Most emerging and middle-income nations have used this monetary policy instrument extensively (NBE, 2021/22).

The National Bank of Ethiopia (NBE, 2009) employs a number of monetary policy measures to promote stable economic growth and low inflation. These actions include establishing minimum interest rates on deposits, establishing reserve requirements for different deposit classes, adjusting commercial bank reserves through open market operations, policing the financial operations of commercial banks, establishing minimum capital requirements, intervening in foreign exchange markets, and determining the required reserve percentage of all deposits held by commercial banks.

Although the aim of these policies is to boost economic growth, their effect on the Ethiopian economy remains ambiguous and doubtful due to increasing prices. While most policies appear to be well intentioned and promising in text, they rarely have the desired effect. These policy failures can be attributed to various factors, such as cultural and traditional inconsistencies, political motives that take precedence over the interests of the populace, a lack of adequate public input, and corruption (Acemoglu & Robinson, 2012; North, Wallis & Weingast, 2009; Williamson, 2000; Bardhan, 1997; Najam, 2000).

Government expenditure has been found to effect inflation through its effect on the money supply, according to various studies. To successfully reduce inflation, experts recommend tactics such as channeling public funds into productive endeavors like DPAs and SOCs, managing the money supply, creating a suitable mix of fiscal and monetary policies, and maintaining a balance between capital and ongoing expenditures (Teshome & Shuremo, 2018).

Recently, inflationary pressures have been influenced by global economic changes, including rising food and non-food prices. High food prices are due to factors like inadequate agricultural productivity, climate change, pests, diseases, and insufficient infrastructure and technology. Non-food prices, on the other hand, have been effected by the increased costs of imported goods, currency devaluation, and supply chain interruptions triggered by factors like the COVID-19 pandemic, political instability, and conflict (IMF & WB, 2021). Furthermore, it is believed that the government's significant capital expenditure project may have a substantial inflationary effect on the economy.

According to Graham, Leary, and Roberts (2015) contend that key measures like exchange rates, interest rates, and inflation rates are interrelated, causing attempts to address a single factor to potentially escalate fluctuations in the others. Ethiopia is presently facing a comparable economic instability, which has led the government to seek financial aid from the International Monetary Fund (IMF).

Many research projects have examined the real effective exchange rate for Ethiopia. Several studies investigated factors influencing the exchange rate, effect on exports, trade balance, and economic growth. However, there is a limited number of studies that explore the joint effect of exchange rate, interest rate, and inflation on economic growth. Additionally, various factors such as inflation, trade balance, foreign direct investment, interest rates, government debt, economic growth, political stability, and global economic aspects significantly influence Ethiopia's exchange rate. Proper exchange rate management is essential for enhancing export competitiveness and economic growth. Depreciation of the Ethiopian birr has a positive effect on the trade balance, and addressing exchange rate volatility is crucial for economic growth and trade performance. Effective macroeconomic management and export base diversification are necessary for a stable exchange rate, promoting economic growth, trade balance, and stability in Ethiopia (Bekele, 2011; Desalegn, 2013; Rao and Tolcha, 2016; Tesema, 2016; Nigussie, 2016; Almaw, 2020).

The relationship between lending interest rates and economic growth has been the subject of recent research, with conflicting outcomes. Studies conducted by Mekonnen (2018) and Desta (2018) emphasize that this relationship is influenced by multiple factors, including context, data period, and evaluation variables. In the case of Ethiopia, Hailegebriel's (2014) findings reveal a significant and negative association between real interest rates and short-run economic growth. This suggests that high interest rates discourage investment and impede economic expansion.

The relationship between inflation and economic growth is an important subject in the field of macroeconomics. It is widely accepted that maintaining low and stable inflation has a positive effect on economic expansion (Bruno and Easterly 1996). On the other hand, high and unpredictable inflation tends to have a negative effect (Smal 1998). To promote accelerated economic growth, economists and policymakers strive to keep inflation rates low and consistent. However, due to various global, regional, and national economic circumstances, the exact connection between inflation and economic growth remains unclear. Uncertainty in inflation levels creates doubts about future prices, influencing crucial economic decisions such as investment, borrowing, and purchasing. Additionally, inflation can lead to

income redistribution, effecting lenders, borrowers, fixed-income earners, and the government. High inflation rates also affect the welfare of lenders and borrowers, as nominal interest rates are dependent on expected inflation levels (Smal 1998).

Recent research utilizing Autoregressive Distributive Lag (ARDL) models found no short-run relationship between inflation and long-run economic growth. Previous studies, including the work of Segni Tesema (2020), have also failed to uncover any co-integration or long-run link between inflation and economic growth. In Ethiopia, some studies, such as Tessema & Chude (2021), have examined this relationship but often did not consider the effect of exchange rates and interest rates on GDP growth. To address this research gap, Feyisa and Feyera (2020) conducted a comprehensive study using annual data from 1980 to 2013, including the exchange rate as an independent variable, to gain a deeper understanding of the factors driving Ethiopia's economic growth.

In conclusion, this research seeks to address the knowledge gap in five areas. Firstly, the discrepancies in the opinions (resulting in inconsistent outcomes) regarding the relationship between exchange rate, lending interest rate, inflation rate, and economic growth, not only in worldwide literature but it's also in Ethiopia, have inspired this paper and added to the understanding in this field. Secondly, it involves incorporating and excluding variables in both the IS-LM (GDP) and growth models, taking into account the Ethiopian economy's features. Thirdly, the method employed in this research comprises both single equation and ARDL approach for long-run relationships and short-run dynamics, along with the OLS to determine the inflation threshold level. The ARDL method is a unique econometric technique used for analyzing relationships in time series data, focusing on both long run and short-run dynamics. It sets itself apart from other methods like Vector Auto regression (VAR) and Vector Error Correction Model (VECM) by offering simultaneous modeling of long-run and short-run effects, incorporating mixed orders (I(0) & I(1)), providing error correction for stability, and allowing bound testing for co-integration without needing the same order of integration. Additionally, the ARDL method performs exceptionally well with small sample sizes. As a result, it offers a versatile and powerful tool for estimating relationships in time series data. Fourth, researching the inflation threshold model in Ethiopia is crucial for identifying the causes of inflation, guiding monetary and fiscal policy-making, promoting economic growth, and protecting social welfare. Fifth, as far as the researcher is aware, there has been no particular study carried out on this topic before.

1.3 Objectives of the study

The objective of this research is to investigate the effect of exchange rate, lending interest rate, and inflation on Ethiopia's economic growth through the application of the ARDL method. In addition, the study endeavors to establish the optimal inflation rate for the country.

1.3.1 Specific objectives

i. Examine the effect of the real effective exchange rate on economic growth in Ethiopia.
ii. Examine the effect of the lending interest rate on Ethiopia's economic growth.
iii. Examine the effect of the inflation rate on Ethiopia's economic growth.
iv. Examining the short-run and long run effects of real effective exchange rate, lending interest rate, and inflation on Ethiopia's economic growth using the ARDL approach.
v. To determine a threshold level of inflation in Ethiopia

1.4 Research questions

This research aims to investigate the effect of fundamental economic elements, including real effective exchange rate, lending interest rate, and inflation, on the real economic growth of Ethiopia by addressing the following questions:

i. What is the effect of the real effective exchange rate on the rate of economic growth in Ethiopia?
ii. Is there a significant connection between the lending interest rate and the economic growth rate in Ethiopia?
iii. Does the inflation rate have a significant effect on the economic growth rate of Ethiopia?
iv. What is the inflation threshold level for the Ethiopian economy?

1.5 Significance of the study

The significance of the current research stems from the importance of economic growth, in addition to the identification of economic factors influencing this growth. Furthermore, the present study holds significance due to its focus on an under-explored area seldom addressed in many studies related to the effect of real effective exchange rates, lending interest rates, and inflation on Ethiopia's economic growth.

This study examines the effect of real effective exchange rates, lending interest rates, and inflation on Ethiopia's economic growth. The findings will be beneficial for those interested in this topic and enhance

academic knowledge. Furthermore, it fills a gap in understanding the influence of these elements on Ethiopia and other emerging countries. The results may also guide policymakers in creating monetary policy strategies. To sum up, the research delves into the complex connection between exchange rates, interest rates, inflation, and economic development.

This work, though significantly varied, can be categorized into four primary approaches.

i. The effect of the real effective exchange rate, lending interest rate, and inflation on Ethiopia's economic growth are integrated in this analysis.
ii. Estimating the inflation threshold level in Ethiopia.
iii. Two economic models are employed: the IS-LM model for output GDP and the growth model.
iv. The work examined documents from 1982 to 2021.

1.6 Limitation

The study employed both a single equation and ARDL approach to analyze long-run relationships and short-run dynamics. Additionally, OLS was utilized to estimate the inflation threshold. To validate the ARDL results and strengthen their reliability, the research employed DOLS and RLS methods, which further supported the findings for real effective exchange rate, inflation, and lending interest rate, ensuring that the model estimation was not random. However, the study did not conduct a sensitivity analysis to assess the robustness of the OLS estimation of the inflation threshold.

The final household consumption was excluded from the gross domestic product model one due to two reasons. Firstly, there was an issue of multicollinearity with other control variables. Additionally, final household consumption was not stationary at level and first difference, but only became stationary after the second difference. Unfortunately, the ARDL (Autoregressive Distributed Lag) method does not allow for the inclusion of variables that are only stationary after the second difference.

The study performed multiple tests, such as unit root, multicollinearity, autocorrelation, heteroskedasticity, autoregressive conditional heteroscedasticity, normality, misspecification, and stability tests, to ensure the model's reliability and robustness. To analyze the data, the study utilized Eviews software and applied the ARDL co-integration test.

1.7 Organization of the study

The study is comprised of five chapters, beginning with the initial chapter, which covers the study's background, problem statement, justification, objectives, research questions, significance, limitation, and, organization. The structure of the remaining parts of the study is as follows: the second chapter offers a literature review of previous studies, encompassing both theoretical and empirical aspects; the third chapter examines the research methods utilized in the study, such as model definition, variable measurement, estimation techniques, data sources, and analytical tools; the fourth chapter showcases the findings and relevant discussions; finally, the fifth chapter provides a summary, conclusions, policies, and recommendations for future research.

Chapter Two

2 Literature review

The literature review section comprises three primary parts. The initial segment examines the current literature regarding economic growth, real effective exchange rate, lending interest rate, and inflation rate concepts. The subsequent segment explores the worldwide empirical research and its findings relating to the area of study. Lastly, the section focuses on investigations conducted to understand the connection between real effective exchange rate, lending interest rate, inflation, and economic growth within the context of Ethiopia, the study area.

2.1 The theoretical framework

Various theories seek to understand the connection between inflation, interest rates, and economic growth, including Milton Friedman's 1967 Monetarist Theory. This theory proposes that when the money supply grows faster than the economy, inflation results, harming economic growth. Central banks can influence inflation and growth by adjusting short-run interest rates (Bain and Howells, 2003). However, the effects of these policy changes are indirect and happen through various channels. Expansionary monetary policy leads to lower real interest rates and increased investment spending, raising aggregate demand and the price level. Therefore, there is a negative relationship between interest rates and economic growth, as well as interest rates and inflation.

Introduced by Adam Smith in 1776 and later developed by Ricardo in 1817, the classical economic theory asserts that economies always reach full employment due to the invisible hand, which allows adaptive prices, wages, and other input costs. According to this view, an increase in Aggregate Demand (AD) prompted by monetary policy changes does not effect output levels; instead, it causes inflation, signifying that inflation and output growth are unrelated.

Conversely, the Keynesian theory, presented by Keynes in 1936, posits a positive correlation between inflation and economic growth only in the short run. This theory is based on the Aggregate Demand (AD) and Aggregate Supply (AS) framework. In the short run, inflation and output are disconnected because of wage and price rigidity. However, in the long run, full employment renders inflation and output unrelated, while in the intermediate phase, the adaptability of prices and wages causes a positive relationship between inflation and output.

The value of a country's currency in international trade, known as the exchange rate, significantly effects

its financial competitiveness and economic stability. Countries across the globe experience currency fluctuations due to market forces or central bank interventions, adopting various exchange rate policies such as dirty float, floating, dirty managed, managed, fixed or pegged. These policies depend on the monetary authorities and economic objectives. Central banks have the autonomy to decide suitable foreign exchange rate regimes, alongside other monetary and financial policies. The effectiveness of an exchange rate policy hinges on the extent of currency misalignment, with overvaluation causing efficiency loss, increased inflation, and reduced GDP growth, while undervaluation does not benefit growth (Bhalla, 2008).

The standard Mundell-Fleming model (Mundell 1963; Fleming 1962), states that under flexible exchange rates, fiscal policy has no effect on output, but monetary policy is very effective in influencing output, assuming international capital markets are integrated. When there is an increase in money supply, the interest rate decreases, and leading domestic investors to seek higher returns by purchasing foreign bonds. This requires buying foreign currency, causing depreciation of the domestic currency and making domestic goods more competitive in international markets. This boosts demand for domestic goods, improving trade balance and domestic output, ultimately reducing unemployment. However, this puts pressure on the labor market, causing wages and price levels to rise, which reduces real money stock and brings the exchange rate back to its initial level. As a result, monetary expansion has a temporary effect on real effective exchange rates and an affirmative effect on real income or output. This analysis assumes immediate adjustment of output and employment, but actual devaluation may take time to increase domestic demand and output, affecting exchange rate adjustment.

2.1.1 Economic growth

Economic growth is a crucial component for the progression of nations, as it effects the economy, politics, and people's lives. It is essential for improving the living standards and well-being of individuals within a society. Economic growth can be described as a continuous rise in the average per capita income, which results in a higher quality of life over time. Achieving economic growth helps address various economic issues, such as high inflation rates and imbalances in payments (Abed Al-Qader, 2002).

2.1.2 Solow’s growth theory

The theoretical model of this study is based on the 1956 growth model developed by Solow, which is widely used in economic analysis due to its ability to incorporate various studies in macro, international

economics, and public finance. Solow's (1956) model suggests that under certain conditions, there is no conflict between natural and unwarranted growth rates, and the system can adapt to different labor force growth rates, ultimately leading to steady-state proportional growth. The model argues that economic growth is driven by the accumulation of labor and capital, and tax policies do not play a role in long-run growth. However, tax structure changes can effect GDP growth levels in the long run during transitional periods.

More recent endogenous growth models, such as Lucas (1988), propose that public policies and institutions can directly affect long-run economic growth rates. Overall, the neoclassical growth model serves as the basis for the study, with various factors influencing economic growth in different ways.

2.1.3 Mundell-Fleming model

The Mundell-Fleming model, also known as the IS-LM-BoP model, represents an economic theory that demonstrates the connection between interest rates, output, and exchange rates within an open economy. Economists Robert Mundell and Marcus Fleming, who independently examined the interaction between exchange rates, monetary policies, and fiscal policies in small open economies with perfect capital mobility, developed the Mundell-Fleming model in the early 1960s.

The Mundell-Fleming model demonstrates the connection among exchange rates, interest rates, and economic performance in an open economy. According to this model, a rising exchange rate, or currency depreciation, can positively influence an export-oriented economy if both import and export demand elasticities surpass one, meaning they are elastic. This is the rationale behind it:

A rise in exchange rate, or currency depreciation, leads to cheaper exports and costlier imports. When a nation's currency value decreases compared to others, its goods and services become more affordable for foreign buyers, increasing export demand. Simultaneously, domestic consumers face higher prices for imported goods, reducing import demand. The elasticity of import and export demand shows how much the quantities demanded are affected by price or exchange rate changes. When both elasticities exceed one, it indicates that there is a high level of sensitivity in the demand for exports and imports to these changes.

When both prerequisites are fulfilled, a devaluation in the exchange rate boosts exports and reduces imports, resulting in an improved trade balance (exports minus imports) and possibly promoting economic expansion. This can positively effect an economy reliant on exports by raising output,

employment, and income levels.

However, it is crucial to remember that the aforementioned assessment presumes that other elements, including interest rates and other countries' economic situations, remain unchanged. In actuality, various factors can effect a country's exchange rate and economic success, and policymakers must meticulously assess the pros and cons of diverse economic strategies.

2.1.4 The classical theory of interest

The Classic Interest Theory, otherwise referred to as the loanable funds theory, is an economic idea that describes the process of determining interest rates in a market economy. Classical economists like Adam Smith, David Ricardo, and John Stuart Mill initially developed this concept, which was later refined by the Swedish economist Knut Wicksell.

The concept relies on the premise that interest rates are dictated by the balance between the availability and need for loanable funds, which are funds accessible for borrowing. As per the Classical Theory, interest rates decrease when there is an abundance of loanable funds and increase when there is a high demand for these funds.

2.1.5 Gross domestic product

The gross domestic product (GDP) serves as a crucial indicator for evaluating a country's economic growth, as it reflects the total monetary value of all goods and services generated within a specific time frame, essentially representing the economy's size. The GDP effectively showcases a country's economic production, performance, and growth, and consequently has a significant influence on closely everyone in the economy. A substantial shift in gross domestic product (GDP), either positively or negatively, typically affects living standards (GDP per Capita) and the stock market. This correlation is reasonable, as a weak economy often leads to decreased corporate profits, subsequent in lower stock prices. Investors are particularly concerned about negative GDP growth, which economists use as one criterion to identify if an economy is experiencing a recession.

Gross domestic product (GDP) is a monetary measurement of the final goods and services, which are purchased by end-users within a country during a specific time frame (for instance, a three-month or one-year period). It encompasses all outputs produced within a country's borders, including market goods and services, as well as non-market services like defense and education provided by the government. In this study, Gross Domestic Product (Constant local currency unit (LCU)) from World

Development Indicators (WDI) was utilized as a proxy for the GDP used in the research. The data consisted of yearly variables, and a log transformation was applied to maintain normalizing data distribution, stabilizing variance, simplifying growth rates and percentage changes analysis, reducing outliers' effect, linearizing relationships, and improving model fit and performance.

2.1.6 The exchange rate

The exchange rate represents the value of a country's currency in relation to another country's currency. In Ethiopia, they use a managed floating exchange rate system, where market forces determine the rate, but government intervention occurs when necessary. To measure the exchange rate, Ethiopia utilizes a multilateral rate, which weighs the birr against the currencies of major trading partners. This method is used because the birr's value be able to appreciate against one currency, like the US dollar, while depreciating against another, such as the euro, due to varying trade terms and foreign policies.

The exchange rate plays a crucial role in this study as it determines a country's trading level with other nations, and its relationship with economic growth is direct. A higher exchange rate results in the local currency's depreciation, which boosts exports and increases the current account balance (X-M) while keeping imports constant. Under a fixed exchange rate system, imports, similar to savings and taxes, reduce the multiplier value as they act as income leakages, whereas exports, like investments and government spending, increase domestic aggregate demand, leading to output expansion through a multiplier process.

2.1.7 Interest rate

An interest rate is the percentage at which a borrower pays for using a lender's money, often confused with the rate of return on savings investments. Influenced by macroeconomic factors, interest rates are monetary policy tools in economics, used by central banks to adjust nominal rates in response to changes in factors like inflation and output. In 1993, Taylor suggested implementing a high interest rate or "tight" monetary policy when inflation exceeds its target or when output surpasses the full employment level, with the aim of alleviating inflationary pressure. The monetary policy rate, sometimes called the real interest rate, is recommended to be high when there is high inflation or output to ease pressure, and low in the opposite scenario to stimulate growth. This study uses the monetary policy rate from the National Bank of Ethiopia as a proxy for the real interest rate.

2.1.8 Inflation Rate

In the model, inflation serves as an explanatory variable to help understand shifts in economic growth rates. Defined as a lasting and significant rise in general prices, inflation effects various macroeconomic factors, including interest rates and balance of payment positions, which in turn affect economic growth. As prices increase, borrowing costs (interest rates) go up, leading to reduced investment levels due to the opposite link between investment and interest rates. This results in a decrease in economic output (GDP) and affects growth. However, when inflation is stable or low, it can contribute to significant economic growth and can be an indicator of growth. While high inflation rates can hinder an economy's growth, controlled or stabilizing inflation can create favorable conditions for growth. Therefore, it is crucial to consider inflation when examining its relationship with economic growth, with the expectation that its coefficient could be either positive or negative.

2.1.9 Government expenditure

General government spending can be represented as a percentage of GDP and on a per capita basis, highlighting the size of governments in different countries. This expenditure includes central, state, and local governments, as well as social security funds. The broad range in this metric highlights the distinct approaches countries use to provide public goods, services, and social protection, rather than solely reflecting differences in resource allocation. Government spending entails consumption, investment, and transfer payments, and in National Income Accounting, purchases of goods and services for immediate use to fulfill individual or collective needs are deemed government final consumption expenditure.

The research utilized overall government spending as an indicator of government expenditure, acquired from the National Bank of Ethiopia (NBE).

2.1.10 Gross capital formation

Investment, as a key macroeconomic factor, affects the Gross Domestic Product in both theoretical and empirical growth models. It involves capital assets like machinery, buildings, and vehicles used in production. Different indicators, including gross fixed capital formation (physical capital) and stock market, are used to analyze investments. In this study, gross fixed capital formation includes improvements in land, plant, machinery and equipment purchases, and infrastructure development like road construction.

2.1.11 Foreign direct investment

Foreign direct investment (FDI) pertains to the lasting involvement of a nation A in nation B, typically encompassing management participation, joint ventures, technology and skills transfers (Shim J.K. et al, 1995). FDI is a key driver of economic expansion, as it bolsters production capacity. It is widely recognized as a critical element in promoting economic growth and raising living standards in emerging economies. Additionally, the presence of international corporations has been linked to positive spillover effects, such as the enhancement of human capital and local institutions.

2.1.12 Money supply

The money supply (M2) is an assessment of the overall amount of money in an economy that encompasses M1 (cash and checking accounts) and near money, which are financial assets that can be readily transformed into cash with minimal or no reduction in value. Near money typically comprises savings accounts, money market mutual funds, and other deposit accounts like certificates of deposit (CDs) and various time deposits. Central banks and economists monitor M2 to gauge the economy's well-being and the success of monetary policy actions.

2.1.13 Trade openness

Trade openness refers to a country's level of participation in global trade through the import and export of goods and services. It is usually measured by comparing a country's total trade (imports and exports) to its GDP. A higher ratio indicates a more open trade approach, while a lower ratio suggests more protectionist or restrictive policies. Trade openness can effect a country's economic growth, productivity, and development, as economies with greater openness often experience increased growth and efficiency due to factors such as specialization, increased competition, and access to new markets and resources.

2.2 Theoretical model

Gross domestic product (GDP) measures the total value of all completed goods and services, specifically those bought by the final consumer, generated within a country during a specific period (e.g., a quarter or a year). It includes all production occurring within the nation's boundaries, encompassing products and services created for market sale as well as some non-market outputs, like government provided defense or educational services.

Gross domestic product (GDP) is calculated based on market values rather than quantities. While production is quantified, these amounts must be adjusted to reflect their worth. In the field of economics,

prices are utilized to assign values to final products, thus multiplying the total production by the price results in the overall value.

The calculation of a country's GDP is typically undertaken by its national statistical agency or the national bank of Ethiopia, utilizing data from numerous sources. In Ethiopia, the National Accounts unit within the Ministry of Planning and Development is responsible for determining GDP. Most countries adhere to established global guidelines when making these calculations. The System of National Accounts, created by organizations such as the International Monetary Fund, European Commission, OECD, United Nations, and World Bank, functions as the global benchmark for calculating GDP.

2.2.1 IS-LM model

2.2.1.1 Origin

In 1936, British economist John Hicks introduced the IS-LM model, a macroeconomic tool designed to determine a nation's equilibrium output (GDP). David Champernowne and W. Briam Reddaway further developed the model after an article in June 1936 and subsequent presentations at an Econometric Society session in Oxford. The IS-LM model aimed to simplify Keynes' aggregate demand analysis by breaking it down into smaller systems of simultaneous equations and serving as a framework for policy analysis and implementation. Hicks' SI-LL diagram, later renamed IS-LM curves by Alvin Hans in 1949, greatly influenced the way economics was taught. It is important to note that before writing his own work, Hicks had access to Harrod's paper on the equation system and Meade's paper on notation.

2.2.1.2 The model

The IS-LM model illustrates the relationship among two curves, which helps to visually understand a specific economy's overall output. The IS curve, an adaptation of the income-expenditure model, considers market interest rates (demand), whereas the LM curve indicates the money available for investment (supply). By doing so, the model offers an insight into investors' choices, taking into account available funds and anticipated returns on investments. Equilibrium is attained when the investment levels align with accessible investment funds. Although criticized, the IS-LM model continues to be widely used in macroeconomic education and policy analysis, particularly in developed economies and within the economics domain.

The IS-LM model illustrates the overall demand in an economy by analyzing the connection among output and interest rates. In a situation without government intervention, higher interest rates typically

lower aggregate demand, particularly for investments and durable goods. This reduction in demand leads to a decrease in output, eventually balancing the amount produced with the amount demanded. This state is when the planned investment equals saving and is known as the IS curve. Conversely, the money market shows that the demand for money increases with higher aggregate income and decreases with higher interest rates.

2.2.1.3 The IS curve

The IS curve depicts the various combinations of real income (Y) and interest rates (r) that lead to equilibrium in the goods or product market, provided that firms are willing to supply the demanded quantity. Essentially, the IS curve demonstrates the balance between income (Y) and interest rates (r) necessary for the demand and supply of goods within an economy to align. Express the following statement mathematically:

$$Yd\ (y, r) = Y \quad \ldots\ldots (2.1)$$

The Yd(y, r) on the left-hand side indicates income, while the Y, which represents the total consumption of goods and services in this context, is equivalent to the total supply in the economy on the right-hand side. This equation validates the fundamental national accounting principle that the market's supplied quantity must equal the income it generates. Consequently, we anticipate that the total demand (GDP) in the economy will be the sum of consumption demand, investment demand, government demand, and net foreign demand. Expressed in mathematical notation as:

$$GDP = Cd + Gd + Id + NXd \quad \ldots\ldots (2.2)$$

In summary, the terms Cd, Id, Gd, and Nxd represent consumption demand, investment demand, government demand, and net export, respectively. Net export is the difference between a country's export and import demand. If the import demand surpasses the export demand, the net export will be negative, and it will be positive in the opposite scenario.

2.2.1.4 The LM curve

In contrast, the LM curve displays various combinations of real income (Y) and interest rate (r) that ensure equilibrium in the money market, taking into account the economy's nominal money supply M and price level P. Thus, the LM curve includes all possible real income (Y) and interest rate (r) pairings required to maintain balance in the money market. This equilibrium occurs when the total money

demand aligns with the overall real money supply available in the market. Mathematically:

$Md\ (y, r) = \underline{M/}$P..... (2.3)

Where, Md symbolizes the total demand for money, whereas M/P refers the total supply of real money.

The construction of the LM curve assumes the real money supply is an external factor, causing a shift in the curve when it changes. Money demand is assumed directly related to income and inversely related to interest rates, resulting in an upward sloping LM curve. The IS-LM model depicts how the Gross Domestic Product (Y*) in an economy is determined at the point where the IS and LM curves intersect.

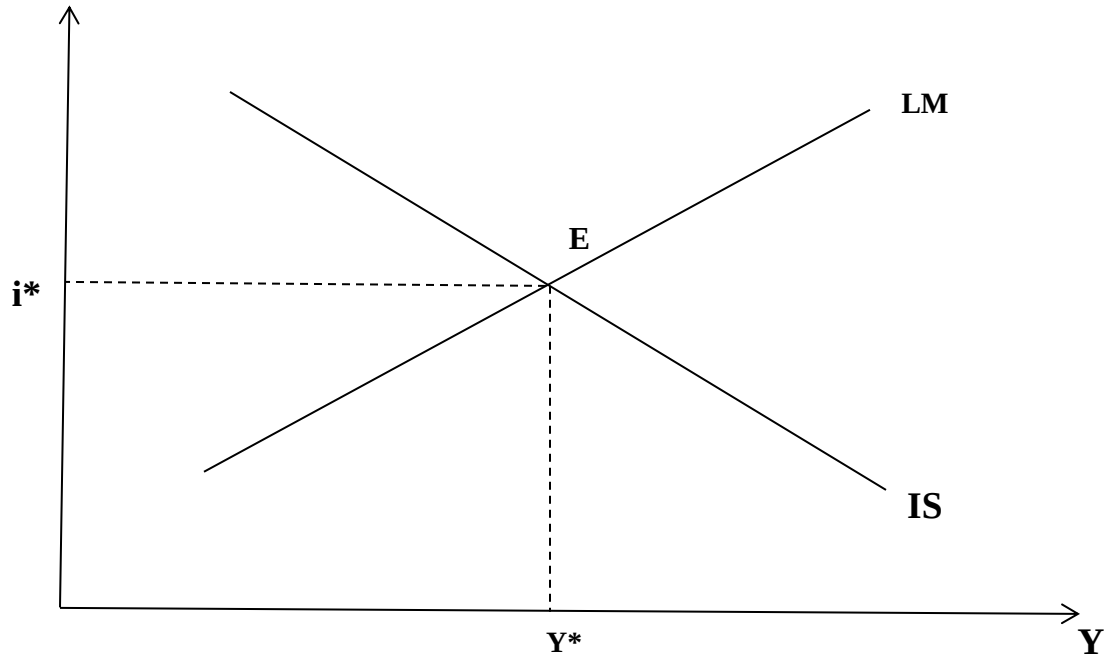


Figure 1: *IS-LM Curves*

The above diagram shows that the equilibrium output (GDP) is found at the intersection of IS-LM at point E. In his 2014 paper, "Critique of the IS-LM model: commercial enterprise deficits, Loanable funds, Keynesians Cross and IS-LM," Kim highlighted significant issues with the IS-LM model when dealing with commercial enterprise deficits, particularly in relation to the loanable funds model. While some critics have focused on the model's assumptions, Minseong Kim mainly concentrated on its essential modeling nature, asserting that the standard IS-LM analysis is in conflict with a simultaneously occurring equilibrium system.

2.3 Proximate growth theories

Numerous well-known proximate growth models, such as the Harrod-Domar Model, Solow-Swan Model, and Romer-Lucas Model, play a significant role in understanding economic expansion. Despite the absence of inflation in their frameworks, it is essential to analyze the elements that contribute to growth in these models.

2.3.1 The Harrod-Domar (Neo-keynesian) growth model

This model is a dynamic version of Keynes's theory that growth is driven by investment, with labor force and technology as external influences. Growth is achieved through increased investment, primarily fueled by local savings. As savings increase, so does investment and growth (Domar 1946). However, the model does not clearly show the relationship between growth and inflation. Domar emphasized that insufficient saving, capital accumulation, and investment lead to prolonged inflation and higher unemployment, indicating that these factors are closely related to investment levels (Domar 1947).

Similarly, Harrod argued that when an economy operates at full employment, inflation is expected to decrease. Inflation raises profit levels and encourages savings. He also asserted that inflation is a sign that the natural rate surpasses the normal growth rate and any attempts to combat inflation would be futile (Harrod 1938).

2.3.2 The Solow-Swan (Neo-classical) growth model

The Solow-Swan growth model uses a temporary production function incorporating labor and capital as key factors. If one factor remains constant while the other increases, output efficiency decreases. For example, with fixed labor, more capital results in diminishing returns on output (Solow 1956). In the Neo-classical growth model, technological advancements play a crucial role in enhancing the productivity of capital and labor, staving off diminishing returns and promoting economic growth (Solow 1956). This model suggests that technology alone can facilitate growth, differing from the Harod-Domar model that emphasizes high capital accumulation. In Solow's analysis, he assumes a stable overall price, with demand for money dependent on real output. However, he acknowledges that this assumption may be unrealistic (Solow 1956).

2.3.3 The Romer-Lucas (Endogenous) growth model

In contrast to the Solow-Swan growth model, the Romer-Lucas model suggests that the process of capital accumulation, rather than being determined externally drives technological change.

Accumulating capital goods, which produce consumer goods, enables workers to become proficient with advanced machinery, leading to technological progress (Lucas 1988). This learning process prevents the occurrence of diminishing returns on output by promoting capital deepening. As a result, capital accumulation continues to be a vital component for achieving economic growth (Romer 1994).

Proximate growth theories do not directly address the connection between inflation and growth. However, theories developed after the Great Depression, like Keynesian and Monetarist theories, have explored this relationship. Keynesians believe in a long-run positive link among inflation and growth, while Monetarists deny any long-run relationship, but admit a short-run positive correlation. New classical assert that anticipated inflation has no effect on growth, but unexpected inflation negatively effects economic growth. New Keynesians, based on the assumption of wage and price rigidities, argue that both anticipated and unanticipated inflation negatively affect a country's economic growth.

The statement highlights the variety of perspectives regarding the link between inflation and economic growth, as provided by different theories. It also points out that a deeper analysis of worldwide empirical research can contribute to a better understanding of this association.

2.4 Empirical Literature Review

Several global research projects have assessed the relationships between factors such as exchange rates, interest rates, inflation, economic growth, and their fluctuations in various countries, encompassing both developing and developed nations. These examinations have been executed at both individual and cross-country levels.

Various research studies have discovered evidence from different countries that supports the belief that long-run economic growth is negatively influenced by exchange rates, interest, and inflation. The cross-country analysis aims to demonstrate the connection among exchange rate, interest rate, inflation, and economic growth primarily in African nations and other specific countries.

Kang-Sock Lee and Richard A. Weruer (2018) investigated the common assumption that lower interest rates lead to higher growth, while higher rates result in lower growth. They argued that in a state of disequilibrium, interest rates should not be used as a policy variable. Instead, factors such as resource constraints should be considered, as this addresses the theoretical bias arising from the axiomatic-deductive method focused on equilibrium. Their findings showed that interest rates are consistently positively correlated with GDP growth, indicating that interest rates tend to follow economic growth.

In 2009, Nicholas carried out a research to investigate the relationship between interest rate liberalization and economic growth. The study analyzed how interest rate reforms affected economic growth over time. The empirical results from the research provided strong evidence for the positive effect of the liberalization of interest rates on financial development.

Arhin et al (2017) identified four main theories in the vast body of literature on interest rate management: classical theory, loanable funds theory, Keynesian theory, and modern theory. The loanable funds theory links interest rates to savings, hoarding, and bank money by considering demand and supply of loanable funds. Classical theory suggests that interest rates are decided by the loanable funds market, with economic fluctuations affected by the money supply, as supported by Meltzer's 1976 research. Keynesian theory sets interest rates based on short-run demand and supply of money and liquidity preference. Lastly, modern theory, or monetarism, believes that factors like wealth and relative prices also contribute to economic growth, besides interest rates.

Semuel and Nurina (2015) investigated the effects of exchange, interest, and inflation rates on Indonesia's GDP from 2005 to 2013. Using a descriptive analytical method and multiple regression analysis, they found that interest and inflation rates positively effect the GDP, while exchange rates showed no significant effect. The researchers suggest further studies to identify more factors affecting the GDP and encourage using larger samples for increased reliability.

Rodrik (2008) found a positive link between exchange rates and economic growth. Ito, Isard, and Symasnsky (1999) also noticed a strong economic growth driven by ample export growth results in increased exchange rates due to a higher demand for the domestic currency. Additionally, Wong et al. (2005) highlighted that attractive exchange rates enhance capital market liquidity, drawing international investments, and subsequently boosting the desired economic growth.

It is evident that there are theoretical foundations for an adverse relationship among economic growth and real interest rates. The primary link between these two is the connection between accumulation and growth. As commonly understood, investments help eliminate growth restrictions and allow the system to exhibit its potential for growth.

There is a theoretical basis for a negative correlation between economic growth and real interest rates, mainly due to their connection with accumulation and growth. Interest rates can either encourage resource allocation towards accumulation or act as a cost that reduces investment levels. Several studies

have found a negative correlation between bank lending rates and economic growth (Giovanni and Shambaugh (2007), Gouseh and Oritsejafor (2007), Agu (1988), and Williams (2009)). However, Akinboade (2004) found mixed results concerning the relationship between these variables in Nigeria. It is evident that interest rates significantly affect investment projects. However, the demand for capital at low interest rates in industrial countries is not well defined, as per D'Adda & Scorcu (2001).

Fisher (1930) claimed that the anticipated fluctuations in interest rates are directly proportional to the alterations in expected real interest rates, and are not affected by the projected inflation rate.

Munde (1963) discovered that nominal interest rates and anticipated inflation rates did not share a direct, adjustable relationship. Eiekmeider and Kuchnienz (2013) noted in their book chapter "China's Savings and Global Economic Performance" that China has become a leading developed economy and a primary financial contributor to the rest of the world. However, they also argue that China's inward-focused growth strategy, coupled with a decrease in Japanese savings, could lead to the decline of the "Asian savings glut," which would then result in global repercussions, such as increased debt service costs and worldwide effects on investment.

Economic growth can directly or indirectly influence interest rates. When GDP growth exceeds expectations, it may lead to inflation, prompting the Central Bank to increase interest rates to control growth. Current research explores the causal relationships between economic growth, investment, and interest rates, with many studies concentrating on Granger causality of these factors in individual countries.

Udoka and Roland (2012) concur that interest rates serve as an indicator of a country's economic growth when viewed from the GDP perspective. Nevertheless, rising interest rates can also signify a contracting GDP. Fortunately, their study reveals that interest rates do not have a significant influence on economic growth. It should be noted that this research, which found that higher interest rates result in lower real growth rates, was conducted in Europe (Giovanni et al., 2009).

Blanchard (2000) defines inflation as the ongoing increase in prices of goods and services in an economy over a specific time frame. The primary goals of macroeconomic strategies in most countries involve consistent economic growth and low inflation. Despite general agreement on the importance of low inflation, opinions differ regarding the relationship between growth and inflation, as noted by Munir and Mansur (2009). There are two main schools of thought: structuralists believe inflation is essential for

growth, while monetarists argue it is harmful.

Stockman's 1981 "equilibrium growth model" suggests that investment and real money have complementary effects due to the cash-in-advance constraint. In contrast, the Mundell-Tobin Effect, originating from the work of Mundell (1963) and Tobin (1965), claims that inflation increases nominal interest rates, making investments more attractive than consumption and leading to economic growth. However, this perspective also states that inflation negatively affects growth by decreasing investment and real money balances.

Supporting the Mundell-Tobin Effect, studies by De Gragario (1992) and Fisher (1993) found negative correlations between economic growth and inflation rates, with inflation adversely affecting productivity and investment growth.

In 1930, Fisher asserted that the anticipated alterations in interest rates are proportional to the expected shifts in real interest rates, remaining unaffected by the predicted inflation rate.

Evans Agalega and Samuel Antwi (2013) found a positive correlation between GDP growth and inflation rate, while there was a negative relationship between GDP growth and interest rates. This suggests that higher inflation leads to increased GDP, whereas rising interest rates result in reduced GDP. Obamuyi T.M. (2006) also discovered a significant effect of lending rates on GDP, revealing a long-run inverse relationship between GDP growth and interest rates. Consequently, lower interest rates contribute to short-run GDP growth, and further reductions can enhance this effect.

Gillman, M., Harris, M. N., & Mátyás, L. (2004) proposed that long-run inflation has shown positive and statistically insignificant results. However, short-run inflation has demonstrated a negative and statistically significant effect with a one-lag period, meaning that increased inflation results in decreased economic growth. Specifically, with an inflation elasticity of -0.002605, a 10% rise in short-run inflation leads to a 0.03% reduction in economic growth at a 1% confidence level.

Khan and Senhadji (2001) calculated the tipping point of inflation, beyond which it considerably hampers growth, to be 11% for developing countries. Furthermore, they propose that the critical inflation level for industrialized countries lies between 1 and 3%.

Nurina and Hetane (2015) employed Partial Least Square (PLS) analysis, a method created by Sewall

Wright (1934), to investigate the influence of inflation, interest rates, and exchange rates on Indonesia's GDP. The goal of the research was to identify the direct and indirect effects of various independent factors on the dependent variable. The results showed a significant negative association between interest rates and GDP, and a substantial positive relationship between exchange rates and GDP. However, inflation did not have a major effect on GDP.

2.5 Empirical Studies in Ethiopian

Many studies have been carried out regarding economic growth and inflation in Ethiopia. The researcher intends to offer a succinct summary of different research related to this inquiry within the Ethiopian context.

Several research studies exploring the connection among inflation and economic growth have previously examined the presence of a link among these two factors (NBE, 2013/14).

Alemayehu and Kibrom (2008) found a positive correlation between inflation and economic growth in 2002/2003, but this relationship reversed from 2003/2004 onwards. Teshome (2011) analyzed Ethiopia's growth and inflation rates, discovering a nonlinear effect on economic growth with varying correlations over time. Abis (2013) researched the long-run and short-run connections between economic growth and inflation in Ethiopia, observing a positive long-run link. The studies emphasize the need for considering the country's economic position in addressing inflation.

Segni Tesma's 2020 research examines the relationship among inflation and economic growth in both short-run and long-run contexts, seeking to identify the causal relationship between these economic elements. The study employs descriptive and econometric analyses of yearly data from 1991 to 2019 for different economic factors, using the ARDL) model.

In a 2017 research by Teshome Bogale and Belachew Teshome, the ARDL model was employed to inspect the link among inflation and economic growth in Ethiopia. The findings revealed a notable negative correlation between the two factors in the short run. This suggests that increased inflation rates in the nation may effect economic growth adversely, as a minimum in the short run.

Nigussie's 2016 research investigates the influence of exchange rates on Ethiopia's economic growth using data from 1985 to 2015. Factors such as real effective exchange rate, government spending, capital formation, money supply, and trade openness are considered. The results show a positive long-run effect

of real exchange rates, money supply, and trade openness, but a negative effect of government consumption. Undervalued currency has long-run negative consequences and a neutral short-run effect, effecting through the supply channel. The study recommends government intervention to counteract exchange rate fluctuations, as agricultural output is not affected by these changes. This action is needed until the economy shifts from agriculture-based to industry-based and relies less on imports.

In 2014, Gedion found a positive relationship between Ethiopia's real effective exchange rate and its economic growth from 1979 to 2012, indicating that a depreciation in the real effective exchange rate leads to an increase in economic growth. This is in line with economic theories that suggest a decline in real effective exchange rate strengthens domestic products' competitiveness in global markets, promoting international trade and economic growth. Gizachew and Mulugeta (2013) also discovered a similar connection using data from 1970 to 2010, stating that an Ethiopian currency depreciation increases exports and growth. However, Deresse (2017) found a negative correlation between real exchange rate misalignments and economic growth, implying that ongoing depreciation or appreciation could harm long-run growth. Meanwhile, Negash (2017) found no significant long-run effect of changes in the REER on Ethiopia's growth, concluding that policies targeting the REER may not significantly affect economic growth.

Various studies, such as Aye Mengistu's 2015 research, have used time series data to analyze the effect of the real effective exchange rate on Ethiopia's economic growth. The findings reveal that a 1% increase in the real effective exchange rate results in a 0.12% economic growth in the short run. In a similar study by Teshome (2014), he examined the relationship between REER and Ethiopian economic growth between 1980 and 2012, using cointegration methods and an error correction model. His results showed that real exchange rate depreciation significantly enhances Ethiopia's economic growth in the short run, which is in line with the economic principle that a depreciating exchange rate makes a country’s exports more competitive globally.

The positive short-run relationship between Ethiopia's real effective exchange rate and its economic growth can be attributed to several factors. Firstly, the depreciation of the Ethiopian Birr may increase exports as domestic products become more competitively priced on the global market. Secondly, the depreciation can also stimulate domestic demand for local goods and services since imported items become more expensive. Lastly, the Ethiopian government has implemented various policies to encourage investment and economic growth, further strengthening the connection between exchange

rates and the nation's growth.

In a 2018 study by Mulugeta and Rao, the relationship between borrowing interest rates and Ethiopia's economic growth was examined using data from 2007 to 2016. The researchers used co-integration, vector error correction model (VECM), and found a significant negative link between lending rates and economic growth, implying that high lending interest rates negatively affect investment activities and hinder economic growth. To promote economic growth, the study recommends adopting policies that encourage competition among financial institutions, lower lending interest rates, and improve credit availability for investors.

Hunibachew's 2021 research highlights the positive effect of real interest rates on Ethiopia's economic growth, with a 1% increase in real interest rates leading to 0.06% growth in the economy. Real interest rates incentivize investors and can be controlled by the national bank, thus affecting economic output.

Debebe's 2021 study indicates that bank lending rates significantly effect economic growth in Ethiopia, with a mutual relationship between bank lending and economic growth. However, no causal link exists between lending rates and other variables in the country. Despite the influence of bank lending indicators, the overall findings suggest that bank lending positively affects Ethiopia's economic growth.

Finally, Feyisa's 2014 study discovered evidence of a threshold effect of inflation on economic growth. The suggested threshold model demonstrates a non-linear relationship between Ethiopia's economic growth and inflation, with a threshold inflation level of 10 percent identified for GDP growth.

Feyisa's research in 2014 found indications of a threshold effect of inflation on economic growth. The proposed threshold model reveals a non-linear relationship between Ethiopia's economic growth and inflation, indicating a 10% threshold inflation level for GDP growth.

This chapter examined various economic theories to better understand GDP and its contributing factors. It found that real effective exchange rate, lending interest rate, inflation rate, and GDP results may lead to different outcomes depending on the empirical analysis used. These varying results are due to the interconnected nature of macroeconomic indicators. Ethiopia's economy faces challenges such as fluctuating exchange rates, high interest rates, inflation, unemployment, heavy debts, and fiscal deficits. Therefore, to achieve macroeconomic stability in Ethiopia, it is important to analyze the effects of real effective exchange rate, lending interest rates, and inflation on the country's GDP.

Chapter Three

3 Methodology

3.1 Introduction

According to NBE's Annual Report (2020-21) states that the Ethiopian economy experienced a 6.3 percent growth rate in 2020/2021, a slight increase from the 6.1 percent growth in the previous year. As a result, per capita income has steadily risen, reaching US$1,092 in 2020/21. The investment to GDP ratio was 28.0 percent, while domestic saving was 19.0 percent. Ethiopia, covering 1.14 million square kilometers with a population of approximately 101.9 million, grows at a rate of about 2.1% per year (NBE, 2020/21). Despite a challenging political climate, Ethiopia has shown consistent economic progress as evidenced by its history of economic activity.

This chapter focuses on developing analytical methods to accomplish the study objectives, using two primary econometric models. The first model examines the relationship between real effective exchange rate, lending interest rate, and inflation on economic growth, while the second estimates the inflation threshold level.

The long-run and short-run relationships among exchange rates, interest rates, inflation, and economic growth are analyzed using the IS-LM model (RGDP) presented in Equation 1. The ARDL and ECM methodologies are utilized to investigate the long run and short-run relationships between these four key macroeconomic variables. Additionally, the growth model (Equation 2) is utilized to determine the inflation threshold level, which closely resembles the model used by Khan and Senhadji (2001). As exchange rates, interest rates, and inflation are frequently monitored and reported by news media due to their direct effect on our daily lives and the economy's health, they influence personal decisions such as consumption, savings, investments, home purchases, bond buying, savings account deposits, exports, imports, or holding foreign currency. Econometric Views (E-views) version 12 is used for all estimations, unit root tests, and diagnostic tests.

The selected variables were collected annually from sources including the National Bank of Ethiopia's statistical bulletin, the Central Statistics Agency, the UNCTAD database, and the World Bank databank. The data for these variables spans a 40-year timeline from 1982 to 2021.The study's objectives were achieved by employing the ARDL model and OLS for data estimate and analysis, utilizing the E-views 12.0 software package.

3.2 Theoretical model specification

As mentioned above, two separate econometric models have been created to address the goals of this research: one focusing on real effective exchange rate, lending interest rate, inflation, and RGDP, while the other centers around inflation and economic growth. The real gross domestic product equation is employed to examine both long run and short-run relationships between the four main macroeconomic variables being studied, whereas the growth model is utilized to calculate the inflation threshold level. In the subsequent sub-sections, these two models are thoroughly explored.

Macroeconomic theory has pinpointed several factors that effect a country's GDP, drawing from classical, neoclassical, and contemporary growth theories. Some of these influencing factors are natural resources, investments, human capital, technological progress, government regulations, aid, trade liberalization, institutional structures, FDI, education levels, political aspects, socio-cultural elements, geographical and demographic components, and more. This study aims to inspect the empirical data regarding the macroeconomic factors of Ethiopia's GDP, taking into account various aforementioned factors.

Based on theoretical concepts, starting with the Keynesian Aggregate Expenditure Function is advantageous. This function is essential for comprehending the relationship between interest rates, exchange rates, and their effect on Gross Output through investment and net export. It also links household consumption, domestic investment, and government expenditure to output. This framework is initiated with the national income identity for an open economy, as shown below:

$$Y = C + I + G + X - M \quad \text{..... (3.1a)}$$

Or

$$Y = C\,(YD) + I\,(r) + G + X\,(e) - M\,(e, Y) \quad \text{..... (3.1}b\text{)}$$

Where, Y represents real gross domestic product, while private consumption (C) depends on disposable income (YD). Investment (I) relies on the interest rate (r), and government expenditure is denoted by G. Exports (X) are determined by the exchange rate (e) and imports, which are a function *M of M (e, Y).* The significance of this model lies in its inclusion of net export, emphasizing the vital effect of foreign participation in the domestic economy through foreign direct investment. It efficiently demonstrates the national income topic within a properly operating market.

In order to accomplish the stated goals, the research investigated the following collection of relevant variables:

$RGDP = F\ (REER, LIR, INF, GE, GCF, FDI)$..... (3.2)

The basic expenditure approach of measuring gross domestic product (GDP) involves calculating the amount of all expenditures in an economy for a given period, plus consumption, investments, government spending, and net exports. In mathematical terms, this can be represented as:

GDP = C + I + G + (X - M),
Where C = consumption, I = investments, G = government spending, X = exports, & M = imports

However, the given specification, RGDP = F (REER, LIR, INF, GE, GCF, FDI), represents a more detailed and comprehensive approach to estimate Real GDP (RGDP), accounting for several additional factors that influence the economic growth.

Here is a brief overview of the variables in the given specification:

Real effective exchange rate- This variable signifies the inflation-adjusted weighted mean of a country's currency compared to a collection or index of other significant currencies. It considerably influences global commerce, effecting both exports and imports. As a result, incorporating REER in the model enables the analysis of the consequences of exchange rate variations on GDP.

Lending interest rates- The level of interest rates in an economy influences investment decisions, affecting businesses' willingness to borrow and spend. Lower interest rates stimulate borrowing and investments, expanding the economy's output. On the other hand, increased interest rates can potentially dissuade borrowing and hinder economic expansion. Incorporating LIR in the model allows for considering the effect of monetary policy on GDP.

Inflation- Inflation affects the purchasing power of the currency and has implications for both consumption and investment. Including this variable in the model allows capturing the effect of rising or falling inflation on the economy's output.

In summary, the given specification, RGDP = F(REER, LIR, INF, GE, GCF, FDI), is derived from the basic expenditure approach by extending it to include additional variables that influence GDP, for

example, factors like inflation, exchange rate, and interest rate. By doing so, the model aims to provide a more comprehensive framework for measuring and analyzing the factors affecting GDP.

3.3 The effect of real effective exchange rate, lending interest rate, & inflation on economic growth (Equation 1)

The study employed the theories presented by Mendenhall et al. (1989) and Oakshott (2006) as the starting point, assuming their applicability in the Ethiopian context. The purpose was to analyze the connection between real effective exchange rate, lending interest rate, inflation, and real GDP in Ethiopia. Based on the research by Mendenhall et al. (1989) and Oakshott (2006), it was hypothesized that interest rate and inflation rate could effect GDP. Examining these factors is essential for understanding economic performance and the monetary policies implemented by the relevant authorities.

The exchange rate is the value of one country's currency compared to another's and is influenced by factors like inflation, interest rates, and real GDP. It effects the balance of payments and overall economy. Mendenhall et al. (1989) studied purchasing power parity and uncovered interest rate parity (UIP) as reasons for exchange rate movements, finding some support for purchasing power parity (PPP) but not for UIP. Meanwhile, Oakshott (2006) examined exchange rate fluctuations' effects on UK macroeconomic indicators, revealing a significant effect on inflation and trade performance. Thus, exchange rate stability is key for macroeconomic stability.

Interest rates represent the cost of borrowing money and the benefit of saving it, significantly influencing inflation control, exchange rate management, and economic growth. Mendenhall et al. (1989) examined the UIP theory, which posits that interest rate disparities between countries correspond to anticipated changes in their exchange rates. Although their research does not entirely support UIP, it does link interest rates to exchange rates. Oakshott (2006) explores how domestic interest rates effect attracting foreign capital and subsequent effects on exchange rates. Higher interest rates commonly result in the domestic currency's appreciation, making exports more costly and imports more affordable. This, in turn, affects the trade balance, inflation rate, and GDP.

Inflation refers to the increase in the average price of goods and services in an economy over time. Mendenhall et al. (1989) and Oakshott (2006) both explore the relationship among inflation and exchange rates in their research. Mendenhall et al. (1989) provide evidence supporting the PPP theory,

which states that a change in exchange rates among two countries should be equal to the difference in their inflation rates. This suggests that higher inflation can cause a country's currency to lose value. Meanwhile, Oakshott (2006) discovers that the UK's inflation rate is sensitive to changes in exchange rates, as these fluctuations directly effect demand and domestic prices, leading to alterations in inflation levels.

Real GDP, adjusted for inflation, represents the value of goods and services produced in an economy. The interconnections between real GDP, exchange rates, interest rates, and inflation are complex. Although Mendenhall et al. (1989) and Oakshott (2006) do not directly explore the link between these variables, their research offers insights into their indirect effect on economic growth through factors like investment, exports, imports, consumer spending, and aggregate demand. In essence, these researchers shed light on the intricate relationships among these variables, which are crucial for understanding the implementation of monetary and fiscal policies for stable economic growth. A deeper understanding of these connections can help policymakers create more effective strategies for sustainable economic development.

The researcher concentrated on exploring the effect of macroeconomic elements, specifically real effective exchange rate, lending interest rate, and inflation, on economic growth. However, control variables such as government spending, gross capital formation, and foreign direct investment were also incorporated into the model. The model was formulated to depict a linear connection among economic growth and the selected variables – real effective exchange rate, lending interest rate, and inflation rate.

The econometric model is expressed below:

$$RGDP = \beta_0 + \beta_1 REER + \beta_2 LIR + \beta_3 INF + \beta_4 GE + \beta_5 GCF + \beta_6 FDI + \varepsilon \quad \text{..... (3.3)}$$

Where:

β_0 = Constant term

$\beta_1 – \beta_7$ = Regression coefficients for independents variables

RGDP = Economic growth is proxy for RGDP)

REER = Exchange rate proxy by real effective exchange rate

LIR = Interest rate proxy by nominal lending interest rate

INF = Inflation proxy by change of consumer prices index,

GE = Government expenditure by general government final expenditure (growth),

GCF = Gross capital formation proxy by gross fixed capital formation (current LCU),
FDI = Foreign direct investment proxy by foreign direct investment, net inflow (share of GDP)
Ɛ = Error term assumed to be strong assumption and independently distributed with zero mean and constant variance.

In addition, the error term includes all other factors affecting GDP that were not included in the model.

Apart from LIR, INF GE, and FDI, all variables in the model below are expressed as natural logarithms. Adopting the natural logarithm for these variables helps transform skewed data into a normal distribution and enhances the model's fit, which is a crucial requirement for econometric estimation, as noted by Verbeek (2004).

By log linear, the model becomes

$$Log\ RGDP_t = \beta_0 + \beta_1 logREER_t + \beta_2 LIR_t + \beta_3 INF_t + \beta_4 GE_t + \beta_5\ logGCF_t + \beta_7 FDI_t + \varepsilon \quad (3.4)$$

Where: log = Natural log

Where;
LnRGDP t = Natural logarithm of real gross domestic product at time t
LnREER = Natural logarithm of real effective exchange rate time t
LIR = Lending interest rate at time t
INF = Inflation rate at time t
GE = Growth of government expenditure at time t
LnGCF = Natural logarithm of gross capital formation at time t
FDI = Share of gross domestic product, foreign direct investment at time t
ε_t = the error term

3.3.1 Definition of terms and measurement of variables

This section presents and assesses dependent, independent, and control variables while identifying the expected signs of independent variables, based on the theories discussed in chapter two.

Variables	Measurement and proxy variables	Expected sign
Dependent variable **Real GDP**	Real gross domestic product refers to the total value of all final goods and services generated within a country's borders during a particular time frame, while accounting for inflation. Essentially, it calculates a country's economic output while considering the changes in price levels over time. This allows for more accurate comparisons of economic growth and productivity over time and between different countries, as it accounts for the effects of inflation and changes in relative price levels. For the aim of this study, Real gross domestic product (Constant LCU) acquired from World development indicators served as a substitute for the gross domestic product. The variables were assessed yearly, and a logarithmic transformation was utilized to normalize the data distribution, minimize the influence of outliers, scale the data for improved comprehension, establish linear connections between variables, and evaluate percentage variations.	
Independent variables **Exchange rate**	The exchange rate refers to the value of one currency compared to another currency. In this case, the direct quote among the Ethiopian birr and the United State dollar was utilized. According to the International Monetary Fund, the U.S. dollar is the most popular currency in the foreign exchange market, dominating around 90% of forex trading. In this research, Real gross	Inconclusive

domestic product (Constant LCU) acquired from World Development Indicators was employed as a substitute for gross domestic product. The variables were measured on a yearly basis, and a log transformation was utilized to standardize data distribution, diminish the influence of outliers, scale the data for improved comprehension, establish linear relationships between variables, and assess percentage alterations.

Ethiopia has experienced various exchange rate regimes throughout its history. Initially, it adopted a fixed exchange rate regime, where the Ethiopian Birr (ETB) was pegged to a foreign currency (mostly USD) to maintain currency stability. Following the fall of the socialist government, Ethiopia moved towards a managed floating exchange rate regime, where the ETB's value was determined by market forces but still subject to government intervention to manage fluctuations. Additionally, Furthermore, a crawling peg exchange rate system, which entails the occasional modification of the ETB relative to a group of foreign currencies based on differences in inflation rates, has been contemplated. Nonetheless, Ethiopia mainly continues to utilize a managed floating system.

Nominal lending interest rate	The lending interest rate refers to the sum that a lender imposes on a borrower for utilizing an asset. The bank lending rate determines the payment made by commercial banks for various deposit types. Differences in terms and conditions across countries effect comparability; however, this study utilizes the National Bank of Ethiopia's monetary policy rate as a proxy for the annual nominal interest rate.	Negative
Inflation	Inflation pertains to the ongoing increase in the overall price level or the pace at which the prices of goods and services consistently rise, resulting in a lower purchasing power for individuals. This effects the distribution of income. The research employed the variation in the consumer price index as an indicator of inflation.	Inconclusive
Control Variable **Government expenditure**	Government expenditure quantifies the money spent by public sector institutions on purchasing goods and providing services, including education, health care, social security, and defense.	Negative
Gross capital formation	Gross capital formation or gross domestic investment refers to the expenditures on the expansion of a country's fixed assets and net changes in inventory levels. Fixed assets consist of land improvements such as fences and drains; acquisitions of plants, machinery, and equipment; as well as infrastructure projects like roads, railways, schools, offices, hospitals, private	Positive

	residences, and commercial or industrial buildings. Meanwhile, inventories represent the goods held by businesses to address temporary or unexpected changes in production or sales, as well as ongoing work. Gross fixed capital formation serves as an indicator for gross fixed capital formation.	
Foreign direct investment	Foreign direct investment involves a country A's long-run involvement in management, joint ventures, technology transfer, and expertise sharing with another country B.	

Source: The researcher's compilation of data based on prior research

3.4 Estimation techniques

Prior to estimating the economic growth model, a unit root test is performed to identify the integration order of the variables. If the variables' integration orders are a mix of I (0) and I (1), the ARDL bound test proposed by Pesaran et al. (2001) is utilized for the model estimation.

3.4.1 Time series issues and unit root tests

The unit root test, commonly used in time series econometric analysis, is a stationary test. Researchers often employ the Augmented Dickey Fuller (ADF) test to examine unit roots in time series data. These statistical methods determine if the data exhibits a unit root or is stationary, with I(0) representing a stationary time series and I(1) denoting a time series with a unit root (Wooldridge 2009).

3.4.2 Augmented dickey-fuller (ADF)

Numerous methods have been developed by researchers to analyze order integration using the Augmented Dickey-Fuller test, established by Dickey and Fuller (1979, 1981). This test involves refuting the null hypothesis of a unit root in non-stationary series in favor of a stationary test model. The Dickey-Fuller test is calculated in three different forms to accommodate various scenarios.

$y_t = \beta + \gamma y_{t-1} + \varepsilon_t$ By subtracting y_{t-1} from either side we get

$y_t - y_{t-1} = \beta + \gamma y_{t-1} - y_{t-1} + \varepsilon_t$ Which is yields

$\Delta y_t = \beta + (\gamma - 1) y_{t-1} + \varepsilon_t$

Let us assume that $\gamma - 1 = \tau$

$\Delta y_t = \beta + \tau y_{t-1} + \varepsilon_t$

Y_t is a Random walk: $Y_t = Y_{t-1} + \varepsilon_t$.. (3.5)

Y_t is a Random walk with drift: $Y_t = \beta_1 + Y_{t-1} + \varepsilon_t$.. (3.6)

Y_t is a Random walk with drift around a stochastic: $\Delta Y_t = \beta_1 + \beta_{2t} + \delta Y_{t-1} + \varepsilon_t$....................... (3.7)

Where, t is the time trend variable. In each case the null hypothesis H_0: $\delta = 0$ and β = 0, i.e., no deterministic trend where the time series is non-stationary and there exists unit root. The alternative hypothesis H_1: $\delta < 0$ and the time series are stationary.

Thus, if the null hypothesis (H_0: δ=0) is rejected, ΔY_t is stationary with varying characteristics for equations (3.5), (3.6), and (3.7), specifically, with a zero mean, a non-zero mean, and around a deterministic trend, according to Gujarati (2004).

The random walk model with drift, which focuses on the stochastic trend (as seen in equation 3.5), can be accurately described by incorporating lagged values of the specified variables Y_t. Estimation for the ADF test can be achieved using equation 3.6.

$$\Delta Y_t = \beta_0 + \beta_{1t} + \delta Y_{t-1} + \omega_1 \Delta Y_{t-1} + \omega_2 \Delta Y_{t-2} + \ldots + \varepsilon_t$$

$$\Delta Y_t = \beta_0 + \beta_{1t} + \delta Y_{t-1} + \sum_{i=0}^{k} w_i \, \Delta Y_t + \varepsilon_t \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 3.8$$

Where, ε_t = White noise error term,

$$\Delta Y_{t-1} = (Y_{t-1} - Y_{t-2}), \Delta Y_{t-2} = Y_{t-2} - Y_{t-3}$$

The most significant concern of the ADF test is to evaluate δ, similar to the Dickey-Fuller test (Ng and Perron 2001)

3.4.3 Phillips Perron (PP) test

Phillips and Peron (1998) introduced a new unit root test, an alternative to the Dickey-Fuller test, to address issues like serial correlation and heteroscedasticity in residuals. They used the Newey-West covariance matrix estimator, which is a non-parametric modification of the previous test, considering potential heteroscedasticity and serial correlation. While the PP test's asymptotic distribution and critical

values are the same as the ADF test, its small-sample performance is inferior, so it should be used alongside other methods (see Schwert (1989), Campbell and Perron (1991), Agiakloglou and Newbold (1992), De Jong et al. (1992), and Liu and Praschnik (1993)). The test equation is specified as:

$$\Delta Y_t = \beta_0 + \beta_1 t + \rho Y_{t-1} + \varepsilon_t \quad \text{..... (3.9)}$$

Where, β_0 is the constant and β_1 denotes the coefficient related to the trend term t. The 'tau' statistic comes from estimating ρ, which is then contrasted with suitable critical values. Assuming ρ is zero implies a unit root in the null hypothesis. The PP test shares the same rejection criteria as the ADF and DF-GLS tests.

3.4.4 Autoregressive distributed lag and Error correction model

Time series variables frequently achieve stationarity through differencing, potentially causing a loss of important long-run characteristics and equilibrium data in regression analysis. Co-integration addresses this issue by recovering the essential long-run information and combining it with short-run dynamics, maintaining the equilibrium relationship between variables.

Co-integration occurs between two variables when they share a long-run equilibrium relationship. This happens when the dependent and independent variables are individually non-stationary, but their combined residuals become stationary (Gujarati, 2009). The concept of combined residuals refers to the situation where, despite the individual non-stationarity of the dependent and independent variables, the differences between the observed and predicted values (i.e., the residuals) exhibit stationarity. Stationarity implies that the statistical properties of the residuals, such as mean and variance, remain constant over time or across observations. This combined stationarity of the residuals is desirable because it indicates that the regression model adequately captures the relationships between the variables, even if the individual variables themselves are non-stationary. It suggests that the model is able to account for the time-dependent patterns or trends present in the data, and that the residuals do not exhibit any systematic patterns or trends themselves. In cases with non-stationary residuals, traditional OLS methods are not suitable, so Phillips (1986) highlights the importance of using co-integration techniques.

In accordance with the traditional Granger (1981), Engle, and Granger (1987) methodologies, co-integration analysis cannot be employed when dealing with variables integrated at varying degrees.

Johansen's co-integration technique requires large data samples for validity and require all the regressors to be integrated of the same order. Nonetheless, ARDL Co-integration approach can be applied whether the regressors are I (1) or I (0). .

The decision to utilize the ARDL method in this study was primarily motivated by its applicability in analyzing time series data, tackling concerns of non-stationarity and endogeneity, exploring cointegration, and employing the bounds testing procedure for hypothesis testing. In line with this rationale, the study employed the ARDL method and bounds testing procedure introduced by Pesaran et al. (2001), as well as Pesaran and Shin (1999), to examine the long-run equilibrium relationship between economic growth, exchange rate, interest rate, and inflation. This approach, which avoids endogeneity issues related to the Engle-Granger method and permits simultaneous evaluation of short and long run parameters, firstly, it offers both unbiased long-run estimates and valid t-statistics (Narayan, 2005). Secondly, it allows for the evaluation of both short-run and long run parameters of the model simultaneously.

Thirdly, the application can be applied regardless of whether the fundamental variables are I (0), I (1), or a combination of both (Pesaran and Pesaran, 1997). Fourthly, compared to the Johansen and Juselius co-integration procedure, the ARDL method offers a more statistically significant approach to determining the co-integration relationship in small samples (Pesaran and Shin, 1999). Fifthly, the model uses a suitable number of lags to capture the data-generating process within a general-to-specific modeling framework (Laurenceson and Chai, 2003). Sixthly, the error correction model (ECM) can be derived from ARDL through a simple linear transformation that integrates short-run adjustments with long-run equilibrium without sacrificing long-run data (Pesaran and Shin, 1999).

Basically, the two-stage ARDL method for co-integration is utilized to evaluate long-run relationships. The initial stage involves examining the existence of a long-run relationship among all variables. Upon finding evidence of co-integration between variables, the second stage focuses on estimating both the long run and short-run models. To estimate the long-run relationship, the ARDL bounds test approach to co-integration consists of two steps: Firstly, the presence of a long-run relationship among all variables in the equation is analyzed. Specifically, the ARDL $(p, q_1, q_2, q_3, q_4, q_5, q_6)$ model can be represented as follows:

$$\Delta \ln RGDP_t = \beta_0 + \sum_{i=1}^{p} \alpha\, \Delta lnGDP_{t-i} + \sum_{i=0}^{q_1} \beta_1\, \Delta \ln REER_{t-i} + \sum_{i=0}^{q_2} \beta_2\, \Delta LIR_{t-i} + \sum_{i=0}^{q_3} \beta_3\, \Delta INF_{t-i} + \sum_{i=0}^{q_4} \beta_4\, \Delta GE_{t-i} + \sum_{i=0}^{q_5} \beta_5\, \Delta lnGCF_{t-i} + \sum_{i=0}^{q_6} \beta_6\, \Delta FDI_{t-i} + \lambda_1 RGDP_{t-1} + \lambda_2 REER_{t-1} + \lambda_3 LIR_{t-1} + \lambda_4 INF_{t-1} + \lambda_5 GE_{t-1} + \lambda_6 GCF_{t-1} + \lambda_7 FDI_{t-1} + \varepsilon_t \quad (3.10)$$

Where, β_0 represents the constant term (drift) and β's are the coefficients determining short-run relationships, whereas λ's are coefficients for long-run relationships. Δ and ε_t stand for the first difference operator and the error term, respectively. The intercept component is represented by β_0, and variables such as RGDP, REER, LIR, INF, GE, GCF, and FDI have already been defined. The summation signs illustrate the error correction dynamics, and the mentioned portion of the equation refers to:

$$\lambda_0 + \lambda_1 RGDP_{t-1} + \lambda_2 REER_{t-1} + \lambda_3 LIR_{t-1} + \lambda_4 INF_{t-1} + \lambda_5 GE_{t-1} + \lambda_6 GCF_{t-1} + \lambda_7 FDI_{t-1} + \varepsilon_t \quad (3.11)$$

Equation 3.11 represents the long-run relationship and incorporates the constant (rest) term. By incorporating the constant term, the model becomes capable of capturing the intercept or the baseline level of the dependent variable (ε_t), even when all independent variables (RGDP, REER, LIR, INF, GE, GCF, and FDI) are zero or have no effect on the dependent variable. The inclusion of a constant term holds significance in regression analysis as it addresses potential systematic bias or fixed effects present in the data. It guarantees that the regression line is not compelled to pass through the origin, thus offering a more precise depiction of the relationship between the variables. The choice of lag relies on criteria like the Akaike Information Criterion (AIC) and the Schwarz Bayesian Criterion (SBC).

The statement addresses the utilization of a bounds test for co-integration, as suggested by Pesaran and Shin (1999) and Pesaran, Shin, and Smith (2001), in order to examine the long-run relationship among exchange rate, interest rate, inflation, and economic growth. The ARDL approach is employed, which involves two stages: initially determining the presence of a long-run association between these variables through an F-test and subsequently estimating the relationship's coefficients and short-run parameters using an error correction representation. The error correction model version of ARDL enables the assessment of the speed at which these variables return to equilibrium. To conduct the bounds test procedure, a restricted version of the ARDL models is estimated, further exploring the long-run connections between exchange rate, interest rate, inflation, and economic growth. Long-run multipliers

are denoted by λ_1 through λ_7, while the short-run coefficients, referred to as λ's, are estimated using the error correction framework in the ARDL models.

The initial step in the ARDL methodology involves estimating equations (3.4) using OLS. Following that, the null hypothesis of no long-run relationship between the variables in equation (3.4) is tested in contradiction of the alternative hypothesis of a long-run relationship between the variables, utilizing the F-test indicated by $F_{RGDP}\ (RGDP|REER, LIR, INF, GE, GCF, FDI)$ and expressed as follows:

H_0: $\lambda_1 = \lambda_2 = \lambda_3 = \lambda_4 = \lambda_5 = \lambda_6 = \lambda_7 = 0$, when there is no long-run relationship between the variables.

H_1: $\lambda_1 \neq \lambda_2 \neq \lambda_3 \neq \lambda_4 \neq \lambda_5 \neq \lambda_6 \neq \lambda_7 \neq 0$, In the long run, a relationship exists between the variables.

Peseran et al. (2001) offered appropriate critical values for the non-standard asymptotic distribution of the F-statistic without distinguishing between independent variables being I (0) or I(1). These critical values are based on the number of independent variables and the inclusion or exclusion of a constant term or time trend in the models. As a result, the calculated F-statistic is compared to two sets of critical values, with the assumption that the independent variables are I (d), where $0 \leq d \leq 1$. The lower critical bound presumes all variables are I (0), while the upper critical bound assumes they are I (1).

If the F-statistic exceeds the upper critical value, it rejects the null hypothesis of no co-integration, implying that the variables have long-run relationships and are either I (0) or I (1). However, if the F-statistic falls below the lower critical bound; the null hypothesis cannot be rejected. In cases where the F-statistic lies between these bounds, the result remains ambiguous (Peseran & Peseran, 1997). When all variables have order zero integration (i.e., I (0)), rejecting the null hypothesis implies the presence of long-run relationships among the variables. Otherwise, the variables are not co-integrated.

Narayan (2005) contends that current critical values, derived from extensive sample sizes, are not applicable to smaller sample sizes. Consequently, the author creates a new set of critical values for a narrower data range consisting of 30-80 observations, using Pesaran et al. (2001)'s methodology. Given that this study utilizes a limited annual time series dataset, Narayan (2005)'s critical values be able to be employed for the bounds F- statistic instead of those by Pesaran et al. (2001). If a long-run connection between variables exists, the subsequent step involves estimating the ECM.

$$\Delta\ln RGDP_t = \beta_0 + \sum_{i=1}^{p} \alpha\, \Delta lnGDP_{t-i} + \sum_{i=0}^{q_1} \beta_1\, \Delta lnREER_{t-i} + \sum_{i=0}^{q_2} \beta_2\, \Delta LIR_{t-i} + \sum_{i=0}^{q_3} \beta_3\, \Delta INF_{t-i} + \sum_{i=0}^{q_4} \beta_4\, \Delta GE_{t-i} + \sum_{i=0}^{q_5} \beta_5\, \Delta lnGCF_{t-i} + \sum_{i=0}^{q_6} \beta_6\, \Delta FDI_{t-i} + \eta_1 ECT_{t-1} + \varepsilon_t \ldots\ldots (3.12)$$

Where η represents the speed at which equilibrium is achieved when there are shock(s) to the system, while error correction term at a given time period (t-1) or (ECT_{t-1}) refers to the residual values acquired from the co-integration model estimation in equation 3.12.

3.5 Growth model (Equation 2)

In this study, we employ a growth model similar to the one developed by Khan and Senhadji (2001) to determine the threshold level of inflation in Ethiopia, focusing on the inflection point or non-linear association between the inflation rate and economic growth. This threshold level analysis model has been widely adopted by numerous researchers in recent years to examine both developed and developing countries, such as Khan and Senhadji (2001) for industrial and developing nations, Ilyas et al. (2014) for Pakistan, and Edeme (2015) for Nigeria. The model comprises five explanatory variables, namely inflation, inflation threshold, growth rate of money supply, growth rate of gross capital formation, and economic openness, which will be elaborated in the final section of this chapter. Additionally, this paper utilizes the same model to estimate the threshold level of inflation in Ethiopia.

The researcher utilized the method proposed by Khan and Sendhadji (2001) to estimate the inflation threshold level, which has been applied in various studies, including Sweidan (2004) for Jordan, Mubarik (2005) and Hussain (2005), Nasir and Nawaz (2010) for Pakistan, Shamim and Mortaza (2005) for Bangladesh, Li (2006) for both developed and developing countries, as well as Munir and Mansur (2009) for Malaysia.

$$\Delta y_t = \beta_0 + \beta_1{}^{*}\Delta x_t + \beta_2{}^{*}D_t(\Delta x_t - t) + \beta_3{}^{*}Z_{it} + \varepsilon_t \ldots\ldots 3.13$$

Where,

Δy_t = Growth rate of gross domestic product,

Δx_t = Inflation

K = Threshold level of inflation

D_t = Dummy variable

Z_{it} = A set of control variables, including gross capital formation growth rate, money supply (M2) growth rate, and trade openness

The coefficients that need to be estimated are β_1, β_2, and β_3.

The definition of a dummy variable is $D_t = \begin{cases} 1: & \Delta x_t > k \\ 0: & \Delta x_t \leq k \end{cases}$ ……3.14

3.5.1 Terms definition and variables measurement

This section identifies and assesses the dependent, independent, and control variables.

Variables	Measurement and proxy variables
Dependent variable **Growth rate of GDP**	The real GDP growth rate represents the percent change in the value of goods and services produced within an economy over a specific period, taking into account inflation and presented in constant prices. This measure assesses economic growth and tracks the performance of an economy over time. By accounting for changes in price levels, the real GDP growth rate provides an accurate representation of an economy's true growth or decline.
Independent variables **Inflation**	Inflation refers to the ongoing increase in the overall price level, which is characterized by the consistent rise in the cost of goods and services, resulting in diminished purchasing power for individuals. It has an effect on the distribution of income. The study employed fluctuations in the consumer price index (CPI) as a representation of inflation.
Dummy variable	A dummy variable takes on a value of 1 when inflation levels exceed the threshold inflation rate (TR) and a value of 0 otherwise. The threshold inflation rate is determined by subtracting the threshold inflation from the inflation rate at time t and then multiplying it by the dummy variable y.

Control Variable	
Money supply growth rate	The rate at which the money supply (M2) expands represents the percentage variation in the total sum of money circulating in an economy over a designated time frame, typically one year. M2 encompasses cash, check deposits, and easily exchangeable near money such as savings accounts, money market accounts, and other short-run deposits. This expansion rate serves as a critical gauge of economic activity since it indicates fluctuations in the access to money for spending and investment purposes, potentially affecting inflation, interest rates, and general economic growth.
Gross capital formation growth rate	Gross capital formation growth rate represents the annual percentage change in the value of investments in fixed assets, such as machinery, buildings, and inventory changes, made within an economy's unit or sector. Gross capital formation serves as a crucial indicator of economic development and potential growth, as it demonstrates the extent of investments and advancements made by businesses and governments to boost future production capacities and economic growth.
Trade openness	Trade openness illustrates the extent to which a country participates in international trade, generally determined by the proportion of imports and exports in relation to its economy's size. This concept reflects a country's economic policies concerning trade barriers, such as tariffs and quotas. Increased openness to trade offers more opportunities for businesses and consumers to access global markets, promoting the exchange of goods, services, and ideas. Typically, this is calculated by dividing the combined value of imports and exports by a country's GDP. A higher ratio implies greater openness and reliance on trade.

Source: The researcher's compilation of data based on prior research

According to the definition provided by Khan and Sendhadji (2001), the variable k signifies the critical inflation level. Referring to equation (3.13) mentioned earlier, the threshold model would be defined using equation (3.15) that follows:

The formula below determines the threshold level of inflation

$$GGDP = \beta_0 + \beta_1 Inf + \beta_2 D(Inf_t - K) + \beta_3 GGCF + \beta_4 GM_2 + \beta_5 OPEN + \varepsilon_t \ldots\ldots\ldots\ldots\ldots\ldots\ldots 3.15$$

$$GGDP = \beta_0 + \beta_1 Inf + \beta_2 TR + \beta_3 GGCF + \beta_4 GM_2 + \beta_5 OPEN + \varepsilon_t \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 3.16$$

Where,

GGDP = The percentage growth rate of real GDP.

INF = Inflation rate, calculated as the yearly percentage increase in the consumer price index (the primary independent and threshold variable employed in the regression analysis), is measured.

D_t= Dummy variable that adopts a value of 1 when inflation rates exceed threshold (TR) percent, and 0 in all other cases.

TR = The threshold inflation level is determined by subtracting the threshold inflation from the inflation rate at time t and then multiplying the result by the dummy variable y.

GM2 = Growth rate of money supply

GGCF = Growth rate of gross capital formation

Open = The level of economic openness is determined by calculating the combined proportion of exports and imports in relation to the GDP.

ε_t - random error term

Dt is a dummy variable with a value of one (1) assigned to inflation rates exceeding K percent and zero (0) in other cases. The parameter K stands for the critical inflation rate at which the correlation between output growth and inflation can be described as: (i) β1 for low inflation levels; (ii) β1 + β2 for high inflation levels. High inflation implies that if β2 is significant, the combined effect of (β1 + β2) should be considered to evaluate its influence on economic growth, which determines the threshold inflation rate.

If the threshold were known beforehand, the model could be calculated using ordinary least squares (OLS). However, since the inflation threshold level (K) must be determined along with other regression parameters, nonlinear least squares is the suitable estimation method. Estimation is done using ordinary least squares, where an arbitrary value of K is initially given and the optimal K is found by minimizing the residual sum of squares (RSS). Therefore, the optimal threshold level is the one that minimizes the sequence of RSS.

3.6 Diagnostic tests

To achieve accurate long-run results, it is essential to consistently perform post-estimation evaluations. Crucial post-estimation tests for dynamic models encompass autocorrelation, heteroscedasticity tests, normality tests, model stability and others.

3.6.1 Series autocorrelation

In 1978, Ljung and Box introduced the Ljung-Box Q test, a method used by researchers to determine the presence of autocorrelation or linear dependence in a data series. The test is defined by a specific formula.

$$Q = T(T+2)\sum_{k=1}^{q} r_k^2 /(T-K) \sim \chi^2(q)$$

While T represents the sample size and q indicates the length of time lag, the model dismisses this.

H_0: No serial correlation

H_1: Serial correlation

Decision rule: If the Chi-Square (x^2) probability is above the 5% significance level, accept the null hypothesis that suggests no serial correlation in residuals. If not, reject the null hypothesis, implying that serial correlation exists in the residuals.

3.6.2 Heteroscedasticity

Heteroscedasticity describes a scenario in which the error term (ε_t) distribution around the mean is inconsistent, meaning it lacks constant variance. Although this does not affect the unbiasedness of the parameter, the consistency features of OLS estimators are no longer minimum variance or efficient. The Breusch-Pagan test helps assess the null hypothesis in comparison to the alternative hypothesis. The null hypothesis suggests that error variances are the same (homoscedasticity), whereas the alternative hypothesis posits that error variances result from one or more factors (heteroscedasticity).

Hypothesis test: H_0: constant error variance or homoskedastic (H_0: $\sigma_1^2 = \sigma_2^2 = \cdots = \sigma^2$),

H_1: no constant error or unrestricted heteroskedastic (H_0: $\sigma_1^2 \neq \sigma_2^2 \neq \cdots \neq \sigma^2$).

Decision rule: If the calculated Chi-square (x^2) surpasses the critical x^2 value, the null hypothesis is rejected, leading to the conclusion that the regression model exhibits heteroscedasticity. Otherwise, if

this condition is not met, the null hypothesis is not rejected, and homoscedasticity is assumed present.

3.6.3 Normality test

Another factor for assessing the suitability of a model is normality, which establishes if the outcome adheres to a symmetrical distribution. If the Jarque-Bera p-value is more than 5%, the model's residuals are considered normal, and if it is less than 5%, they are not.

Hypothesis: H_0: residuals are normally distributed

H_1: residuals are not normally distributed

3.6.4 Model specification test

A model is considered misspecified if it omits significant variables or has an incorrect functional structure. The Ramsey RESET test is used to verify the model's correct specification by examining the hypothesis mentioned below.

Hypothesis:

H_0: the model is correctly specified, with the appropriate functional form and all relevant variables included.

H_1: either the model is incorrectly specified, with an incorrect functional form or some relevant variables excluded, or irrelevant variables included.

If the Ramsey RESET test's probability value exceeds 5%, the null hypothesis cannot be rejected.

3.6.5 Multicollinearity test

Multicollinearity refers to the presence of a notable degree of correlation, or linear dependence, among multiple independent variables. This frequently occurs in regression models with numerous independent variables, potentially due to some variables representing the same concept or phenomenon. However, it is vital to note that a strong correlation does not necessarily imply multicollinearity.

While multicollinearity does not inherently violate Ordinary Least Squares (OLS) assumptions, it can cause issues when there is perfect multicollinearity. As per Greene (2000), this may lead to increased variances in the model and unstable coefficients, possibly causing incorrect signs or extreme magnitudes. To detect multicollinearity, techniques such as the variance inflation factor and BKW's (2000) coefficient variance decomposition (Eigenvalue and condition number) are commonly employed.

In this specific study, the BKW approach was used.

The coefficient decomposition process helps reveal the eigenvector decomposition of the coefficient covariance matrix, identifying potential collinearity issues among regressors. The estimation of decomposition follows BKW 2000 guidelines. Even though BKW employs the singular-value decomposition technique for separating the variance-covariance matrix, the same result can be achieved with the eigenvalue decomposition since the matrix is square and positive semi-definite.

In basic OLS regression, the matrix representing the variance and covariance of coefficients can be decomposed into specific components;

$$\mathrm{Var}(\beta) = \sigma^2 (X^1 X)^{-1} = \sigma^2 \mathrm{V} S^{-1} V^1 \ldots\ldots\ldots \quad (3.17)$$

Where S represents a diagonal matrix consisting of eigenvalues from X' X, while V is a matrix with columns that correspond to the respective eigenvectors.

The variance of each individual coefficient estimate can then be expressed as:

$$\mathrm{Var}(\beta) = \sigma^2 \sum_j V_{ij}^2 \ldots\ldots\ldots \quad (3.18)$$

The covariance matrix's j-th condition number, denoted as kj, is defined as $K_j \equiv \frac{Min(\mu_m)}{\mu_j}$, where µj represents the j-th eigenvalue and vij refers to the element in the (i, j)-th element of the matrix V.

Let $\emptyset_{ij} \equiv \frac{V_{ij}^2}{\mu_j}$ and $\emptyset_i \equiv \sum_i \emptyset_{ij}$

The proportion of variance decomposition is referred to as; $\pi_{ji} \equiv \frac{\emptyset_{ij}}{\emptyset_i}$

The previously mentioned ratio, in conjunction with the condition numbers, can then be utilized as a diagnostic tool to detect collinearity among the various coefficients.

As per BKW, it is mandatory to adhere to the subsequent process;

Examine the condition numbers of the matrix. If a condition number is below 0.001 (1/900), it could signal collinearity. Note that BKW uses a threshold of 30 or higher, but this is based on the condition

numbers of X, not $X' X^{-1}$. Additionally, if there are any small condition numbers, it is essential to analyze the variance-decomposition proportions. If two or more variables have values greater than 0.5 associated with a small condition number, there might be possible collinearity between those variables.

3.6.6 Stability of the model

The model's stability is assessed using the cumulative sum of squares of residuals stability test (CUMSUMSQ). In this instance, the Cumulative Sum Test (CUSUM test), which relies on the recursive estimates' residuals, offers an appropriate evaluation.

Hypothesis: H_0: The CUSUM distribution is a symmetric distribution centered at 0.

H_1: The CUSUM distribution is not symmetric distributed and no normal distribution

Decision rule: When the CUSUM statistics chart lies within the boundaries of the critical region for a test at a 5% significance level, we accept the null hypothesis that the distribution is normal; conversely, if it falls outside these boundaries, we reject the null hypothesis.

3.6.7 Robustness Checks

To confirm and validate the results obtained from ARDL estimation, Dynamic Ordinary Least Squares (DOLS) and Robust Least Squares (RLS) techniques are employed. The results derived from both DOLS and RLS serve to strengthen the ARDL estimates and ensure that the model findings were not incidental.

3.6.8 Dynamic ordinary least squares (DOLS) Co-integration DOLS

Stock and Watson (1993) introduced the Dynamic OLS (DOLS) method as an effective technique for estimating time series data, notably appropriate for small sample sizes. In contrast to the Johansen co-integration approach, which encounters problems due to possible misspecifications, DOLS tackles endogeneity and serially correlated errors by incorporating leads and lags of first differences in regressors and employing the Generalized Least Square (GLS) procedure. Both DOLS and Johansen exhibit similar asymptotic optimality characteristics. A DOLS-based economic growth model is demonstrated below.

Economic growth

$$= \mathrm{X}, \mathrm{M}' + \sum_{i=-\mathrm{m}}^{i=m} \emptyset, \Delta lnREER_{t-i} + \sum_{i=-\mathrm{m}}^{i=m} \emptyset, \Delta LIR_{t-i} + \sum_{i=-\mathrm{m}}^{i=m} \emptyset, \Delta INF_{t-i}$$

$$+ \sum_{i=-\mathrm{m}}^{i=m} \emptyset, \Delta GE_{t-i} + \sum_{i=-\mathrm{m}}^{i=m} \emptyset, \Delta lnGCF_{t-i} + \sum_{i=-\mathrm{m}}^{i=m} \emptyset, \Delta FDI_{t-i} + \mu_t \ldots\ldots\ldots\ldots\ldots\ldots 3.19$$

Where; M represents the values $\beta_0, \beta_1, \beta_2, \beta_3, \beta_4$, ɤ, α, and π, while X consists of 1, REER, LIR, INF, GE, GCF, FDI. Additionally, m, n, and l denote the leads and lags of repressors. When economic growth is at I(1), and if as a minimum some independent variables are I(1) or I(0), then the DOLS method can be utilized.

3.6.9 Recursive least squares (RLS) regression and time series analysis

The Recursive Least Squares (RLS) technique is designed for robust estimation, making it less sensitive to the influence of outliers. This method addresses some limitations present in traditional parametric and non-parametric approaches. While Ordinary Least Squares (OLS) can provide favorable results when its fundamental assumptions are not violated, it may lead to imprecise outcomes when these assumptions are not met. Consequently, OLS lacks resilience against breaches of its assumptions, while RLS is purposely created to endure such transgressions of OLS assumptions.

Chapter Four

4 Empirical findings, analysis and discussions

4.1 Introduction

In this chapter, we present the results of the computed economic growth function. The discussion starts with an overview of analytical methods, followed by exhibiting descriptive statistics, and proceeds with assessing diagnostic test results, unit root analysis, long run and short-run effects. Finally, the chapter concludes in identifying the inflation threshold level.

4.2 Summary of analytical methods

The objective of this research is to investigate the effect of real effective exchange rate, interest rate, and inflation on the economic growth of Ethiopia and estimating inflation threshold level. Information was gathered from the NBE, MOF, and World development indicators (World Bank) during the timeframe of 1982-2021. Eviews 12 was used to create all data visualizations, including graphs, figures, and tables, as detailed in the appendix. This study utilizes various analytical methods, such as unit root tests, diagnostic tests, model, model specification and estimation, robustness assessments.

4.3 Descriptive statistics

Descriptive statistics is a branch of statistics that focuses on summarizing, analyzing, and presenting data in a meaningful way. It helps to describe the main features of a dataset using various measures such as central tendency, dispersion, and shape. Descriptive statistics does not involve making any conclusions or predictions beyond the data in question but aims to provide a clear and concise overview of the data.

Descriptive statistics are used in almost every field, including business, economics, psychology, sports, and more, as they provide valuable insights into the characteristics and patterns within data

From Table 4.0, the economic growth during the entire period had a maximum value of 14.61665 and a minimum value of -12.33892, with an average of 13.20405 and a standard deviation of 0.734392. The real effective exchange rate had a maximum of 5.842147 and a minimum of 4.390739, indicating a significant range. Its average was 4.843730 and its standard deviation was 0.270074. Additionally, the lending interest rate had an average of 11.314, alternating from a low of 6.8 to a high of 15.5, with a standard deviation of 2.575331. Finally, the average inflation rate had a mean of 9.9035, varying from a minimum of -9.81 to a maximum of 44.36, and a standard deviation of 11.31735.

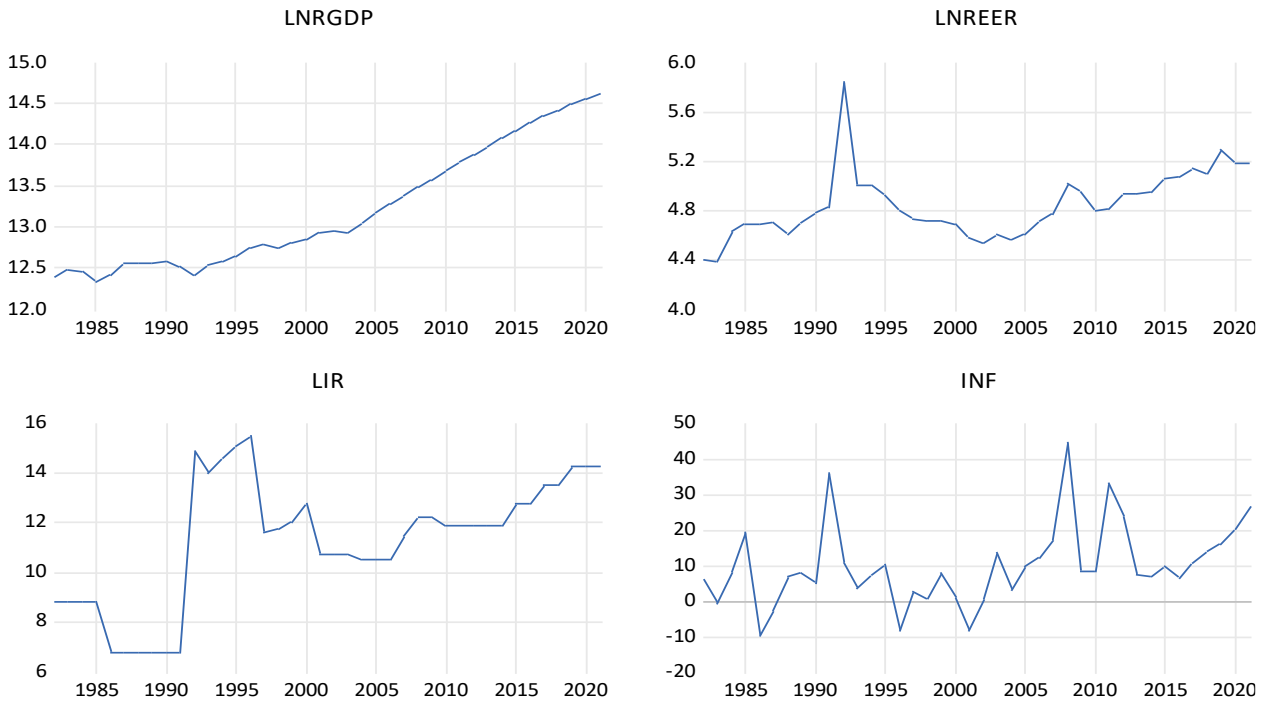
Table 4.0: Summary of the variables statistics

	LnRGDP	LnREER	LIR	INF	GE	LnGCF	FDI
Mean	13.20405	4.843730	11.31400	9.903500	8.130000	10.59822	1.828274
Std. Dev.	0.734392	0.270074	2.575331	11.31735	2.026595	2.022516	1.872673
Min.	12.33892	4.390739	6.800000	-9.810000	3.730000	7.943784	0.000000
Max.	14.61665	5.842147	15.50000	44.36000	11.93000	14.26040	5.576213
Obs.	40	40	40	40	40		40

Note: Min is minimum; Max is maximum Std. Dev. represents Standard Deviation; obs is Observation.

Source; the researcher has carried out calculations using the Eviews 12 software package

Figure 2: Economic growth, exchange rate, interest rates and inflation of Ethiopia 1982 - 2021



Source: Own computation using E-views 12

4.4 Correlation matrix

The correlation matrix was utilized to determine the strength of the relationship among the dependent

variable (RGDP) and the independent variables.

Table 4.1 depicts the outcomes of the multicollinearity test. The assessment of multicollinearity in this study was conducted using a correlation matrix. A correlation value exceeding 0.8 among independent variables signifies a severe presence of multicollinearity.

Table 4.1: Correlation matrix of the variables

	LNRGDP	REER	LIR	INF	GE	LNGCF	FDI
LNRGDP	1.000000						
REER	0.491150	1.000000					
LIR	0.506593	0.638521	1.000000				
INF	0.379130	0.342286	0.121514	1.000000			
GE	0.055571	-0.333925	-0.009477	-0.088281	1.000000		
LNGCF	0.989065	0.519119	0.585673	0.370660	0.100956	1.000000	
FDI	0.592811	0.088236	0.305141	-0.036566	0.047405	0.616146	1.000000

Source; Researcher's computation using Eviews 12 Package

In summary, the analysis of the relationship among the dependent variable (RGDP) and the independent variables (REER, LIR, INF, GE, LNGCF, and FDI) was conducted using the correlation matrix presented in Table 4.1. The multicollinearity test, using the correlation matrix, indicated no significant multicollinearity issues among the independent variables as none of the correlation values surpassed 0.8. This implies that the variables do not have strong linear relationships with each other and can be used as independent predictors in a regression model without causing multicollinearity problems.

4.5 Unit root test results

Table 4.2 presented below demonstrates the unit root test implementation using augmented dickey-fuller and phillips perron tests. The assessment took place at the level with intercept, and both intercept and trend were included for all variables. The variables evaluated at log levels included RGDP, real effective exchange rate, and gross capital formation. According to the results of both tests, stationarity at levels was exhibited by real effective exchange rate (only in intercept) and inflation (in intercept, as well as intercept and trend). Moreover, the augmented dickey-fuller and phillips perron tests identified stationarity for RGDP, real effective exchange rate, lending interest rate, government expenditure, gross capital formation, and foreign direct investment only after the first differencing.

Table 4.2: Unit root test outcomes with intercept only: ADF Test results

At levels			At 1st difference			
Variables	ADF-statistic	Lag	Variables	ADF-Statistic	Lag	I(0)
LnRGDP	2.432949 [1.0000]	0	ΔLnRGDP	-4.335882 [0.0014]***	3	I(1)
LnREER	-3.043887 [0.0395]**	0	ΔLnREER	-9.112545 [0.0000]***	0	I(0)
LIR	-1.905086 [0.3266]	0	ΔLIR	-6.737797 [0.0000]***	0	I(1)
INF	-4.421006 [0.0011]***	0	ΔINF	-8.568866 [0.0000]***	0	I(0)
GE	-2.437623 [0.1385]	0	ΔGE	-7.606013 [0.0000]***	0	I(1)
LnGCF	1.144825 [0.9972]	0	ΔLnGCF	-6.893572 [0.0000]***	3	I(1)
FDI	-2.220262 [0.2026]	0	ΔFDI	-7.13943 [0.0000]***	0	I(1)

Note: ***, ** and * signify significance at the 1%, 5%, and 10% levels respectively, Δ symbolizes the first difference, and *I (0)* denotes integration order. P-Values are represented by the values in parenthesis.
Source; Researcher's construct using Eviews 12

Table 4.3: Outcomes of unit root test incorporating intercept and trend: ADF Test results.

At levels			At 1st difference			
Variables	ADF-Statistic	Lag	Variables	ADF-Statistic	Lag	I(0)
LnRGDP	-1.470690 [0.8227]	0	ΔLNRGDP	-5.615147 [0.0002]***	0	I(1)
LnREER	-3.412115 [0.0644]*	0	ΔLNREER	-8.992679 [0.0000]***	0	I(1)
LIR	-2.437504 [0.3557]	0	ΔLIR	-6.644063 [0.0000]***	0	I(1)
INF	-4.978134 [0.0013]***	0	ΔINF	-8.375989 [0.0000]***	2	I(0)
GE	-2.351949 [0.3977]	0	ΔGE	-7.624405 [0.0000]***	0	I(1)
LnGCF	1.745983[0.7112]	0	ΔLNGCF	-7.477767 [0.0000]***	0	I(1)
FDI	-3.098750 [0.1208]	0	ΔFDI	-7.033168 [0.0000]***	0	I(1)

Note: ***, ** and * signify significance at the 1%, 5%, and 10% levels respectively, Δ symbolizes the first difference, and *I (0)* denotes integration order. P-Values are represented by the values in parenthesis.
Source; Researcher's construct using Eviews 12

The augmented dickey-fuller test results for various variables at level and first difference are displayed in Table 4.2 (intercept only) and Table 4.3 (intercept with trend). Most variables are found to be non-stationary at level based on these test results, with real effective exchange rate (REER) and inflation rate (INF) being the two exceptions. REER and INF are stationary at 5 and 1 percent, respectively, according

to the augmented dickey-fuller test with intercept only and also when considering both intercept and trend. Inflation is observed to be stationary at 1 percent, which suggests that it is an I (0) variable. Other variables, such as gross domestic product, are identified as I (1) when testing with intercept only and with intercept and trend. Additionally, government expenditure, gross capital formation, and foreign direct investment are all classified as I (1) variables.

Table 4.4: Unit root test outcomes with intercept only: PP Test results

At levels			At 1st difference			
Variables	PP-Statistic	Bwd	Variables	PP-Statistic	Bwd	I(0)
LnRGDP	2.396694 [0.9999]	3	ΔLnRGDP	-4.335882 [0.0014]***	0	I(1)
LnREER	-2.920857 [0.0520]*	2	ΔLnREER	-9.112545 [0.0000]***	0	I(1)
LIR	-2.018750 [0.2779]	4	ΔLIR	-6.737797 [0.0000]***	0	I(1)
INF	-4.421006 [0.0011]***	0	ΔINF	-8.568866 [0.0000]***	0	I(0)
GE	-2.437623 [0.1385]	0	ΔGE	-7.606013 [0.0000]***	0	I(1)
LnGCF	1.144825 [0.9972]	0	ΔLnGCF	-6.893572 [0.0000]***	3	I(1)
FDI	-2.220262 [0.2026]	0	ΔFDI	-7.13943 [0.0000]***	0	I(1)

Note: ***, ** and * signify significance at the 1%, 5%, and 10% levels respectively, Δ symbolizes the first difference, Bwd is the Band Width, and *I (0)* denotes integration order. P-Values are represented by the values in parenthesis.

Source; Researcher's construct using Eviews 12

Table 4.5: Outcomes of unit root test incorporating intercept and trend: PP Test results

At levels			At 1st difference			
Variables	PP-Statistic	Bwd	Variables	PP-Statistic	Bwd	I(0)
LnRGDP	-1.478783 [0.8199]	1	ΔLnRGDP	-5.342993 [0.0005]***	2	I(1)
LnREER	-3.529693 [0.0500]*	8	ΔLnREER	-8.992679 [0.0000]***	0	I(1)
LIR	-2.644560 [0.2640]	4	ΔLIR	-6.644063 [0.0000]***	0	I(1)
INF	-5.011027 [0.0012]***	4	ΔINF	-8.455254 [0.0000]***	0	I(0)
GE	-2.417837 [0.3652]	5	ΔGE	-7.624405 [0.0000]***	0	I(1)
LNGCF	-1.729309 [0.7190]	3	ΔLNGCF	-7.477767 [0.0000]***	0	I(1)
FDI	-3.198073 [0.0997]	0	ΔFDI	-7.033168 [0.0000]***	0	I(1)

Note: ***, ** and * signify significance at the 1%, 5%, and 10% levels respectively, Δ symbolizes the first difference, Bwd is the Band Width, and *I (0)* denotes integration order. P-Values are represented by the values in parenthesis.

Source; Researcher's construct using Eviews 12

Table 4.4 and 4.5 display the outcomes of unit root tests, including only intercept and intercept with the trend at levels and first differences. It becomes obvious that all variables, excluding inflation, were stationary at the first difference under the PP test while not being stationary at levels. To confirm the variables' integration as having varying orders, both ADF and PP tests were carried out, revealing a combination of I (0) and I (1) data types. Since the integration orders are mixed, the Johansen Co-integration test cannot be utilized in this study. Instead, the ARDL model will be employed for further examination.

4.6 Analysis of co-integration

In order to establish the connection between real effective exchange rate, lending interest rate, inflation rate, and economic growth, it is crucial to investigate the existence of long-run equilibrium among these elements by performing co-integration tests. The research uses mixed order data that becomes stationary after the first difference. In situations where the data is of I (0) and I (1) order, the most suitable method to use is the ARDL bound testing model. Bound testing can confirm the presence of co-integration between the variables being studied. The decision criteria proposed by Pesaran et al. (2001) are outlined in the Appendix.

To identify whether time series variables have co-integration, the F-test is computed and related to critical values at a particular significance level.

i. If the F-test exceeds the critical value's upper bound, it indicates the existence of co-integration among the variables.
ii. If the F-test is smaller than the lower bound of critical values, it implies that the variables do not exhibit co-integration.
iii. If the F-test falls within the range of critical values, the outcomes are uncertain and it cannot be definitively determined if there is co-integration or not.

Table 4.6: Results of the ARDL bounds test

Observations included: 35		
The null hypothesis states that there are no long-run relationship present		
T-statistic	Value	k
F-test	4.616109	6
Bounds of critical values		
Significance	I (0) Bound	I (1) Bound
10%	2.12	3.23
5%	2.45	3.61
2.50%	2.75	3.99
1%	3.15	4.43

Source; Researcher's calculation using Eviews 12

The F-statistic of 4.616109 in Table 4.6 surpasses the upper bound value of 4.43, even at a 1% significance level, suggesting that the null hypothesis can be rejected. This means there is a long-run relationship among the variables $\lambda_1 = \lambda_2 = \lambda_3 = \lambda_4 = \lambda_5 = \lambda_6 = \lambda_7 = 0$, can be rejected in favor of the alternative hypothesis, suggesting a long-run relationship among the variables $\lambda_1 \neq \lambda_2 \neq \lambda_3 \neq \lambda_4 \neq \lambda_5 \neq \lambda_6 \neq \lambda_7 \neq 0$, as indicated by the alternative hypothesis. This conclusion is based on the research of Pesaran, Shin, and Smith (2001) and Narayan (2005) at a 1% critical value. As a result, the null hypothesis can be rejected, and a long run relationship is accepted, allowing for the ARDL approach to be used for long run, short-run, and error correction models (ECM).

4.7 Analysis of long-run results

Table 4.7 demonstrates a positive long-run correlation between the real effective exchange rate, inflation, and economic growth. In contrast, lending interest rates exhibit a negative long-run association with economic growth. Apart from the real effective exchange rate, lending interest rate, and gross capital formation, the remaining variables possess limited statistical significance in explaining economic growth due to their t-values being below 2.

The real effective exchange rate positively influences economic growth with a statistical significance, possessing an elasticity of 0.386664. This indicates that a 1% increase or appreciation in the real effective exchange rate could result in a 0.39% rise in economic growth, assuming all other variables remain constant. Although this supports the idea that a growing exchange rate (appreciation) can

positively affect an export-driven economy if its import and export elasticities exceed unity (Mundell-Fleming), it does not guarantee a favorable outcome for Ethiopia's predominantly import-based economy regarding the effect of a rising exchange rate on RGDP.

This finding aligns with studies conducted by Nigussie (2016), Gedion (2014), and Gizachew and Mulugeta (2013), who identified a positive and significant long-run association between the real effective exchange rate and economic growth. Additionally, Deresse (2017) discovered a significant negative long-run relationship between real exchange rate misalignment and economic growth. This implies that consistent depreciation or appreciation of the real exchange rate might hinder Ethiopia's economic growth in the long-run.

For Ethiopia's long-run economic growth, maintaining stability in the real effective exchange rate is crucial. Continuous depreciation or appreciation of the REER could negatively effect factors such as export competitiveness, inflation, capital flows, and debt burdens, which are essential in influencing the economy's growth potential.

On the other hand, Negash (2017) discovered that alterations in the real effective exchange rate did not have any considerable long-run effects on economic growth. As a result, it was determined that policy efforts designed to affect the real effective exchange rate may not substantially influence the country's economic growth. This is in link with Semuel & Nurina (2015) and other researchers, who found no statistically significant relationship between GDP and economic growth. In opposition to this view, Rodrik (2008) argued that the real effective exchange rate has a positive and statistically significant effect on economic growth in the long run.

In summary, a positive and significant long-run relationship exists between the real effective exchange rate and Ethiopia's economic growth at the 10% level, as it influences multiple factors such as promoting exports, substituting imports, attracting foreign direct investments, and facilitating tourism, remittances, and debt service. Ensuring Ethiopia maintains a competitive real effective exchange rate is essential for its ongoing economic development.

According to Table 4.7, the lending interest rate demonstrates the anticipated sign and is statistically significant at a 1% significance level. It exhibits a negative correlation between interest rates and long-run economic growth in Ethiopia, with a negative coefficient of -0.058592. This implies that a 10% increase in interest rates would lead to a 0.59% decrease in economic growth. This finding is supported

by the IS-LM model, which argues that higher interest rates result in reduced investments due to increased borrowing costs. Furthermore, elevated borrowing costs not only diminish investments but also adversely effect the production of goods and services, ultimately causing a country's overall GDP to decline.

Another way real interest rates can influence GDP is through the speculative demand for money. High-interest rates curtail the speculative use of money, which affects the gross domestic product. This result is consistent with the classical interest rate theory, which proposes a negative relationship between the interest rate and investment, ultimately shaping long-run economic growth. The outcome also supports the empirical studies conducted by Mulugeta and Rao (2018).

In terms of a long-run relationship, this finding contradicts Debebe's (2021) empirical research. Nevertheless, Hunibachew's (2021) study discovered that real interest rates had a positive effect on economic growth in the long run.

The substantial and detrimental long-run relationship between lending interest rates and economic growth in Ethiopia may result from various elements such as elevated lending rates, reduced consumption and investment, inflation, inefficient financial systems, crowding out effect, susceptibility to external disturbances, and undeveloped financial markets. Tackling these elements is vital for fostering enduring economic growth in Ethiopia.

Looking at Table 4.7, we can notice that inflation has a positive but insignificant effect on economic growth since it doesn't show statistical significance at 1%, 5%, or 10% levels. The positive coefficient of 0.03490 indicates that a 10% increase in inflation might result in a 0.35% growth in the economy over the long run. However, this relationship is not statistically significant. The insignificance implies that the Ethiopian economy may not be highly influenced by inflation fluctuations over time. This finding is consistent with the empirical studies of Abis (2013), Teshome (2011), and Alemayehu and Kibrom (2008) but contradicts Segni Temsa's (2020) results, which stated a negative and insignificant effect of inflation on Ethiopia's economic growth.

The super-neutrality effects proposed by Sidrauski (1967), which indicate that there is no connection between inflation and long-run output growth rate, show that this research is in line with established theories. According to Sidrauski, the way households respond to inflation influences the steady-state economic growth. This could mean that Ethiopians do not exhibit a consistent reaction to inflation, as

household behaviors toward inflation can vary over time. The study argues that during periods of inflation, individuals in Ethiopia might choose to invest in capital or hold government bonds. This implies that, in the long run, inflation does not effect real variables in the country.

The positive and insignificant long-run connection between inflation and economic growth in Ethiopia can be ascribed to various elements, including:

i. Structural factors, such as the high dependence on agriculture, have an effect on the country's overall economic expansion and inflation rates
ii. Moreover, the long run connection between inflation and growth is influenced by elements such as institutional quality, fiscal policy, and exchange rate policy, which can affect inflation and growth distinctively in diverse situations. This may potentially account for the lack of significance in the relationship between these factors for Ethiopia over an extended period.

However, potential challenges like climate change, political instability, limited infrastructure, and overreliance on agriculture could affect this dynamic in the long run. Continued investment and sound policymaking will be crucial for sustaining long-run economic growth in Ethiopia.

Table 4.7: Long-run co-integration results estimation for economic growth (Refer to Appendix II)

ARDL (5, 3, 2, 2, 1, 2, 3) selected based on AIC dependent variable: LnRGDP				
Variable.	Coefficient.	Std Error.	T-Ratio.	Prob-value.
LnREER	0.386664	0.187467	2.062574	0.0661*
LIR	-0.058592	0.014554	-4.025821	0.0024***
INF	0.003490	0.003658	0.954113	0.3625
GE	-0.015058	0.024393	-0.617301	0.5508
LnGCF	0.364955	0.024189	15.08781	0.0000***
FDI	0.044954	0.020442	2.199102	0.0525*
C	8.166374	0.921435	8.862668	0.0000***

Note: The symbols ***, ** and * represent significance levels at 1%, 5%, and 10% respectively
Source: The author has created this statement using Eviews 12 software.

In summary, this research investigates the effect of the real effective exchange rate, lending interest rate, and inflation on the economic growth of Ethiopia. The findings indicate that the real effective exchange rate positively contributes to economic growth in the long run, while, as per classical theory, the lending interest rate hampers growth. Inflation exhibits a positive and either neutral or insignificant long-run effect on economic growth. This assessment concentrates on the long-run implications of these macroeconomic elements; the subsequent section will explore their short-run effect on Ethiopia's economic growth.

4.8 The Error correction model (ECM) and analysis of short-run results

The ECM demonstrates the short-run dynamics between dependent and independent variables. Utilizing maximum of 5 and 3 lags, the ARDL model identifies the appropriate lags for the predictor variables and conducts regression automatically, as seen in the ARDL Co-integration and Long Run Form in Appendix X. The subsequent table displays the short-run ARDL results.

Table 4.8 demonstrates a significant positive correlation between the real effective exchange rate and short-run economic growth. With a coefficient of 0.106865, a 1% increase in the real effective exchange rate leads to a 0.107% growth in the economy. This statistically significant result indicates that Ethiopia's economy responds to variations in the real effective exchange rate over a short period, possibly due to the country's import and export elasticity. Furthermore, the effect of modifications in the real effective exchange rate is experienced relatively swiftly, resulting in a significant positive long-run influence on the economy, as mentioned earlier in the section discussing long-run dynamics. This empirical finding is consistent with the studies conducted by Mengistu (2015), Lakew (2015), and Teshome (2014).

Compared to the initial year's real effective exchange rate, a negative and significant effect on economic growth was observed at both lag 1 and lag 2, suggesting that Ethiopia's real effective exchange rate has short-run effects on the economy, with implications lasting beyond the first year. The coefficients of -0.181955 and -0.131691 demonstrate a decrease in economic growth as the real effective exchange rate increases. Specifically, a 1% increase in the real effective exchange rate would result in economic growth dropping by 0.18% and 0.13% for lag 1 and lag 2, respectively. The effects of exchange rate changes on the economy may not be immediately felt and can take time to fully materialize. In the short run, the positive effect of an exchange rate change may dominate as businesses and individuals adjust their behavior. However, with a lag of one or two years, the negative consequences, such as reduced investment or decreased consumer purchasing power, may start to manifest, leading to a negative

relationship between exchange rates and economic growth. Excluding the first year, these short-run findings do not correspond with the long-run Keynesian absorption theory related to currency depreciation in the exchange rate, which substantiates Deresse's 2017 study.

Although long-run lending interest rates exhibited negative and statistically significant outcomes, their short-run effects were also negative and statistically significant. The lending interest rate had a -0.022445 coefficient, meaning that a 1% increase would result in a 0.022% decline in economic growth. This is statistically significant, indicating that the Ethiopian economy responds to changes in lending interest rates in the short run. Both long and short run results are consistent with the classical interest rate theory. These findings support the empirical research of Mulugeta and Rao (2018), but they do not confirm the studies of Debebe (2021) and Hunibachew (2021).

In the long run, inflation has displayed positive yet statistically insignificant outcomes, while in the short run; it has exhibited a negative and statistically significant influence at a one-lag duration. This suggests that an escalation in inflation contributes to a decline in economic growth. With an inflation elasticity of -0.002605, a 10% rise in short-run inflation leads to a 0.03% drop in economic growth at a 1% confidence level. This is in line with the adverse effects of inflation proposed by Stockman (1981) and Fischer (1983). The findings are consistent with prior research by Khan and Senhadji (2011), Gillman et al (2004), and Teshome Bogale and Belachew Teshome (2017), yet they contradict the conclusions of Abis (2013), Teshome (2011), and Alemayehu and Kibrom (2008).

Drawing on Stockman's idea of the cash-in-advance constraint, individuals must possess money ahead of time for consumption or capital investment. Stockman suggests that an increase in inflation results in a decline in the real value of cash held by individuals, leading to reduced capital investments. This decrease in investment adversely affects economic growth. This concept explains the detrimental effects of inflation on Ethiopia's short-run economic growth, as illustrated in Table 4.8. Roa and Yesigat's (2015) research corroborates these results, demonstrating a negative relationship between inflation and short-run economic growth. Their study shows that a 1% rise in inflation leads to a 0.23% decrease in Ethiopia's economic growth.

As shown in the table 4.8 below, government expenditure exhibits a positive but statistically insignificant impact in the short run. Similarly, gross capital formation displays a positive and statistically significant effect with a one-period lag. Conversely, foreign direct investment demonstrates

a negative and statistically significant influence with a one-period lag.

Table 4.8: Estimations for short-run economic growth results (Refer to Appendix III)

ARDL (5, 3, 2, 2, 1, 2, 3) selected based on AIC dependent variable: LnRGDP

Variable.	Coefficient.	Std Error.	T-Statistic.	Prob.
C	3.862377	0.535197	7.216738	0.0000***
D(LnRGDP(-1))	0.453574	0.103975	4.362320	0.0014***
D(LnRGDP(-2))	-0.284133	0.093921	-3.025247	0.0128**
D(LnRGDP(-3))	0.590024	0.079614	7.411029	0.0000***
D(LnRGDP(-4))	-0.344382	0.080057	-4.301714	0.0016***
D(LnREER)	0.106865	0.039361	2.715016	0.0217**
D(LnREER(-1)	-0.181955	0.035610	-5.109621	0.0005***
D(LnREER(-2)	-0.131691	0.023248	-5.664557	0.0002***
D(LIR)	-0.022445	0.006020	-3.728094	0.0039***
D(LIR(-1))	0.009196	0.004350	2.114135	0.0606*
D(INF)	-0.000316	0.000340	-0.929181	0.3747
D(INF(-1))	-0.002605	0.000414	-6.288611	0.0001***
D(GE)	0.002670	0.003155	0.846492	0.4171
D(LnGCF)	0.031354	0.026560	1.180493	0.2651
D(LnGCF(-1))	0.102106	0.031547	3.236663	0.0089***
D(FDI)	0.006027	0.003592	1.677955	0.1243
D(FDI(-1))	-0.021615	0.003540	-6.106427	0.0001***
D(FDI(-2))	-0.015488	0.003275	-4.729908	0.0008***
CoinEq(-1)*	-0.472961	0.065778	-7.190301	0.0000***

R squared	0.951074
Adjusted R squared	0.896032
S.E of regression	0.018130
F statistic	17.27905
Durbin Watson stat	2.311733
Prob(F statistic)	0.000000

Note: The symbols ***, ** and * represent significance levels at 1%, 5%, and 10% respectively
Source: The author has created this statement using Eviews 12 software.

In a similar manner, the ECT represents the rate at which the system reestablishes a balanced state. In essence, it measures the pace at which the model regains equilibrium following a disturbance. The ECT has a negative and significant coefficient, indicating that the economy recovers equilibrium in less than a year after a short-run shock. The results clearly demonstrate that when the system is in disequilibrium, the model readjusts at a 0.472961 rate. Put differently, the model returns to equilibrium at a 47.30% speed within a year.

The adjusted R square is 0.896032, indicating that the explanatory variables account for 89.60% of the fluctuations in economic growth. The entire model is statistically significant, with all variables displaying anticipated signs and significance, except for inflation, which has no long-run effect on the Ethiopian economy. As anticipated, there is a significant negative effect of the interest rate.

4.9 Diagnostic test results

The diagnostic tests carried out comprised the serial correlation test, heteroskedasticity test, ARCH test, normality test, specification test, functional form, and multicollinearity test. The findings of these tests can be seen in the table presented below.

Table 4.9 demonstrates the use of the Durbin-Watson statistic is a measure of autocorrelation in the residuals of a regression model. It ranges from 0 to 4, with values around 2 indicating no significant autocorrelation. In the case of the given result, a Durbin-Watson statistic of 2.311733 suggests that there is a moderate positive autocorrelation present in the residuals of the regression model. This means that there is a tendency for the residuals to be positively correlated with each other, indicating that there may be some underlying pattern or relationship not accounted for by the model. Furthermore, the Breusch-Pagan-Godfrey test produced a probability value of 0.8939, also exceeding 5%, meaning that the homoscedasticity null hypothesis cannot be dismissed, and indicating the absence of heteroskedasticity. Additionally, the Bera-Jarque statistics display a P-value of 0.374550, which exceeds 0.05, signifying that there are no irregularities in the data and therefore, a normal distribution of errors is present, as depicted in the table below.

Table 4.9: Post estimation diagnostic test results (Appendices V, VI, VII, VIII, and XI)

T- Statistics.	Results.	P-value.	Test.
Serial Correlation	2.311733		Durbin Watson stat
Heteroskedasticity	F(24,10)=0.541899	(0.8939)	Breusch-Pagan-Godfrey
ARCH Test	F(1,32)=1.710461	(0.2002)	ARCH
Normality	JB=1.964059	(0.374550)	Jarque-Bera
Functional form	F(1,9)=0.627945	(0.4485)	Ramsey RESET
			BKW coefficient
Multicollinearity	Small proportions not near to one (1)		variance decomposition

Source; Researcher's construct using Eviews 12

In conclusion, the outcomes of the diagnostic tests confirm that the model is statistically reliable, as they detected no problems related to serial correlation, heteroskedasticity, ARCH effect, normality, specification, functional form, or multicollinearity.

The lack of serial correlation signifies that the model is free from problems associated with omitted variables or misspecification. Having homoscedasticity and no ARCH effect indicates that the model's errors remain consistent across various observation levels, resolving any concerns related to volatility clustering. With normally distributed errors, it is reasonable to assume that the model adheres to the classical linear regression assumptions.

The Ramsey RESET test confirms the functional form and specification of the model, guaranteeing correct specification and resolving any problems related to model misspecification. This is evidenced by the probability value surpassing 5 percent, as shown in the table above. Additionally, the CUSUM and CUSUM sum of square tests in Appendix IX illustrate the constancy of the coefficients and residual variances over time, indicating that the model is reliable and consistently generates precise outcomes.

Lastly, the smallest condition number of 3.74E-09 in Appendix XI suggests a potential occurrence of multicollinearity. However, none of the twenty-four regressors has proportions greater than 0.5 in relation to the smallest condition number, clearly demonstrating that there is no presence of near-perfect multicollinearity.

In summary, the outcomes from the diagnostic tests suggest that the model acts as a robust statistical

tool for understanding the relationship between the relevant variables. The model's high quality and effectiveness demonstrate its potential for being used in developing policies and making decisions.

4.10 Robustness checks

To confirm and support the ARDL results, the research utilized DOLS and RLS methods. Table 4.10 displays the analysis outcomes, which, despite varying magnitudes, exhibit similar signs and significance levels as the ARDL estimates. This clearly indicates that the DOLS and RLS results reinforce the ARDL findings, ensuring that the model estimation for real effective exchange rate, inflation, and lending interest rate is not chance.

Table 4.10: Robustness check using DOLS and RLS

Variable	DOLS Coefficient	P-Value.	RLS Coefficient.	P-Value.
LNREER	0.433110	0.0000	2.298796	0.0000
LIR	-0.029163	0.0000	-0.077332	0.0002
INF	0.001724	0.3073	-0.002954	0.4906
GE	0.009948	0.0924	0.068351	0.0004
LNGCF	0.377504	0.0000	0.218414	0.0000
FDI	-0.003007	0.6059	0.070943	0.0242

Source; Author's construct using Eviews 12

This study accurately demonstrates the long-run effects of exchange rate, inflation, and interest rate on Ethiopia's economic growth, consequently offering crucial understanding for making deductions and establishing policies.

4.11 Empirical estimation of the threshold level of inflation

In the third chapter, we investigated the use of the ordinary Least Square (OLS) technique for precisely identifying the inflation threshold level. This method aims to pinpoint the optimal inflation threshold from a range of escalating values by either maximizing the R^2 value or reducing the residual sum of squares (RSS).

The first difference of the real gross domestic product growth rate (GGDP) and the initial inflation rate,

as previously mentioned in this empirical model, are utilized to estimate inflation and economic growth. The first difference in the growth of gross capital formation, the first difference in the growth rate of money supply, and the first difference in openness are also used as control variables. This implies that the growth of gross fixed capital formation is calculated based on the gross capital formation and the first difference of gross capital formation.

4.11.1 Data and descriptive statistics

The descriptive statistics of the sample data show that the average economic output growth is 6.141000, the mean inflation rate stands at 9.90%, the average gross capital formation (GCF) is at 20.93% percent, and the growth of the money supply (M2) has a mean value of 17.43%. Furthermore, the average trade openness (OPEN) throughout the sample period is 9.767618 (Table 4.11).

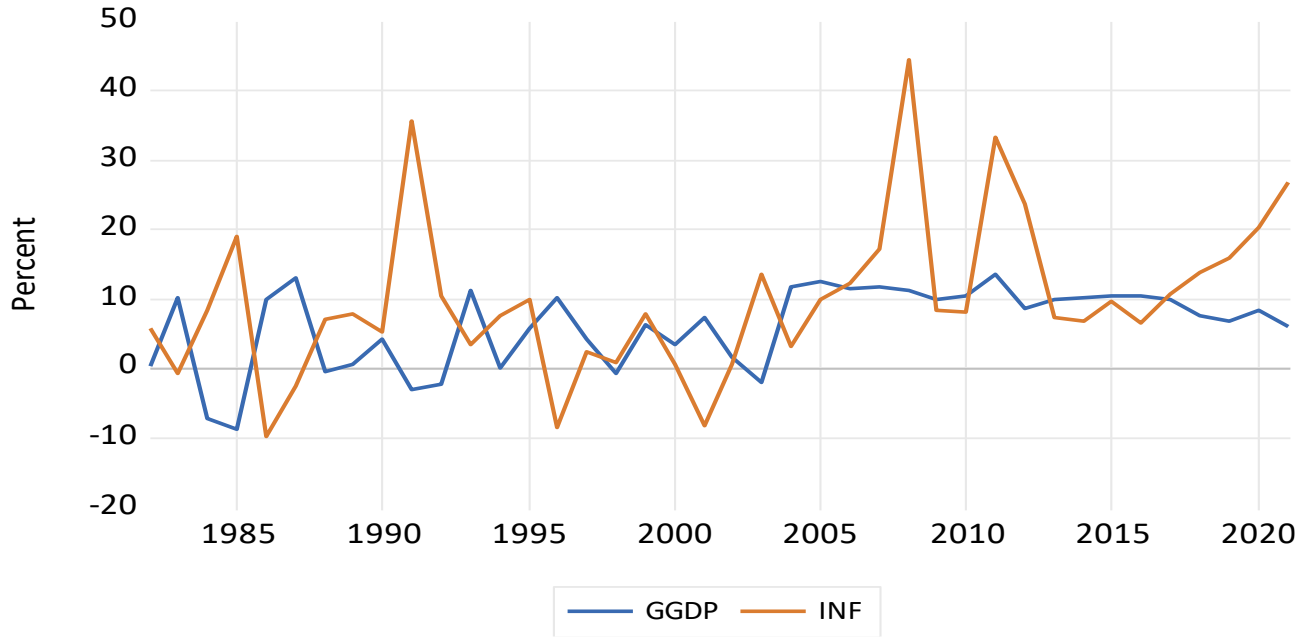
Table 4.11: Descriptive Statistics

Variable.	N.	Mean.	SD.	Min.	Max.
GDP Growth rate (GGDP)	40	6.141000	5.811156	-8.790000	13.46000
Inflation (INF)	40	9.903500	11.31735	-9.810000	44.36000
Growth of Gross Capital Formation(GGCF)	40	20.92650	24.92471	-25.85000	98.42000
M2 growth rate (GM2)	40	17.43250	7.926793	4.100000	39.20000
Trade openness (OPEN)	40	9.767618	10.09088	0.848500	31.46400

Source: own calculation employing E-views 12 software

Figure 3 depicts the trend of inflation and GDP growth throughout the research period from 1982 to 2021. Upon visually analyzing the trends in inflation and GDP growth, it becomes evident that there is a predominantly negative and non-linear correlation between the two. Generally, higher inflation rates correspond with lower growth rates, and in certain instances, both variables progress simultaneously.

Figure 3: Trends in Inflation and Real GDP Growth



Source: Own computation employing E-views 12 software

4.11.2 Unit root test results

Table 4.12 displays the results of the unit root tests for the concerned variables. The Augmented Dickey-Fuller (ADF) test for unit root reveals that economic growth and inflation are stationary, as are gross capital formation, growth of money supply, and trade openness. As a result, the unit root test findings suggest that the inflation variables possess an integration order of zero, I(0), while the integration order for economic growth, gross capital formation, money supply, and trade openness is one, I(1).

Table 4.12: ADF unit root test results (p-values)

Variable	At level		At 1st difference		Order of Integration
	Trend and Constant	Constant	Trend and Constant	Constant (P Values)	
GGDP	0.2933	0.1842	0.0000	0.0000	I (1)
INF	0.0013	0.0011	0.0000	0.0000	I (0)
GGCF	0.0000	0.0000	0.0000	0.0000	I (0)
GM2	0.0283	0.1123	0.0000	0.0000	I (1)
OPEN	0.9108	0.9995	0.0087	0.0089	I (1)

Source; Author's construct using Eviews 12

4.11.3 Estimation Results and Inferences

Upon assessing the stationarity of variables within the time series, a long-run equilibrium is determined by estimating 14 unique equations that have various threshold levels, spanning from 2 to 15. In accordance with Khan and Sendhaji's (2001) suggestion, the model possessing the lowest residual sum of squares and statistical significance is selected as the inflation rate threshold level. Employing this method, the resulting equation meeting these requirements has a threshold inflation of 7 percent. This outcome is consistent with Khan and Sendhaji's (2001) prior observation of an inflation threshold between 7% and 11% for developing countries.

Table 4.13: OLS estimation of the optimal inflation threshold

Dependent variable: GGDP

Variable	Coefficient	Std. Error	t-Statistic	Prob.
INF	-0.775142	0.226770	-3.418195	0.0017
TR7	0.703962	0.282818	2.489099	0.0180
GGCF	0.102536	0.040210	2.549976	0.0156
GM2	0.215891	0.155645	1.387069	0.1747
OPEN	0.015546	0.701491	0.022161	0.9825
C	1.790592	1.512192	1.184103	0.2448

R-squared	0.347847	Normality	0.247063 (0.883794)
Adjusted R-squared	0.249036	Serial Correlation	1.561660 (0.2258)
Sum squared resid.	1168.194	Hetroskedasticity Test	1.611833 (0.1843)
F-statistic	3.520324	ARCH Test	1.624363 (0.2107)
Prob (F-statistic)	0.011655	Ramsey RESET	0.024030 (0.8778)
Durbin -Watson stat.	2.398636		

Source; Author's construct using Eviews 12

The result in Table 4.13 demonstrate that when inflation is below 7 percent, it has a considerably positive effect on GGDP. The preferred threshold for inflation was selected due to the least residual sum of

squares (RSS = 1168.194) and a higher R^2 = 0.347847 in comparison to calculations involving inflation thresholds ranging from 2 to 15 (see Appendix XIV). According to the regression analysis, a 1-percentage point rise in the yearly inflation rate at this specific threshold would lead to a 0.70 percentage point increase in the annual GDP growth rate. This implies a positive relationship between inflation rate and GDP growth rate at this particular inflation threshold.

Higher inflation can be both good and bad for economic growth, depending on the context and level of inflation. Moderate inflation can be beneficial for economic growth because it encourages spending and investment. When consumers expect prices to increase in the future, they are more likely to spend their money now rather than save it. Businesses are also more likely to invest in new projects or expand their operations when they anticipate future price increases. This increased spending and investment can stimulate economic growth.

However, high inflation can be detrimental to economic growth. When inflation is too high, it erodes the purchasing power of money and makes planning for the future more difficult, which can lead to reduced consumer spending and business investment. High inflation can also lead to uncertainty in the economy, which can negatively affect business and consumer confidence, further hindering economic growth.

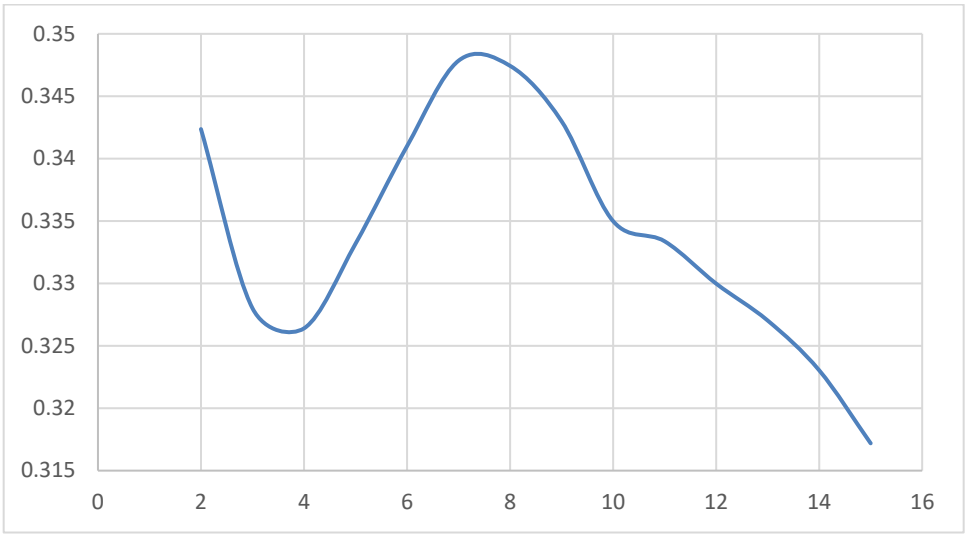
Moreover, high inflation can lead to increased interest rates as central banks attempt to control inflation, which can then result in reduced investment and slower economic growth.

Conversely, the results showed that in the Ethiopian scenario (without a threshold), the total influence of inflation, indicated by the inflation rate, and has a significant negative effect on growth.

The model's adjusted R^2 demonstrated that the model explains 25% of the dependent variable's variation. A Durbin-watson statistic of 2.40 signifies no autocorrelation between the variables. Furthermore, the residual diagnostic tests corroborate the stability of the residuals, indicating no serial correlation, normal distribution, and homoscedasticity. Therefore, it is feasible to use the model for statistical inference.

To summarize, the results of determining the optimal inflation threshold level show that an inflation rate of up to 7% does not significantly harm economic growth. However, if the inflation rate goes beyond 7%, it will negatively affect economic growth.

Figure 4: Graph of R-Squared



As observed in Figure 3, the R-squared level declines until the designated inflation threshold (k) hits 4%. However, there is an upward shift in R-squared when the inflation threshold rises from 4% to 7%. Beyond 7%, increasing the inflation threshold results in a decrease in R-squared value, indicating that R-squared reaches its maximum value at 7%.

In conclusion, the sensitivity analysis Two-stage least squares (2SLS) was not carried out to assess the model's robustness, so the interpretation should be approached cautiously. The model's potential lack of robustness may be due to the linear estimation technique employed and the data quality. Therefore, additional research is necessary on this subject, particularly in the context of Ethiopia.

Chapter Five

5 Conclusion and Recommendations

5.1 Conclusion

The chapter being discussed includes a summary of the results, conclusions drawn from these results, and crucial suggestions. In addition, this chapter also examines the limitations associated with the research and possible avenues for future studies. The summary of the findings presents a clear comprehension of the research problem, objectives, and overall results. The conclusion highlights the general outcome in relation to the hypothesis. Recommendations offer direction for government policies and other macroeconomic stakeholders concerning elements influencing the country's economic growth and its administration. Moreover, this chapter addresses the constraints encountered during the research and suggests areas for additional investigation.

This study aims to determine the relationships between real effective exchange rates, lending interest rates, inflation, and economic growth in both long and short-run scenarios. Additionally, the research addresses the factors that influence long-run economic growth. Moreover, it aims to examine the optimal level of inflation rate that can be maintained without negatively affecting economic growth.

This research paper aims to enrich the existing literature in this field by conducting an extensive examination of literature reviews, identifying any existing gaps, and addressing those gaps. In addition, it offers valuable policy guidance for macroeconomic policymakers and central bankers on the appropriate inflation levels to target in the country's monetary policy.

Based on the co-integration test findings, the researcher rejected the null hypothesis and chose the alternative hypothesis - indicating the presence of co-integration among the variables. Table 4.6 supports this, where the F-statistic of 4.616109 exceeds the maximum upper bound I (1) value of 4.43, even at the 1% level.

In order to evaluate the long-run effect on economic growth, Autoregressive Distributed Lag and Error Correction Term approaches were utilized. The majority of the variables were found to be significant based on the rule of thumb, with the exception of inflation and government spending. The findings showed that a 1% increase in the real effective exchange rate would result in a 0.39% growth in the economy, assuming other factors remain constant. This can be attributed to the stable exchange rate in Ethiopia (managed float), leading to the positive relationship between the exchange rate and economic

growth. Likewise, employing the IS-LM model, there was a decrease in economic growth corresponding to a 0.059 percent increase in the interest rate. Additionally, when the country's inflation increases by 10%, economic growth declines by 0.035%.

The findings reveal that the exchange rate considerably enhances economic growth in the short run. Interest rates have a persistent influence on growth in both short and long timeframes. In Ethiopia, interest rates have a notably detrimental effect on economic growth in both the short and long run. Contrarily, the short-run effect of inflation on economic growth is negative and significant at lag1, unlike its long-run implications.

According to the model's significant and negative ECT, a shock will not result in any long-run deviations from equilibrium. This means that if there is a disturbance, the model will regain its long-run equilibrium. With an adjustment coefficient of 0.472961, it indicates that the model will restore its long-run trajectory in under a year.

Though there is a positive long-run relationship between the two macroeconomic factors, high and unstable inflation rates can negatively effect growth. As a result, determining the inflation threshold level is a crucial goal of this research. A key finding of this paper is the recognition of a 7% inflation threshold. When inflation is either above or below 7%, it hinders economic growth, while a 7% inflation rate ensures optimal growth. While this rate of inflation may be considered high for developed nations, it is acceptable for a developing country like Ethiopia. This finding is consistent with the well-known study by Khan and Senhadji (2001), which also sought to determine the inflation threshold level.

In light of the previously mentioned results, the researchers put forth several suggestions, which were in link with the Mundell-Fleming model, the classical interest rate theory, and the perspectives of Sidrauski, Stockman, Mundell, and Tobin on how inflation affects economic growth.

5.2 Recommendation

The institutions responsible for developing monetary policies and regulatory authorities, for example the Ministry of Finance, Planning and Development Commission, National Bank of Ethiopia, and others, need to delve deeper into the relationships between different elements and assess their influence on the economic expansion of Ethiopia.

In the process of policy formulation and decision-making, it is essential for all stakeholders to consider

the collective effect of economic factors on Ethiopia's economic development, rather than concentrating only on their separate effects. This is because of the interconnectedness of these variables.

An example of this is the National Bank of Ethiopia's single-digit inflation targeting, which may not be the most efficient approach to encourage favorable economic expansion, given that other variables like exchange rates and lending interest rates have similar effects on the economy.

In simpler words, based on this finding, it is recommended to maintain the current managed float exchange rate system in Ethiopia to support economic growth. Additionally, policymakers should monitor and manage other factors that may influence economic growth to ensure a favorable environment for sustained development. It is important to consider the time lags in the transmission mechanism when analyzing the effects of exchange rate changes on the economy. In the short run, exchange rate changes may have a positive effect as businesses and individuals adjust their behavior. However, it is crucial to recognize that negative consequences, such as reduced investment and decreased consumer purchasing power, may start to manifest with a delay of one or two years. Policymakers and analysts should consider these time lags when formulating policies or making economic projections to avoid potential negative effects on economic growth.

The government should create, implement, and support initiatives and projects for promoting exports, with the goal of enhancing economic growth through the devaluation of the birr. The effectiveness of this strategy rely on the elasticity of locally produced goods meant for export, which must be considerably elastic.

On the other hand, it was noticed that interest rates negative affect economic growth. As a result, it is crucial to keep interest rates comparatively low to guarantee that the cost of capital stays below the marginal productivity of capital.

In order to accomplish this goal, the National Bank of Ethiopia (NBE) must persist in its pursuit of the lending interest rate. Furthermore, the NBE needs to decrease domestic borrowing. As a result of this reduction in domestic borrowing, for example, the Treasury bill rate will be lowered. It should reach a point where investing in fixed deposits becomes more appealing than investing in Treasury bills.

Based on the findings mentioned earlier, it is suggested that those responsible for creating monetary and fiscal policies pay close attention to the provided insights. This will assist them in developing successful

strategies to appropriately manage these microeconomic factors, ultimately promoting economic growth.

5.3 Suggestions for future research

Seeing the results of the present study, potential future research could explore the following topics: Firstly, examining the optimal lending rate essential for Ethiopia's economic development; secondly, conducting an analysis to evaluate the effect of lending rates on private sector investments in the nation. Furthermore, future studies could investigate the relationship between elements such as real effective exchange rates, lending interest rates, inflation, and economic growth in developing and emerging countries with comparable economic situations to improve comprehension of their interplay across various economies and by including the estimation of the structure break.

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APPENDICES A

APPENDIX I. ARDL Bounds Test

ARDL Bounds Test
Date: 04/10/23 Time: 23:25 Sample: 1982 2021
Included observations: 35
Null Hypothesis: No long-run relationships exist

Test Statistic	Value	k
F-statistic	4.616109	6
Critical Value Bounds		
Significance	I(0) Bound	I(1) Bound
10%	2.12	3.23
5%	2.45	3.61
2.50%	2.75	3.99
1%	3.15	4.43

Dependent Variable: LNRGDP
Method: ARDL
Date: 04/10/23 Time: 16:23
Sample (adjusted): 1987 2021
Included observations: 35 after adjustments
Maximum dependent lags: 5 (Automatic selection)
Model selection method: Akaike info criterion (AIC)
Dynamic regressors (3 lags, automatic): LNREER LIR INF GE LNGCF FDI
Fixed regressors: C
Number of models evaluated: 20480
Selected Model: ARDL(5, 3, 2, 2, 1, 2, 3)

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
LNRGDP(-1)	0.980613	0.290746	3.372752	0.0071
LNRGDP(-2)	-0.737708	0.289019	-2.552453	0.0287
LNRGDP(-3)	0.874157	0.211920	4.124948	0.0021
LNRGDP(-4)	-0.934405	0.266488	-3.506369	0.0057
LNRGDP(-5)	0.344382	0.152640	2.256162	0.0477
LNREER	0.106865	0.076683	1.393602	0.1936
LNREER(-1)	-0.105944	0.074087	-1.429992	0.1832
LNREER(-2)	0.050265	0.050130	1.002698	0.3397
LNREER(-3)	0.131691	0.041592	3.166255	0.0101
LIR	-0.022445	0.011594	-1.935858	0.0816
LIR(-1)	0.003930	0.010092	0.389407	0.7051
LIR(-2)	-0.009196	0.007364	-1.248812	0.2402
INF	-0.000316	0.000938	-0.336660	0.7433
INF(-1)	-0.000638	0.001036	-0.615640	0.5519
INF(-2)	0.002605	0.001092	2.386167	0.0382
GE	0.002670	0.007716	0.346079	0.7365
GE(-1)	-0.009792	0.007767	-1.260696	0.2360
LNGCF	0.031354	0.057422	0.546035	0.5970
LNGCF(-1)	0.243361	0.066687	3.649314	0.0045
LNGCF(-2)	-0.102106	0.080772	-1.264123	0.2349
FDI	0.006027	0.007292	0.826481	0.4278
FDI(-1)	-0.006380	0.005525	-1.154803	0.2750
FDI(-2)	0.006126	0.006369	0.961954	0.3588
FDI(-3)	0.015488	0.005459	2.837133	0.0176
C	3.862377	1.342579	2.876834	0.0165

R-squared	0.999700	Mean dependent var	13.31549
Adjusted R-squared	0.998981	S.D. dependent var	0.718337
S.E. of regression	0.022933	Akaike info criterion	-4.536640
Sum squared resid	0.005259	Schwarz criterion	-3.425677
Log likelihood	104.3912	Hannan-Quinn criter.	-4.153136
F-statistic	1389.500	Durbin-Watson stat	2.311733
Prob(F-statistic)	0.000000		

*Note: p-values and any subsequent tests do not account for model

APPENDIX II. ARDL Co-integrating and Long Run Form

ARDL Long Run Form and Bounds Test
Dependent Variable: D(LNRGDP)
Selected Model: ARDL(5, 3, 2, 2, 1, 2, 3)
Case 2: Restricted Constant and No Trend
Date: 04/10/23 Time: 16:24
Sample: 1982 2021
Included observations: 35

Co-integrating Form

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	3.862377	1.342579	2.876834	0.0165
LNRGDP(-1)*	-0.472961	0.151763	-3.116444	0.0109
LNREER(-1)	0.182877	0.101237	1.806431	0.1010
LIR(-1)	-0.027712	0.008233	-3.366096	0.0072
INF(-1)	0.001651	0.001805	0.914524	0.3820
GE(-1)	-0.007122	0.011862	-0.600371	0.5616
LNGCF(-1)	0.172609	0.054390	3.173557	0.0099
FDI(-1)	0.021261	0.009334	2.277765	0.0460
D(LNRGDP(-1))	0.453574	0.285645	1.587893	0.1434
D(LNRGDP(-2))	-0.284133	0.173620	-1.636526	0.1328
D(LNRGDP(-3))	0.590024	0.169384	3.483354	0.0059
D(LNRGDP(-4))	-0.344382	0.152640	-2.256162	0.0477
D(LNREER)	0.106865	0.076683	1.393602	0.1936
D(LNREER(-1))	-0.181955	0.076177	-2.388598	0.0380
D(LNREER(-2))	-0.131691	0.041592	-3.166255	0.0101
D(LIR)	-0.022445	0.011594	-1.935858	0.0816
D(LIR(-1))	0.009196	0.007364	1.248812	0.2402
D(INF)	-0.000316	0.000938	-0.336660	0.7433
D(INF(-1))	-0.002605	0.001092	-2.386167	0.0382
D(GE)	0.002670	0.007716	0.346079	0.7365
D(LNGCF)	0.031354	0.057422	0.546035	0.5970
D(LNGCF(-1))	0.102106	0.080772	1.264123	0.2349
D(FDI)	0.006027	0.007292	0.826481	0.4278
D(FDI(-1))	-0.021615	0.005702	-3.790582	0.0035
D(FDI(-2))	-0.015488	0.005459	-2.837133	0.0176

* p-value incompatible with t-Bounds distribution.

Long Run Coefficients

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LNREER	0.386664	0.187467	2.062574	0.0661
LIR	-0.058592	0.014554	-4.025821	0.0024
INF	0.003490	0.003658	0.954113	0.3625
GE	-0.015058	0.024393	-0.617301	0.5508
LNGCF	0.364955	0.024189	15.08781	0.0000
FDI	0.044954	0.020442	2.199102	0.0525
C	8.166374	0.921435	8.862668	0.0000

EC = LNRGDP - (0.3867*LNREER -0.0586*LIR + 0.0035*INF -0.0151*GE +
0.3650*LNGCF + 0.0450*FDI + 8.1664)

APPENDIX III. ARDL Error Correction Regression

ARDL Error Correction Regression
Dependent Variable: D(LNRGDP)
Selected Model: ARDL(5, 3, 2, 2, 1, 2, 3)
Case 3: Unrestricted Constant and No Trend
Date: 04/12/23 Time: 13:57
Sample: 1982 2021
Included observations: 35

ECM Regression
Case 3: Unrestricted Constant and No Trend

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	3.862377	0.535197	7.216738	0.0000
D(LNRGDP(-1))	0.453574	0.103975	4.362320	0.0014
D(LNRGDP(-2))	-0.284133	0.093921	-3.025247	0.0128
D(LNRGDP(-3))	0.590024	0.079614	7.411029	0.0000
D(LNRGDP(-4))	-0.344382	0.080057	-4.301714	0.0016
D(LNREER)	0.106865	0.039361	2.715016	0.0217
D(LNREER(-1))	-0.181955	0.035610	-5.109621	0.0005
D(LNREER(-2))	-0.131691	0.023248	-5.664557	0.0002
D(LIR)	-0.022445	0.006020	-3.728094	0.0039
D(LIR(-1))	0.009196	0.004350	2.114135	0.0606
D(INF)	-0.000316	0.000340	-0.929181	0.3747
D(INF(-1))	-0.002605	0.000414	-6.288611	0.0001
D(GE)	0.002670	0.003155	0.846492	0.4171
D(LNGCF)	0.031354	0.026560	1.180493	0.2651
D(LNGCF(-1))	0.102106	0.031547	3.236663	0.0089
D(FDI)	0.006027	0.003592	1.677955	0.1243
D(FDI(-1))	-0.021615	0.003540	-6.106427	0.0001
D(FDI(-2))	-0.015488	0.003275	-4.729908	0.0008
CointEq(-1)*	-0.472961	0.065778	-7.190301	0.0000

R-squared	0.951074	Mean dependent var	0.062443
Adjusted R-squared	0.896032	S.D. dependent var	0.056229
S.E. of regression	0.018130	Akaike info criterion	-4.879497
Sum squared resid	0.005259	Schwarz criterion	-4.035165
Log likelihood	104.3912	Hannan-Quinn criter.	-4.588034
F-statistic	17.27905	Durbin-Watson stat	2.311733
Prob(F-statistic)	0.000000		

* p-value incompatible with t-Bounds distribution.

F-Bounds Test — Null Hypothesis: No levels relationship

Test Statistic	Value	Signif.	I(0)	I(1)
F-statistic	4.616109	10%	2.12	3.23
k	6	5%	2.45	3.61
		2.5%	2.75	3.99
		1%	3.15	4.43

APPENDIX IV. Breusch-Godfrey Serial Correlation LM Test

Breusch-Godfrey Serial Correlation LM Test:
Null hypothesis: No serial correlation at up to 2 lags

F-statistic	0.326215	Prob. F(2,8)	0.7308
Obs*R-squared	2.639151	Prob. Chi-Square(2)	0.2672

Test Equation:
Dependent Variable: RESID
Method: ARDL
Date: 04/10/23 Time: 16:45
Sample: 1987 2021
Included observations: 35
Presample missing value lagged residuals set to zero.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LNRGDP(-1)	0.104274	0.399900	0.260751	0.8009
LNRGDP(-2)	-0.006215	0.359724	-0.017276	0.9866
LNRGDP(-3)	-0.034672	0.234270	-0.147999	0.8860
LNRGDP(-4)	-0.015197	0.302663	-0.050213	0.9612
LNRGDP(-5)	-0.001079	0.170334	-0.006333	0.9951
LNREER	-0.018245	0.088632	-0.205856	0.8420
LNREER(-1)	-0.010032	0.083412	-0.120273	0.9072
LNREER(-2)	0.010048	0.055886	0.179787	0.8618
LNREER(-3)	0.000693	0.045588	0.015212	0.9882
LIR	-0.000837	0.012614	-0.066365	0.9487
LIR(-1)	0.001806	0.011734	0.153934	0.8815
LIR(-2)	-0.000971	0.008911	-0.108922	0.9159
INF	-0.000355	0.001184	-0.299455	0.7722
INF(-1)	0.000236	0.001330	0.177621	0.8634
INF(-2)	7.46E-05	0.001201	0.062121	0.9520
GE	-0.001316	0.009121	-0.144298	0.8888
GE(-1)	-0.001229	0.009118	-0.134826	0.8961
LNGCF	0.017459	0.070579	0.247362	0.8109
LNGCF(-1)	-0.010415	0.073211	-0.142256	0.8904
LNGCF(-2)	-0.026035	0.096536	-0.269694	0.7942
FDI	-0.001034	0.008014	-0.128984	0.9006
FDI(-1)	0.000625	0.006362	0.098291	0.9241
FDI(-2)	0.001920	0.007358	0.260936	0.8007
FDI(-3)	-0.001469	0.006729	-0.218343	0.8326
C	-0.327106	1.500170	-0.218046	0.8329
RESID(-1)	-0.346681	0.480262	-0.721857	0.4909
RESID(-2)	-0.158943	0.438558	-0.362423	0.7264

R-squared	0.075404	Mean dependent var	6.22E-16
Adjusted R-squared	-2.929532	S.D. dependent var	0.012437
S.E. of regression	0.024655	Akaike info criterion	-4.500753
Sum squared resid	0.004863	Schwarz criterion	-3.300913
Log likelihood	105.7632	Hannan-Quinn criter.	-4.086568
F-statistic	0.025093	Durbin-Watson stat	2.030238
Prob(F-statistic)	1.000000		

APPENDIX V. Heteroskedasticity Test: Breusch-Pagan Godfrey

Heteroskedasticity Test: Breusch-Pagan-Godfrey
Null hypothesis: Homoskedasticity

F-statistic	0.541899	Prob. F(24,10)	0.8939
Obs*R-squared	19.78630	Prob. Chi-Square(24)	0.7089
Scaled explained SS	2.113169	Prob. Chi-Square(24)	1.0000

Test Equation:
Dependent Variable: RESID^2
Method: Least Squares
Date: 04/10/23 Time: 16:46
Sample: 1987 2021
Included observations: 35

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.007194	0.017552	0.409868	0.6905
LNRGDP(-1)	-0.003947	0.003801	-1.038534	0.3235
LNRGDP(-2)	0.003510	0.003778	0.929077	0.3747
LNRGDP(-3)	-0.000958	0.002770	-0.345744	0.7367
LNRGDP(-4)	0.001956	0.003484	0.561512	0.5868
LNRGDP(-5)	-0.001661	0.001996	-0.832514	0.4246
LNREER	0.000591	0.001002	0.590014	0.5683
LNREER(-1)	-0.000442	0.000969	-0.455869	0.6582
LNREER(-2)	0.000343	0.000655	0.522767	0.6125
LNREER(-3)	-6.47E-05	0.000544	-0.119062	0.9076
LIR	4.38E-06	0.000152	0.028912	0.9775
LIR(-1)	1.59E-05	0.000132	0.120512	0.9065
LIR(-2)	-6.63E-05	9.63E-05	-0.688576	0.5067
INF	4.02E-06	1.23E-05	0.327603	0.7500
INF(-1)	-1.88E-05	1.35E-05	-1.386295	0.1958
INF(-2)	-3.09E-06	1.43E-05	-0.216521	0.8329
GE	8.63E-05	0.000101	0.855811	0.4121
GE(-1)	-5.43E-06	0.000102	-0.053504	0.9584
LNGCF	-0.000188	0.000751	-0.250589	0.8072
LNGCF(-1)	0.000180	0.000872	0.206347	0.8407
LNGCF(-2)	0.000538	0.001056	0.509342	0.6216
FDI	2.21E-05	9.53E-05	0.231621	0.8215
FDI(-1)	3.93E-06	7.22E-05	0.054405	0.9577
FDI(-2)	-9.86E-05	8.33E-05	-1.184702	0.2635
FDI(-3)	4.57E-05	7.14E-05	0.640524	0.5362

R-squared	0.565323	Mean dependent var	0.000150
Adjusted R-squared	-0.477902	S.D. dependent var	0.000247
S.E. of regression	0.000300	Akaike info criterion	-13.21101
Sum squared resid	8.99E-07	Schwarz criterion	-12.10005
Log likelihood	256.1927	Hannan-Quinn criter.	-12.82750
F-statistic	0.541899	Durbin-Watson stat	2.296084
Prob(F-statistic)	0.893897		

APPENDIX VI. Heteroskedasticity Test: ARCH

Heteroskedasticity Test: ARCH

F-statistic	1.710461	Prob. F(1,32)	0.2002
Obs*R-squared	1.725153	Prob. Chi-Square(1)	0.1890

Test Equation:
Dependent Variable: RESID^2
Method: Least Squares
Date: 04/10/23 Time: 16:47
Sample (adjusted): 1988 2021
Included observations: 34 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.000119	4.97E-05	2.399846	0.0224
RESID^2(-1)	0.224755	0.171851	1.307846	0.2002

R-squared	0.050740	Mean dependent var	0.000153
Adjusted R-squared	0.021075	S.D. dependent var	0.000250
S.E. of regression	0.000247	Akaike info criterion	-13.71646
Sum squared resid	1.95E-06	Schwarz criterion	-13.62667
Log likelihood	235.1797	Hannan-Quinn criter.	-13.68584
F-statistic	1.710461	Durbin-Watson stat	2.090818
Prob(F-statistic)	0.200244		

APPENDIX VII. Ramsey RESET Test

Ramsey RESET Test
Equation: UNTITLED
Omitted Variables: Squares of fitted values
Specification: LNRGDP LNRGDP(-1) LNRGDP(-2) LNRGDP(-3) LNRGDP(-4) LNRGDP(-5) LNREER LNREER(-1) LNREER(-2) LNREER(-3) LIR LIR(-1) LIR(-2) INF INF(-1) INF(-2) GE GE(-1) LNGCF LNGCF(-1) LNGCF(-2) FDI FDI(-1) FDI(-2) FDI(-3) C

	Value	df	Probability
t-statistic	0.792430	9	0.4485
F-statistic	0.627945	(1, 9)	0.4485
Likelihood ratio	2.360584	1	0.1244

F-test summary:

	Sum of Sq.	df	Mean Squares
Test SSR	0.000343	1	0.000343
Restricted SSR	0.005259	10	0.000526
Unrestricted SSR	0.004916	9	0.000546

LR test summary:

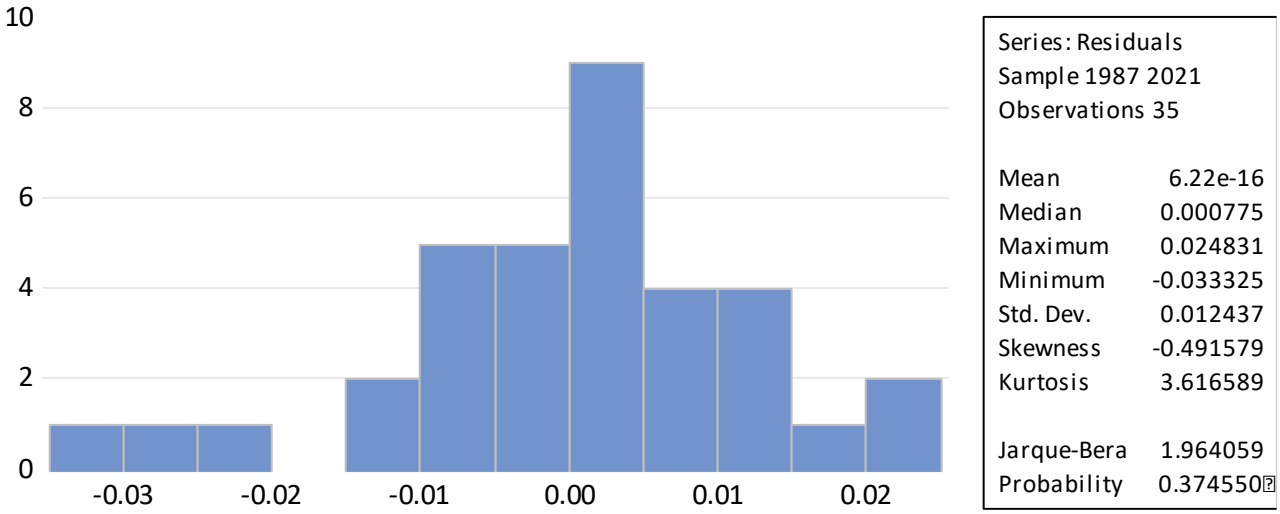
	Value
Restricted LogL	104.3912
Unrestricted LogL	105.5715

Unrestricted Test Equation:
Dependent Variable: LNRGDP
Method: Least Squares
Date: 04/10/23 Time: 16:47
Sample: 1987 2021
Included observations: 35

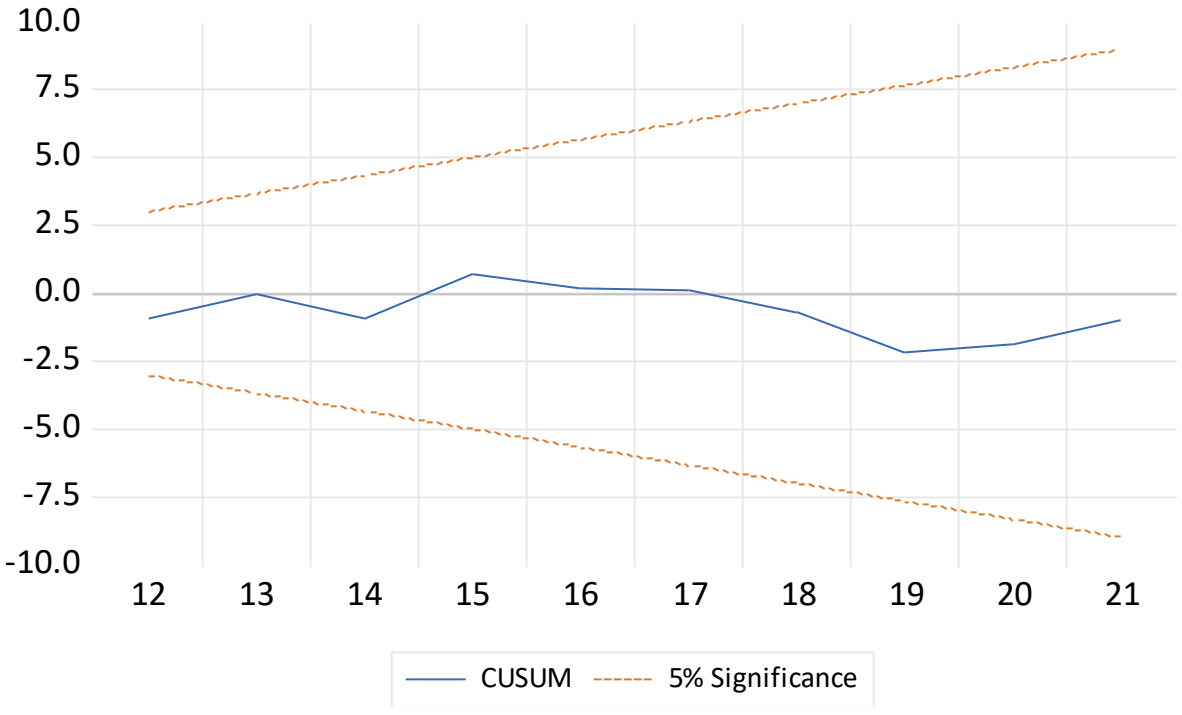
Variable	Coefficient	Std. Error	t-Statistic	Prob.
LNRGDP(-1)	2.316973	1.712241	1.353181	0.2090
LNRGDP(-2)	-1.789313	1.359359	-1.316291	0.2206
LNRGDP(-3)	2.211325	1.701192	1.299868	0.2259
LNRGDP(-4)	-2.333839	1.786764	-1.306182	0.2239
LNRGDP(-5)	0.940141	0.767739	1.224558	0.2518
LNREER	0.325418	0.286659	1.135209	0.2856
LNREER(-1)	-0.246502	0.192779	-1.278682	0.2330
LNREER(-2)	0.125257	0.107545	1.164691	0.2741
LNREER(-3)	0.330485	0.254423	1.298960	0.2262
LIR	-0.062516	0.051930	-1.203859	0.2594
LIR(-1)	0.011927	0.014409	0.827728	0.4292
LIR(-2)	-0.019534	0.015050	-1.297923	0.2266
INF	-0.000840	0.001163	-0.722438	0.4884
INF(-1)	-0.001928	0.001941	-0.993547	0.3464
INF(-2)	0.006054	0.004493	1.347467	0.2108
GE	0.007383	0.009859	0.748837	0.4731
GE(-1)	-0.025468	0.021307	-1.195286	0.2625
LNGCF	0.061636	0.069892	0.881868	0.4008
LNGCF(-1)	0.591950	0.445118	1.329872	0.2163
LNGCF(-2)	-0.242861	0.195772	-1.240528	0.2461
FDI	0.013468	0.011975	1.124650	0.2898
FDI(-1)	-0.016905	0.014426	-1.171840	0.2713
FDI(-2)	0.015332	0.013307	1.152169	0.2789
FDI(-3)	0.037979	0.028922	1.313158	0.2216
C	-1.189962	6.520922	-0.182484	0.8592
FITTED^2	-0.053932	0.068059	-0.792430	0.4485

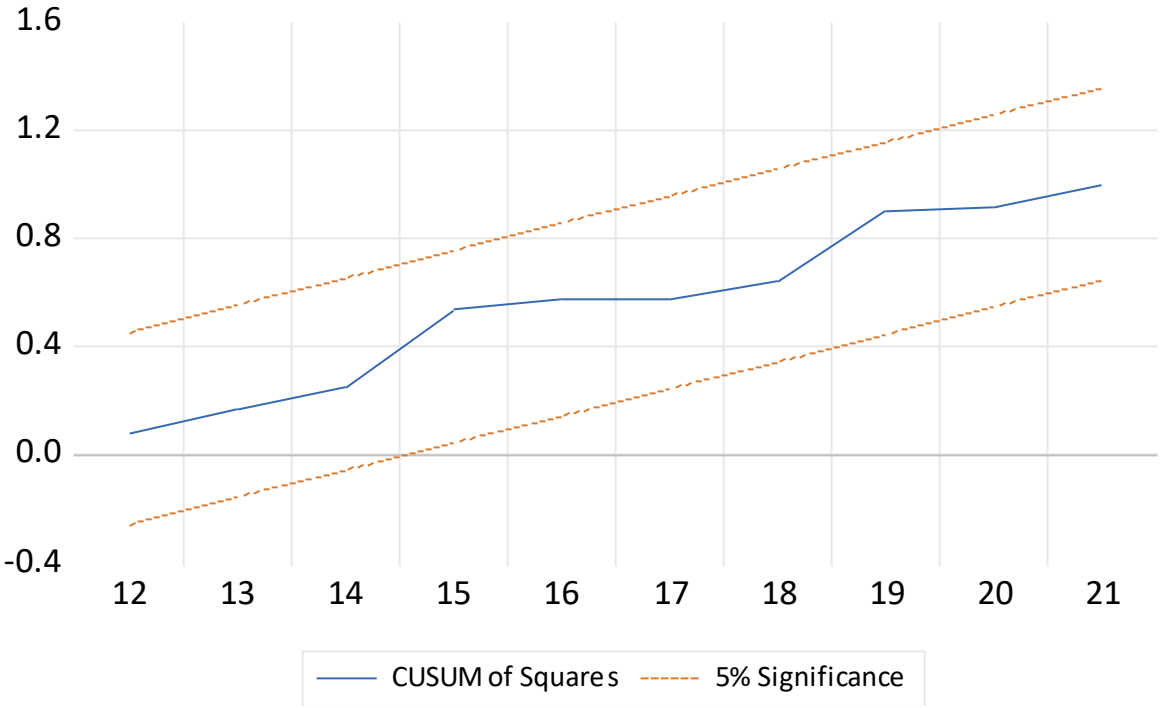
R-squared	0.999720	Mean dependent var	13.31549
Adjusted R-squared	0.998941	S.D. dependent var	0.718337
S.E. of regression	0.023372	Akaike info criterion	-4.546942
Sum squared resid	0.004916	Schwarz criterion	-3.391541
Log likelihood	105.5715	Hannan-Quinn criter.	-4.148098
F-statistic	1284.316	Durbin-Watson stat	2.123859
Prob(F-statistic)	0.000000		

APPENDIX VIII. Jarque-Bera Normality test

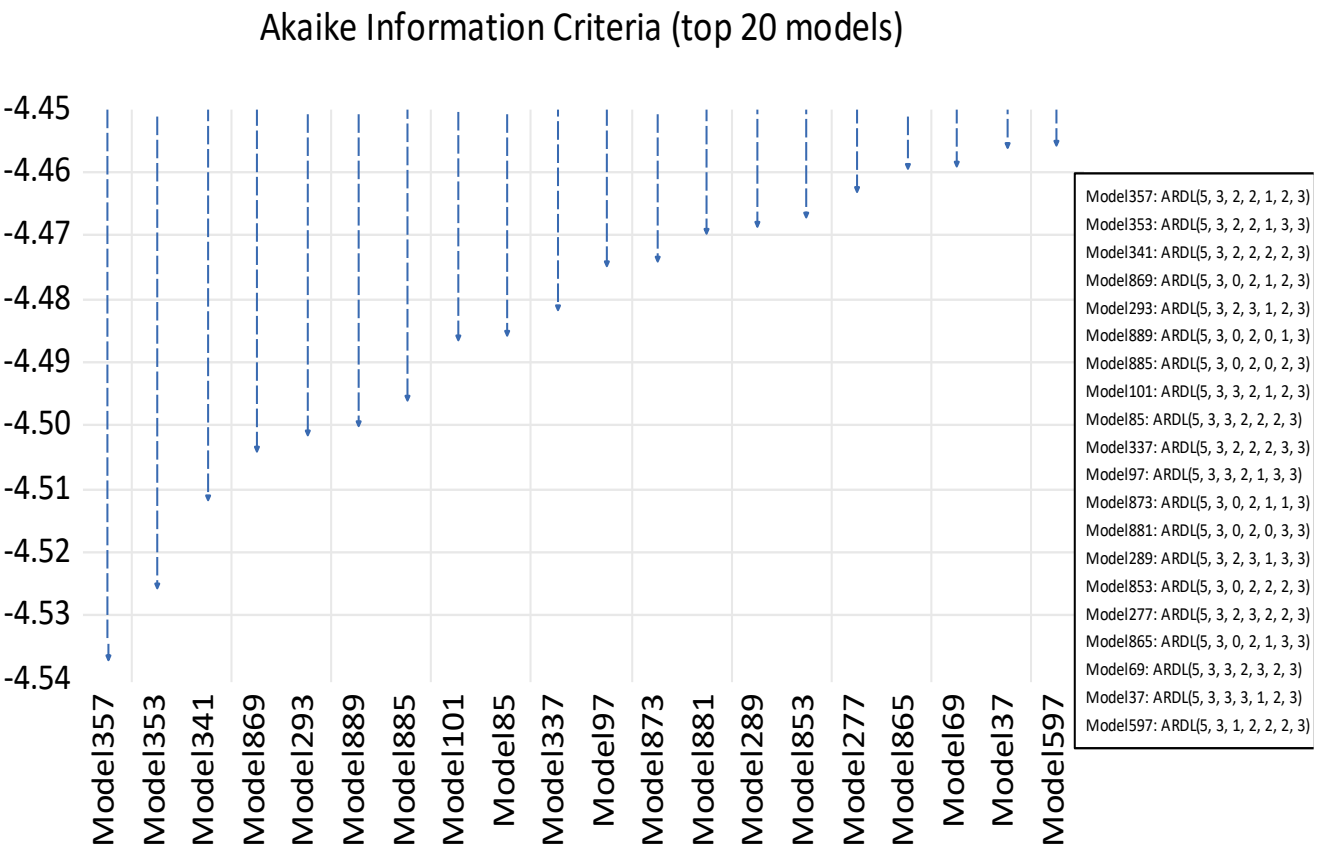


APPENDIX IX. CUSUM and CUSUM sum of squares





APPENDIX X. Optimum Model Selection by AIC



APPENDIX XI. Coefficient Variance Decomposition

Coefficient Variance Decomposition
Date: 04/10/23 Time: 17:01
Sample: 1982 2021
Included observations: 35

Eigenvalues	1.819061	0.215902	0.047237	0.032167	0.010685	1.06E-05	6.11E-06	2.60E-06	1.66E-06	0.001007	0.000625	3.16E-05	2.91E-05	2.39E-05	1.66E-05	1.50E-
Condition	3.74E-09	3.15E-08	1.44E-07	2.12E-07	6.37E-07	0.000641	0.001114	0.002619	0.004110	6.76E-06	1.09E-05	0.000215	0.000234	0.000285	0.000410	0.0004

Variance Decomposition Proportions

											Associated Eigenvalue					
Variable	1	2	3	4	5	17	18	19	20	10	11	12	13	14	15	16
LNRGDP(-1)	0.007151	0.753986	0.231038	0.001159	0.004394	2.92E-07	4.46E-08	1.02E-06	2.10E-08	0.000557	9.49E-06	1.82E-06	1.34E-08	5.50E-07	7.37E-07	6.04E-
LNRGDP(-2)	0.047181	0.826033	0.000956	0.110530	0.013156	1.67E-07	7.51E-08	1.16E-06	1.45E-08	0.000903	9.21E-05	2.35E-06	1.79E-11	5.66E-07	1.30E-06	1.81E-
LNRGDP(-3)	4.17E-06	0.491035	0.399886	0.078100	0.024959	3.19E-07	2.92E-07	2.32E-06	1.70E-08	0.001343	2.85E-06	7.11E-06	1.66E-08	1.95E-06	2.73E-06	2.45E-
LNRGDP(-4)	0.132727	0.641317	0.067448	0.145088	0.005906	2.74E-07	2.70E-07	1.47E-06	5.78E-09	2.13E-05	8.33E-06	3.92E-06	1.71E-07	2.00E-06	1.51E-06	2.40E-
LNRGDP(-5)	0.074206	0.421913	0.068223	0.179348	0.248290	7.66E-07	1.15E-06	4.36E-06	9.18E-09	0.000464	6.52E-07	5.59E-06	5.03E-08	5.19E-06	4.78E-06	6.29E-
LNREER	0.054509	0.064479	0.318033	0.020080	0.010525	3.75E-07	2.60E-06	5.00E-06	4.82E-07	0.001622	0.001029	1.43E-05	3.21E-05	7.75E-07	2.68E-05	2.07E-
LNREER(-1)	0.021559	0.145888	0.009855	0.236947	0.007056	6.67E-10	5.95E-06	3.68E-06	6.86E-07	0.013591	0.000935	1.31E-05	3.68E-05	4.46E-07	3.83E-06	1.71E-
LNREER(-2)	0.049944	0.012089	0.038584	0.239524	0.339681	5.49E-06	1.21E-06	3.53E-06	2.19E-06	0.107594	0.123419	2.94E-07	1.18E-05	8.18E-06	2.33E-05	8.31E-
LNREER(-3)	0.002857	0.215751	0.017821	0.009654	0.270139	3.40E-06	1.33E-06	4.03E-06	3.06E-06	0.231035	0.167228	1.35E-05	6.98E-06	4.64E-06	2.03E-05	4.08E-
LIR	0.120481	0.006007	0.051740	0.313203	0.009891	0.009446	0.005154	7.46E-05	0.002396	0.032511	0.003515	0.077755	0.014120	0.000474	0.001865	0.0015
LIR(-1)	0.003929	0.001319	0.014634	0.188999	0.048910	0.000582	0.001293	0.002432	0.002165	0.025696	0.008201	0.021008	0.058673	0.014387	0.001135	0.0351
LIR(-2)	0.076502	0.078363	0.218128	0.004070	0.066602	0.018372	0.015258	0.007233	0.002255	0.001121	0.003967	0.039163	0.029202	0.036942	0.005835	0.0469
INF	0.049809	0.048885	0.245817	0.170284	0.024904	0.004004	0.002788	0.015794	0.004988	0.000543	0.000675	2.33E-05	1.44E-05	0.056687	0.006792	0.0058
INF(-1)	0.022701	0.376312	0.156267	0.011963	0.015945	0.001321	0.016854	0.000220	0.000377	0.033691	0.004237	0.114277	0.002973	0.001490	0.043593	0.0032
INF(-2)	0.096769	0.265595	0.013819	0.098761	0.022845	0.000657	0.001292	0.002250	0.000757	0.015917	0.028678	0.025841	0.016310	0.042165	0.021493	0.0058
GE	0.055955	0.319050	0.207033	0.017899	0.015357	0.010051	0.014853	0.012533	0.002452	0.005485	8.70E-05	0.003824	4.67E-05	0.046733	0.044925	0.0017
GE(-1)	0.257274	0.100623	0.034509	0.255982	0.041721	0.002122	0.004325	0.008995	0.003670	7.68E-06	0.001525	0.047225	0.000133	0.080865	0.051750	0.0019
LNGCF	0.013603	0.005644	0.160681	0.260170	0.000910	2.77E-05	8.54E-05	4.87E-06	9.82E-06	0.003235	0.000276	0.000322	8.19E-07	7.20E-05	0.000539	3.13E-
LNGCF(-1)	0.136112	0.219058	0.083112	0.015243	0.047798	8.27E-06	7.05E-05	4.37E-06	7.62E-06	0.004239	0.000124	8.00E-05	9.25E-05	0.000121	0.000494	1.30E-
LNGCF(-2)	0.057514	0.370457	0.031901	0.271286	0.034714	6.78E-07	6.03E-05	5.10E-06	5.36E-06	0.002432	0.000229	4.55E-05	2.58E-06	0.000105	0.000271	2.07E-
FDI	0.077496	0.426009	0.010335	0.006182	0.044545	0.020280	0.006955	2.28E-05	0.001922	0.032811	0.000165	0.001180	0.070151	0.056301	0.007995	0.1071
FDI(-1)	0.001459	0.043647	0.085564	0.000195	0.001161	0.048566	0.000871	0.000177	0.004380	0.019961	0.002310	0.005945	0.301084	0.019546	0.099849	0.0593
FDI(-2)	0.004813	0.173930	0.016873	0.206155	0.008089	0.000118	0.027471	0.000129	0.003096	0.046245	0.000107	0.144074	0.136280	0.126195	0.000477	0.0077
FDI(-3)	0.049088	0.132250	0.160815	0.054713	0.126060	0.159149	0.022469	0.000120	0.004473	0.008889	0.004015	0.154482	0.008692	0.065723	6.28E-06	0.0055
C	0.999557	0.000377	4.72E-05	1.41E-05	3.51E-06	1.68E-10	5.79E-10	2.53E-10	6.21E-12	2.98E-07	3.41E-08	3.08E-09	1.44E-10	1.40E-09	3.98E-09	1.84E-

Eigenvectors

											Associated Eigenvalue					
Variable	1	2	3	4	5	17	18	19	20	10	11	12	13	14	15	16
LNRGDP(-1)	0.018229	-0.543334	-0.643006	0.055199	0.186449	0.048198	-0.024844	0.182217	-0.032734	-0.216180	0.035839	0.069826	-0.006248	-0.044119	0.061289	-0.0184
LNRGDP(-2)	0.046547	0.565323	0.041111	0.535746	0.320690	0.036302	-0.032034	0.192866	-0.027086	-0.273646	0.110970	0.078878	-0.000226	-0.044472	0.080835	-0.0317
LNRGDP(-3)	0.000321	-0.319594	0.616593	-0.330209	0.323880	0.036724	-0.046302	0.200211	-0.021447	-0.244716	-0.014301	0.100525	-0.005059	-0.060465	0.085936	-0.0270
LNRGDP(-4)	0.071984	0.459289	-0.318436	-0.565960	-0.198127	0.042824	-0.056009	0.200555	-0.015740	0.038763	-0.030771	0.093881	-0.020427	-0.077136	0.080325	-0.0336
LNRGDP(-5)	-0.030830	-0.213379	0.183440	0.360420	-0.735787	0.041000	-0.066275	0.197728	-0.011363	0.103551	0.004931	0.064200	-0.006349	-0.071089	0.081958	-0.0312
LNREER	-0.013274	0.041906	0.198973	0.060586	-0.076105	-0.014408	-0.050059	0.106403	0.041373	0.097304	-0.098423	-0.051656	-0.080595	-0.013806	0.097408	-0.0028
LNREER(-1)	0.008066	0.060901	0.033839	-0.201075	-0.060205	0.000587	-0.073099	0.088100	0.047674	0.272155	-0.090656	0.047631	0.083373	-0.010117	0.035595	-0.0791
LNREER(-2)	-0.008306	-0.011862	-0.045306	0.136792	0.282639	0.036066	-0.022315	0.058441	0.057623	0.518136	-0.704592	0.004830	-0.031915	-0.029321	0.059381	0.0117
LNREER(-3)	-0.001648	-0.041577	0.025547	-0.022785	0.209125	0.023547	-0.019439	0.051813	0.056523	0.629948	0.680482	0.027135	0.020383	0.018320	0.046016	-0.0216
LIR	0.002984	-0.001934	-0.012134	-0.036178	0.011155	-0.345922	-0.336698	-0.062124	0.441084	-0.065874	0.027501	-0.574987	-0.255494	0.051654	0.122950	0.1170
LIR(-1)	-0.000469	0.000789	-0.005617	0.024461	-0.021590	0.074738	-0.146767	-0.308698	0.364920	-0.050974	-0.036563	0.260133	0.453318	0.247567	-0.083482	-0.4881
LIR(-2)	0.001510	0.004437	0.015825	-0.002619	-0.018385	0.306417	0.367953	-0.388502	0.271769	0.007770	0.018558	0.259183	-0.233372	-0.289493	0.138123	0.4116
INF	-0.000155	0.000446	0.002140	-0.002159	-0.001432	-0.018226	-0.020038	-0.073138	0.051495	0.000689	0.000975	0.000805	-0.000661	-0.045688	0.018985	-0.0185
INF(-1)	-0.000116	-0.001368	-0.001885	0.000632	-0.001266	0.011562	0.054412	-0.009531	-0.015629	0.005993	-0.002698	0.062295	0.010477	0.008180	0.053118	-0.0151
INF(-2)	-0.000252	-0.001211	-0.000590	0.001913	0.001596	-0.008591	-0.015871	0.032118	-0.023343	0.004339	0.007395	0.031206	-0.025851	-0.045843	0.039291	0.0215
GE	0.001353	0.009380	0.016154	-0.005756	0.009250	-0.237470	-0.380390	-0.535828	-0.296925	0.018007	-0.002879	0.084862	-0.009777	-0.341168	-0.401561	0.0835
GE(-1)	0.002921	0.005303	0.006639	-0.021911	-0.015348	0.109837	0.206628	-0.456942	-0.365656	-0.000678	-0.012134	-0.300192	-0.016595	0.451757	0.433841	-0.0882
LNGCF	-0.004966	-0.009284	-0.105905	0.163303	-0.016755	-0.092824	0.214697	0.078597	-0.139851	0.102906	0.038180	-0.183113	0.009639	0.099636	-0.327369	0.0829
LNGCF(-1)	-0.018242	-0.067172	0.088457	0.045905	0.141042	-0.058877	0.226482	0.086430	-0.143087	0.136816	-0.029700	-0.106071	0.118949	0.150058	-0.363968	0.0619
LNGCF(-2)	-0.014362	0.105804	0.066378	-0.234566	-0.145584	-0.020417	0.253658	0.113146	-0.145289	-0.125514	-0.048935	-0.096938	0.024052	0.169169	-0.326747	0.0948
FDI	-0.001505	-0.010243	0.003411	-0.003197	0.014889	-0.318792	0.246001	-0.021594	-0.248434	0.041622	0.003749	0.044555	-0.358179	-0.353895	0.160095	-0.6159
FDI(-1)	0.000156	0.002484	-0.007436	-0.000430	-0.001821	-0.373776	-0.065967	0.045573	-0.284161	0.024597	-0.010625	0.075764	0.562209	-0.157984	0.428660	0.3473
FDI(-2)	0.000328	-0.005716	-0.003806	0.016123	0.005541	0.021230	-0.426987	0.044783	-0.275399	0.043156	-0.002641	0.429926	-0.436007	0.462733	0.034158	0.1448
FDI(-3)	-0.000897	0.004273	0.010073	-0.007120	0.018751	0.668567	-0.331010	0.037048	-0.283741	0.016219	0.013840	-0.381606	0.094385	-0.286247	-0.003358	-0.1047
C	-0.995222	0.056108	-0.042450	-0.028132	0.024347	0.005337	-0.013072	0.013241	0.002599	-0.023112	0.009921	0.013244	-0.002988	-0.010258	0.020805	-0.0046

APPENDIX XII Dynamic OLS (DOLS) Output

Dependent Variable: LNRGDP
Method: Dynamic Least Squares (DOLS)
Date: 04/10/23 Time: 17:44
Sample (adjusted): 1984 2020
Included observations: 37 after adjustments
Cointegrating equation deterministics: C
Fixed leads and lags specification (lead=1, lag=1)
Long-run variance estimate (Bartlett kernel, Newey-West fixed bandwidth = 4.0000)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LNREER	0.433110	0.065848	6.577382	0.0000
LIR	-0.029163	0.003062	-9.523673	0.0000
INF	0.001724	0.001617	1.066186	0.3073
GE	0.009948	0.005439	1.828797	0.0924
LNGCF	0.377504	0.007128	52.96109	0.0000
FDI	-0.003007	0.005675	-0.529884	0.6059
C	7.432223	0.300447	24.73724	0.0000

R-squared	0.999547	Mean dependent var	13.20683
Adjusted R-squared	0.998642	S.D. dependent var	0.704884
S.E. of regression	0.025980	Sum squared resid	0.008099
Long-run variance	0.000259		

APPENDIX XIII. Robust Least Square (RLS) Output

Dependent Variable: LNRGDP
Method: Robust Least Squares
Date: 04/10/23 Time: 17:43
Sample: 1982 2021
Included observations: 40
Method: M-estimation
M settings: weight=Bisquare, tuning=4.685, scale=MAD (median centered)
Huber Type I Standard Errors & Covariance

Variable	Coefficient	Std. Error	z-Statistic	Prob.
LNREER	2.298796	0.070346	32.67821	0.0000
LIR	-0.077332	0.021028	-3.677642	0.0002
INF	-0.002954	0.004286	-0.689281	0.4906
GE	0.068351	0.019403	3.522625	0.0004
LNGCF	0.218414	0.037943	5.756376	0.0000
FDI	0.070943	0.031485	2.253213	0.0242

Robust Statistics

R-squared	0.693425	Adjusted R-squared	0.648341
Rw-squared	0.917691	Adjust Rw-squared	0.917691
Akaike info criterion	47.31668	Schwarz criterion	61.58427
Deviance	2.358383	Scale	0.244500
Rn-squared statistic	106856.2	Prob(Rn-squared stat.)	0.000000

Non-robust Statistics

Mean dependent var	13.20405	S.D. dependent var	0.734392
S.E. of regression	0.451598	Sum squared resid	6.933981

APPENDIX XIV. Least Squares Estimation of Inflation Threshold Model (from K = 2 to K = 15)

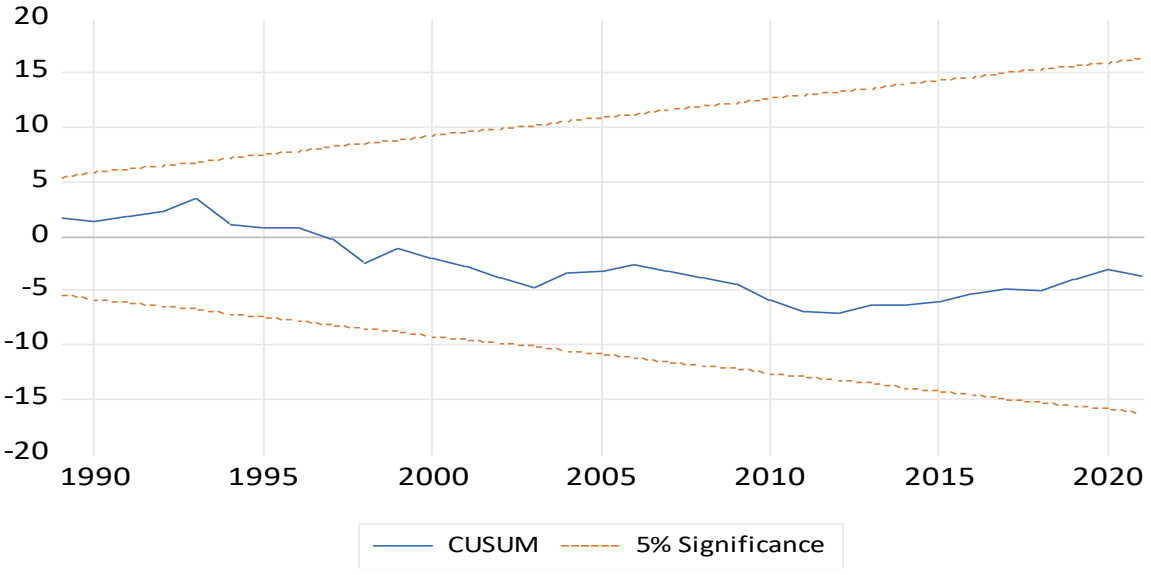
Dependent variable = GGDP							
K	Variable	Coefficient	Std. Error	t-Statistics	Probability	RSS	R^2
K = 2%	C	0.083429	1.455273	0.057329	0.9546	1178.012	0.342366
	INF	-1.099619	0.358037	-3.071239	0.0042		
	TR2	0.978313	0.403830	2.422587	0.0211		
	GGCF	0.098270	0.040283	2.439476	0.0202		
	GM2	0.250363	0.158582	1.578755	0.1239		
	OPEN	0.010157	0.704837	0.014410	0.9886		
K = 3%	C	0.616296	1.455541	0.423414	0.6747	1203.729	0.328009
	INF	-0.967611	0.328154	-2.948653	0.0058		
	TR3	0.845960	0.376876	2.244666	0.0316		
	GGCF	0.098346	0.040726	2.414851	0.0214		
	GM2	0.241514	0.159959	1.509845	0.1406		
	OPEN	0.025518	0.712311	0.035824	0.9716		
K = 4%	C	0.988758	1.467968	0.673555	0.5053	1206.609	0.326401
	INF	-0.894718	0.299795	-2.984429	0.0053		
	TR4	0.781881	0.351510	2.224346	0.0331		
	GGCF	0.098940	0.040786	2.425826	0.0209		
	GM2	0.235530	0.159702	1.474810	0.1497		
	OPEN	0.024578	0.713269	0.034458	0.9727		
K = 5%	C	1.306457	1.482268	0.881391	0.3845	1194.457	0.333185
	INF	-0.852094	0.272496	-3.127000	0.0037		
	TR5	0.753893	0.326432	2.309498	0.0273		

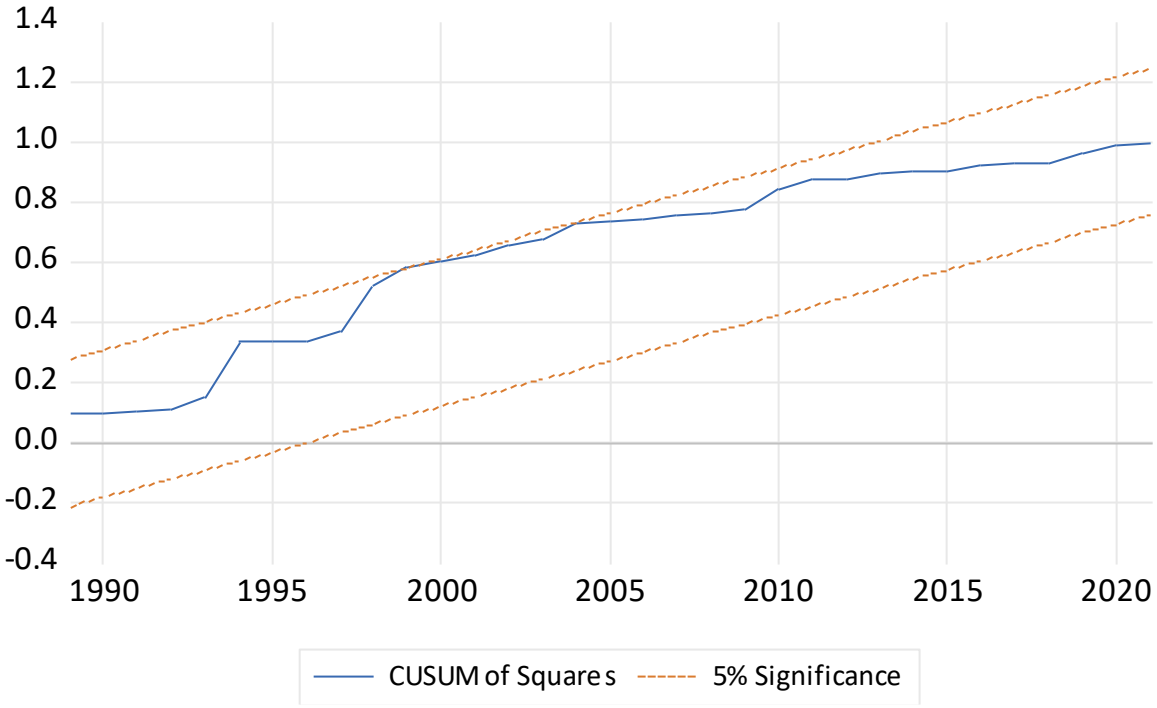
	GGCF	0.099789	0.040596	2.458125	0.0194		
	GM2	0.231258	0.158437	1.459626	0.1538		
	OPEN	0.014323	0.709887	0.020177	0.9840		
K = 6%	C	1.568010	1.497050	1.047400	0.3025	1180.462	0.340998
	INF	-0.813787	0.248092	-3.280184	0.0025		
	TR6	0.730017	0.303431	2.405879	0.0219		
	GGCF	0.101192	0.040388	2.505532	0.0173		
	GM2	0.223521	0.156909	1.424522	0.1637		
	OPEN	0.012248	0.705525	0.017360	0.9863		
K = 7%	C	1.**790592**	1.512192	1.184103	0.2448	**1168.194**	**0.347847**
	INF	-0.775142	0.226770	-3.418195	0.0017		
	TR7	0.703962	0.282818	2.489099	0.0180		
	GGCF	0.102536	0.040210	2.549976	0.0156		
	GM2	0.215891	0.155645	1.387069	0.1747		
	OPEN	0.015546	0.701491	0.022161	0.9825		
K = 8%	C	1.897481	1.527160	1.242490	0.2228	1168.930	0.347436
	INF	-0.734502	0.212477	-3.456850	0.0015		
	TR8	0.673885	0.271276	2.484133	0.0182		
	GGCF	0.104445	0.040291	2.592286	0.0141		
	GM2	0.209457	0.155432	1.347579	0.1870		
	OPEN	0.024837	0.701353	0.035413	0.9720		
K = 9%	C	1.929473	1.540390	1.252587	0.2192	1176.877	0.342999
	INF	-0.699100	0.203456	-3.436128	0.0016		
	TR9	0.651799	0.268196	2.430312	0.0207		

	GGCF	0.105503	0.040480	2.606333	0.0136		
	GM2	0.205832	0.155850	1.320706	0.1957		
	OPEN	0.027030	0.703769	0.038407	0.9696		
K = 10%	C	1.909070	1.553725	1.228705	0.2279	1191.213	0.334996
	INF	-0.659933	0.195668	-3.372716	0.0019		
	TR10	0.622412	0.266902	2.331989	0.0260		
	GGCF	0.106858	0.040813	2.618239	0.0132		
	GM2	0.203119	0.156739	1.295905	0.2040		
	OPEN	0.020111	0.708589	0.028382	0.9775		
K = 11%	C	1.909649	1.557238	1.226305	0.2288	1194.111	0.333378
	INF	-0.639452	0.189372	-3.376700	0.0019		
	TR11	0.621955	0.269023	2.311901	0.0272		
	GGCF	0.107829	0.040923	2.634912	0.0127		
	GM2	0.201967	0.156897	1.287256	0.2070		
	OPEN	0.003113	0.710321	0.004382	0.9965		
K = 12%	C	1.889162	1.561242	1.210038	0.2349	1200.182	0.329989
	INF	-0.616838	0.183602	-3.359639	0.0020		
	TR12	0.616550	0.271660	2.269564	0.0299		
	GGCF	0.107764	0.041036	2.626102	0.0130		
	GM2	0.198305	0.157189	1.261568	0.2159		
	OPEN	0.010386	0.711909	0.014589	0.9884		
K = 13%	C	1.860972	1.563095	1.190569	0.2423	1205.483	0.327030
	INF	-0.595689	0.177946	-3.347581	0.0020		
	TR13	0.612338	0.274307	2.232304	0.0325		

	GGCF	0.107896	0.041146	2.622251	0.0131		
	GM2	0.196079	0.157479	1.245111	0.2219		
	OPEN	0.017630	0.713247	0.024718	0.9804		
K = 14%	C	1.820001	1.565088	1.162875	0.2532	1212.622	0.323045
	INF	-0.573794	0.172661	-3.323251	0.0022		
	TR14	0.605500	0.277543	2.181643	0.0364		
	GGCF	0.107865	0.041283	2.612802	0.0134		
	GM2	0.193946	0.157896	1.228315	0.2280		
	OPEN	0.026580	0.715084	0.037171	0.9706		
K = 15%	C	1.766559	1.569104	1.125840	0.2684	1223.106	0.317191
	INF	-0.552216	0.168697	-3.273413	0.0025		
	TR2	0.597639	0.283759	2.106152	0.0429		
	GGCF	0.107426	0.041458	2.591171	0.0141		
	GM2	0.191083	0.158517	1.205441	0.2366		
	OPEN	0.036056	0.717949	0.050221	0.9602		

APPENDIX XV. Threshold CUSUM and CUSUM sum of squares




1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
-0.2
-0.4
1990
1995
2000
2005
2010
2015
2020
CUSUM of Squares
5% Significance