MACROECONOMIC DETERMINANTS OF INFLATION IN ETHIOPIA: ARDL APPROACH TO COINTEGRATION

A Research Paper Submitted to the School of Graduate Studies of Jimma University in Partial Fulfilment of the Requirements of the Master of Science in Economics (Development Economics)

BY: SAMUEL TOLASA

JIMMA UNIVERSITY

BUSINESS AND ECONOMICS COLLEGE

DEPARTMENT OF ECONOMICS

JUNE, 2021

JIMMA, ETHIOPIA

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BY: SAMUEL TOLASA

UNDER THE GUIDANCE OF:

MAIN ADVISOR: Mr. SISAY T. (Assistant Professor)
AND
CO-ADVISOR: Mr. NEGESE T. (MSc.)

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DECLARATION

I the undersigned, declare that a research paper entitled with **"Macroeconomic Determinants of Inflation in Ethiopia: ARDL Approach to Co-integration"** is my original work and it has not been submitted by any other person for an award of degree of master in this or any other university/institution. All references in the thesis have been duly acknowledged and cited in the reference list.

Declared by:

Name: Samuel Tolasa

Signature_____ Date: _____

Approved by:

This thesis has been submitted for examination with our approval as research advisors.

Main Advisor: Sisay Tolla (Asst. Professor) Signature _____ Date: _____

Co-advisor: Negese Tamirat (MSc.) Signature _____ Date: _____

CERTIFICATE

This is to certify that the thesis entitled with **"Macroeconomic Determinants of Inflation in Ethiopia: ARDL Approach to Cointegration",** submitted to Jimma University for the award of the degree of Master of Science in Economics (Development Economics) and is a record of confide research work carried out by **Mr. Samuel Tolasa**, under our guidance and supervision.

Therefore, we hereby declare that no part of this thesis has been submitted to any other university or institutions for the award of any degree or diploma.

Main Adviser: Sisay Tolla (Asst. Professor)
Jimma University, Business and Economic College
Department of Economics

*Signature*_____ *Date*_____

Co-advisor: Negese Tamirat (MSc.)
Jimma University, Business and Economic College
Department of Economics

*Signature*_____ *Date*_____

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_____	_____	_____
Internal Examiner	*Signature*	*Date*
_____	_____	_____
External Examiner	*Signature*	*Date*
_____	_____	_____

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List of acronyms

ADF	Augmented Dickey Fuller
AIC	Akaike Information Criterion
ARDL	Autoregressive Distributed Lag
CPI	Consumers Price Index
CUSUM	Cumulative Sum of Squares of Recursive
DW	Durbin Watson
ECM	Error Correction Model
ECT	Error correction Term
EEA	Ethiopian Economic Associations
EPDRF	Ethiopian People Democratic Republic of Front
ERP	Economic Recovery Program
ETB	Ethiopian Birr
E-VIEWS	Electronic Views
FPE	Final Prediction Error
GDP	Gross Domestic Product
HQIC	Hannan and Quinn Information Criterion
I (0)	Integrated Order Zero
I (1)	Integrated Order One
I (2)	Integrated Order Two
IFS	International Financial Statistics
IMF	International Monetary Fund
JB	Jarque-Bera
LDC	Less Developed Countries
LM	Lagrange Multiplier
M1	Narrow Money
M2	Broad money
MoFEC	Ministry of Finance and Economic Cooperation
MoFED	Ministry of Finance and Economic Development
NBE	National Bank of Ethiopia
OECD	Organization for Economic Cooperation and Development
OLS	Ordinary Least Square
PP	Phillips-Perron

QTM	Quantity Theory of Money
R&D	Research and Development
REER	Real Effective Exchange Rate
RGDP	Real Gross Domestic Product
SBIC	Schwarz Bayesian Information Criteria
SMLR	Sequential Modified Likelihood Ratio
US	United States
USD	United States Dollar
VAR	Vector Autoregressive
VAT	Value Added Tax
VEC	Vector of Error Correction
VECM	Vector of Error Correction Model
VIF	Variable Inflation Factor
WDI	World Development Indicator
WEO	World Economic Outlook
WW II	Second World War

Abstract

Maintaining inflation rate at optimal level is among important mechanism of balancing macroeconomic volatility to ensure steady economic growth. The main objective of the research was to examine the macroeconomic determinants of inflation and analyse whether the identified variables have significant impact on inflationary situation in Ethiopia. The study employed ARDL model using annual data for period 1981-2020. To realize the objective, macroeconomic variables' data were taken from National Bank of Ethiopia, International Monetary Fund and World Bank databases. The study also used augmented Dickey-Fuller and Phillips-Perron unit root tests to check stationarity of the variables. The test result revealed that almost all variables become stationary after the first difference. The ARDL-bound test was applied to examine the presence of con-integration between the variables. Accordingly, the result from bound test indicated the existence of long run relationship between the variables entered into the model. The estimated error correction model (ECM) with -0.53 coefficient also confirmed the existences of co-integration with high speed of adjustment towards the long run equilibrium. In the long run, natural logarithm of both real GDP and real effective exchange rate, and lending interest rate are positive and significant determinants of inflation, while broad money supply, real GDP, population size, gross national saving and previous year imports all in natural logarithmic are found to be the short run drivers of inflation. To contain inflation in Ethiopia, the study recommends that a policy action on reducing real effective exchange rate and utilizing broad money supply in productive way along with supply side measures should be designed, among others.

Keywords: *Inflation, Macroeconomic determinants, ARDL model, Bound test, Co-integration, ECM, Ethiopia.*

CHAPTER ONE

1. INTRODUCTION

1.1 Background of the Study

Macroeconomists define inflation as a persistent increase in the general price level of goods and services. A price rise for specific product in particular period of time is, however, not perceived as inflation. The term is controversial which has taken various definitions since it was defined by Neo-classical economists. They defined it as a galloping increase in prices caused by excessive rise in the quantity of money circulating in the economy. Keynesians, however, believe that inflation occurs when money supply goes beyond full employment level (Jhingan, 1997). To call the phenomenon to be happened, the increase in the general price of goods and services should have continuity. Although low level of inflation plays a very important role in healthy functioning of countries' economic performance, it is generally recognized that an irregular fluctuation in the rate of inflation is considered as a main indicator of the unpredictability of their economy (Mishkin, 2009).

Economists have classified inflation in to four types based on their rate and degree of its effect on an economy. The first is creeping inflation (mild inflation). It is the very slow type of price growth which is less than 3% per annum. This type of inflation is considered as important for economic growth. The second type is walking inflation, which has growth rate between 3-10% a year. This type of inflation is not perceived as favorable to the economy because it generates unexpected demand which economy cannot afford. In expectation of future higher prices, people start to buy more than what they really want. This exacerbates the demand movement further to the point where even sellers cannot supply. The third inflation, whose growth rate is greater than or equal to 10% is called galloping inflation. This inflation badly affects an economy because purchasing power of money recklessly gets depreciated, and businesses and employee's income cannot conform to the up going costs and prices. It also causes foreign investors to be discouraged by making capital needed unaffordable. Galloping inflation causes economic instability by losing credit demand to the government financiers. This type of inflation is therefore must be disallowed. The final and the most devastating is hyperinflation. It happens when prices rise steeply to more than 50% in a month. Usually, it is caused when government irresponsibly prints money to pay for war (Amadeo, 2014).

One of the main aims of an economy is keeping the price level stable. Like other countries do, an essential objective of economic policies in Ethiopia is making macroeconomic variables balanced with steady economic growth and lower inflation and unemployment. In fact, there is some sort of controversy among subject's literatures about a level of inflation that considered as low. Nevertheless, recent literatures mostly agree on the existence of threshold level above which inflation harm economic growth. Getachew, (2018) suggested that between 1981 and 2003 average inflation rate was low with 5.2% growth rate, excluding shock years resulted from drought and civil war in 1985 and 1991/92, respectively. From 2004 onwards, however, the country has experienced unprecedented growth of price of which vast majority of series during those years registered double digit. In contrary to trend movement of the phenomenon, the threshold identified by studies such as Emirta (2012) Lambabo (2017), Getachew (2018) and IMF(2020) are 11%, 12%, 9%, 8% respectively. From these evidences we can conclude that only single digit rate of inflation is suitable to the growing Ethiopian economy and hence the need to intervention in case double digit is appeared.

Stability of price level is among factors that highly contribute to and determine growth rate of an economy. As pointed by (Fullerton, et al 1997), if inflation is not kept at low level, it adversely affects a social welfare and makes domestic economy not to perform efficiently. Furthermore, to both foreign and domestic investors, it makes investment uncertain and destroys the terms of trade in the country by raising the price of domestic goods and services beyond the regional and the world market price level. Consequently, the domestic trade become uncompetitive in international market (Ananias and Valence, 2012). For that reason, reducing inflationary rates is a main concern in any economic policy agenda. Knowing the underlying source of inflation is therefore very crucial in an attempt to take stabilization measures.

There are different theoretical hypothesis as to the causes of inflation. According to the structuralism economists, inflation is attributed to the structure of the developing countries economy. For them, more than agricultural sector, the industrial sector is sensitive to economic policies. They also attribute rapid growth of the service sector as a cause to inflation through its linkage with population growth and immigration. Besides, as to structuralism view, tightened fiscal and monetary policy has nothing to do with inflation, but deteriorate economic growth of less developed countries (LDC). In addition, the level of

competition and section of society who owned large share of national income is another concealed source of inflation especially for countries with high investment (Jalil, 2011).

According to monetarist, on the other hand, the expansion of money supply beyond the growth of real output is cause of inflation. As to the explanation of Friedman and Schwartz (1963), monetarism fore economists, price is determined by money supply both in short run and long run, but money supply only affects output in short run. Inflation also viewed to be resulted from either increase in aggregate demand or a decrease in aggregate supply; these two sources affect price level of an economy.

Keynesians and his followers believe that an inflation resulting from increase in aggregate demand is called demand-pull inflation. According to Robert (1982), demand-pull inflation arises due to many factors like money supply, government expenditures, exports or gross domestic product, etc. Cost-push advocators, on the other hand, defined inflation as an increase in general price level resulted from increase in cost of production. The main sources of cost-push inflation may be decrease in aggregate supply, which could be due to raise in production cost, increasing wages, higher imports, rising taxes, budget deficit or fiscal deficit.

Empirically, number of studies such as Solomon (2012), Enu and Havi (2014) Martin and Veerachamy (2015) and Teamrat (2017) have attempted to discourse the fundamental causes of the price rise at both global and national level. In a number of specific countries, these causes range from long-term economic and demographic trends to short-term problems, like export bans, bad weather, high oil prices and speculation. At global level, economic variables like GDP growth, money supply, oil price, national expenditure and imports of goods and services are among variables most frequently emphasized as influential sources of CPI growth rate.

However, it does not mean every country is affected in the same magnitude in case the variable under consideration is dynamic over time; each country may owe their corresponding exerting force. For example, Lim and Sek (2015) highlighted the factors causing inflation in high inflation and low inflation countries. According to their explanation, GDP growth and imports of goods and services have been found to have significant long run effect on inflation in low inflation countries while money supply, GDP growth, and national expenditure have affected long run price level trend in high inflation countries.

When we look at the highlight of inflationary trend in Ethiopia, since 2008 when the highest and unprecedented CPI growth rate is recorded with 44.37%, (In fact the authority's computation is greater than this figure) inflation has been strongly accelerated even relative to Sub-Saharan African countries. After this exceptional shock, price growth trend continued to surge although there are some sort of fluctuations up to 2020, with maximum 33.2% and minimum rate 7.4% record in 2011 and 2014 respectively (National Bank of Ethiopia, 2016/17, 2020). According to the authority's report (2018/19 & 2020) food inflation have significant share of general inflation in 2018. But the trend was reversed in the next year when non-food item contributed higher portion of the general. As to the World Development Indicator (2020), from the annual year 2018 on, when average headline inflation rose from 13.8 to 15.8 percent because of the growth in food and non-food inflation, the trend has gone further away from the NBE single digit target to 20.1% in 2020 annual year by surpassing 10% thresholds identified by various studies including Admasu (2014) and Lambabo (2017).

Though Ethiopia has experienced a low inflation particularly before 2003, recently double digit inflation has become worrisome for policy makers as well as the society as it reflected by its outstrip beyond the threshold identified by some researchers such as Emirta (2013), Admasu (2014) and Getachew (2018), among others. For example, the first researcher studied the optimal level of inflation in Ethiopia around which inflation optimally affects economic growth by applying threshold approach. Analyzing data from 1971-2010, the study then concluded that conducive inflation level for Ethiopia is about 8%-10%. In addition, as Admasu explained in his analysis of inflation and economic growth for the period 1991 to 2013, the estimated price level percentage change that supposed to be attractive to economic growth is 10%. Any inflation level exceeding the estimated threshold level or the target, may not allow long-term and sustainable economic growth.

Furthermore, number of recent studies such as Solomon (2013), Teshale (2016), Teamrat (2017) and Tadesse (2020), among others, has devoted in identifying the possible macroeconomic sources of inflationary experience in Ethiopia. The main causes of inflation considered in the literature are: the growth in money supply, unjustified level of GDP growth, national saving, the spreading overall budget deficit and ways of financing this deficit, and import of goods and services. However, we know less about the effect of population size, measured as population growth rate, on CPI growth in Ethiopia and to knowledge of the

researcher the influence of this variable has not been empirically considered while the country is among the most populous countries in the continent.

Besides, these empirical researches tried to consider real effective exchange rate as one of the important factors influencing growth rate of inflation in Ethiopia, though there is inconsistency in the effects of this variable. Some researchers (e.g. Sisay, 2008; Solomon, 2013) claim that exchange rate depreciation negatively affects consumers' price index while others (e.g. Teshale (2016) and Tadesse (2020)) argue in support of positive association between exchange rate and the variable under consideration because, as to them, the depreciation may not discourage import.

Additionally, there is a controversial among scholars about the impacts of real GDP on inflation growth rate. Respecting the theoretical correlation of price and output, some researchers such as Rao (2015), Fitsum (2016) and Minyahil et al. (2016) argue for the existence of negative causality between real GDP and price level in Ethiopia. Contrarily, other researchers such as Solomon (2013), Lambabo (2017) and Mesfin (2021)), among others, have found that economic growth stimulates inflation by serving producers as an incentive to produce more outputs. In the recent growth and inflation literatures, the former argument have got strong theoretical influences about price rise can adversely affect growth of the economy through its channel with wage and profit redistribution. Therefore, this inconclusive argument among scholars whether real GDP is positively or negatively linked to inflation is another literature inconsistency that motivated the researcher to conduct the study.

In the meantime, as to the indication of Abel (2016) and Mesfin (2021), the level of income per capita in Ethiopia is very low but expenditure on consumption items such as food is very high; inflationary experience results in a low level of welfare with average per capita income of $783 over the period 2006/07 to 2018/19. The country targeted to achieve lower-middle-income status by 2025, but facing macroeconomic imbalances of which inflation growth is need critical concern. Thus, it is essential that the government intervene to control the price trend in the country. However, such intervention requires appropriate policies devise from careful observation of the forces behind the price fluctuations. Hence, studying the possibility of controlling inflation and its dynamics is one of the themes need to be addressed in Ethiopia. The purpose of this study is therefore to examine the macroeconomic determinants of inflation and its trend in Ethiopia using updated time series data spanning over 1981 to 2020.

1.2 Statement of the Problem

Inflation is the main issue both for consumers and policy makers. It can impose a real cost on society in terms of the efficiency with which the exchange mechanism works and thereby decrease the motivations to save, invest and work, and by providing incorrect signals that alter production and work effort. By reducing the purchasing power of the poor, inflation is considered as the worst burden to the lower income group society though potentially it can hit any income groups. Its consequence of reducing purchasing power concerns government purchase of goods and services too. Due to this reason, policymakers need to emphasize to the on-going rate of inflation and its acceleration tendency. In addition, often the association of inflation and economic decline calls a concern to contain the inflation rate (IMF report, 2020, p.10).

Moving inflation rate is an indicator of macroeconomic imbalances that could reduce economic growth and lead an implementation of sustainable development goals not to achieve its target. Macroeconomic policies are designed to keep inflation at lower rate and thus, minimum desirable inflation level should be maintained to have healthy economic growth rate. Moreover, when the government intends to keep inflation at minimum rate, controlling the inflation level ought to be aimed and this necessitates knowing the main sources of the phenomenon (Teamrat, 2017).

Historically, the inflation level registered in the past two regimes has different trend. As indicated by Ashagire (2015), comparing to other countries, inflation has been relatively low in Ethiopia during the Dergue regime (1974-91), but it was higher than the preceding regimes. Even if inflation rate was slow during the regime, it was unstable and difficult to give prediction about the future years. Appreciation of the nominal exchange of the birr was one factor that responsible to such low and volatile inflation rate. In addition, the nature of the economic system practiced during the regime was command economy; physical and financial targets such as price level determination, saving, interest, credit, money supply and output and investment were set by central planning agency (Teshale, 2016).

After the downfall of the Dergue regime, a look at of the inflationary trend shows upward movement of CPI, conflicting with the country's economic growth rate though its annual rate varies. As to Admasu (2014), a healthy threshold level of inflation for GDP growth for Ethiopia is 10 percent for the period 1991 to 2013. Between 1991/92 and 2019, however, the vast majority of annual CPI rate recorded above this threshold indicating undesirable

movement of price level. This recent uptick of inflation is associated to an increase in food and non-food prices (NBE, 2018/19).

In its country report, IMF (2018) pointed out that since 2015 inflation has been raised up above the NBE single-digit objective (8%) even though growths of monetary aggregates were slow. The upward trending since 2015 was driven by an accommodative monetary stance, worsened as a result of devaluation in October 2017. The authority only began narrowing the monetary stance in 2018 while broader monetary aggregates credit continued to durably increase to late-2018 due to transmission lags. Recently, inflation rose to 20.8 percent in November 2019 mainly driven by food price inflation, which in part has been affected by interruptions to logistics networks, decline in average-rainfall in selected areas, delays in delivering inputs such as fertilizer to some areas, and higher transportation costs. Non-food inflation also surpassed 10 percent between 2017 and 2019 (IMF, 2020).

Several of studies were done on determinants of inflation in Ethiopia. For example, Solomon (2013), Teshale (2016), Getachew (2018) and Tadesse (2020) are among researchers who undertook an investigation on identifying factors influencing inflation in Ethiopia. However, the number of variables included are not only limited but also some of them are irrelevant and couldn't explain the inflationary experience of the country. And the considered times series as a size of observations was limited. For instance, Solomon (2013) examined the influence of real Gross Domestic Product, nominal average annual deposit interest rate, average annual exchange rate, fiscal deficit excluding grants, international petroleum price index and Bain's monopoly mark-up index on inflation dynamics in Ethiopia. This study is criticized not only by its inclusion of inappropriate variables – especially the last two variables and the contradicting impact of exchange rate in driving inflation dynamic – but also ignored other important macroeconomic variable such as population growth and national saving.

Furthermore, recent studies conducted by Temesgen (2013), Teshale (2016), Gemechu &Abebe (2020) and Tadesse (2020), among others, also share similar shortcoming; even if the variables these studies used are not all the same, they didn't incorporate other relevant explanatory such as population size. Conducting study without giving due credit to such important variables can lead to unreliable conclusion. In Ethiopia, the second most populous country in Africa with rapid growth rate, population growth had not been considered in examining sources of rising prices level. According to Enu, & Havi, (2014) and Martin & Veerachamy (2015), who have done an investigation on macroeconomic determinants of

inflation in Ghana and Rwanda respectively, population growth has found to be significantly affecting inflation trend of these developing countries even with lower population number compared to Ethiopia.

This study is different from the previous researches in many ways. First, unlike the previous studies, the study included other key macroeconomic determinants like population size, and imports of goods and services in addition to theoretically accustomed variables like broad money supply and gross domestic product. Thus, based on the ground of theoretical and empirical justification, the study examined the impact of these variables by incorporating them into the employed econometric model. Even though there is no standard theoretical illumination on how population growth reinforces inflation trend, the empirical literature (eg. Liu & Westelius, 2016; Ozimek, 2017 and Juselius &Takáts, 2018) discussed the mechanisms through which demography affects price change. Hence, we can examine effect of population growth in the case of Ethiopia where population number is rapidly growing.

The second one is that the study has considered the large number of observations from 1981 to 2020 using updated data. Since Ethiopian millennium when the maximum inflation rate was recorded 44.37%, the variable remained the government's emphasis due to its adverse impact on each household in particular and the nation's economy in general. A look at statistical data of the country's performance in attempting to bring the annual CPI percentage change down to economically favourable inflation threshold calls to re-examine a policy design. As Admasu (2014) pointed out in his analysis of inflation and economic growth between the periods 1991 to 2013, the estimated threshold of price level percentage change that indicated as attractive to economic growth is 10%.

Moreover, while identifying the economically healthy CPI growth, the national bank authority has targeted to maintain inflation growth rate at single-digit, 8%, (NBE, 2018 and 2020). Unfortunately, the phenomenon continued to prevail, at least in average, beyond the estimated threshold or the authority's single-digit target, showing signal of galloping inflation in the country. Henceforth, examining the source of this inflationary experience and its trend using updated data is vital to reconsider the policy action. Therefore, it is this state of inflationary phenomenon being beyond single digit and controversies in the effect of the mentioned macroeconomic variables on price growth motivated the researcher to undertake a study on the macroeconomic determinants of inflation in Ethiopia.

1.3 Objective of the Study

1.3.1 General objective

The main purpose of the study was to investigate the macroeconomic determinants of inflation in Ethiopia over the study period 1981 to 2020 using ARDL co-integration approach. To realize this general objective, the study attempted to achieve the next specific objectives.

1.3.2 Specific objectives

- To analyze trend of inflation in Ethiopia
- To examine whether there is long run con-integration between the dependent and independent variables
- To identify the short run and long run determinants of inflation in Ethiopia

1.4 Research Questions

The study investigated the macroeconomic determinants of inflation and examined whether the identified variables have significant impact on inflationary situation in Ethiopia. Hence, at the end of the investigation, the study has provided answer to the following questions:

- What inflation trend is observed in Ethiopia between 1981 and 2020?
- Is there a con-integration characteristic between the dependent and independent variables?
- Which variables determine short run and long run inflation trend in Ethiopia?

1.5 Significance of the study

Since high rate of inflation has begun to be a problematic especially in developing countries, the phenomenon has attracted attention of economists, policy makers and researchers due to its adverse effects economic performance. High inflation is one of the major challenges that Ethiopia's economy facing today. Despite the government's effort, the trend of this phenomenon remained among central agenda to the economy. Even though certain number of researches attempted to identify the principal sources of inflationary experience in Ethiopia, other potential factors such as population growth has not been considered. This research, however, examined the impact of this macroeconomic factor in addition to apparently known variables in Ethiopian context.

The study is important because of its contribution in the subsequent areas. It can have significant importance to government policy makers and other stakeholders in pursuit of providing the appropriate scientific knowledge to control inflation in Ethiopia. The other contribution of the paper is that it explicitly takes into account and stresses the contemporary effect of growing population number of the country on price dynamics. Because it considered the effect of population growth, it can add more knowledge and insights to the subject's prevailing literature which recently emerged as the country begun to experience high inflation rate especially in the last two decades. The study can also help the future researchers who want to carry out a study on the inflation as a reference.

Therefore, it incredibly contributes to the overall objective of macroeconomic policy in general and anti-inflationary policies in particular as it identifies the important macroeconomic variables that have driven inflationary situation in Ethiopia.

1.6 Scope of the Study

The study was delimited to investigate the macroeconomic determinants of inflation in Ethiopia using annual time series data spanning over 1981 up to 2020. This sample size is chosen because the numbers of explanatory variables and lags included in the model exhausts the degree of freedom in the regression. This requires moderate or large sample size. However, it is constrained by availability of data not to go beyond the limited year from the past. Because price growth had not been great concern before 1981 due to its low level, the time series length is thought to be adequate to examine the whether the identified factors determining have long run and short run impact on inflation during the study period. The range of study period is selected as it is suitable and long enough to capture the long run deriving forces of inflationary trend.

1.7 Limitation of the study

Some limitations associated to data availability were encountered during the investigation. One of these shortcomings was data accessibility over longer series of years. The researcher could not find the disaggregated components of some variables particularly private and public domestic saving as ingredients of gross national saving for the purpose of trend analysis. Due to inadequate database servers, the researcher was tempted to get data for some variables. As mentioned in scope of the study, the sample size (1981-2020) with 40 observations was employed due to lack of sufficient data particularly for variables such as real effective exchange rate and imports of goods and services. Although adequate efforts have been made

to include important empirically identified variables by extensively reviewing literature, the researcher stresses that the variables considered in the study might not be the only macroeconomic variables in the economy in driving prices growth. Finally, the study was conducted in the context of Ethiopia; so, implications or policy recommendations forwarded by the paper may not reflect the situation of other developing nations.

1.8 Organization of the paper

As the usual procedure, contents of the paper was thoroughly organized and classified in to six chapters along with its corresponding topics. The first chapter introduces theoretical and empirical background of the study followed by statement of the problem, and then states objectives, scope, and significance of the study. In chapter two, the most related theoretical and empirical literature reviews were discussed. In chapter three, methodology that employed in process of undertaking the study such as research design which encompasses types and sources of data, data collections and analysis methods were discoursed. Results from descriptive trend analysis of inflation growth rate in combination with each explanatory and the findings from econometric data analysis are presented and discussed in chapter four. Finally, chapter five concludes and recommends based on findings of the study.

CHAPTER TWO

2. REVIEW OF RELATED LITERATURE

2.1 Theoretical Literature

2.1.1 Definition and measures of inflation

Since neoclassical defined the term inflation, it has been experienced various changes and modifications. According to them, inflation is a continued increase in price of goods and services aroused from excessive money supply. The leading man of monetarists view, M. Friedman, price level is determined by money supply both in short run and long run unlike output which influenced by money only in the short run. In their early elucidation in Quantity Theory of Money (QTM), rapid growth of money beyond output constantly and universally causes inflation. However, Keynesians believe that inflation is caused from rise in money supply above the level of full employment (Jhingan, 1997).

Even though several economists differently define inflation, there is a consensus in its nature of sustainable rise of general price level. Based on percentage change increase in price, Boyles (2020) has reviewed and discussed the five types of inflation. Though prices constantly rise, they have several magnitudes which make them to be fallen in one of the classifications. When prices rise with very slow movement as of creeper, we call it creeping inflation. It is occurred if annual price growth not exceeds 3 percent. This kind of inflation supposed to be vital for an economy. However, if price rise lies between 3 and 10 percent, it is named as walking inflation. Walking inflation is serves government as a cautionary sign in case it turns to moving inflation. If annual rise in price level goes beyond 10 percent, it is called running or galloping inflation. Hyperinflation is a typical increase of price above 50 percent growth rate. Now let us briefly discuss each of them along with their causes.

2.1.2 Types of inflation

a) Creeping inflation

A price rise with less 3 percent per annual growth rate is called creeping or mild inflation. It is caused by excess of spending growth comparative to the total output in the economy and hence related to demand pull inflation. This type of inflation is important for economic growth by setting price rise anticipation among the buyers. Creeping inflation promotes better

economic performance by stimulating the current consumers to buy more due to higher price expectation in the future (Amadeo, 2014).

b) Walking inflation:

If prices of goods and services rise beyond creeping inflation, it is called walking inflation. This type of inflation is robust and harmful to an economy. Its growth rate lies between 3-10 percent per year. In this case of inflation consumers buy more and more commodities to circumvent the exacerbated high future prices. Such rise in buying may further intensify the demand to the level where suppliers cannot make their product available to the market. Consequently, supply shortage can be happed which further pulls up the price to the stage where consumers cannot afford (Amadeo, 2014).

c) Galloping inflation:

If walking inflation is not timely managed, it hovers to double digit price rate called galloping inflation. As a result the value of money get depreciated rapidly in the way businesses and income of employees cannot conform to the up going prices. It further leads to make foreign capitalist to escape the country, which result in capital deficiency. Galloping inflation make the economy unsecured and desperately undermine acceptability of the government officials. This type of inflation has been occurred during WW II in Europe and US, various Latin American countries such as Brazil and Argentina in the period 1970s and 1980s. thus, galloping inflation must be prohibited before it happened.

d) Hyperinflation:

It occurs when prices of goods and services hike to more than 50 percent. According to Boyles (2020), this inflation caused when government irresponsibly prints money for war purpose while the GDP is not capable of supporting the money growth. Hyperinflation can also be resulted from demand pull which arise when suppliers hoard commodity by observing the market situation. Experience this type of inflation was observed in Germany in the 1920s, Zimbabwe in the 2000s, and Venezuela in the 2010s and in America the civil war.

Hyperinflation also caused by too much money slops in the economy excessive demand. Since consumers recognize the prevailing situation, they inevitably expect higher inflation. Such trend entails in the worsening of inflation due to aggravated excessive demand. This type of inflation usually happens during the period of economic depression. Once inflation

reaches hyper level, it is not responsive to accustomed tightened monetary and fiscal policy actions. Controlling such inflation may involve too much cost in the prevalence of widespread unemployment (Hall, 1982).

e) Stagflation:

A type of inflation occurred when the economy is in economic stagnation is called stagflation. The situation happens when serious inflation is combined with bad economic performance and high unemployment. Stagflation is a serious threat especially to the central bank as the phenomenon might not react to monetary and fiscal policies. When central bank responds by increasing interest rate to fight inflation, contraction of money supply in the period of stagflation further poses unemployment risk. As such, combating Stagflation becomes possibly the most tempting type of inflation to control. An example of this inflation occurred during the crises of 1970s in United States and the United Kingdom, which caused distress to central banks of both nations.

2.1.3 Causes of Inflation

a) Demand Pull Inflation

During John Keynes (1883-1946) and his fellows, aggregate demand was considered as main causes of demand pull inflation. Investment, consumption and government expenditure and net exports are major components aggregate demand. Disequilibrium created due imbalance of demand for goods and services and its supply hikes price until equilibrium is re-established. The shortage instigated from excess demand leads to competition of businesses, government and consumers in the market on the limited amount of goods and services. Such phenomenon further leads to pull up the price until restoration of equilibrium (Campbell and Stanley, 1986).

As to Keynesians, if aggregate demand, at full employment, surpasses aggregate supply prices begin to rise. Rapidity if inflation arises from demand pull inflation depends on demand and supply gap. They did not hesitate to accept that supply constraint can lead to price growth even if the full employment is not achieved. According to Keynesians demand pull theory, policies that reduce each elements of aggregate demand are fruitful in decreasing the burden of higher demand and inflation. Increasing tax is one mechanism of reducing government expenditure and controlling the amount of money in circulation can be effective in an attempt to manage inflation caused by excess aggregate demand. However, during the

time of hovered inflation such as hyperinflation, cutting government expenditure by increasing tax and regulating volume of money might not practically work.

b) Cost push inflation

This type of inflation is occurred when wages get raised as result of law imposed by unions and employers attempt to increase profit. Cost push inflation has been known even during the time of medieval period, but re-examined in 1950s and later in the 1970s as the main source of inflation. The primary cause of cost push inflation is the rapid increase in nominal money than the actual labour productivity. Labour unions enforce their employers to pay higher wage, which in turn increase production cost to the producers. Then, employers are will be forced to claim higher price for their commodity. Nevertheless, the price rise again makes the union to request improved wage payment. In such way, the interest of unions and producers cause cost-push inflation. Due to their strong bargaining power, wage imitation and monetary accommodation of trade unions in developed countries have been had capacity of receiving higher wage rate than the labour productivity (Campbell & Stanley, 1986).

Furthermore, profit push is also another source of cost-push inflation. Monopolistic and oligopolistic firms raise the price of their commodities in order to compensate the the increased wage and other production costs and hence they can enhance their profit. Since these firms exercise imperfect competition, they can execute price of their respective product. Thus, profit-driven inflation is called administered-price inflation (Jalil, 2011).

2.1.4 Theories of Inflation

i) Quantity Theory of Money

The theory essentially gives credit to central bank as key regulator of price level because the vast proportional change in price resulted from monetary expansion. According to the QTM (quantity theory of money), inflation is occurred because of the central bankers' inclination. As to explanation of Hetzel (2007), the theory was supported by Friedman (1976), who asserted that a discrepancy in price mostly driven by monetary phenomenon. The quantity equation (MV = PY) of Fisher (1911) was the classicalist's fundamental investigation. In this case, P is general price level, Y is real output, V is velocity of money (the average number of times a unit of currency circulated in a year) and M denotes volume of money supply. Under the assumption of flexible wage and price, Fisher argues that a change in money supply causes price level to be changed with the same proportion. This proposition is founded on the assumption of unchanged velocity and real output.

Classicalist's analysis on inflation is simple and mainly focuses on the view of monetarism. According to them, the general economy comprises two components, namely the nominal and real sectors along with their corresponding determinants. This indicates that if the quantity equation holds, only the real factors influence real variable such as Y (real output). Besides, velocity of money is exogenously determined by level of technology institutional arrangements and the society's custom, not by money expansion. Assuming velocity and real output to be fixed in the Fisher's model, (MV = PY), the QTM assert that any shock in money supply would be reflected by proportional variation in general price level (Ray and Anderson, 2011).

Moreover, the above argument could be represented by $(\%\Delta M + \%\Delta V = \%\Delta P + \%\Delta Y)$; and since $\%\Delta V = 0$ and $\%\Delta Y = 0$, the relationship between the remaining two nominal terms can be, $\%\Delta M = \%\Delta P$; the impact of monetary shock on general price is complete. Where, Δ is (the difference operator). Real income (Y) could not be affected by money supply in that it only influenced by the real factors. The symbol $\%\Delta P$ represents the rate of change in aggregate price level which we call inflation rate, and $\%\Delta M$ represents the rate by which money grows. So, in the equation above, letting $\%\Delta V$ zero and $\%\Delta Y$ being governed by other exogenous factors, we remain with the equation $\%\Delta M = \%\Delta P$. A fundamental implication here is that a given change in growth of money induces exactly similar growth in the inflation rate, which provokes Milton Friedman to hold for inflation as being *"always and everywhere a monetary phenomenon".*

In general, in the classical model real variables are invariant of the quantity of money; the quantity of money only determines the level of price. A mere rise in money supply with unresponsive production would only results in persistent increase in aggregate price, which is known to be inflation, but there would be no other resultant effect. Hence, the optimum policy is to cut unreasonable monetary growth; money growth rate beyond the real income growth rate is hence unproductive. Milton Friedman (1976) advised that for a given percentage change in money supply to be matched exactly by equal and proportional growth of real GDP.

ii) Monetarist Theory

The followers of Friedman (1912-2006) are referred as monetarists, who suggested that "only money matters". According monetarists, monetary policy is a powerful mechanism than

fiscal policy in ensuring stability of an economy. For them, money supply is dominant determinant of both price and output level although not the only factor. Volume of money determines prices both in the short run and long run while it influences output only in short run. But, some researchers Gokal and Hanif (2004) argue that doubling economic factors, for example wage rate, should not be worrisome to pay the same proportional increase of price. By observing such trend, individuals accordingly adjust themselves; hence, money becomes neutral in case individuals predict the future price rise. Thus, real sector of the economy such as output and employment remain unaffected.

The notion of neutrality works when equilibrium real output is not influenced by volume of money in the long run process. Moreover, if growth rate of real GDP are independent of money growth, neutrality tremendously holds. Inflation is foreseeable when money supply growth exceeds growth rate of GDP. Monetarists, therefore advocate that growth is independent of money supply, but it is directly proportional with the growth of nominal output. In conclusion, money growth has no impact on the long run growth of real output, but highly drives price level (Birol, 2005).

iii) Keynesian Theory

Though debatable, the classical version of *QTM* remained a dominant macroeconomic ideology since 1930s. Since then, an immediate attack emerged from the Great Britain economist John Keynes following a Great Depression. We noted in the classical model that a monetary impulse has no real effect on the economy. For classical economists, changes in money supply impact only the nominal variables but not the real variables (Hoover, 2012). Keynes rejected this hypothesis and analyzed the money-price spirals differently. His attack takes the following forms.

To the beginning, he didn't believe in the fallacy of direct causal links between money and price. The classicalists' analysis was based on the prior implicit assumption of the economy operating at full employment. This assumption was an important stepping point for Keynes in his critics against the *QTM.* He hence maintained that, in the presence of idle labor and other material resources; forming such an implicit assumption could be of a futile task (Dutt and Skott, 2005). Continuing his justification, he identified three basic reasons why an economic agents demand money balance; the transaction demand (in line with the traditional economists), the precautionary demand *(for emergency cases)* and the speculative demand

(money even as store of value); with the latter being the key tool in his attack against the *QTM* (Krusell, 2004).

He contained these three motives together in his money demand function given by ($\frac{Md}{P}$) = f(-i, +Y)), and related money demand positively to income and negatively to the level of interest rates: thereby recognizing the role of interest rate in affecting the demand for money. Price being determined by the demand and supply for money, Keynes formulated his own quantity equation given by P = $\frac{M}{D}$, or $\frac{M}{P}$ = D. Where; M is the nominal stock of exogenously determined money supply; D, the demand for money and P is the general price level (Keynes, 1936).

Keynes has made an important macroeconomic revolution in monetary economics while recognizing the role of interest rate in economic decision thereby identifying the role many plays in the economic system. With the nominal interest rate included in his money demand function, Keynes stressed that, changes in the quantity of money affect price level only after impacting the level of interest rate, and hence investment, output and employment so that the transmission mechanism between money and the price level is indirect. The immediate impact of change in the quantity of money rests on the interest rate but not on price. It implies that when interest rate decreases - following positive shock in the quantity of money, the level of investment responds by increasing. Hence, the levels of output, income and employment increase also as well. The additional level of employment, in fact, imposes additional pressure on aggregate demand, and that the rising wage and other costs together induce the price level to rise. Here, the transmission of monetary impact on price is not only indirect, but the effect is not complete, since part of the money balance is held by the speculators, see (Nelson, 2007; Krusell, 2004).

Both versions of *QTM* are similar after the economy attains its full employment level by recognizing the full impact of money growth on the general price level. The Keynes's version reveals that the elasticity of price with respect to any monetary shock be equal to zero (ep = 0) in an economy with idle resources to utilize. According to him, in such an economy, monetary injections would enable utilize idle resources and employment which increases output in a proportion to changing aggregate demand, hence there would be no impact on prices in the short run (Dutt and Skott, 2005). The elasticity becomes one, given the level of output and employment fixed at full capacity and is '*True inflation'* for Keynes. Any

monetary growth while the economy is operating at full capacity induces proportional change on price.

iv) Structuralism Theory

Streeten (1962) and Baumol (1967) indicated the importance of country specific structural factors in inflationary process. They used the coexistence of segmented sectors: a progressive (industrial) sector and a traditional (agricultural) sector to show the link between inflation and income distribution. It is assumed that the industrial sector is sensitive to policies while the agricultural sector less so. Growth in aggregate demand results in output and employment of the industrial sector rising in the short run. This increases wages in the industrial sector with the consequence of rise in demand and, hence, price of agricultural products (food). This rise in agricultural prices will induce rise in wages of the sector, which results in rise in demand for industrial products. This cycle of income distributional conflict pushes prices continuously.

Kalecki (1963) suggests a related but a slightly different rationalization based on an economy producing two types of goods (necessities and non-essentials) to explain the inherent distributional conflict that derives inflation. He argues that if national income grows at a rate faster than warranted by supply of necessities, price of necessities will rise. The equilibrium condition will be restored "through a fall in the real income of the broad masses of the population" (Kaleck, 1963).

2.2 Empirical Literature Review on inflation

This section discusses a review of related empirical studies conducted on inflation around the World. In the first part, literature reviews studies done on macroeconomic determinants of inflation from countries other than Ethiopia have been made. Next, literatures from Ethiopia that attribute to the subject have been reviewed. While doing so, emphasis was made on data used, methodology adopted, the nature of the relationship between identified macroeconomic determinants and inflation, and the suggested policy options and implications by the study.

2.2.1 Empirical Literature review from other countries

This section discusses the empirical evidences from the world outside Ethiopia. It includes selected most relevant and recently done empirical papers from all over the globe. Even if some of them were done using cross country data, most of these studies employ time series

data. Variables were incorporated in to their corresponding model based on the context of that particular country's source of inflation.

Iya & and Aminu (2014) studied "An Empirical Analysis of the Determinants of Inflation" in the case of Nigeria on the data spanning over 1980 to 2012 using OLS estimation method. This study also uses the Granger causality test in order to examine causation between inflation and its hypothesized determinants: money supply, exchange rate, government expenditure, and interest rate. Furthermore, co-integration and vector error correction techniques were applied to examine the long run and short run association between price level and the independent variables.

The outcomes from Johansen co-integration test reveals existence of long run relationship between inflation and the variables under consideration. As pointed by the authors, there is positive and significant relationship between money supply and interest rate, and inflation but, exchange rate and government expenditure have negative influence on it. In line with their finding, the forwarded policy implication by the researchers is appropriate that the economy's good performance in terms of price stability can be attained by bringing money supply down and interest rate and improving exchange rate and government expenditure in the context the country.

An empirical study into the subject was undertaken on high and low inflation countries economy. Lim and Sek (2015) in their paper with title "*An Examination on the Determinants of Inflation*" studied factors causing inflation in high inflation and low inflation countries using annual panel data from 1970 to 2011. To test the short run and long run influences of explanatory variables on inflation an Error Correction Model (ECM) was employed based on the Autoregressive Distributed Lag (ARDL) modelling. Accordingly, GDP growth and imports of goods and services have been found to have the significant long run effect on inflation in low inflation countries. Further, results from ECM show that money supply, GDP growth, and national expenditure have been determining price level trend in high inflation countries in long run. This study also indicates positive, negative and negative significant impact of money supply, GDP growth and imports of goods and services on inflation of low inflation countries respectively.

Using time series data for the period from 1970 to 2013, Martin and Veerachamy (2015) have examined determinants of inflation in Rwanda by employing ordinary least square regression

estimation method. This paper aimed at investigating the influence of import of goods and services, government spending, population growth, agriculture output and foreign direct investment on inflation. According to their finding, the major determinants of inflation in Rwanda are agriculture output and import of goods and services.

Uncommon to recent studies except a study conducted by Enu and Havi (2014), this paper examines the impact of population growth impact on inflation, and their investigation reveals statistically significant and negative link of this variable with inflation. However, the influence of government spending and foreign direct investment on inflation is observed to be insignificant negative and positive respectively. Applying co-integration approach, they investigated the macroeconomic factors affecting inflation in Ghana which aimed at examining whether foreign direct investment, population growth, foreign aid, agricultural and service's output have a significantly impacted the inflationary experience in the country over 1964 - 2008 study period . According to them, all included variables were found to be have stationary property and integrated of first order one i.e. I (1).

The result from Johansen co-integration test and VEC (Vector Error Correction) estimation reveals the existence of both long run and short run relationship among the variables. The main identified long run determinants of inflation in Ghana are: foreign direct investment, population growth, service's output and foreign aid. Unlike those previously conducted investigations on the subject matter, the study's inclusion of macroeconomic variables like population growth and service's output make it peculiar.

By their investigation on macroeconomic factors that has been a cause of inflation in Ghana during the period 1990 to 2009, Gyebi and Boafo (2013) find that real output, real exchange rate and money supply were the strongest factors that have been responsible for rising price level in the country. According to this study, the depreciation of exchange rate and ERP (Economic Recovery Program) implementation played an important role in dropping the raising price level in Ghana, witnessing that the program abled to achieved its aim of bringing down inflationary trend in the country.

Unfortunately, this paper is criticised on two grounds. The included variables were very limited in number. It simply tested structural and monetarist theory in the context of Ghana neglecting other supply side important variables like agricultural output, foreign direct investment and export of goods and services. The econometric model used is, on the other

hand, not rigorous and extensive enough to predict the short run and long run determinants of inflation in Ghana. Whether these variables were co-integrated or not is not checked using appropriate analysis.

Using co-integration analyses, Loua, et al. (2018) scrutinized the factors that have contributed to the level of price in Republic of Guinea, for the time series data spanning from 1990 to 2015. The study aimed to investigate whether gross domestic per capita, money supply, and exchange rate have significantly influenced the inflationary experience for the duration of the mentioned period. The examined Johansen co-integration reveals the existence of both long and short-term connection between the variables under study. Accordingly, money supply and exchange rate positively and significantly affected inflation. The effect of GDP per capita, on the other hand, is found to have negative and significant impact on price level. Johansson's co-integration test result also shows the existence a long-run and short-run link between inflation, gross domestic product per capita money supply, and exchange rate in Guinea.

Furrukh, (2016) analysed demand and supply side factors causing inflation in Pakistan using time series data spanning over 1972 to 2014. This study uses autoregressive and distributed lag (ARDL) model to examine long run and short run impact of variables. The identified demand side causes of inflation are: roads, population, and government expenditure whereas supply side inflation factors are: government revenue, imports, external debt, electricity generation and. According to the finding the demand side variables: population, government expenditure, roads have significantly affected inflation. On the other hand: imports, electricity generation, government revenue, and external debt are the supply side factors which have found to have significant influence on inflation in Pakistan. In this rigorous analysis of price dynamism, variables like government expenditure, roads, imports, government revenue and external debt are the long run causes of inflation. In addition to this, in the long run, a negative association between price level and foreign direct investment, electricity generation and population is seen in the result of the investigation.

In conclusion, the various studies from other countries convey the dissimilarity of combination of variables from both supply and demand sides hypothesized to affect inflation. This may occurred due to factors determining phenomenon of inflation are subjective to the country under consideration even though some variables such as real GDP, money supply and import most commonly considered as explanatory variable. Nevertheless, these studies

generally share common objective that identifying long run and short run causes of price level using co-integration and error correction model respectively.

2.2.2 Related Empirical Literature in Ethiopia

Sisay (2008) studied about inflation in Ethiopia with the title 'determinants of recent inflation in Ethiopia' using econometric technique of co-integration. The study employed quarterly data spanning from third quarter of 1997/98 up to second quarter of 2007/8. The incorporated macroeconomic variables are: one period lagged consumer price index, real GDP, exchange rate, broad money supply, period lagged money supply, lending interest rate, overall budget deficit, and price of gas oil. According to the study's finding, inflation is structural and monetary phenomena in Ethiopia. It founds that the long run inflation in the country is caused by structural, monetary expansion, lending rates and expectations. On the other hand, exchange rate, one quarter lagged money supply, gas oil prices and deficits have been found to have no significant impact on inflation in the long run. Gas oil price insignificance is supported by many studies whereas variables like budget deficit and exchange rate found to have mixed impact on inflation.

Using vector auto regressive (VAR) and single equation error correction models, Alemayehu and Kibrom (2008) looked at the sources of recent inflationary experience in Ethiopia over the study period 1994/5 and 2007/8. According to their finding, factors causing inflation vary across food and non-food sectors. To food inflation real income, money supply, inflation expectation and international food prices are the most significant determinants in long run, whereas; money supply, interest rate, and inflation expectation are identified as long run contributing factor of non-food inflation. On the other hand variables such as wages, international prices, exchange rates and food supply are found to influence inflation in short run.

Solomon (2013) studied source of price dynamics in Ethiopia by combining equation of weighted price with expected price level equation using OLS model and annual data spanning over 1971 - 2014. Real GDP, nominal average annual deposit interest rate, average annual exchange rate, fiscal deficit, international petroleum price index and Bain's monopoly mark-up index were employed. The outcome of his study shows that monetary and fiscal fundamentals are important determinants of price dynamics in the short run. But in the long run, Real GDP is the most essential variable while weak relationship between inflation and foreign prices is detected by the investigation. In fact, some studies confirm both finding.

Teshale (2016) investigated determinants of inflationary experience in Ethiopia using time series data from the period 1974/75 to 2014/15. This study used Johansen Co-integration methodology and Vector Error Correction approach with two lag length, in order to examine long run and short run macroeconomic variables. He used macroeconomic variable such as broad money supply, real effective exchange rate, overall budget balance and real gross domestic product as explanatory variables and consumer price index as dependent variable.

Accordingly, the study's finding reveals that, in long run money supply, real gross domestic product and overall budget deficit have positive and statistically significant impact on Consumer's Price Index (CPI). In short run, budget deficit's preceding year is the only variable dedicated in explaining current year consumer price index. This study also recommended appropriate policy implication emphasizing on the long run influence of money supply growth and budget deficit in speeding up inflationary experience in Ethiopia. Nevertheless, this study is criticized for it incorporated only limited number variable in to the specified model. It would have been more sensible if important variable in affecting inflation like national saving and agricultural output were included.

Teamrat (2017) also examined determinants of Inflation in Ethiopia using the ordinary least square method. And the data obtained span from 1975 to 2014. In the study, consumer price index treated as dependent variable while: broad money supply, gross domestic product credit facility, exports of goods and services, imports of goods and services and gross national saving included as explanatory variables. To check the existence of a short-run and long-run association between inflation and its determinants, he employed co-integration tests.

The empirical analysis results from error correction and co-integration reveal that GDP is the only variable that positively and significantly affects inflation both in the short and long-run. According to him, 98 percent of variation of inflation during the study period was explained by GDP. In addition, broad money supply, and gross national saving and import of goods and services have been found to have significant positive and negative impact on consumer price index respectively. Here is a suggested recommendation by the study; *"…broad money supply is to be controlled and gross national saving is to be encouraged to reduce inflation in the country"*. Though the suggested implication is appropriate according to the investigation outcome, it gives more credit to GDP as principal explaining variable which contradicts with other papers done on the same area.

Finally we conclude by summarizing the most recent paper result undertaken by Tadesse (2020). This study mainly aimed at identification and examination of macroeconomic determinants of inflation in Ethiopia using annual data spanning over 1985 to 2018. The result from OLS econometric model identified economic variables determining inflationary situation by specifying both long run and short run version of the model. The researcher found that, both in long run and short run, real interest rate and real effective exchange rate are significant determinants of inflation during the study period. On the other hand, broad money supply affects inflation only in the long run while gross domestic saving found to have insignificant impact on price growth both in the short run and long run. This study is criticized for its exclusion of important variables that considered by other researchers such as real GDP which even found significant. Thus, the conclusion and recommendation forwarded by the researcher may not be reliable in the absence of important variables from being examined.

To sum up, the number of papers done on the macroeconomic determinants in Ethiopia is limited and those existing researches mostly devoted to examine the influence of GPD growth, money supply, import and export of goods and services and budget deficit on CPI though they come up with different conclusion. The difference in their finding is attributes to dissimilarity of number of hypothesized determinants and combination of the explanatory variables included in their respective model specification. This lack of consensus on factors that cause inflation, which characterized by unpredictability even when considered at quarterly bases of a year, lead to conflicting policy prescription. Therefore, it is sound argument that re-identifying those elements behind a rise in price level in the country is paramount important.

CHAPTER THREE

3. RESEARCH METHODOLOGY

3.1 Type of Data

The researcher employed secondary quantitative data in order to realize the defined study's objective. The rationale of using this type of data lies in the nature or subject matter (i.e. both dependent and independent variables) themselves requires a numerical data which have already been collected by an individual(s) or certain institution(s). Its characteristics of less expensiveness and time-consuming to obtain comparing to primary data makes it preferable too. The supporting data and information for the investigation was obtained from different relevant secondary data sources such as related publications, annual reports and bulletins.

3.2 Source and Method of Data Collection

Since the research entirely applies secondary data, extraction of data is not as exhaustive as the primary data to collect and organize. The secondary data for both dependent variable (CPI) and independent variables such as real GDP, broad money supply, lending interest rate, gross national saving, population size, real effective exchange rate and import of goods and services data were acquired from concerned institutions and organizations. These institutions and organizations include National Bank of Ethiopia (NBE), World Economic Outlook (WEO) of IMF and World Development Indicators (WDI) of the World Bank (WB).

Table 3.1: Specific sources of data

S.N	Variables	Source of data
1.	Consumer price Index (CPI)	NBE
2.	Money Supply (MS)	WDI
3.	Real Gross Domestic Product (RGDP)	WDI
4.	Lending Interest Rate (IR)	NBE
5.	Real Effective Exchange Rate (REER)	NBE
6.	Gross National Saving (GNS)	WDI
7.	Population size (POP)	IMF (World Economic outlook)
8.	Import of goods and services (IM)	WDI

3.3 Method of Data Analysis

For the purpose of data analysis the study employed both descriptive and inferential method of data analysis. The descriptive method was used to depict the trends of inflation represented by CPI in combination with each explanatory variable: money supply, real GDP, lending interest rate, national saving, population size, real effective exchange rate, import of goods and services. To examine the long run and short run relationship among macroeconomic determinant variables of inflation, on the other hand, the bound test of ARDL model of time series econometric method of data analysis was employed.

In econometrics procedures, first unit root test was conducted to check for the stationarity of the time series model using Augmented Dickey Fuller (ADF) test and Phillips-Perron test (PP). The co-integration test was applied using ARDL bound co-integration approach to examine whether the variables have long run relationship. Co-integration test serves as a bridge whether to specify both long run and short run model or the latter alone. If bound test of co-integration leaded to conclude the presence of long run relationship between the variables, both models should be estimated. The coefficients of long run model are estimated from level form of the variables without differencing, but short run model (ECM) is derived from the ARDL model by transforming the equation in to the re-parameterized form. The long run information will not be loosed in case coefficient of error correction term captures evidence of the relationship through its speed of adjustment interpretation. However, short run version of the ARDL model is specified if the bound test does not indicate the existence of long run relationship (Nkoro, 2016).

3.4 Model Specification

One of the main important stages of a research in establishing the relationship among variables is to express their association in mathematical form up on which the model is set up. Then, the connection between economic variables under consideration has been empirically dealt based on the data obtained from the sample selected. This process is called a model specification.

Based on theoretical knowledge of variables' interaction, there are several functional models in multivariate regression analysis. In this case, however, Irving Fisher's (1911), modern version of quantity theory of money (QTM) which establishes a direct and proportional relationship between price level and money supply was used as initial model development.

As indicated by Alimi (2010), the model founds on the following two identities which measure expenditures in two different ways.

Y = MV …… (3.1)

Y = py …… (3.2)

Therefore, MV = py …… (3.3)

Where: y = real output

Y = nominal value of output (= nominal output)

P = price level (i.e. the average price of commodities)

M = money supply

V = velocity of circulation of money (M) against output (y) during the specified period.

To transform the quantity equation to the theory of price determination, Fisher acknowledged equation (3.3) as an identity with the following two economic behaviour assumptions.

i) The association between the quantity of money in circulation and the velocities of money circulated in the economy as well as deposits is not clearly known. Rather the velocity of money circulation and deposits depend on technological conditions such as individual countries rates of turnover which depend also on individual customs, population density, rapidity of transport, commercial customs, and other technical conditions, but not on the quantity of money and deposits, nor on the price level.

ii) The amount of trade does not depend on the quantity of money which is similar to the velocity of circulation of money.

It is possible to rewrite the quantity theory of equation (QTM) in expression of percentage rate of change (i.e. in terms of growth rates) as:

$$\boldsymbol{m_t + v_t = p_t + y_t} \quad \text{…… (3.4)}$$

Where: p is the logarithm of the price level, v is the logarithm of the velocity of money, m is the logarithm of money supply, and y is logarithm of real output. If inflation theory of the monetarist is correct, it is possible to develop mathematical relationship between inflation and other exogenous factors determining it in addition to money supply and real output. This model is akin to papers that were done by Sisay (2008), Alimi (2010), and Tadesse (2020).

Moreover, there are two grounds of justification for the specified model. Firstly, the general formula of the model is defined based on the Fisher's (1911) quantity theory of money, which states that variation in money supply proportionally changes level of prices in the economy.

Secondly, the variables entered in the model are incorporated after extensive assessment of empirical literature of the subject about the important macroeconomic factors that reflect price growth in Ethiopia. The considered variables could explain the effects of demand-side, supply-side (cost-push) and imported price on the level of domestic price. Hence, functional form of the explained and the explanatory variables employed can be deterministically specified as the following.

$$IFL = f(BMS, RGDP, IM, REER, POP, IR, GNS, D) \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (3.5)$$

Where; IFL- is inflation (general price level) measured as the change in CPI

BMS = Broad money supply as a measure of monetary policy

RGDP = Real Gross Domestic Product as a measure of fiscal policy

IM = import of goods and services

REER = real effective exchange rate

POP = Population size measured as population growth rate

IR = Lending interest rate

GNS = Gross national saving

D = dummy variable for unexpected shocks

Under the assumption of constant velocity of money, the multivariate long run relationship between inflation and the seven variables can be econometrically re-specified in logarithmic form.

$$LCPI_t = \alpha + \beta_1 LBMS_t + \beta_2 LRGDP_t + \beta_3 LPOP_t + \beta_4 LREER_t + \beta_5 LIM_t + \beta_6 LGNS_t + \beta_7 IR_t + \beta_8 D + \varepsilon_t \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 3.6$$

Where α is the constant term, βi′s are the coefficients of independent variables to be estimated where i = 1, 2, ….8 ; coefficient of the dummy variable is $\beta_8 = 1$ if there is a shock in trend of inflation and 0 other wise; LCPI is logarithm of consumer price index; LBMS is logarithm of money supply; LRGDP is logarithm of real GDP; LIM is logarithm of import of goods and services; LREER is logarithm of real effective exchange rate; LPOP is logarithm of population size, IR is lending interest rate; LGNS is logarithm of gross national saving; ε is error term which is assumed to be white noise and t is the time period.

3.4.1 Description of the variables

***Consumer Price Index* (*CPI*):** is the Ethiopian consumer price index and it measures changes in the prices of basket of goods and services that households consume. Such

changes have an effect on the real purchasing power of consumers' incomes and their welfare. When prices of different goods and services vary by different rate, a price index can only reflect their average movement. A price index is usually given a value of unity, or 100, in some reference period and the values of the index for other periods of time are intended to show the average proportionate or percentage change in prices from this price reference period (Fitsum, 2016). In the study, the annual average of CPI for each year was used.

CPI in logarithm form is used as a proxy to inflation growth rate in the study because it has advantage over GDP deflator by measuring the price level of all goods and services that bought by domestic consumers. Unlike the GDP deflator which does not include changes in the price of imported goods, CPI incorporates all imported goods and also represents a proportion of all domestically produced goods and services because it exclusively focuses on consumer goods. Using GDP deflator to measure percentage changes in price level can underestimate the cost of living by excluding the price of imported goods. Therefore, CPI is more suitable when consumers' cost of living is desired to be measured (Zeder, 2018).

Money supply (BMS): Traditionally, money supply can be defined from its narrow and broader sense. Narrow money (M_1) is a measure of money stock intended primarily for use in transactions. It consists of currency held by the public, traveler's checks, demand deposits and other checkable deposits. Broad money (M_2) is a measure of the domestic money supply that includes M_1 plus Quasi-money (savings and time deposits), overnight repurchase agreements, and personal balances in money market accounts. Mostly, M_2 includes money that can be quickly converted to M_1 (see Mishkin, 2009). The NBE takes the broader definition of money or M_2 as money supply and also in the study this definition was used in terms of USD.

Money supply is linked to inflation through financial resources and instruments which regulated by monetary policy. Inflation is occurred if NBE eases to regulate financial intermediaries to maintain legislative liquidity requirement of time and deposits. Inflation also gets accelerated when central bank decreases interest rate or purchases the prevailing government bonds (Desta (2010).

Real Gross Domestic Product (RGDP): is aggregate measure of the size of an economy adjusted for price changes. Gross domestic product (GDP) is the value of all final goods and

services produced in the country for a given period of time. The market value of GDP depends on the actual quantity of goods and service produced, and their price. The actual quantity of goods produced some times is called the volume. Therefore, real GDP was used to capture the overall economic performance (Segni, 2020).

Real GDP mainly related to inflation through capital accumulation and progress in the efficiency of factor of production. As to the proposition of Bruno (1993), unstable and high price growth affects investment and capital rate of return. Additionally, Feldstein (1996) argued that return on capital could be reduced even under complete expectation of inflation provided that the taxation system of many industrialized countries remained non-neutral. Moreover, uncertainty in inflation dampens foreign investor's attraction and also reduces confidence on the future monetary policy. Real GDP can also be associated with inflation through its factors such as investment on research and development (R&D) and hence human capital (Jones and Manuelli (1993). Therefore, negative relationship between real output and inflation was expected even though there is controversy in the empirical literature on correlation of the two variables.

Population size (POP): In the word of Lebreton et al. (1992) population size is defined as *"range of the number of individuals present in a subjectively designated geographic".* In case of the study, however, logarithmic form of population size makes the variable population growth rate. Both supply and demand side causes of inflation are driven by population growth in a variety of ways. Accelerated population growth can be associated with inflation by enhancing aggregate demand and housing market instrumental variable; this explains why inflation is persistently insubstantial in some places where population size is low (Ozimek, 2017).

Real Effective Exchange Rate: The real effective exchange rate (REER) is the weighted average of a country's currency in relation to an index or basket of other major currencies. The weights are determined by comparing the relative trade balance of a country's currency against each country within the index. The variable was expressed in terms of the ratio of national currency (ETB) to United States' dollar. Under flexible exchange rate regime of open economy, it is most likely that depreciation in exchange rates influence the price of imported goods, aggravating consumer and producer price indexes to be driven up (Sen, 2019). Thus, positive relationship between real effective exchange rate and CPI is expected.

Lending interest rate (IR): As to the definition provided by Samuel and Nurina (2015), interest rate is a worth gained from the asset or wealth either invested or saved. They also suggest that both demand and supply side of an economy can be affected by interest rate and inflation through their linkage with money. It is a cost of loans which influences the demand for credit and hence money supply. According to IMF (2018), however, interest rate has three functions: the return on financial assets so that act as incentive to save or lend, as a cost of capital, and links the foreign financial asset rate of return with inflation (Ojima & Emerenini, 2015). Based on the Fisher's hypothesis, Ayub et al. (2014) argues that interest rate is negatively correlated with inflation. Therefore, this study hypothesises that there is indirect relationship between lending interest rate and inflation.

Imports (IM): is the monetary value of foreign goods or services that are produced abroad, but bought by firms, households, organizations and government agencies of a country in a certain period of time. They include payments for visible and invisible imports. Visible imports comprise final products, oil products, finished and semi-finished components, whereas invisible imports include payments for financial services, tourist expenditure from abroad, and organizational services.

Theoretically, imports of goods and services exert pressure on inflation through exchange rate and purchasing power parity channels. According to Houck's (1980) explanation, inflation can be reduced by maintaining yearly exchange rate at lower level which overvalues currency of the country. Overvaluation in turn raises imports and discourages exports. On the other hand, domestic price can be influenced by altering purchasing power parity of their country's currency. Policy makers can either overvalue currency of their own country by spending foreign exchange assets to purchase the domestic currency or devalue it by purchasing foreign exchange and thereby lower price of their own currency. Therefore, relationship between import and CPI as a proxy to inflation is usually positive in theory (Ariful, 2013).

Gross national saving (GNS): National saving measures the amount of income that households, businesses and government save. Fundamentally, it is calculated as the difference between national income and consumption. It also measures a nation's financial health because it is saving that generates investment (Abel, 2016). According to the hypothesis of standard life-cycle model, the single way through which inflation is affected by domestic saving is real interest rate. However, El-Seoud (2014) argues that there are more two ways in

which inflation and saving are related to each other. Inflation can create doubt about the future earning streams and hence consumers may save more for cautionary purpose. Additionally, inflation could be correlated with saving through its effect on real wealth. Saving can reinforce inflation if consumers endeavour to hold certain level of liquid assets or wealth relative to their income. Hence, we can reasonably consider national saving as additional explanatory variable.

Dummy variable (D): in a model of price dynamics, dummy variables are included to capture shocks in price rate of change resulting from droughts, short-run high price volatility arise from world food price inflation and perceived domestic supply shortages (Rashid, 2010) and improvement in political and legal institutions and so on (Easterly, 1993). In this particular study, single dummy was created to capture the sharp increase in general price during 2008 and the sharp change in structural trend of inflation growth identified using unit root with break. The unit root test with break showed that the break point is 2015. Hence, 2008 and 2015 to 2020 took artificial number one (1) and zero (0) otherwise.

Error term (Ut): denotes a disturbance term with a zero mean and normal distribution i.e. constant variance.

Table 3.1: Summary of variables' description

Variables	Description	Unit of measurement	Expected relationship
CPI	Consumers Price Index	Price index	Dependent variable
BMS	Broad Money Supply	Millions of USD	Positive
RGDP	Real Gross Domestic Product	Millions of USD	Negative
REER	Real effective exchange rate	ETB per US$	Positive
IM	Import of Goods and Services	Millions of USD	Positive
POP	Population Size	Millions	Positive
IR	Lending interest rate	In percent	Negative
GNS	Gross National Saving	Millions of USD	Negative

3.5 Model Estimation Procedures

The econometric data analysis in the research encompasses various procedures: unit root test, lag length selection, and ARDL co-integration approach, identification and estimation of long run model, error correction model of short run dynamics, and finally examination of all diagnostic tests to check model's validity. If the ARDL approach to co-integration (i.e. bound co-integration testing) identifies a single co-integrating vector which means one long run relationship equation, then ARDL model of the co-integrating vector is re-parameterized into ECM. The single model's result of short-run dynamics (i.e. traditional ARDL) and long run relationship of the variables are obtained from the re-parameterized result (see Nkoro, 2016). Data processing was carried out using E-view 10 software package.

3.5.1 Stationary test

Testing stationarity is a pre-requisite for co-integration test to each individual time series variables. A time series data analysis involves determination of stationarity which means the order of integration of each variable deliberated in the study. A time series variable is said to be stationary if its mean and variance are constant over time and the value of the covariance between the two time periods depends only on the distance of lag between the two time periods and not the actual time at which the covariance is computed. If the variable does not fulfil these conditions, the time series is said to be non-stationary which mean the existence of unit root problem. As first discovered by Yule, regressing non stationary variables may result in spurious correlation which can mislead an inference (Gujarati, 2008). Hence, a test to check an existence of stationarity property is needed. The most widely used unit root tests like Augmented Dickey-Fuller (ADF) and Phillip-Perron (PP) methods of testing stationarity was employed.

i) Augmented Dickey Fuller (ADF) test

The Augmented Dickey fuller unit root test helps to identify whether a time series has stationary property or unit root problem. The early procedure of a time series analysis is checking unit root property before proceeding to long run relationship between variables because it is a precondition to conduct co-integration analysis. To begin with, we can specify the unit root model of CPI at its level in order to start procedure of the test as follows:

$$\Delta CPI_t = \alpha_0 + \delta CPI_{t-1} + \sum_{i=1}^{k} \theta_i \, \Delta CPI_{t-i} + \varepsilon_i \quad \text{..... (3.7)}$$

Where, $\mathrm{CPI_t}$ is the variable of choice; Δ is the first difference operator, $\delta = (1 - \rho)$ is coefficient of the first lag, and θ_i's are parameters (for i = 1, 2 …k), ε_i is a stationary stochastic process and k indicates the number of optimal lag length chosen by Akaike Information Criterion (AIC). The rationale of using this criterion lies in its better performing comparing to other information criterions when relatively small sample size is used, i.e. n < 60 observations. The hypotheses of the above equation can be formed as the next.

H_0: δ = 0, there is a unit root which means the time series is not stationary.

H_1: $\delta < 0$, the time series is stationary i.e. there is no unit root.

The decision procedure is as follow: If the ADF *tau* (τ) *statistics,* calculated by dividing coefficient of $\mathrm{CPI_{t-1}}$ to standard error, is less than McKinnon's critical values, then the null hypothesis (H_0) is failed to be rejected in which case the time series is non-stationary. In the other case, if tau statistics exceeds the theoretical critical values, the alternative hypothesis is accepted implying stationarity of the underlying time series. However, if the null hypothesis failed to be rejected, further differencing the time series will be conducted until the null hypothesis is rejected and stationarity is achieved (Harris, 1995). Therefore, the above equation is adjusted in to second differences on lagged first and *k* lags of second differences so that the order of integration of the time series is determined.

$$\Delta^2 CPI_t = \alpha_0 + \gamma \Delta CPI_{t-1} + \sum_{i=1}^{k} \vartheta_i \, \Delta^2 CPI_{t-i} + \epsilon_i \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (3.8)$$

In this case, the following hypotheses will be tested.

H_0: γ = 0, there is a unit root problem i.e. the time series is not stationary.

H_1: $\gamma < 0$, which means there is no unit root problem i.e. the time series is stationary

A time series is said to be said integrated of order one, I (1), if they become stationary at their first differences. Likewise, if they become stationary at second differences, they are called integrated of order two, I (2). For the above equations (3.7) and (3.8) the standard Augmented-Dickey-Fuller (ADF) test examines the order of integration of the variables.

ii) Phillips-Perron (PP)

Although there are various types of the unit-root tests, Phillips-Perron (PP) test was conducted for the same purpose as side to Augmented-Dickey-Fuller (ADF) test. As described by Gujarat (2008) non-parametric statistical methods are used in Phillips and Perron test to consider for the serial correlation of the error terms. This means the test does

not add lagged difference terms. Further explanation need not be gone to show how it works since the asymptotic distribution of the PP test is similar with ADF test statistic.

3.5.2 ARDL model

The study employed autoregressive distributive lag (ARDL) model of 'Bounds Testing Approach' to co-integration which was developed by Pesaran (1997), Pesaran and Shin (1999) and Pesaran et al. (2001). This model is selected based on the theoretically defined relationship between dependent and independent variables and finite nature of the selected sample size. Given the endogenous variable, the ARDL approach of co-integration testing procedure specifically helps us to know whether the underlying variables in the model are co-integrated or not. Besides, the model is relatively more efficient when the sample size is small or finite which is suitable to the chosen sample size.

In addition, the researcher selected ARDL procedure of co-integration method because of its several advantages. Some of them are mentioned here. Firstly, the procedure can be applied whether the regressors are I (1) or I (0) or combination of both. Second, the ARDL model is statistically a more strong approach in determining the co-integration relationship between variables when simple size is small, but other techniques like VAR models require large data samples for validity. Third, the ARDL procedure does not restrict variables to have the same optimal lags as other models do. Endogeneity is less of a problem in this approach since each of the underlying variables stands as a single equation. Fourth, the ARDL procedure can distinguish dependent and explanatory variables when there is a single long run relationship that only a single reduced form of equation is assumed in the model (Pesaran, et al. 2001). The final and an important advantage of ARDL model is that the Error Correction Model (ECM) can be derived from ARDL model through a simple linear transformation, which integrates short run adjustments with long run equilibrium without losing long run information. To capture the data generating process from general to specific modelling frameworks, the related ECM model takes an adequate number of lags (Nkoro, 2016).

The general form of ARDL model is specified as follow:

$$y_t = \alpha_{0i} + \sum_{i=1}^{p} \gamma_i y_{t-i} + \sum_{j=0}^{q} \beta_j X_{t-j} + \varepsilon_{it} \quad \text{..... (3.9)}$$

Where y_t is the rate of inflation (*INF*); α_{0i} is the constant, i = 1,2,…k; X_t is a vector of explanatory variables; γ_i's are coefficients of dependent variable lags; $\beta_j's$ are coefficients of independent variables and their corresponding lags; p and q are number of lags of the

dependent variable and vector of explanatory variables respectively and ε_t is a mean-zero uncorrelated error term.

By extending the above general equation, the long run ARDL model can be specified to examine the relationship between various explanatory variables and inflation in this study. Specifically, the following long run regression equation was run.

$$LCPI_t = \alpha_0 + \sum_{i=1}^{p}\gamma_{1i}LCPI_{t-i} + \sum_{j=0}^{q_1}\beta_{1j}LBMS_{t-j} + \sum_{j=0}^{q_2}\beta_{2j}LRGDP_{t-j} + \sum_{j=0}^{q_3}\beta_{3j}LIM_{t-j} + \sum_{j=0}^{q_4}\beta_{4j}LREER_{t-j} + \sum_{j=0}^{q_5}\beta_{5j}LPOP_{t-j} + \sum_{j=0}^{q_6}\beta_{6j}IR_{t-j} + \sum_{j=0}^{q_7}\beta_{7j}LGNS_{t-j} + \beta_8 D + \beta_9 T + \varepsilon_{it} \quad \ldots\ldots (3.10)$$

By denoting p and q_i, we are allowing regressors to have different lag orders, where i = 1, 2 ...k, and T denotes trend. For the purpose of lag choice (p, q_1, q_2, q_3, q_4, q_5, q_6, q_7), the Akaike Information Criterion (AIC) was used given its well-known property of consistent model selection in finite-dimensional models (Shao, 1997).

3.5.3 ARDL approach to co-integration

In non-stationary time series, a regression becomes meaningful if variables are co-integrated of the same order. In other word, variables are said to be co integrated if the residual of a regression possessing unit roots are stationary. Testing co-integration helps to check whether a long run relationship exists among non-stationary variables. A stationarity test of residual establishes a way to conduct test for the existence of co-integration. In this study, ARDL approach to co-integration or bound co-integration testing approach was used.

To check for the long run relationship between explanatory variables and the variable of interest, the ARDL (p, q_1, q_2.....q_7) bound co-integration model is specified as follow:

$$\Delta LCPI_t = \alpha_0 + \theta_0 LCPI_{t-1} + \theta_1 LBMS_{t-1} + \theta_2 LRGDP_{t-1} + \theta_3 LIM_{t-1} + \theta_4 LREER_{t-1} + \theta_5 LPOP_{t-1} + \theta_6 IR_{t-1} + \theta_7 LBNS_{t-1} + \sum_{i=1}^{p}\gamma_{1i}\Delta LCPI_{t-i} + \sum_{j=0}^{q_1}\beta_{1j}\Delta LBMS_{t-j} + \sum_{j=0}^{q_2}\beta_{2j}\Delta LRGDP_{t-j} + \sum_{j=0}^{q_3}\beta_{3j}\Delta LIM_{t-j} + \sum_{j=0}^{q_4}\beta_{4j}\Delta LREER_{t-j} + \sum_{j=0}^{q_5}\beta_{5j}\Delta LPOP_{t-j} + \sum_{j=0}^{q_6}\beta_{6j}\Delta IR_{t-j} + \sum_{j=0}^{q_7}\beta_{7j}\Delta LGNS_{t-j} + \beta_8 D + \beta_9 T + \epsilon_t \quad \ldots\ldots (3.11)$$

Where: Θ_0, Θ_1….Θ_7 are coefficients that measure long run relationships; β_1, β_2… β_8, are coefficients that measure short run relationships; p and q_1, q_2…q_7 denote lag length of the auto regressive process and distributive lags respectively; D is a dummy variable for short term shocks, Δ denotes the first difference operator; ϵ_t is the usual white noise residuals and t is time series.

To test the long run relationship between the variables, the bound test approach for co-integration was conducted in line with Pesaran and Shin (1999) and Pesaran, et al. (2001) proposal. The bound test examines the F-test of the null hypothesis against the alternative hypothesis formed as follow:

Null hypothesis: $H_0: \Theta_0 = \Theta_1 = \Theta_2 = \Theta_3 = \Theta_4 = \Theta_5 = \Theta_6 = \Theta_7 = 0$ i.e. there is no long run relationship among the variables.

Alternative hypothesis: $H_1: \Theta_0 \neq \Theta_1 \neq \Theta_2 \neq \Theta_3 \neq \Theta_4 \neq \Theta_5 \neq \Theta \neq_6 \neq \Theta_7 \neq 0$ i.e. means the existence of long run relationship among the variables.

The non-standard F-statistics can be used to test the above hypothesis. The critical values of the F-statistics have already been established by Pesaran, et al. (2001); however, Narayan (2005) argues that the estimated critical values are relatively suitable for large sample size (n>500) and according to him using such critical values for small sample size may produce misleading results. Founding on similar procedure, Narayan (2004) has provided a new set of critical values for small sample sizes (30<n<80). For this purpose, two sets of critical values - the upper bound values and the lower bound values were provided.

The procedure of testing the above hypothesis is as follow: The upper bound of the critical value and the computed F-statistics is compared. If the computed F-statistics exceeds the upper bound of the critical value, then the null hypothesis is rejected in favour of alternative hypothesis of the existence of co-integration among the variables. On the other hand, if the calculated F-statistics is found to be less than the lower bound, the null hypothesis cannot be rejected. Nonetheless, the outcome would be inconclusive if the test statistics lies within the two bounds (Pesaran *et al.* 2001).

3.5.4 ARDL – error correction model

If the co-integration test confirms the presence of long-run relationship among all the dependent and independent variables, we can estimate both long run and short run models. If there is co-integration we estimate equation (3.10) for the long run model. For short run

dynamics, the error correction model specification (ECM) was estimated and elasticities can be manipulated from the following ARDL- error correction model.

$$\Delta LCPI_t = \alpha_0 + \sum_{i=1}^{p} \gamma_{1i} \Delta LCPI_{t-i} + \sum_{j=0}^{q_1} \beta_{1j} \Delta LBMS_{t-j} + \sum_{j=0}^{q_2} \beta_{2j} \Delta LRGDP_{t-j} + \sum_{j=0}^{q_3} \beta_{3j} \Delta LPOP_{t-j} + \sum_{j=0}^{q_4} \beta_{4j} \Delta LREER_{t-j} + \sum_{j=0}^{q_5} \beta_{5j} \Delta LIM_{t-j} + \sum_{j=0}^{q_6} \beta_{6j} \Delta LBNS_{t-j} + \sum_{j=0}^{q_7} \beta_{7j} \Delta IR_{t-j} + \beta_8 D + \boldsymbol{\lambda ECT_{t-1}} + \epsilon_t \quad (3.12)$$

In this case:

$\text{ECT}_{t-1} = (LnCPI_{t-i} - \Phi X_{t-i})$; X_{t-i} is vector of level and their corresponding lagged explanatory variables; $\lambda = (1 - \sum_{i=1}^{p} \gamma_i)$ and $\Phi = \frac{\sum_{i=0}^{q} \beta_i}{\alpha}$

Where: ECT is error correction term with one period lag; λ is error correction parameter which measures the speed of adjustment back to the long run equilibrium; whereas the rest de notation are according to the prior definition in the preceding equation.

The error correction term (ECT) captures the relationship between the short run and long run. It is derived from the long run model and shows how variables quickly converge to equilibrium. The coefficient of ECT should also be statistically significant and if the coefficient has negative sign, it confirms the existence of a co integrating relationship; however, if sign of the coefficient is positive the model is explosive that there is no convergence. If the estimates of ECT = 1, then 100% of the adjustment takes place within the period, the adjustment is rapid and complete, and if the estimate of ECT = 0.5, then 50% of the adjustment takes place each year. ECT = 0, indicates non-existence of adjustment (Nkoro & Uko, 2016).

3.5.5 Diagnostic tests

The post estimation tests are required to check reliability of the estimated result. The most commonly used post estimation tests in dynamic models are: autocorrelation test, heteroscedasticity test, normality test and model stability test. The types of tests going to be employed to examine their corresponding hypothesis are briefly discussed below.

Autocorrelation test

Autocorrelation is one of the diagnostic test for evaluating the complete specification and robustness of an econometric model result. Autocorrelation is a special case of correlation which refers to the relationship between successive values of the same variable. In this case, however, the serial correlation of the residuals was tested. Conducting this test is needed because the presence of autocorrelation causes the variance of OLS estimates to be inefficient. This makes estimates of beta in the regression model underestimated. Therefore, testing whether the model regression suffered of this problem is important. There are many tests for autocorrelation, but the study was used Breusch-Godfrey Lagrange Multiplier (LM) test due to its relevancy to multivariate test for residual serial correlation up to some specified lag order. If the null hypothesis is rejected at the standard critical values, we conclude that there is serial correlation among the residuals.

Heteroscedacity test

Heteroscedasticity problem arise when the variance of error term is not constant. In other word, distribution of the residual around the mean varies with time. In the presence of this problem, the OLS estimators are still consistent and unbiased, but it makes minimum variance property of the OLS not to be maintained (Wooldridge, 2013). To examine the heteroscedasticity of the residuals, Breusch-Pagan-Godfrey test was used because it helps to detect any linear forms of heteroscedasticity. Additionally, the test was supplemented by ARCH test to check robustness of the result. The procedure of testing the null hypothesis is:

Null hypothesis (H_0): The error variance is homoscedastic.

Alternative hypothesis (H_1): The error variance is not homoscedastic,

Decision rule: If the computed Chi –square is higher than the critical value at the chosen level of significance, usually 5%, the null hypothesis of homoscedasticity is rejected. Otherwise, we can accept alternative hypothesis.

Normality Test

Another econometrics analysis criterion is normality test. It is the test of whether data are symmetrically distributed or skewed. The Jarque-Bera probability was used to conduct normality test of the model. If the probability of Jarque-Bera is greater than 5%, then we say that the model is normal and skewed otherwise.

Model stability test

The most commonly used to test stability of model is Cumulative sum of squares of recursive (CUSUM). The test is based on the residuals from the recursive estimates and presented by figure.

Null hypothesis H_0: CUSUM distribution is a symmetric centred at 0.

Alternative hypothesis H_1: CUSUM is not symmetrically distributed.

Decision rule: The null hypothesis of normal distribution is failed to be rejected when the graph of CUSUM statistics lies within the bounds of the critical region at 5% level of significance and the alternative hypothesis of not symmetrically distributed is accepted otherwise.

CHAPTER FOUR

4. RESULTS AND DISCUSSIONS

4.1 Introduction

This chapter presents and discusses the result from descriptive and econometrics methods of data analysis. Both methods exclusively address the stated research objectives. In descriptive analysis, the results of trend of each explanatory variable in combination with general inflation movement were discussed. It aimed to reveal the trend of consumer price index rate with the corresponding independent variables. It helps to display whether there are significant ups and downs, direct or indirect movement of each macroeconomic variable with CPI growth. In case some variables closely related to each other, trend movement of paired variables were compared with inflation to enable cross association among the independent variables. For example, lending interest rate and effective real exchange rate were treated simultaneously in showing their trend, but exclusive discussion was provided for each of them. Therefore, we answer the first objective of the study while describing trend of each explanatory variable relative to inflation.

Econometric method of data analysis aimed to provide answer to the last three research questions through testing hypothesis in each step. It begins by selecting optimum lags using appropriate criterions followed by ADF and PP unit root tests. In the third sub-section, the estimated result from ARDL model was presented along with statistical significance of each variable. The next subsection summarized the diagnostic tests of model reliability. Estimated regression output of the bound test and long run, and short run were made available in sub-section five and six, respectively. Finally, the findings from long run and short run model perspective to each considered variable were discussed by comparing them with findings of other empirical studies.

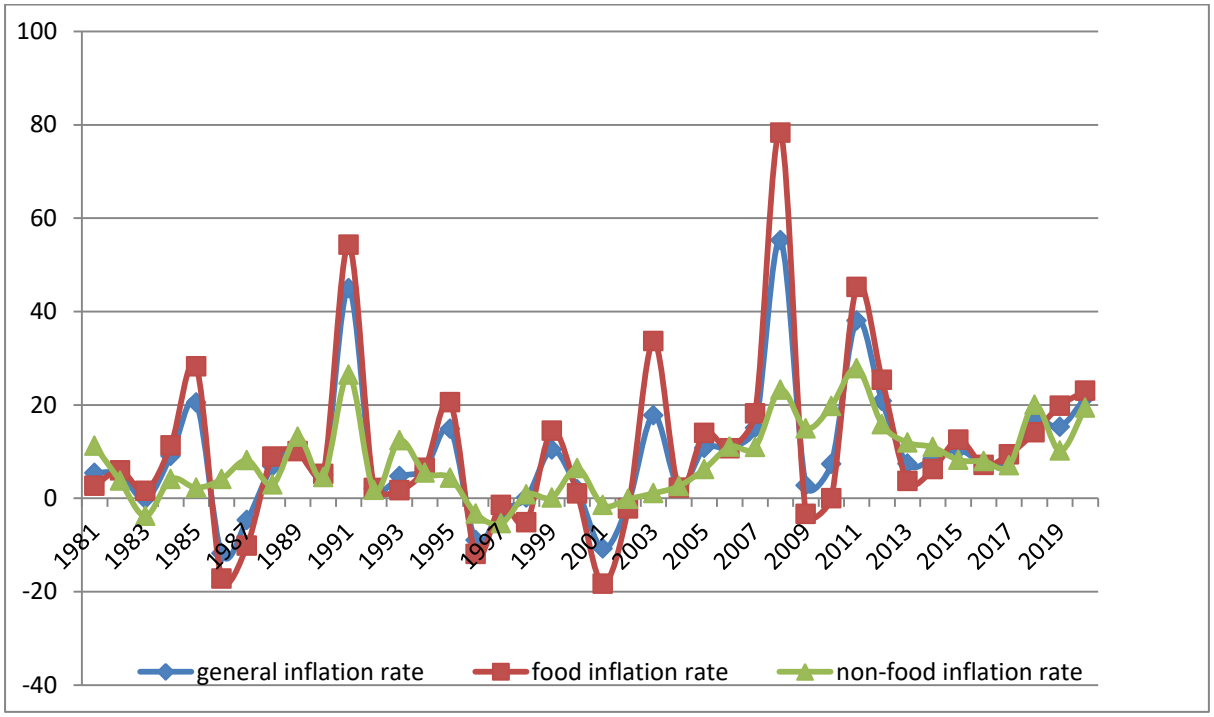
4.2 Descriptive trend analysis of inflation in Ethiopia

The growth rate trend of the general CPI during the study period, as displayed by the figure, has similar trend with food inflation rate. It shows that the general inflation growth is mainly driven by non-food inflation. A Look at of inflation trend over the study period could enable the reader to observe varying co-movement in food and non-food components of the index. Since 2003 the country has been experiencing rising price level as seen from the trend shown by actual data and indicates of IMF (2018) report. Both general and food inflation rate was

negative (-8.9%) and (-11.9%) in 1996 and (-10.8%) and (-18.3%) in 2001 respectively. However, the general inflation rate amplified to 17.7 in 2003 and then gone down in 2004 to 2.4 percent due to agricultural output recovery and better economic growth performance (Fitsum, 2016).

Between 2004 and 2008, both variables have been growing in rising rate. According to the evidence from NBE, in 2008, both general and food inflation rate surged to 55.24 & 78.3 percent, respectively. Conversely, data from international institutions report 44.38% for general CPI growth of Ethiopia though the trend witnesses the highest for both databases. As to Durevall, Loening and Yohannes (2013) the causes attributed to high inflation during this period comprise combination of agricultural supply shock, money expansion and imported inflation resulted from international prices. Non-food inflation, on the other hand, reached its minimum rate in 1997 and maximum rate in 2011, recording -5.4 and 27.84 respectively.

Figure 4.1: Trend of inflation in annual percentage change



Source: own computation from NBE data, 2021

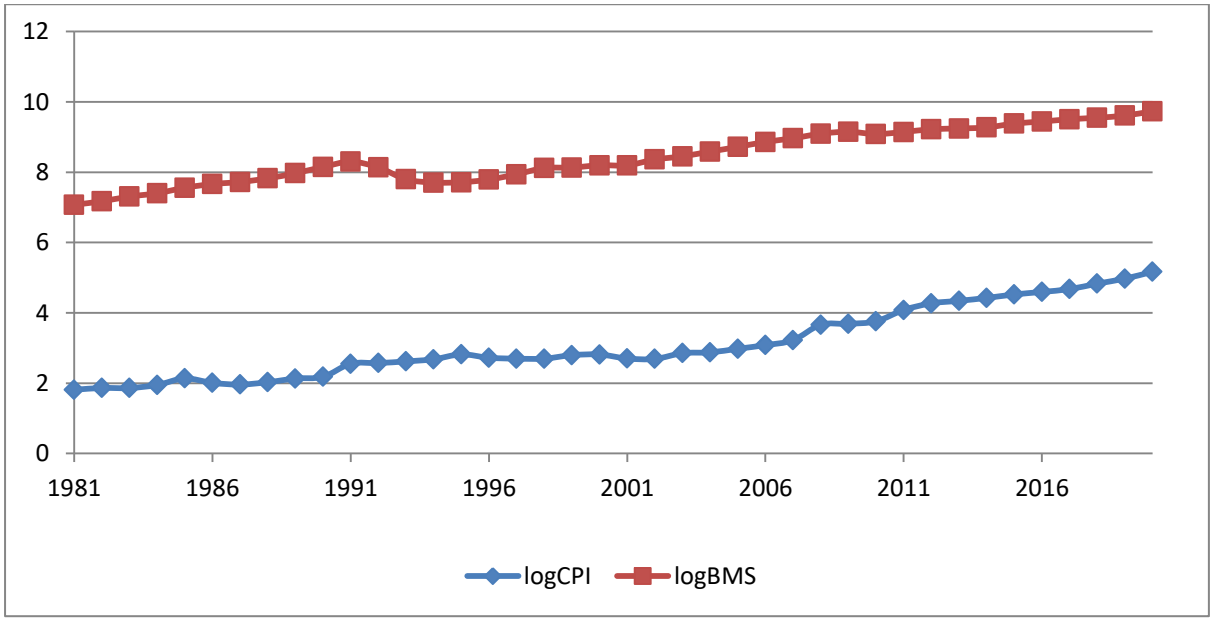
In general, one can observe the erratic nature of general inflation trend that there were substantial ups and down movement of price growth from 1981 to 2013. It was dropped to 2.7% in 2009/10 followed by 8% in 2010. The rate again surged to 38% in 2011 and then declined to 20.8% in 2012. However, from 2012 to 2016 general inflation has been growing with single digit. Then, the trend reversed in 2017 when inflation started to rise with double

digit until the end period of this study (2020) with 10.7% and 21.5% growth rate in these years, respectively. Overall, trend of aggregated consumer price index growth rates recorded in Ethiopia since 2003 is a typical of galloping inflation that needs intervention. Unlike non-food inflation which has been growing with insubstantial volatility, general inflation was following footsteps of the food inflation rate during the study sample. This result confirms significant deviation of non-food path from both general and food inflation rate.

4.2.1 Inflation and broad money supply

Broad money supply (M2) is one of the important variables in influencing inflationary situations both in theory and empirical experience. NBE defines currency outside the bank, demand deposit, transferable and other deposits, and quasi money as components of M2. According to the Quantity Theory of Money, inflation has a positive and direct association with money supply. Further, if the money supply growth rate exceeds the real output, it is inevitable for inflation to happen. Its rate can even get faster due to more money chasing given constant velocity of money. Founding on this theory, it is rationale to expect positive relationship between broad money and inflation rate. Therefore, a look at of logarithmic trend inflation in consumer price index and broad money supply in mill of USD reveals that both variables have co-movement during study period. Figure 4.2 illustrates the relationship between the inflation rate and M2 measured expressed by their corresponding logarithm form.

Figure 4.2: Trends of inflation and broad money (in log form)



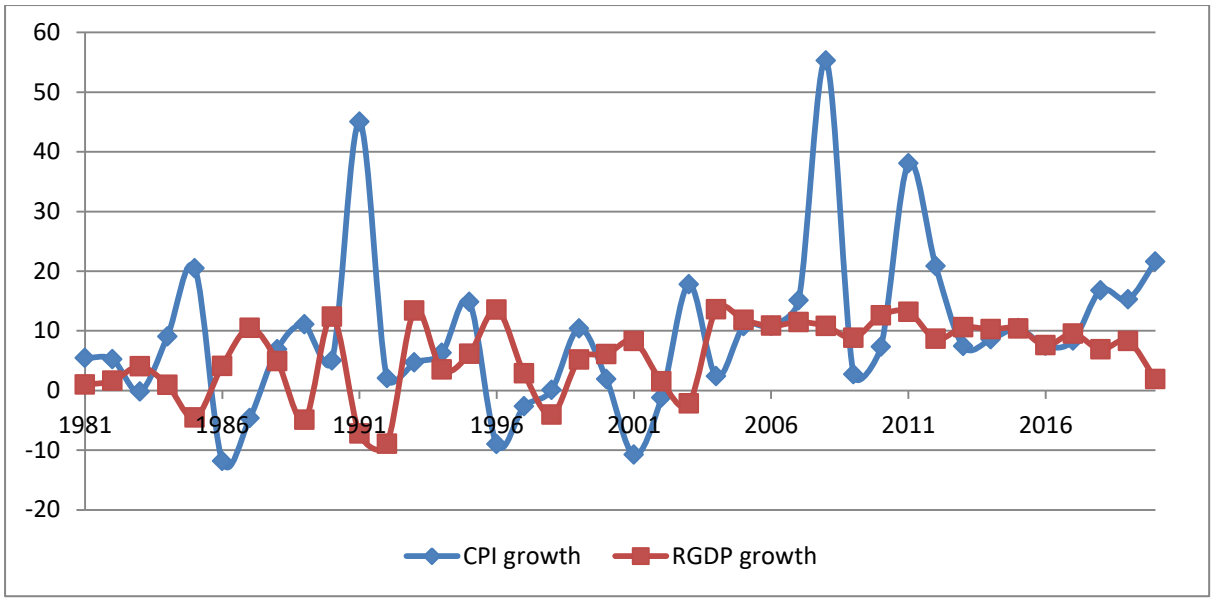
Source: own computation from NBE data, 2021

Figure 4.2 revealed that the two variables trend in the same direction though CPI growth rate seem faster than broad money growth since 2007. Overall, this demonstrates not only rising general price level but also shows us the presence of expansionary monetary policy practice in the country. For example, a few years back before the downfall of Derg regime, money growth has been positive of which most of them were double digits. However, during the beginning years (1992-95) of EPDRF regime the growth turned to be negative. The negative money growth disappeared since 1996 except in 2001 and 2009 when zero and negative growth rate of broad money is documented, respectively. Additionally, significant percentage change of broad money was observed since 2013 to 2020, with maximum 29.2% and minimum 18% in 2017 and 2019 respectively. These evidences strongly support positive co-existence between money growth and inflation rate during the study period.

4.2.2 Inflation rate and real GDP growth

Over the last four decades, economic performance has gone through various phases of inflation and economic progress. These changes stimulated from underlying changes in economic policies and response in economic agents toward these policies. Before 2003, Ethiopia's experience of inflation was low with single digit and some negative, but with exceptional years of supply shock and war. In the year 1985 there was supply shocks which resulted in widespread famine and caused CPI rate to surge to 20.46 and deteriorated output by negative growth (-4.56). Six years later, real GDP was declined by -7.2% due to the civil war in 1991/92. During the same period, when EPRDF come to power, high inflation rate with 45% was registered. The next graph was plotted real output rate on CPI growth in the chosen time span.

Figure 4.3: CPI rate and RGDP growth



Source: Own computation using NBE and WDI data for Inflation and RGDP respectively, 2021.

Nevertheless, between 2004 and 2020 both inflation and real output begun to increase rapidly, but majority of record series are double digit for inflation. Within the indicated time interval, the highest growth rate was registered during 2008 for inflation (55%), while 2004 and 2011 years are maximum growth rate for output with 13.57% and 13.2%, respectively. When we look at trend graph (Figure 4.3) of both series, the plot of RGDP growth and CPI rate against the study periods leads one to observe inconclusive association. From 1981 to 2003 the growth paths of both series appear to have negative co-movement. However, from 2004 to 2019 growth path of output seem remained stable, forgetting its preceding trend. Therefore, by looking at percentage change trend movement of inflation and RGDP, determining their relation leaves us indeterminate.

4.2.3 Trend of real effective exchange rate, interest rate and inflation

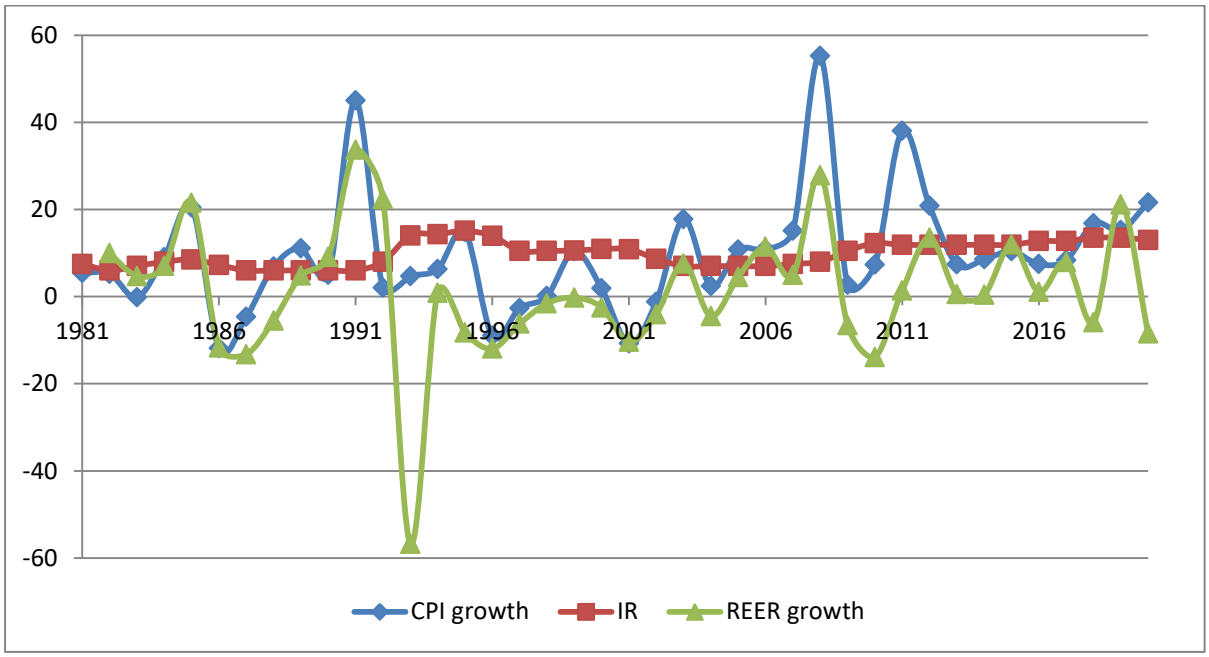
Real effective exchange rate can be defined as the number of units of domestic currency that can buy a unit of foreign currency or vice versa. It is the adjusted version of nominal effective exchange rate to price change respective to the price of trading partner. In this study, effective exchange rate was expressed in domestic currency per US dollar. As Teshale (2016) indicated in his analysis, exchange rate regime is officially managed in Ethiopia while market clearing (floating exchange rate) is practiced in United States which firmly determined by the

demand for and supply of the USD. Domestic currency can be depreciated or appreciated based on whether domestic per foreign currency exchange rate rise or decline, respectively. Effective exchange rate in relation with inflation growth was analysed using official data from Ethiopia.

Similar to price growth movement, exchange rate growth has been observed to be volatile during the study period. Before 2005, exchange rate has shown non-considerable development, excluding year of civil war (1991) when inflation and effective exchange rate surged to 45% & 33% respectively. Over these years, majority of the time series demonstrates negative growth rates. From 2005 on, however, the trend begun to increase and reached its maximum (27%) due to accumulation of foreign exchange reserve in 2008 which resulted from worldwide depression and global price rise. Between 2009 and 2011 the authority sold foreign exchange rate to regulate internal liquidity which lead to reverse the previous trend.

Since 2012, a look at of growth rates reveals progressive deprecation of Birr against USD, resulting real over valuation of the foreign money, triggering foreign exchange shortages. IMF (2020) argues that the worthy reason behind the shortage is highly related with the overvaluation of US$ against Birr. It also suggests that devaluating domestic currency without tackling the problem of foreign exchange possibly worsens the shortage in short term and encourages inflation too. The selected high depreciation rates: 13.5%, 11.9% and 21.1% seen in 2012, 2015 and 2019 respectively, confirms not only the above evidence but also supports the existence of high linkage between effective exchange rate and CPI growth. In general, we find drift movement of both variables in similar trending direction (see the figure 4.4), indicating their positive correlation.

Figure 4.4: The relationship between effective exchange rate, interest rate and inflation



Source: own computation based on the data of NBE, 2021

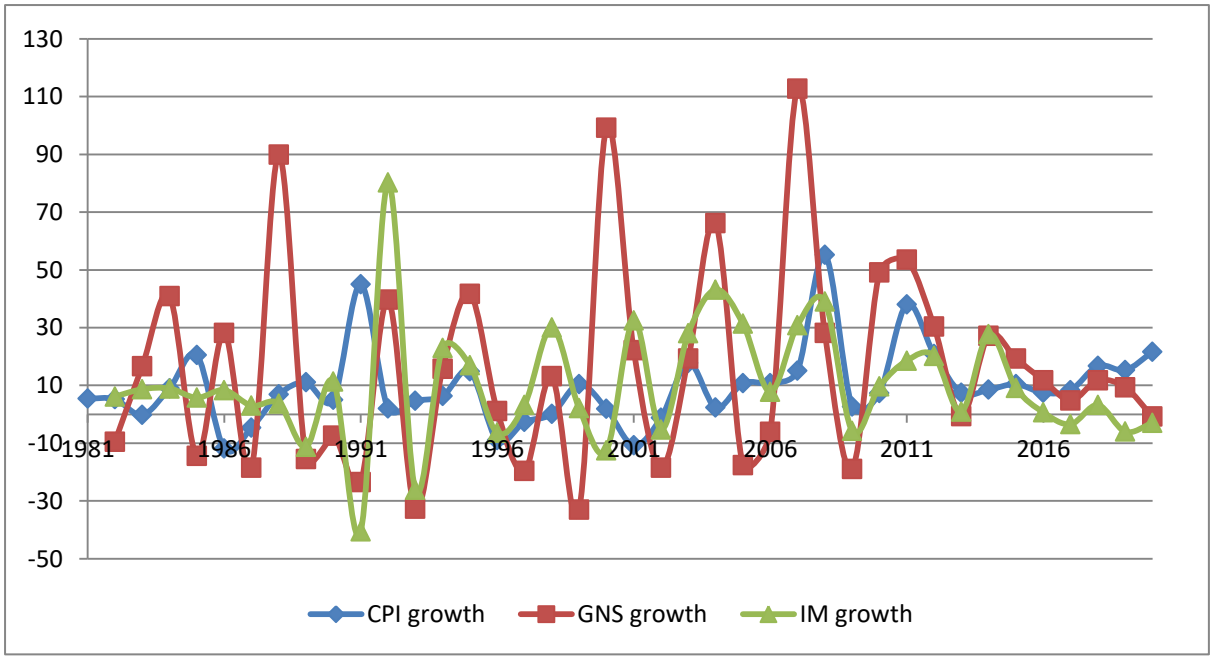
Unlike exchange rate which follows footstep of CPI growth, lending interest rate graph relative to inflation shows that the variable linearly moved without up and down turns during the study. The insight that might be drawn from the plot is that lending interest rate has not been responded to change in price level or vice versa even though further statistical computation is needed to determine whether there is significant relationship between them.

However, some theorists hypothesise in trying to show the direct and indirect relationship between interest rate and inflation. For example, Monetarist (Friedman, 1967) argues for indirect and negative impact of interest rate through its channel with money and output growth. According to them, expansionary monetary policy causes interest rate to be decreased and get investment encouraged, which intern leads to increase in aggregate demand. Higher aggregate demand leads to raise price of an output and hence negative relationship. Therefore, since the result from descriptive analysis has tendency of portraying neither of the theories, the casual relationship between the two variables left for further analysis through econometric statistical inference.

4.2.4 Imports, gross national saving and inflation growth

Total imports growth between 1981and 1988 has not shown significant fluctuation, but the progressed with positive rate. During this time, inflation has not also been policy concern; if there was any price hike, it had been due to short term shock caused from drought. A greater fluctuation was, however, observed since 1989 when total imports expenditure decreased from USD 1286.1 to 1141.3 by showing 11.26 percentage decreases. Imports were substantially deteriorated by 40.6% during 1991 civil war, but accompanied by faster rise in the subsequent year 1992. The maximum growth rate of imports was registered in the indicated year with over 80.2% growth rate. Over the 1993 -2020 period, total expenditure on import bill was fluctuating with unpredictable rate to compare with price growth. In general, the spiral movement of the series (see the next graph) has made the relationship between imports and inflation growth difficult to determine.

Figure 4.5: Trend of imports, gross national saving and inflation growth



Source: own computation using data from NBE (for CPI) and WDI, 2021

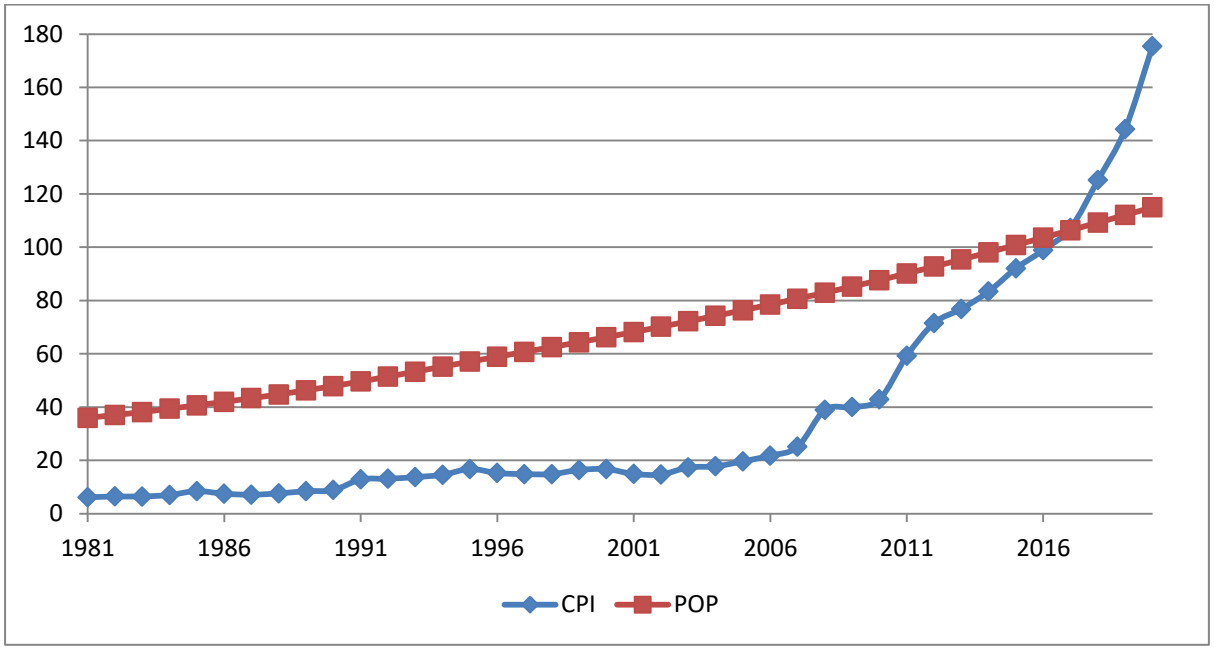
From the above graph (figure 4.5) we can see that gross national saving has shown greater fluctuation than import bill trend, confirming the most volatile nature of the variable of the considered variables by this study. Over 1981 -2020 period, gross national saving has been growing substantially, but with unstable twisting trend. The minimum (-33%) and maximum (112.7%) rates were also registered with in this range in 1999 and 2007, respectively. Nevertheless, a look at of aggregate values indicates that the year when upward trending

period started is 2005. In this year, the total value of public and private saving was USD 2123.13 and reached its maximum value (USD 28, 349.2) in 2019 with sharp increase experience. Overall, national saving has shown progressive improvement during the entire range of the study even if significant fluctuations were comprehended. However, it is perplexing to determine whether positive or negative relationship between inflation and national saving exist by considering their annual percentage change.

4.2.5 Inflation and population size in Ethiopia

Between 1981 and 1998, Ethiopia's population has been growing with some sorts of fluctuation. About 35.984528 total populations have been documented in 1981 with 2.4 growth rate. The rate grown to 2.77 percent in 1982 when the number increased by more than a million. Between the year 1983 and 1997 the growth ranged from 3.03 to 3.6 percent which were registered in 1997 and 1992, respectively. Since 1992, when the highest growth rate was documented during the study time, population has been increasing with declining growth rate, but greater than the rate observed in the top most populous countries in Africa namely Nigeria and Egypt. According to the data from WDI (2020) the total number surged approximately to 115 million of which 52.9 million belong in labour force group. By considering the gradually declining population growth of Ethiopia, it would again be difficult to decide the connection between population growth and inflation rate which has been showing substantial volatility. Thus, let us describe the path of population size relative to the values of consumer price index so that certain insights can be obtained whether there has been co-movement among the variables.

Figure 4.6: The relationship between inflation and population size



Source: own computation using NBE and WDI database for CPI and population respectively, 2021.

The above graph is plotted using population size data against CPI values over the study period. The trend reveals that population number has been raising with almost steady rate; while mean CPI has been slowly tending between 1981 and 2006. However, the path started to sharply rise since 2007 by significantly deviating from its prior movement and in 2017 surpassed the trend of population size measured in millions head count. Overall, it appears that inflation and population size move in the same direction when observed in terms of their corresponding measurement values.

4.3 Econometric result analysis

4.3.1 Lag length selection

Prior to undertaking unit root tests and estimating the underlying model, maximum lags length must be determined at early stage. As the estimation results are highly sensitive to lags length of variables, the optimum number of lags needs to be selected before conducting other tests or estimations. These lag numbers are determined by information criterions: Akaike Information Criterion (AIC), Schwartz-Bayesian Information Criterion (SBIC), Final prediction error (FPE), Hannan-Quinn information criterion (HQIC). These criterions automatically select the maximum lag length to be incorporated. But, they may not necessarily give the same result due to their applicability in different sample sizes. For

example, AIC and FPE are appropriate for small sample sizes (60 or less) while SBIC and HQIC better performs for large (greater than 60) sample sizes (Liew, 2004). Therefore, this study used AIC due to its better performance comparing to other information criterions when relatively small sample size is applied, i.e. n < 60 observations. The next table shows a computed result using *EViews 10*.

Table 4.1 Lag order selection

Lag	LogL	LR	FPE	AIC	SC	HQ
0	184.2475	NA	1.28e-15	-8.749869	-7.974170	-8.473881
1	402.6830	310.4083	1.08e-18	-15.98331	-11.71697*	-14.46538
2	516.3241	107.6600*	4.78e-19*	-17.70127*	-9.944282	-14.94139*

* indicates lag order selected by the criterion
Source: own computation using EViews 10, 2021

From the above table 4.1, the asterisks (*) mark the maximum lag length automatically selected by the criterions. Accordingly, all criterions except SC indicated that the optimum lag that minimizes their corresponding values is two. However, we should note that it does not necessarily mean each variable has two lag lengths. It rather shows the highest length above which lag should not be included. Therefore, it is possible to some variables to have lower than the automatically determined lag length. For example, when each of them individually tested, dummy variable and logarithmic form of other variables - CPI, RGDP, POP and REER- have one maximum lag length while the rest explanatory variables have two.

4.3.2 Unit root test

Lag length determination is followed by conducting stationarity test. It is a pre-requisite for co-integration test of the time series variables because estimation without undertaking unit root test may leads to spurious result. This test is also essential to make sure that all variables are integrated of order zero or one so that the method ARDL bound test will not be hindered. The Augmented Dickey-Fuller (ADF) and the Phillips-Perron (PP) unit root testing methods were employed for this purpose. In ADF test, the Akaike information criterion (AIC) was selected because the lag length of the time series was determined based on this criterion due to its good performance in small finite sample size. On the other hand, Newey-West

bandwidth automatically selects lag for Phillips-Perron (PP) unit root test. The below table 4.2 summarizes the results of stationary test from both methods.

Table 4.2: Augmented Dickey-Fuller and Phillips-Perron Unit Root Tests

	At level		At first difference	
Series	Intercept	Intercept & trend	Intercept	Intercept & trend
		ADF unit root test		
LCPI	1.591	-0.882	-5.342***	-5.775***
LBMS	-0.317	-3.161	-3.956***	-3.883**
LGNS	1.027	-1.028	-6.393***	-6.685***
LIM	0.265	-1.512	-2.195*	-8.914***
LIR	-2.58*	-2.926	-4.333***	-4.258***
LPOP	-1.673	-0.989	-6.265***	-6.768***
LREER	-1.746	-1.685	-6.351***	-6.335***
LRGDP	2.384	-1.412	-4.945***	-5.212***
DUM	-0.978	-3.000	-8.599***	-8.638***
			Philips-Perron	
LCPI	1.661	-0.884	-5.352***	-5.775***
LBMS	-0.574	-2.01	-2.906**	-2.820
LGNS	0.615	-1.833	-8.204***	-9.120***
LIM	-0.011	-1.811	-8.398***	-8.409***
LIR	-1.478	-2.183	-4.374***	-4.302***
LPOP	-3.027**	-0.608	-6.273***	-8.775***
LREER	-1.746	-1.685	-6.452***	-6.620***
LRGDP	2.437	-1.397	-5.034***	-5.855***
DUM	-1.716	-2.975	-9.197***	-12.880***

Note: The values represent *t*-statistics of the ADF (upper panel) and PP (lower panel) unit root tests. The asterisks ***, ** and * denotes statistical significance of the test at 1, 5 and 10 percent level of significance respectively.
Source: compiled by the author based on the result of *EViews 10* computation, 2021

The ADF and Phillips-Perron (PP) unit root tests result reveals that all variables of the model except logarithm of population size (LPOP), which is stationary under PP unit root test with intercept at 5 percent level of significance, of the model are non-stationary at level. From ADF test, we can observe that at least at 5 percent level of significance all variables except logarithm of import of goods and services (LIM) become stationary after first difference in both intercept and intercept & trend cases. However, we find the differenced LIM is stationary with intercept & trend only. Similar outcome is found under Philips-Perron (PP), but logarithm of broad money supply (LBMS) is the exceptional in this case. First

differenced LBMS is stationary at 5 percent without trend while first differenced version of all other variables is stationary at 1 percent level of significance in both intercept and intercept & trend cases. In general, the result of ADF and PP stationarity test provides similar result that almost all included variables are I (1), i.e. integrated order one.

4.3.3 ARDL Model Estimation Results

The study employed autoregressive distributive lag (ARDL) model. The model applies 'Bounds Testing Approach' to co-integration which was developed by Pesaran (1997), Pesaran and Shin (1999) and Pesaran et al. (2001). Prior to estimation the optimum lag length was chosen using Akaike information criterion (AIC). Accordingly, dependent and independent variables take one and two lag orders respectively. Then, the ARDL parameters' estimates with CPI as dependent variables are estimated.

Table 4.3 reports the parameter estimates for the ARDL regression with *CPI* (a proxy variable to inflation) as the dependent variable and *BMS, RGDP, POP, REER, IM, GNS, IR* and dummy variable *(DUM)* as independent variables. All variables were expressed in logarithm except *IR* and *DUM*. According to the AIC, the chosen lag structures for the above variables are [p, q_1, q_2….q_8] = [1, 2, 1, 1, 0, 2, 2, 0, and 1] respectively (see appendix 2). All of the coefficients have the expected sign except *LRGDP*, *LIM* and *IR*. Even though the sign of *LIM* coefficient contradicts the theory, the ARDL regression result sows that the variable is statistically insignificant.

Table 4.3: ARDL model estimation result

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
LCPI(-1)	0.465652***	0.162450	2.866431	0.0103
LBMS	0.576537**	0.249709	2.308830	0.0330
LBMS(-1)	-0.522915**	0.236330	-2.212649	0.0401
LBMS(-2)	0.326507**	0.158004	2.066451	0.0535
LRGDP	0.379384	0.289846	1.308917	0.2070
LRGDP(-1)	1.176211***	0.290012	4.055728	0.0007
LPOP	9.163103***	1.966616	4.659326	0.0002
LPOP(-1)	-4.247535*	2.207937	-1.923757	0.0703
LREER	0.369465***	0.131393	2.811915	0.0115
LIM	0.021306	0.075753	0.281255	0.7817
LIM(-1)	0.069397	0.085437	0.812262	0.4273
LIM(-2)	-0.324808***	0.093507	-3.473619	0.0027
LGNS	-0.091353	0.055260	-1.653159	0.1156

LGNS(-1)	-0.116179**	0.053728	-2.162344	0.0443
LGNS(-2)	-0.126656**	0.055563	-2.279512	0.0350
IR	0.035321***	0.012575	2.808793	0.0116
DUM	-0.050070	0.050676	-0.988054	0.3362
DUM(-1)	-0.087986**	0.040938	-2.149265	0.0455
C	-33.91097***	9.045080	-3.749106	0.0015
@TREND	-0.160352**	0.069876	-2.294798	0.0340

Notes: Sample period used for estimation is 1981 - 2020. The asterisks ***, ** and * marks statistical significance of coefficients at, 1, 5 and 10 percent level of significance respectively.
Source: Own computation using *EViews 10*, 2021.

From the above table we can infer that the first lag of CPI is significant at 1 percent. All coefficients of *LBMS* (current level, first and second lags) are also significant at five percent level of significance. Both current and lagged coefficients of RGDP are positive, but coefficient of the first lag is significant only. In addition, variables selected without lags such as LPOP, REER and IR are highly significant too and they all positively associated to consumer price index. However, the result displays insignificance of current coefficients of LIM and LGNS, but both first and second lag of LGNS are statistically significant at 5 percent while import of goods and services is significant only at second lag. Finally, we can note that the model has constant and trend as reflected by their statistical significance at 1 and 5 percent level of significance respectively. The next sub-section presents statistical reliability checks of the model.

4.3.4 Post estimation diagnostics and stability tests

The post estimation tests are required to check reliability of the estimated result. The most commonly used post estimation tests in dynamic models are: normality, autocorrelation, heteroskedasticity, model specification and stability tests. Such tests are undertaken to guarantee the regression of the model that the obtained results are free from spurious regression. Additionally, they warrant robustness of the model. Summary statistics of these diagnostics tests are reported in the below table; however, original output of these test are attached in appendix heading of this paper (see appendix 5).

Table 4.4: Summary of diagnostics tests

Types of tests	F-statistics	Df	Prob.	Prob.Chi-Square
Breusch-Godfrey test	1.32	F(2,16)	0.29	0.068
Heteroskedasticity (BPG)	0.88	F(19,18)	0.60	0.5021
Heteroskedasticity (ARCH)	0.65	F(2, 33)	0.52	0.50

Normality test (JB-statistics)	0.26		0.87
Ramsey RESET Test	1.002	F(1,17)	0.33
Durbin-Watson test	2.24 (d-stat)		

Source: Compiled from diagnostics tests after ARDL model estimation using *EViews 10,* 2021

Autocorrelation test

Conducting this test is needed because the presence of autocorrelation causes the variance of OLS estimates to be inefficient. This makes estimates of beta in the regression model underestimated. Therefore, testing whether the model regression suffered of this problem is important. As indicated in the table, the model is not suffered from serial correlation. Breusch-Godfrey Lagrange multiplier test fails to reject null hypothesis of no residual autocorrelation at 5% level of significance. In addition, Durbin-Watson d-statistics lies between 1.7 and 2.3, which supports the evidence from Breusch-Godfrey LM test. Besides, the d-statistics confirms non-spuriousness of the regression since the value exceeds the adjusted R- squared.

Heteroskedastcity test

Heteroscedasticity problem arise when variance of the error term is not constant. In other word, distribution of the residual around the mean varies with time. In the presence of such problem, the OLS estimators are still consistent and unbiased, but it makes minimum variance property of the OLS not to be maintained (Wooldridge, 2013). Breusch-Pagan-Godfrey test from the above table 5.4 conveys that both standard (0.60) and Chi-squared probability (0.50) values are greater than 5% level of significance. This result leads to decision of failing to reject null hypothesis of homoscedastic nature of the error variance. At F (2, 33) degrees of freedom, both standard (0.52) and Chi-squared (0.50) probabilities of ARCH test supports robustness of the result from Breusch-Pagan-Godfrey test. Hence, we can conclude that variance of the error term is uniformly distributed around the mean.

Normality Test

The Jarque-Bera (JB) probability was used to conduct normality test of residuals. In the above summary table of diagnostics tests, the JB statistics (0.26) is much higher than the standard level of significance, 0.05 and the probability of obtaining this value is 0.87 (see appendix 5(a) to visualize the graph). Therefore, since the residuals are normality distributed, we can claim that the hypotheses of coefficient estimates are validly tested.

Model specification test

Ramsey RESET test checks whether model is correctly specified or omitted variable exist. The idea behind the test is examining the constructed functional form between dependent and independent variables. The decision criterion is: accept null hypothesis of no omitted variable if Ramsey RESET p-value is greater than 0.05. Contrarily, if the p-value of the test becomes equal or less than 0.05, then we conclude the model is miss-specified. The result from this test indicates the RESET test p-value (0.33) highly exceeds the significance level. Thus, the specified model has no omitted variable(s).

Model stability test

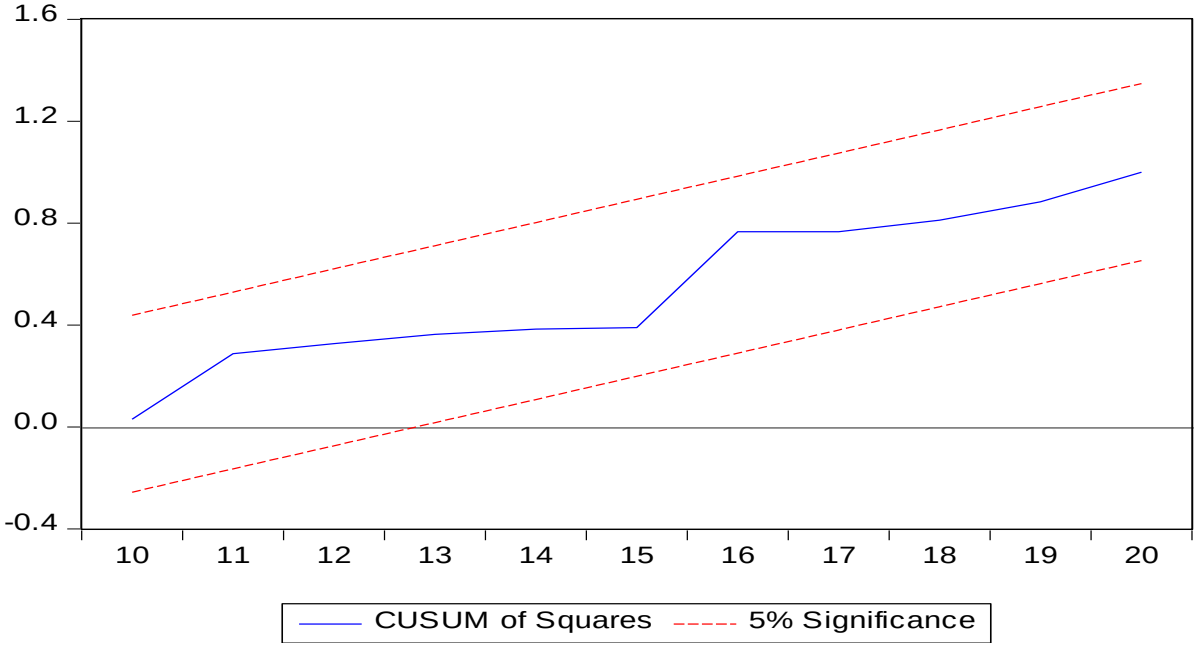
The most commonly used to test stability of a model is cumulative sum of recursive (CUSUM) test and CUSUM of squares graph. The test is based on the residuals from the recursive estimates and presented by figure.

Null hypothesis H_0: CUSUM distribution is a symmetric centred at 0.

Alternative hypothesis H_1: CUSUM is not symmetrically distributed.

Decision rule: The null hypothesis of normal distribution is failed to be rejected when the graph of CUSUM statistics lies within the bounds of the critical region at 5% level of significance and the alternative hypothesis of not symmetrically distributed is accepted otherwise.

Figure 4.7: CUSUM of Squares for model stability test



Source: Model diagnostics test result using *EView 10,* 2021.

The evidence from figure 4.7 leads us to accept null hypothesis that cumulative sum of squares of recursive (CUSUM) is symmetrically distributed. At the same level of significance, the CUSUM test (see non-squared version of the statistics under appendix 5) confirms similar result in support of robust model stability. Since the model passes all diagnostic tests and stability tests, we can proceed to examine co-integration test.

4.3.5 Co-integration test and the ARDL long run model

After running the ARDL model, co-integration test is required to identify whether to specify both long run and short run models or the latter alone. To check presence of co-integration in ARDL model, Pesaran, et al. (2001) developed the bound test which later improved by Narayan (2005) for small sample sizes. Having lower and upper values, the bound test depends on F-statistics. The value of F-statistics is computed using Wald-test from null hypothesis by making long run coefficients equal to zero. If the computed the F-statistics lies below the lower bound, the null hypothesis of no co-integration will be failed to be rejected. Contrarily, if the value is greater than the upper bound of the statistics, the null hypothesis of no co-integration is rejected in conclusion of existence of long run relationship. The following table presents the result from bound test.

Table 4.5: ARDL Bound test for long run relationship

F-Bounds Test		Null Hypothesis: No levels relationship		
Test Statistic	Value	Signif.	I(0)	I(1)
			Asymptotic: n=1000	
F-statistic	12.70766	10%	2.13	3.09
K	8	5%	2.38	3.41
		2.5%	2.62	3.7
		1%	2.93	4.06

Source: own computation using *EViews 10,* 2021.

F-statistics from the above table 4.5 reveals that the F- value (12.71) exceeds the values of upper bound at all levels of significance. This leads us to reject the null hypothesis of no level relationship in favour of alternative hypothesis. The evidence strongly confirms the existence of co-integration between the variables. Hence, long run and short run models can be reasonably estimated. The following table reports the estimated parameters estimates of long run equation of the model.

Table 4.6: The long run ARDL parameter estimates

Variables	Coefficient	Standard error	*t*-Statistic	*p*-value
LBMS	0.711389	0.514510	1.382655	0.1837
LRGDP	2.911203***	1.047708	2.778641	0.0124
LPOP	9.199189*	4.691364	1.960877	0.0656
LREER	0.691431***	0.220760	3.132053	0.0058
LIM	-0.438113*	0.214664	-2.040930	0.0562
LGNS	-0.625414*	0.346957	-1.802568	0.0882
IR	0.066100***	0.022061	2.996206	0.0077
DUM	-0.258364**	0.111119	-2.325117	0.0320
@TREND	-0.300090*	0.169558	-1.769839	0.0937

Note: The dependent variable is CPI*t* over the sample period 1981-2020. The asterisks ***, ** and * marks statistical significance of coefficients at, 1, 5 and 10 percent level of significance, respectively
Sources: own computation using *EViews 10*, 2021.

Table 4.6 presents long-run result of ARDL model with inflation (*CPI*) as dependent variable whereas the rest variables: broad money supply (*LBMS*), real gross domestic product (*LRGDP*), population size (*LPOP*), real effective exchange rate (*LREER*), imports of goods and services (*LIM*), gross national saving (*LGNS*), lending interest rate (*IR*) and dummy variable (*DUM*) are explanatory variables. All variables are expressed in logarithm form except lending interest rate and dummy variable. *IR* entered in to data processing as it is because the variable itself reported on database in percent. The last variable (DUM) takes one (1) artificial number for the shock year of 2008 and all years after a break year identified using unit root with break; however, series years without such experience take zero (0). Thus, we do not need to express the last two variables in logarithm form. Overall, the incorporated regressors explained the model by ***99.7*** percent of variation. The long run equation form of the inflation model is specified by:

$$\mathbf{LCPI} = -\mathbf{0.3} + \mathbf{0.71LBMS} + \mathbf{2.91LRGDP} + \mathbf{9.19LPOP} + \mathbf{0.69LREER} - \mathbf{0.44LIM} - \mathbf{0.63LGNS} + \mathbf{0.07IR} - \mathbf{0.24DUM} \quad \text{Equation 4.1}$$

(-1.77) (1.38) (2.77) (1.96) (3.13) (-2.04) (-1.8) (2.99) (-2.33)

Where; numbers in parenthesis are t-values of the corresponding coefficients.

Now let us turn to describe each variable in terms of sign and statistical significance, but interpretations and findings relative to other researches were discussed in the subsequent

section. In long run, broad money supply (LBMS) is not statistically significant in this case, but coefficients of real gross domestic product (RGDP), real effective exchange rate (LREER) and interest rate (IR) are positive and found to be highly significant at 1% level of significance. In addition, import of goods and services (LIM) and dummy variable coefficients are significant at 5%; however, their sign shows negative correlation of these variables with consumer price index (CPI). On the other hand, variables such as: population size (LPOP), gross national saving (LGNS) and time trend (T) are weakly significant (at 10 percent), but population coefficient is positive while coefficients of the latter variables are negative. Short run relationship of these variables was examined in the next sub-section.

4.3.6 The short run ARDL model estimation result

Estimating an error correction would be imperative once the existence of long-run relationship between the variables is confirmed through co-integration test. The re-parameterized short-run relationship between inflation and macroeconomic variables was scrutinized with the Error Correction Model (ECM). From the regression output, we find that one year lagged coefficient of ECT is negative and statistically significant. Further, the coefficient (-0.53) lies between 0 and -1 as expected, indicating monotonic convergence of the error correction toward the equilibrium. It implies almost more than 50 percent of the short run dynamics get adjusted toward the long run equilibrium. The following table 4.7 reports the results of the ARDL- error correction model.

Table 4.7: ECM Regression

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-34.07132***	2.464803	-13.82314	0.0000
D(LBMS)	0.576537***	0.090086	6.399814	0.0000
D(LBMS(-1))	-0.326507***	0.087660	-3.724684	0.0016
D(LRGDP)	0.379384**	0.160539	2.363199	0.0296
D(LPOP)	9.163103***	1.262939	7.255380	0.0000
D(LIM)	0.021306	0.047122	0.452149	0.6566
D(LIM(-1))	0.324808***	0.054228	5.989696	0.0000
D(LGNS)	-0.091353**	0.033298	-2.743513	0.0134
D(LGNS(-1))	0.126656***	0.029487	4.295372	0.0004
D(DUM)	-0.050070*	0.029156	-1.717352	0.1031
CointEq(-1)	-0.534348***	0.038703	-13.80634	0.0000

R-squared = 0.909402	F-statistic = 27.10205	Prob(F-statistic)	= 0.000000
Adjusted R-squared = 0.87584		Durbin-Watson stat	= 2.246313

Note: The dependent variable is DCPI*t* over the sample period 1981-2020. The asterisks ***, ** and * marks statistical significance of coefficients at, 1, 5 and 10 percent level of significance, respectively
Sources: own computation using *EViews 10*, 2021.

Result from error correction model (ECM) in table 4.7 reveals that except imports of goods and services (DLIM), all variables are statistically significant although their statistical significance varies. At 1% level of significance, macroeconomic variables such as growth of broad money supply and its one year lag, population size, one year lagged of both gross national saving and imports are found to be statistically significant in short run. On the other hand, real GDP and gross national saving are statistically significant at 5 % whereas the dummy variable found to be significant only at 10 percent. Regarding direction of these variables' effect on inflation, coefficients of one year lagged money supply, gross national saving and the dummy show their negative correlation with inflation while the remaining variables have positive association with the variable of interest. Overall, short run regressors jointly explained the variation of the regressand variable by 87%, as indicated by the ECM adjusted coefficient of determination.

4.4 Discussion of variables in both models

Broad money supply (LBMS): As expected, both coefficient estimates of short run and long run found to be positive, but the long run is insignificant. Nevertheless, the ECM version of ARDL model reveals that both current and one year lagged growth of broad money supply has strong impact on inflationary situation in Ethiopia. The estimate of the short run elasticity of money supply is 0.58. It can be inferred as; other things remain the same, one unit percentage increase in money supply leads to raise inflation growth by about 0.58%. This finding is consistent with empirical studies: Loening *et al.* (2010), Abate and Rao (2015), Teamrat (2017) and Atnafu (2020), which suggested that monetary growth is instantly inflationary phenomenon without any long run adjustment toward the equilibrium. However, the finding partially supports the QTM and contradicts the reformulated QTM (Keynes's Version) theory, which claims non effect of money expansion on general price level.

Real gross domestic product (RGDP): The result from both short run and long run dynamics suggests positive and significant effect of output on aggregated price growth in Ethiopia. The coefficients of long run and short run are 2.91 and 0.37 respectively. In the long run, percentage change impact of real GDP exceeds a unit elasticity (e >1), implying strong association between the variable with price dynamics in Ethiopia. This can be interpreted as: ceteris paribus, a percentage change in output causes the consumer price index to be changed

by 2.91 percentages. In opposite to the prior expectation, the direction of correlation between output sector and inflation suggested to be positive. In fact, sign of the coefficient is one of the study's gaps of inconsistency, which aimed to examine the literature contradiction in the effect of this variable. This finding is not limited to the current study, because researchers such as Solomon (2013), Teshale (2016), Lambabo (2017) and Mesfin (2019) have come up with similar conclusion.

Justification of the positive effect of real GDP on inflation could be explained on grounds of following reasons. During the past two decades, Ethiopia's economy has experienced the fastest growth performance with double digits growth rate in some years. At the same time significant prices evolution and volatilities have been observed. Better real GDP performance could be due to increase in relative share of industrial and service sector along with their productivity improvement, enhancement in factor accumulation and factor productivity, and considerable growth in infrastructural development.

More specifically, the positive association of real GDP growth with inflation can be reasoned in three ways. Firstly, by reducing households' propensities to save, moderate price increase can induce growth. Similarly, when prices of products rise, the nominal rates of return on capital relative to the cost could be increased and thereby reallocate profit share of firms through rising propensity to save and invest. Secondly, price growth could redistribute money volume from money holders to the central authority which commonly known as inflation tax. The reallocated money can serve the government to initiate new investment or expand the existing one and therefore enhance output growth. The third one is that substantial improvement of total investment as a share of real GDP was observed since 2004 when inflation begun to upsurge. Thus, the positive link between inflation and real GDP can be explained through households' propensity to save, redistribution of money holdings in the economic system and the improved share of investment.

Population size (LPOP): In short run, this variable found to be highly significant at 1 % level of significance and its sign is positive as expected. Other things remain the constant, the elasticity coefficient (9.16) implies that a percentage increase in population size leads inflation rate to be grown by 9.16 percentages. The elasticity is almost the same in the long run, but it weakly affects price growth. The result suggests the importance of population size in explaining inflationary situation in Ethiopia. The role of this variable has not been explicitly considered in previously conducted researchers, which makes the current study

peculiar. Nevertheless, studies conducted in developing countries such as Ghana, Rwanda and Pakistan by Enu and Havi (2014), Ruzima and Veerachamy (2015) and Furrukh *et al.* (2016) respectively, reveal importance of population growth in explaining inflation in context of these countries though its impact in relation to direction and time dimension is different. Therefore, population size is among short run drivers of price growth in Ethiopia.

Real effective exchange rate (LREER): As theoretically expected, the result from long run model shows that coefficient of real effective exchange rate is positive and highly significant too. The coefficient shows, in long run, effective exchange rate induces 0.69 percent of inflation, other thing remain the same. This finding could be due to the influence of progressive currency devaluation undertaken in Ethiopia since 1992. It also supports the conclusions drawn by Alemayehu (2008), Tadesse (2020), and IMF report (2020). During the study period therefore, exchange rate has been important long run sources inflation in Ethiopia.

Imports of goods and services (LIM): The short run re-parameterized coefficient of import is insignificant in current year, but one year lagged coefficient of import is highly significant and also positively affects the growth of consumer price index. A percent increase in previous year import causes inflation to be grown by 0.32 percent, holding other things constant. This result is consistent with Teamrat (2017). Unexpected according to theoretical hypothesis, its long run coefficient is negative and statistically significant at 10%, showing that import of goods and services is less important in driving long run price dynamics in Ethiopia.

Gross national saving (LGNS): In short run, both the current year gross national saving and its one year lagged coefficients show significant influence of national saving on consumer price index. Keeping other things constant, unit increase in a percentage of national saving reduces consumers price index by 0.066, while its previous year encourage by 0.13, indicating stronger effect of national saving inertial than its current influence. In long run process, a single percent rise in gross national saving diminishes consumer price index by 0.63, other thing remain the same. Nevertheless, the long run statistical significance is weak (at 10 percent level of significance), which reveals the robustness of national saving in determining short run inflation growth than in the long run process. This finding highly supports econometric evidences found from Ethiopia by Lambabo (2017) and Teamrat (2017). Generally, we can conclude that gross national saving is among significant

determinants of inflation both short run and long run model though statistically weak in the latter case.

Lending interest rate (IR): In contrast to theoretical expectation (based on the Monetarists), an increase in the lending interest rate by a percent induces consumer price index by 0.07 percent, other things remain constant. This finding suggest in positive relationship between lending interest rate and growth of price level though the magnitude is too small. Thus, it would be imperative to conclude that Monetarist (Friedman, 1967) theory of interest rate do not work in Ethiopia. Yet, the finding supports the works of Minyahil *et al* (2016), in argument for less effectiveness of interest rate in affecting inflation in the long run. As to their explanation, the rise of demand for non-financial assets and future expectation of inflation by the public due to past experience of money growth and inflation are among the provided justifications. Low financial development and less inclusiveness of financial system may also moderately elucidate the less importance of the monetary instrument.

Dummy variable: It is a created variable to capture the price shock (sharp increase in price) during 2008 and the sharp change in structural trend of inflation growth identified with unit root with break. The unit root test with break showed the break point is 2015. The result shows that in the long run, the shock adversely affected inflation rate with 0.26 percent contribution. Effect of the shock and structural trend is, however, weak in both magnitude (-0.05) and statistical significance (10%) in short run. This may lead us to conclude that the shock and upward trending of inflation years since 2015 is not forgotten and stronger in long run than short run process.

CHAPTER FIVE

5. CONCLUSIONS AND POLICY IMPLICATIONS

5.1. Conclusions

Even though historically inflationary situation in Ethiopia is relatively low with exceptional years of shocks resulted from drought and civil war, recently inflation has been persistently growing with double digit in contrary to the NBE single digit target. As a developing country, although sustainable economic growth is expected to be accompanied by justifiable inflation rate, the trend for Ethiopia indicates outstrip of the phenomenon beyond the threshold that favourable to functioning of the economy.

Various theoretical and empirical literatures, which were conducted mostly in developing countries including Ethiopia, have been reviewed. Most of the empirical papers devoted to consider monetary instrumental variables such as money supply, interest rate and effective exchange rate, while fiscal instruments: GDP, government expenditure and budget deficit were deliberated as source of price growth. However, the impact of population size was not yet explicitly scrutinized even though the country's population number being grown is clear to influence especially the demand side.

In addition, the inconsistency in the direction of impact of RGDP and effective exchange rate on inflation growth is also another aspect that motivated the researcher. Focusing on the existence of controversy in the literature on the effect of these two variables and influence of population size, the study aimed to empirically examine macroeconomic determinants of inflation in Ethiopia using time series database spanning over the years 1981 to 2020. To realize the objective, the ARDL-Bound test, which developed by Pesaran, et al (2001) and later improved by Narayan (2005), was employed to check whether con-integration exist among the variables entered in to the model. Then both long run and short run (ECM) version of model regressed after checking all diagnostic tests.

The bound test of co-integration shows the existence of long run relationship between the variable included in the model. Additionally, the empirical result reveals that in the long run: real GDP, real effective exchange rate and lending interest rate are found to be dominant determinants of inflationary situation in Ethiopia. All of these variables positively affected CPI rate. The magnitude of real output elasticity is greater than a unit, whereas effective exchange rate and interest rate are considered to be moderately and weakly affected the

variable of interest, respectively. Broad money supply has insignificant role in stimulating price in the long run. In support of recent empirical researches it would be important to note that the growth of RGDP has a leading role in influencing long run inflation in Ethiopia. Therefore, this finding is in a position of supporting positive effect of real GDP on inflationary growth in the context of Ethiopia. The slight effect of interest rate may have resulted from underdevelopment and low inclusiveness of financial sector in Ethiopia.

On the other hand, the speed of error correction measure obtained from ECM indicated the existence of fast adjustment of the disequilibrium toward long run equilibrium. It implies that almost more than 50% of the error annually gets adjusted to achieve the equilibrium. Furthermore, from the ECM result the main determinants: one year lagged and current year coefficients of gross national saving and broad money supply, current real GDP and current population size found to be important factors driving the price dynamic in short run. RGDP is the only variable affected general price growth both in short run and long run. Besides, imports have only inertial effect on short run dynamic of inflation. Relative to other macroeconomic variables, elasticity of logarithm of population size is found to have greater effect on short run dynamics of price growth, which may reflect high influence of population size in pressuring up the consumers price index. Hence, the implication of this finding is either the amount of aggregate demand force of the public has grown beyond the production level or supply side has not grown to meet the prevailing demand.

5.2 Policy Implications

Findings of the study concluded that real effective exchange rate, real GDP and interest rate are found to be positive sources of inflation in the long run, whereas broad money supply and population size are most essential variables (in terms of statistical significance and magnitude) in determining short run dynamics of inflationary situation in Ethiopia. Based on these results therefore this research forwards the following policy implications.

- The current finding stresses the importance of real effective exchange rate in driving long run inflation in Ethiopia. It is believed that devaluation promotes import substitution and encourages export by making the domestic goods cheaper at international markets than domestic markets. In Ethiopia, enormous capital, intermediate and consumer's goods are imported because of limited existence of industrial manufacturing capacity to satisfy the domestic demands. Since exports' share of GDP is very low relative to imports, persistently devaluating the domestic

currency leads not only to inflation but also exhaust foreign exchange reserves because of inelastic nature of imports to devaluation in Ethiopia. Thus, rather than relying on birr devaluation to encourage export, the next two alternatives could mitigate the inflation problems related the rising foreign exchange rate. The first one is enhancing export performance through diversifying export items along with their productivity. The second alternative is substituting the imported commodities through establishing new manufacturing industries and expanding the current industrial sectors for commodities that the economy largely access by importing them from foreign trade partners. If stable and optimum exchange rate is combined with above two measures, essential capital goods will be imported relatively with cheap cost which in turn helps to build import substitution industries.

- In short run dynamics, broad money supply found to be dominant sources of inflation rate in Ethiopia, in partial support of monetarist view. This implies either reducing money supply through tight monetary policy or directing the increased money supply in to productive development infrastructures can play a role in controlling persistent price growth. Since the main reason behind soaring general price is food inflation, consumers who earn fixed income are the primary victim of the phenomenon because price hike deteriorates purchasing power of their income. This situation in turn reduces propensity to save and hence to invest, discouraging sustainable economic growth. Thus, the government ought to respond by utilizing the circulating money on productive investment by supplementing it with flexible wage.

- On the other hand, population size found to have high effect on consumer price index growth primarily in the short run. This could be through stimulating demand for commodities. One of the measures taken to make supply side balance with the growing demand arose from the pressure of high population number is boosting production capacity of the government as well as creating conducive environment to the private producers. If tight monetary policy is opted to curb price rise, again it should be integrated with supply-side policy because it adversely affects economic growth. As the major component of general inflation comes from food price, government expenditure should be target to enhance production and supply of food related items. In addition, applying fixed price policy on basic materials and food items can have significant role in price stabilization.

- Finally, the study revealed positive association between real GDP and inflation. This finding does not imply that the rising inflation in Ethiopia is favourable for output growth because the country's economy has experienced high growth rate especially during the last two decades. Thus, further research needs to be conducted by explicitly identifying supply and demand side models of inflation along with their relative importance and thereby analysing how the growing real output linked with the increasing price level in Ethiopia.

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Appendices

Appendix 1: LAG selection criterion and unit root tests

VAR Lag Order Selection Criteria

Endogenous variables: LCPI LBMS LRGDP LIM LGNS LIR LPOP LREER DUM

Exogenous variables: C @TREND

Date: 05/14/21 Time: 15:58

Sample: 1981 2020

Included observations: 38

Lag	LogL	LR	FPE	AIC	SC	HQ
0	184.2475	NA	1.28e-15	-8.749869	-7.974170	-8.473881
1	402.6830	310.4083	1.08e-18	-15.98331	-11.71697*	-14.46538
2	516.3241	107.6600*	4.78e-19*	-17.70127*	-9.944282	-14.94139*

* indicates lag order selected by the criterion

LR: sequential modified LR test statistic (each test at 5% level)

FPE: Final prediction error

AIC: Akaike information criterion

SC: Schwarz information criterion

HQ: Hannan-Quinn information criterion

Unit root tests

1. ADF unit root test

Null Hypothesis: Unit root (individual unit root process)
Series: LCPI, LBMS, DUM, LGNS, LIM, LIR, LPOP, LREER, LRGDP
Date: 05/14/21 Time: 16:01
Sample: 1981 2020
Exogenous variables: Individual effects, individual linear trends
User-specified maximum lags
Automatic lag length selection based on AIC: 0 to 1
Total number of observations: 339
Cross-sections included: 9

Method	Statistic	Prob.**
ADF - Fisher Chi-square	197.756	0.0000
ADF - Choi Z-stat	-11.8735	0.0000

** Probabilities for Fisher tests are computed using an asymptotic Chi -square distribution. All other tests assume asymptotic normality.

Intermediate ADF test results D(UNTITLED)

Series	Prob.	Lag	Max Lag	Obs
D(LCPI)	0.0001	0	2	38
D(LBMS)	0.0229	1	2	37

D(DUM)	0.0000	0	2	38
D(LGNS)	0.0000	1	2	37
D(LIM)	0.0000	0	2	38
D(LIR)	0.0091	0	2	38
D(LPOP)	0.0000	0	2	38
D(LREER)	0.0000	0	2	38
D(LRGDP)	0.0008	1	2	37

2. Philip-Perron unit root test

Null Hypothesis: Unit root (individual unit root process)
Series: LCPI, LBMS, DUM, LGNS, LIM, LIR, LPOP, LREER, LRGDP
Date: 05/14/21 Time: 16:05
Sample: 1981 2020
Exogenous variables: Individual effects
User-specified bandwidth: 2 and Bartlett kernel
Total (balanced) observations: 342
Cross-sections included: 9

Method	Statistic	Prob.**
PP - Fisher Chi-square	215.748	0.0000
PP - Choi Z-stat	-12.6744	0.0000

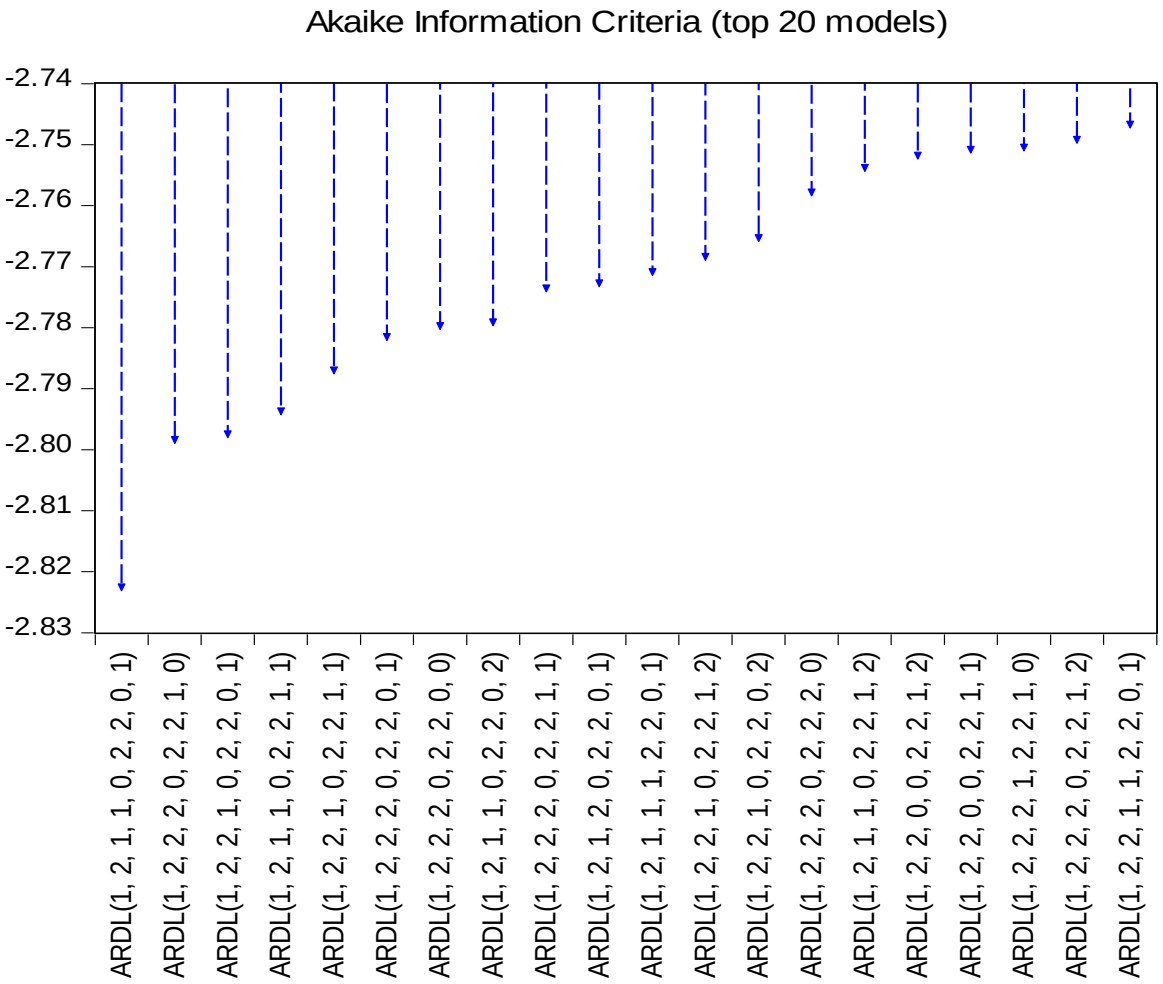
** Probabilities for Fisher tests are computed using an asymptotic Chi-square distribution. All other tests assume asymptotic normality.

Intermediate Phillips-Perron test results D(UNTITLED)

Series	Prob.	Bandwidth	Obs
D(LCPI)	0.0001	2.0	38
D(LBMS)	0.0161	2.0	38
D(DUM)	0.0000	2.0	38
D(LGNS)	0.0000	2.0	38
D(LIM)	0.0000	2.0	38
D(LIR)	0.0013	2.0	38
D(LPOP)	0.0000	2.0	38
D(LREER)	0.0000	2.0	38
D(LRGDP)	0.0003	2.0	38

Appendix 2: Model selection summary and ARDL estimation output

1. Model selection summary



2. ARDL output

Dependent Variable: LCPI
Method: ARDL
Date: 05/20/21 Time: 08:04
Sample (adjusted): 1983 2020
Included observations: 38 after adjustments
Maximum dependent lags: 1 (Automatic selection)
Model selection method: Akaike info criterion (AIC)
Dynamic regressors (2 lags, automatic): LBMS LRGDP LPOP LREER LIM LGNS IR DUM
Fixed regressors: C @TREND
Number of models evalulated: 6561
Selected Model: ARDL(1, 2, 1, 1, 0, 2, 2, 0, 1)

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
LCPI(-1)	0.465652	0.162450	2.866431	0.0103
LBMS	0.576537	0.249709	2.308830	0.0330
LBMS(-1)	-0.522915	0.236330	-2.212649	0.0401
LBMS(-2)	0.326507	0.158004	2.066451	0.0535
LRGDP	0.379384	0.289846	1.308917	0.2070
LRGDP(-1)	1.176211	0.290012	4.055728	0.0007
LPOP	9.163103	1.966616	4.659326	0.0002
LPOP(-1)	-4.247535	2.207937	-1.923757	0.0703

LREER	0.369465	0.131393	2.811915	0.0115
LIM	0.021306	0.075753	0.281255	0.7817
LIM(-1)	0.069397	0.085437	0.812262	0.4273
LIM(-2)	-0.324808	0.093507	-3.473619	0.0027
LGNS	-0.091353	0.055260	-1.653159	0.1156
LGNS(-1)	-0.116179	0.053728	-2.162344	0.0443
LGNS(-2)	-0.126656	0.055563	-2.279512	0.0350
IR	0.035321	0.012575	2.808793	0.0116
DUM	-0.050070	0.050676	-0.988054	0.3362
DUM(-1)	-0.087986	0.040938	-2.149265	0.0455
C	-33.91097	9.045080	-3.749106	0.0015
@TREND	-0.160352	0.069876	-2.294798	0.0340

R-squared	0.998697	Mean dependent var	3.173643
Adjusted R-squared	0.997321	S.D. dependent var	0.978431
S.E. of regression	0.050647	Akaike info criterion	-2.822473
Sum squared resid	0.046171	Schwarz criterion	-1.960585
Log likelihood	73.62698	Hannan-Quinn criter.	-2.515820
F-statistic	725.8418	Durbin-Watson stat	2.246313
Prob(F-statistic)	0.000000		

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

Appendix 3: ARDL long run form and bound test

ARDL Long Run Form and Bounds Test
Dependent Variable: D(LCPI)
Selected Model: ARDL(1, 2, 1, 1, 0, 2, 2, 0, 1)
Case 4: Unrestricted Constant and Restricted Trend
Date: 05/20/21 Time: 08:09
Sample: 1981 2020
Included observations: 38

Conditional Error Correction Regression

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-33.91097	9.045080	-3.749106	0.0015
@TREND	-0.160352	0.069876	-2.294798	0.0340
LCPI(-1)*	-0.534348	0.162450	-3.289305	0.0041
LBMS(-1)	0.380129	0.200592	1.895041	0.0743
LRGDP(-1)	1.555595	0.325307	4.781930	0.0001
LPOP(-1)	4.915568	2.064550	2.380939	0.0285
LREER**	0.369465	0.131393	2.811915	0.0115
LIM(-1)	-0.234105	0.094369	-2.480751	0.0232
LGNS(-1)	-0.334189	0.108168	-3.089542	0.0063
IR**	0.035321	0.012575	2.808793	0.0116
DUM(-1)	-0.138056	0.054007	-2.556257	0.0198
D(LBMS)	0.576537	0.249709	2.308830	0.0330
D(LBMS(-1))	-0.326507	0.158004	-2.066451	0.0535
D(LRGDP)	0.379384	0.289846	1.308917	0.2070
D(LPOP)	9.163103	1.966616	4.659326	0.0002
D(LIM)	0.021306	0.075753	0.281255	0.7817
D(LIM(-1))	0.324808	0.093507	3.473619	0.0027
D(LGNS)	-0.091353	0.055260	-1.653159	0.1156
D(LGNS(-1))	0.126656	0.055563	2.279512	0.0350
D(DUM)	-0.050070	0.050676	-0.988054	0.3362

* p-value incompatible with t-Bounds distribution.
** Variable interpreted as Z = Z(-1) + D(Z).

Case 4: Unrestricted Constant and Restricted Trend

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LBMS	0.711389	0.514510	1.382655	0.1837
LRGDP	2.911203	1.047708	2.778641	0.0124
LPOP	9.199189	4.691364	1.960877	0.0656
LREER	0.691431	0.220760	3.132053	0.0058
LIM	-0.438113	0.214664	-2.040930	0.0562
LGNS	-0.625414	0.346957	-1.802568	0.0882
IR	0.066100	0.022061	2.996206	0.0077
DUM	-0.258364	0.111119	-2.325117	0.0320
@TREND	-0.300090	0.169558	-1.769839	0.0937

EC = LCPI - (0.7114*LBMS + 2.9112*LRGDP + 9.1992*LPOP + 0.6914
*LREER -0.4381*LIM -0.6254*LGNS + 0.0661*IR -0.2584*DUM -0.3001
*@TREND)

F-Bounds Test — Null Hypothesis: No levels relationship

Test Statistic	Value	Signif.	I(0)	I(1)
			Asymptotic: n=1000	
F-statistic	12.70766	10%	2.13	3.09
k	8	5%	2.38	3.41
		2.5%	2.62	3.7
		1%	2.93	4.06

Appendix 4: Error Correction Model

ARDL Error Correction Regression
Dependent Variable: D(LCPI)
Selected Model: ARDL(1, 2, 1, 1, 0, 2, 2, 0, 1)
Case 4: Unrestricted Constant and Restricted Trend
Date: 05/20/21 Time: 08:12
Sample: 1981 2020
Included observations: 38

ECM Regression
Case 4: Unrestricted Constant and Restricted Trend

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-34.07132	2.464803	-13.82314	0.0000
D(LBMS)	0.576537	0.090086	6.399814	0.0000
D(LBMS(-1))	-0.326507	0.087660	-3.724684	0.0016
D(LRGDP)	0.379384	0.160539	2.363199	0.0296
D(LPOP)	9.163103	1.262939	7.255380	0.0000
D(LIM)	0.021306	0.047122	0.452149	0.6566
D(LIM(-1))	0.324808	0.054228	5.989696	0.0000
D(LGNS)	-0.091353	0.033298	-2.743513	0.0134
D(LGNS(-1))	0.126656	0.029487	4.295372	0.0004
D(DUM)	-0.050070	0.029156	-1.717352	0.1031
CointEq(-1)*	-0.534348	0.038703	-13.80634	0.0000

R-squared	0.909402	Mean dependent var	0.086965
Adjusted R-squared	0.875847	S.D. dependent var	0.117362
S.E. of regression	0.041353	Akaike info criterion	-3.296157
Sum squared resid	0.046171	Schwarz criterion	-2.822119
Log likelihood	73.62698	Hannan-Quinn criter.	-3.127498
F-statistic	27.10205	Durbin-Watson stat	2.246313
Prob(F-statistic)	0.000000		

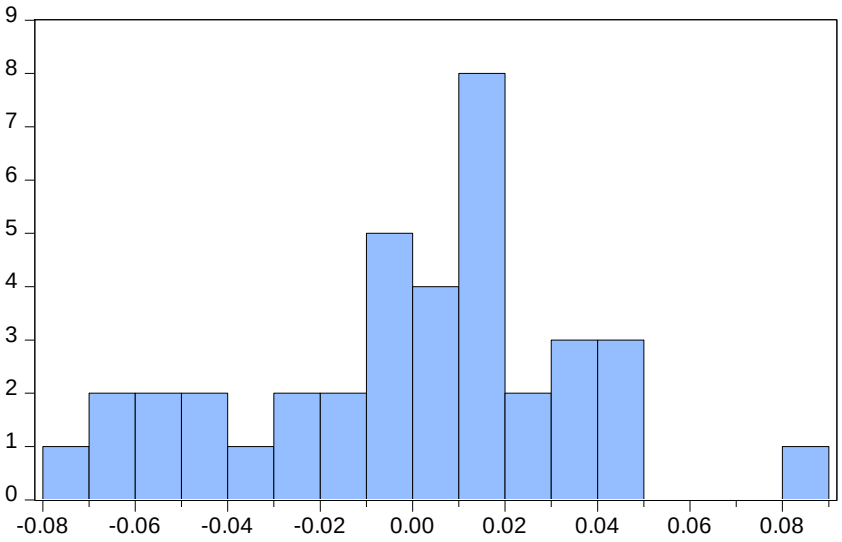
* p-value incompatible with t-Bounds distribution.

F-Bounds Test — Null Hypothesis: No levels relationship

Test Statistic	Value	Signif.	I(0)	I(1)
F-statistic	12.70766	10%	2.13	3.09
k	8	5%	2.38	3.41
		2.5%	2.62	3.7
		1%	2.93	4.06

Appendix 5: Diagnostic Tests

a. Normality test



Series: Residuals
Sample 1983 2020
Observations 38

Mean	-2.44e-15
Median	0.005834
Maximum	0.088453
Minimum	-0.072354
Std. Dev.	0.035325
Skewness	-0.199237
Kurtosis	2.911547
Jarque-Bera	0.263791
Probability	0.876433

b. Serial correlation test

Breusch-Godfrey Serial Correlation LM Test:

F-statistic	1.322354	Prob. F(2,16)	0.2941
Obs*R-squared	5.390210	Prob. Chi-Square(2)	0.0675

c. Heteroskedasticity

Heteroskedasticity Test: Breusch-Pagan-Godfrey

F-statistic	0.880621	Prob. F(19,18)	0.6079
Obs*R-squared	18.30623	Prob. Chi-Square(19)	0.5021
Scaled explained SS	3.925832	Prob. Chi-Square(19)	0.9999

d. Ramsey RESET test

Ramsey RESET Test

Equation: UNTITLED

Specification: LCPI LCPI(-1) LBMS LBMS(-1) LBMS(-2) LRGDP LRGDP(
-1) LPOP LPOP(-1) LREER LIM LIM(-1) LIM(-2) LGNS LGNS(-1)
LGNS(-2) IR DUM DUM(-1) C @TREND

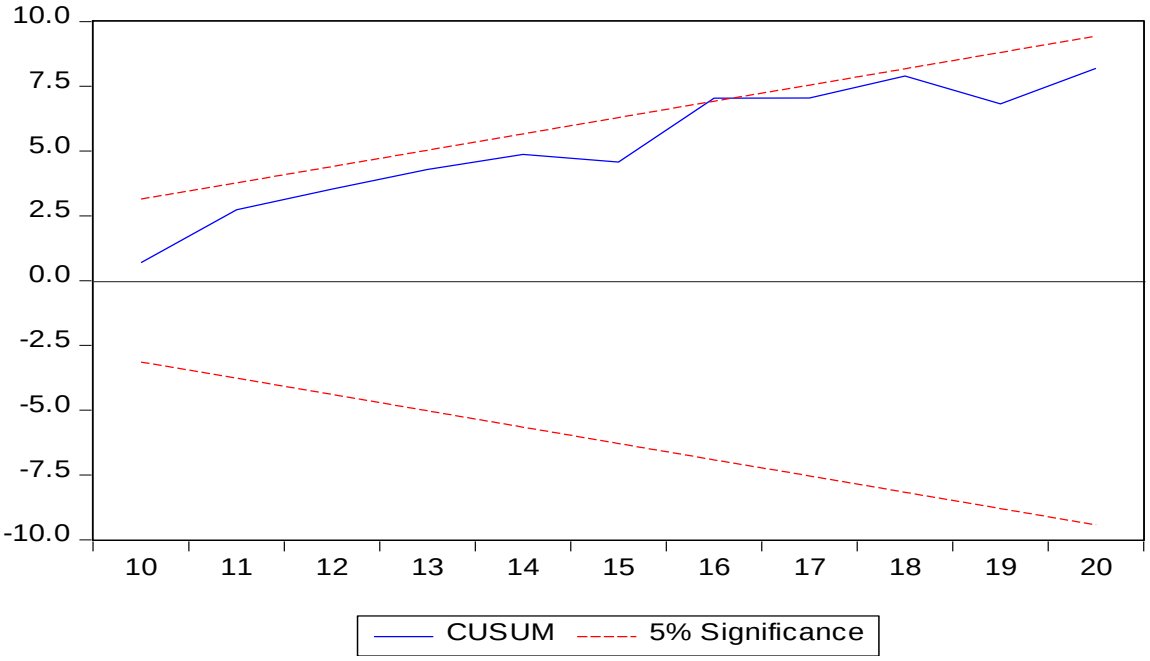
Omitted Variables: Squares of fitted values

	Value	df	Probability
t-statistic	1.001050	17	0.3308
F-statistic	1.002101	(1, 17)	0.3308

F-test summary:

	Sum of Sq.	df	Mean Squares
Test SSR	0.002570	1	0.002570
Restricted SSR	0.046171	18	0.002565
Unrestricted SSR	0.043601	17	0.002565

e. CUSUM Test



f. CUSUM squares test